# FCC TEST REPORT

For

HKC Corporation limited

All In One PC

Model No.: DTAIO238-1

Additional Model No.: /

| | | |
|---|---|---|
| Prepared for | : | HKC Corporation limited |
| Address | : | Building 1,2,3,Huike Industrial Park, Mingying Industrial Zone,ShuiTian,ShiYan,Baoan, shenzhen, China |
| Prepared by | : | Shenzhen LCS Compliance Testing Laboratory Ltd. |
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| Web | : | www.LCS-cert.com |
| Mail | : | webmaster@LCS-cert.com |
| Date of receipt of test sample | : | July 13, 2017 |
| Number of tested samples | : | 1 |
| Serial number | : | Prototype |
| Date of Test | : | September 14, 2017~October 23, 2017 |
| Date of Report | : | October 23, 2017 |

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# FCC TEST REPORT
## FCC CFR 47 PART 15 C(15.247)

| | |
|---|---|
| **Report Reference No. ..... :** | **LCS170713093AE1** |
| Date of Issue ..... : | October 23, 2017 |
| **Testing Laboratory Name..... :** | **Shenzhen LCS Compliance Testing Laboratory Ltd.** |
| Address ..... : | 1/F., Xingyuan Industrial Park, Tongda Road, Bao'an Avenue, Bao'an District, Shenzhen, Guangdong, China |
| Testing Location/ Procedure ..... : | Full application of Harmonised standards ■<br>Partial application of Harmonised standards □<br>Other standard testing method □ |
| **Applicant's Name ..... :** | **HKC Corporation limited** |
| Address ..... : | Building 1,2,3,Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, Shenzhen, China |
| **Test Specification** | |
| Standard..... : | FCC CFR 47 PART 15 C(15.247) |
| **Test Report Form No. ..... :** | LCSEMC-1.0 |
| TRF Originator ..... : | Shenzhen LCS Compliance Testing Laboratory Ltd. |
| Master TRF ..... : | Dated 2011-03 |

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| | |
|---|---|
| **EUT Description. ..... :** | **All In One PC** |
| Trade Mark..... : | DIREKT-TEK |
| Model/ Type reference ..... : | DTAIO238-1 |
| Ratings ..... : | DC 19V adapter from AC 120V/60Hz<br>Adapter input:AC100~240V, 50/60Hz, 1.2A<br>Output: DC 5V, 3A |
| Result ..... : | **Positive** |

| **Compiled by:** | **Supervised by:** | **Approved by:** |
|---|---|---|
| Calvin Weng | Dick Su | Gavin Liang |
| Calvin Weng/ Administrators | Dick Su/ Technique principal | Gavin Liang/ Manager |

# FCC -- TEST REPORT

| | |
|---|---|
| **Test Report No. :** **LCS170713093AE1** | October 23, 2017<br>Date of issue |

| | | |
|---|---|---|
| EUT..... | : | All In One PC |
| Type / Model..... | : | DTAIO238-1 |
| **Applicant.....** | **:** | **HKC Corporation limited** |
| Address..... | : | Building 1,2,3,Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan,Baoan, shenzhen, China |
| Telephone..... | : | |
| Fax..... | : | |
| **Manufacturer.....** | **:** | **HKC Corporation limited** |
| Address..... | : | Building 1,2,3,Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan,Baoan, shenzhen, China |
| Telephone..... | : | |
| Fax..... | : | |
| **Factory.....** | **:** | **HKC Corporation limited** |
| Address..... | : | Building 1,2,3,Huike Industrial Park, Mingying Industrial Zone, ShuiTian, ShiYan, Baoan, shenzhen, China |
| Telephone..... | : | |
| Fax..... | : | |

| **Test Result** | **Positive** |
|---|---|

The test report merely corresponds to the test sample.

It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

## Revision History

| Revision | Issue Date | Revisions | Revised By |
|---|---|---|---|
| 00 | October 23, 2017 | Initial Issue | Gavin Liang |
| | | | |
| | | | |

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# 1. GENERAL INFORMATION

## 1.1. Description of Device (EUT)

| | | |
|---|---|---|
| EUT | : | All In One PC |
| Test Model | : | DTAIO238-1 |
| Power Supply | : | DC 19V/1.89A by adapter<br>Adapter input:AC100~240V, 50/60Hz, 1.2A |
| Hardware Version | : | I2-APL-MAIN-LP253-RM-V3.0 |
| Software Version | : | V1.0 |
| Bluetooth | : | |
| Frequency Range | : | 2.402-2.480GHz |
| Channel Number | : | 79 channels for Bluetooth V3.0 (BT Classics)<br>40 channels for Bluetooth V4.0 (BT LE) |
| Channel Spacing | : | 1MHz for Bluetooth V3.0 (BT Classics)<br>2MHz for Bluetooth V4.0 (BT LE) |
| Modulation Type | : | GFSK, π/4-DQPSK, 8-DPSK for Bluetooth V3.0 (BT Classics)<br>GFSK for Bluetooth V4.0 (BT LE) |
| Bluetooth Version | : | V4.0 |
| Antenna Description | : | PIFA Antenna |
| Antenna Gain | : | Antenna 0, maximum antenna gain is -1.0dBi |
| WIFI(2.4G Band) | : | |
| WLAN | : | Supports IEEE 802.11b/802.11g/802.11n |
| WLAN FCC Operation Frequency | : | IEEE 802.11b: 2412 – 2462 MHz<br>IEEE 802.11g: 2412 – 2462 MHz<br>IEEE 802.11n HT20: 2412 – 2462 MHz<br>IEEE 802.11n HT40: 2422 – 2452 MHz |
| Channel Spacing | : | 5MHz |
| WLAN Channel Number | : | 11 Channels for WIFI 20MHz Bandwidth(IEEE 802.11b/g/n HT20)<br>7 Channels for WIFI 40MHz Bandwidth(IEEE 802.11n HT40) |
| Modulation Type | : | IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK)<br>IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11n: OFDM (64QAM, 16QAM,QPSK,BPSK) |
| Antenna Description | : | PIFA Antenna |
| Antenna Gain | : | Antenna 0: maximum antenna gain is -1.0dBi<br>Antenna 1: maximum antenna gain is -1.0dBi |
| Directional Gain | : | 3 dBi (-1.0+10log$_{10}$(2)=2.0dBi) |

## 1.2. Host System Configuration List and Details

| Manufacturer | Description | Model | Serial Number | Certificate |
|---|---|---|---|---|
| TEKA | Power Adapter | TEKA036-1901890UK | --- | FCC VoC |

## 1.3. External I/O Cable

| I/O Port Description | Quantity | Cable |
|---|---|---|
| USB Port | 5 | N/A |
| MIC port | 1 | N/A |
| Earphone | 1 | N/A |
| HDMI Port | 1 | N/A |
| TF Card Port | 1 | N/A |
| DC in Port | 1 | 1.5m, unshielded cable |

## 1.4. Description of Test Facility

The CNAS Registration Number is L4595.
FCC Registration Number is 899208.
Industry Canada Registration Number is 9642A-1.
ESMD Registration Number is ARCB0108.
UL Registration Number is 100571-492.
TUV SUD Registration Number is SCN1081.
TUV RH Registration Number is UA 50296516-001
NVLAP Registration Code is 600167-0

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.4:2014 and CISPR 16-1-4:2010 SVSWR requirement for radiated emission above 1GHz.

## 1.5. Statement of the Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. To CISPR 16 – 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements” and is documented in the LCS quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

## 1.6. Measurement Uncertainty

| Test Item | | Frequency Range | Uncertainty | Note |
|---|---|---|---|---|
| Radiation Uncertainty | : | 9KHz~30MHz | ±3.10dB | (1) |
| | | 30MHz~200MHz | ±2.96dB | (1) |
| | | 200MHz~1000MHz | ±3.10dB | (1) |
| | | 1GHz~26.5GHz | ±3.80dB | (1) |
| | | 26.5GHz~40GHz | ±3.90dB | (1) |
| Conduction Uncertainty | : | 150kHz~30MHz | ±1.63dB | (1) |
| Power disturbance | : | 30MHz~300MHz | ±1.60dB | (1) |

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

## 1.7. Description of Test Modes

The EUT has been tested under operating condition.

This test was performed with EUT in X, Y, Z position and the worst case was found when EUT in X position.

Worst-case mode and channel used for 150 KHz-30 MHz power line conducted emissions was the mode and channel with the highest output power that was determined to be IEEE 802.11b mode (Mid Channel).

AC conducted emission pre-test at both at AC 120V/60Hz and AC 240V/50Hz modes, recorded worst case;

AC conducted emission pre-test at power adapter modes, recorded worst case;

Worst-case mode and channel used for 9 KHz-1000 MHz radiated emissions was the mode and channel with the highest output power that was determined to be IEEE 802.11b mode (Mid Channel).

Worst-Case data rates were utilized from preliminary testing of the Chipset, worst-case data rates used during the testing are as follows:

IEEE 802.11b Mode: 1 Mbps, DSSS.
IEEE 802.11g Mode: 6 Mbps, OFDM.
IEEE 802.11n Mode HT20: MCS0, OFDM.
IEEE 802.11n Mode HT40: MCS0, OFDM.
BT LE: 1Mbps, GFSK.

Channel List & Frequency

IEEE 802.11b/g/n HT20

| Frequency Band | Channel No. | Frequency(MHz) | Channel No. | Frequency(MHz) |
|---|---|---|---|---|
| 2412~2462MHz | 1 | 2412 | 7 | 2442 |
| | 2 | 2417 | 8 | 2447 |
| | 3 | 2422 | 9 | 2452 |
| | 4 | 2427 | 10 | 2457 |
| | 5 | 2432 | 11 | 2462 |
| | 6 | 2437 | -- | -- |

IEEE 802.11n HT40

| Frequency Band | Channel No. | Frequency(MHz) | Channel No. | Frequency(MHz) |
|---|---|---|---|---|
| 2412~2462MHz | -- | -- | 7 | 2442 |
| | -- | -- | 8 | 2447 |
| | 3 | 2422 | 9 | 2452 |
| | 4 | 2427 | -- | -- |
| | 5 | 2432 | -- | -- |
| | 6 | 2437 | -- | -- |

Bluetooth V4.0 (BT LE)

| Channel | Frequency(MHz) | Channel | Frequency(MHz) |
|---|---|---|---|
| 0 | 2402 | 20 | 2442 |
| 1 | 2404 | --- | --- |
| 2 | 2406 | --- | --- |
| --- | --- | 37 | 2476 |
| --- | --- | 38 | 2478 |
| 18 | 2438 | 39 | 2480 |
| 19 | 2440 | | |

# 2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen LCS Compliance Testing Laboratory Ltd.

## 2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

## 2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure KDB558074 D01 DTS Meas. Guidance and KDB 662911 are required to be used for this kind of FCC 15.247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

## 2.3. General Test Procedures

### 2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

### 2.3.2 Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013.

# 3. SYSTEM TEST CONFIGURATION

## 3.1. Justification

The system was configured for testing in a continuous transmits condition.

## 3.2. EUT Exercise Software

The sample will be controlled by DRTU.exe to enter RF test mode to control sample change channel, modulation and so on;

## 3.3. Special Accessories

N/A

## 3.4. Block Diagram/Schematics

Please refer to the related document

## 3.5. Equipment Modifications

Shenzhen LCS Compliance Testing Laboratory Ltd. has not done any modification on the EUT.

## 3.6. Test Setup

Please refer to the test setup photo.

# 4. SUMMARY OF TEST RESULTS

| Applied Standard: FCC Part 15 Subpart C | | |
|---|---|---|
| FCC Rules | Description of Test | Result |
| §15.247(b) | Maximum Conducted Output Power | Compliant |
| §15.247(e) | Power Spectral Density | Compliant |
| §15.247(a)(2) | 6dB Bandwidth | Compliant |
| §15.247(a) | Occupied Bandwidth | Compliant |
| §15.209, §15.247(d) | Radiated and Conducted Spurious Emissions | Compliant |
| §15.205 | Emissions at Restricted Band | Compliant |
| §15.207(a) | Conducted Emissions | Compliant |
| §15.203 | Antenna Requirements | Compliant |
| §15.247(i)§2.1093 | RF Exposure | Compliant |

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# 5. TEST RESULT

## 5.1. On Time and Duty Cycle

### 5.1.1. Standard Applicable

None; for reporting purpose only.

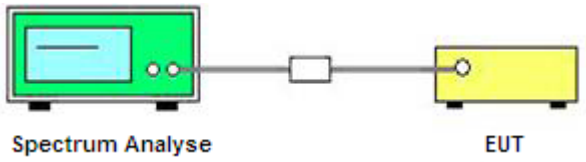
### 5.1.2. Measuring Instruments and Setting

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

### 5.1.3. Test Procedures

1. Set the center frequency of the spectrum analyzer to the transmitting frequency;
2. Set the span=0MHz, RBW=8MHz, VBW=50MHz, Sweep time=5ms;
3. Detector = peak;
4. Trace mode = Single hold.

### 5.1.4. Test Setup Layout




### 5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

### 5.1.6. Test result

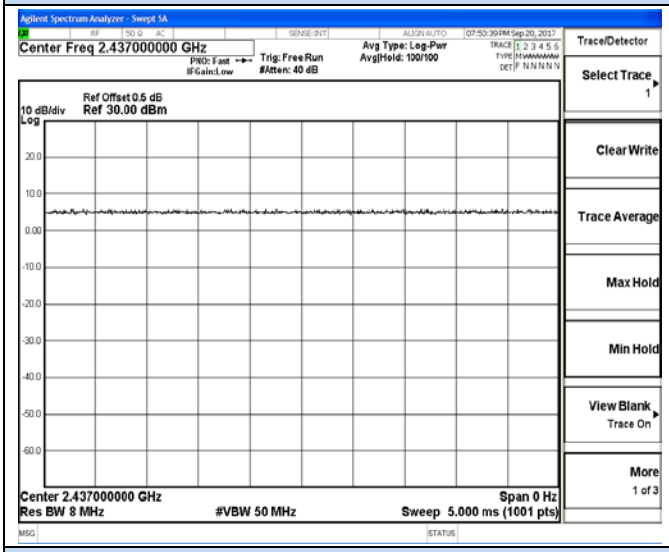
| Mode | On Time B (ms) | Period (ms) | Duty Cycle x (Linear) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) | 1/B Minimum VBW(KHz) |
|---|---|---|---|---|---|---|
| BT LE | 5 | 5 | 1 | 100 | 0 | 0.010 |
| IEEE 802.11b | 5 | 5 | 1 | 100 | 0 | 0.010 |
| IEEE 802.11g | 5 | 5 | 1 | 100 | 0 | 0.010 |
| IEEE 802.11n HT20 | 5 | 5 | 1 | 100 | 0 | 0.010 |
| IEEE 802.11n HT40 | 5 | 5 | 1 | 100 | 0 | 0.010 |

*Remark:*

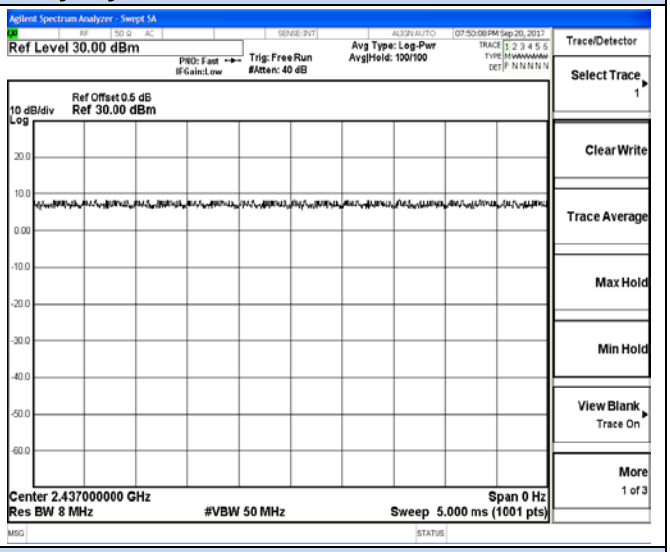
*1. Measured duty cycle for WLAN at both antenna 0 and antenna 1 port, the two antenna ports results were same, just recorded results at antenna 0;*

*2. Bluetooth only work at Antenna Port 0;*

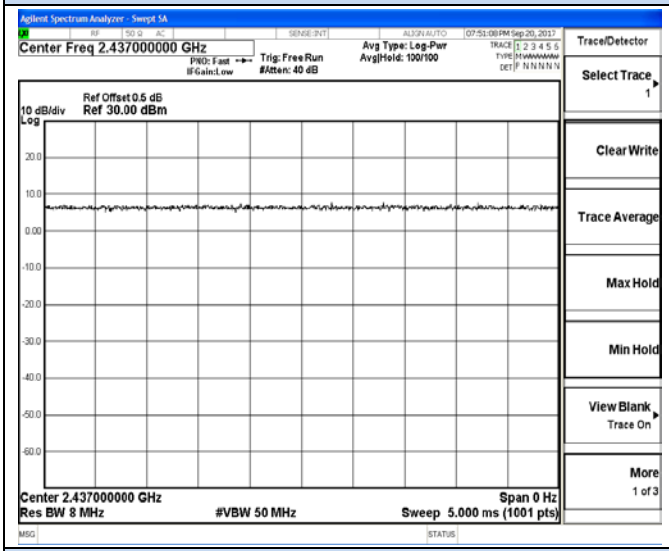
## On Time and Duty Cycle



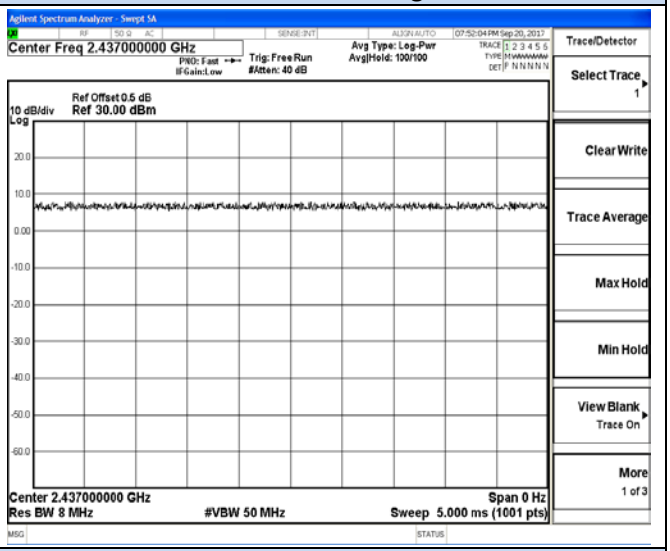

IEEE 802.11b



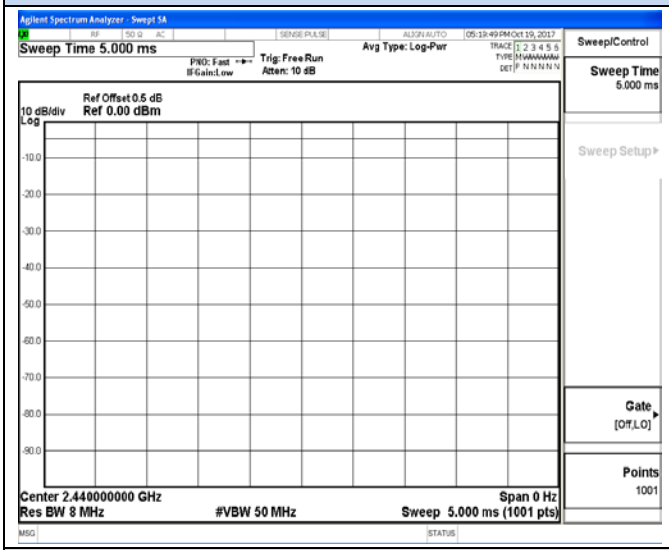

IEEE 802.11g




IEEE 802.11n HT20




IEEE 802.11n HT40




BT LE

## 5.2. Maximum Conducted Output Power Measurement

### 5.2.1. Standard Applicable

According to §15.247(b): For systems using digital modulation in the 2400-2483.5 MHz and 5725-5850 MHz band, the limit for maximum peak conducted output power is 30dBm. The limited has to be reduced by the amount in dB that the gain of the antenna exceeds 6dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi without any corresponding reduction in transmitter peak output power.

### 5.2.2. Measuring Instruments and Setting

Please refer to equipment list in this report. The following table is the setting of the power meter.

### 5.2.3. Test Procedures

According to KDB558074 D01 DTS Measurement Guidance Section 9.1 Maximum peak conducted output power, 9.1.2 the maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

According to KDB558074 D01 DTS Measurement Guidance Section 9.2 Maximum average conducted output power, 9.2.3.1 Method AVGPM (Measurement using an RF average power meter)

(a) As an alternative to spectrum analyzer or EMI receiver measurements, measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.

1) The EUT is configured to transmit continuously, or to transmit with a constant duty factor.

2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.

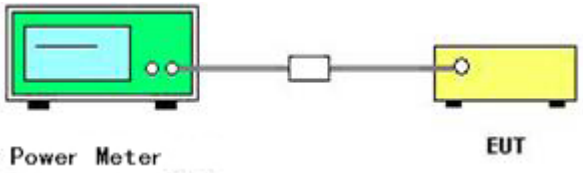
3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

(b) If the transmitter does not transmit continuously, measure the duty cycle (x) of the transmitter output signal as described in Section 6.0.

(c) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.

(d) Adjust the measurement in dBm by adding 10log (1/x), where x is the duty cycle to the measurement result.

### 5.2.4. Test Setup Layout




### 5.2.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.2.6. Test Result of Maximum Conducted Output Power

| Temperature | 25 ℃ | Humidity | 60% |
|---|---|---|---|
| Test Engineer | Jayden Zhuo | Configurations | IEEE 802.11b/g/n & BT LE |

| Test Mode | Channel | Frequency (MHz) | Measured Peak Output Power (dBm) | | | Limits (dBm) | Verdict |
|---|---|---|---|---|---|---|---|
| | | | Antenna 0 | Antenna 1 | Sum | | |
| IEEE 802.11b | 1 | 2412 | 16.50 | 16.35 | -/- | 30 | PASS |
| | 6 | 2437 | 16.87 | 16.60 | -/- | | |
| | 11 | 2462 | 16.71 | 16.53 | -/- | | |
| IEEE 802.11g | 1 | 2412 | 16.06 | 15.91 | -/- | 30 | PASS |
| | 6 | 2437 | 16.09 | 15.95 | -/- | | |
| | 11 | 2462 | 15.23 | 15.25 | -/- | | |
| IEEE 802.11n HT20 | 1 | 2412 | 12.38 | 12.13 | 15.27 | 30 | PASS |
| | 6 | 2437 | 12.64 | 12.52 | 15.59 | | |
| | 11 | 2462 | 12.51 | 12.49 | 15.51 | | |
| IEEE 802.11n HT40 | 3 | 2422 | 12.20 | 12.08 | 15.15 | 30 | PASS |
| | 6 | 2437 | 12.06 | 11.97 | 15.03 | | |
| | 9 | 2452 | 12.28 | 12.25 | 15.28 | | |
| BT – LE | 0 | 2402 | 0.36 | -/- | | 30 | PASS |
| | 19 | 2440 | -0.11 | -/- | | | |
| | 39 | 2480 | -0.03 | -/- | | | |

*Remark:*

1. *Measured output power 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 no need measured or sum as cannot work at MIMO mode;*
5. *Bluetooth Lower Energy can only work at Antenna 0 port;*

## 5.3. Power Spectral Density Measurement

### 5.3.1. Standard Applicable

According to §15.247(e): For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

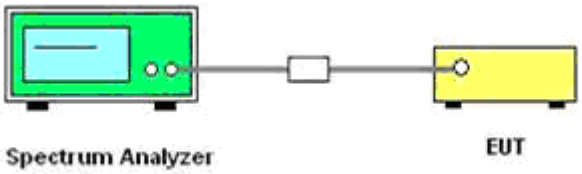
### 5.3.2. Measuring Instruments and Setting

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

### 5.3.3. Test Procedures

1. The transmitter was connected directly to a Spectrum Analyzer.
2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
3. Set the RBW = 30 KHz for WIFI and RBW = 3 KHz for BLE.
4. Set the VBW ≥ 3*RBW
5. Set the span to 1.5 times the DTS channel bandwidth.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum power level in any 3 kHz band segment within the fundamental EBW.
11. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 5.3.4. Test Setup Layout




### 5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

### 5.3.6. Test Result of Power Spectral Density

| | | | |
|---|---|---|---|
| Temperature | 25℃ | Humidity | 60% |
| Test Engineer | Jayden Zhuo | Configurations | IEEE 802.11b/g/n & BT LE |

| Test Mode | Channel | Frequency (MHz) | Measured Peak Power Spectral Density (dBm/30KHz) | | | Directional Gain | Limits (dBm/3KHz) | Verdict |
|---|---|---|---|---|---|---|---|---|
| | | | Antenna 0 | Antenna 1 | Sum | | | |
| IEEE 802.11b | 1 | 2412 | -4.110 | -4.323 | -/- | 2.00 | 8 | PASS |
| | 6 | 2437 | -4.058 | -3.949 | -/- | | | |
| | 11 | 2462 | -3.856 | -4.806 | -/- | | | |
| IEEE 802.11g | 1 | 2412 | -6.720 | -6.987 | -/- | 2.00 | 8 | PASS |
| | 6 | 2437 | -4.757 | -4.332 | -/- | | | |
| | 11 | 2462 | -7.577 | -7.999 | -/- | | | |
| IEEE 802.11n HT20 | 1 | 2412 | -7.881 | -6.999 | -4.407 | 2.00 | 8 | PASS |
| | 6 | 2437 | -5.782 | -5.287 | -2.517 | | | |
| | 11 | 2462 | -8.372 | -8.145 | -5.247 | | | |
| IEEE 802.11n HT40 | 3 | 2422 | -10.996 | -11.544 | -8.251 | 2.00 | 8 | PASS |
| | 6 | 2437 | -8.830 | -8.848 | -5.829 | | | |
| | 9 | 2452 | -11.264 | -12.281 | -8.732 | | | |

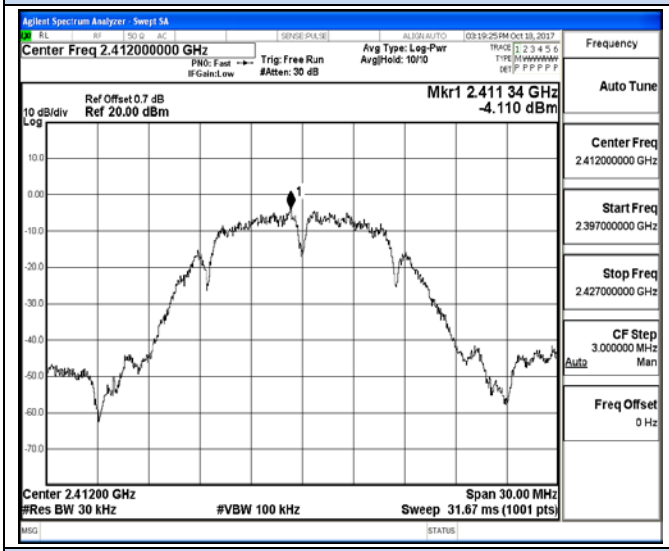
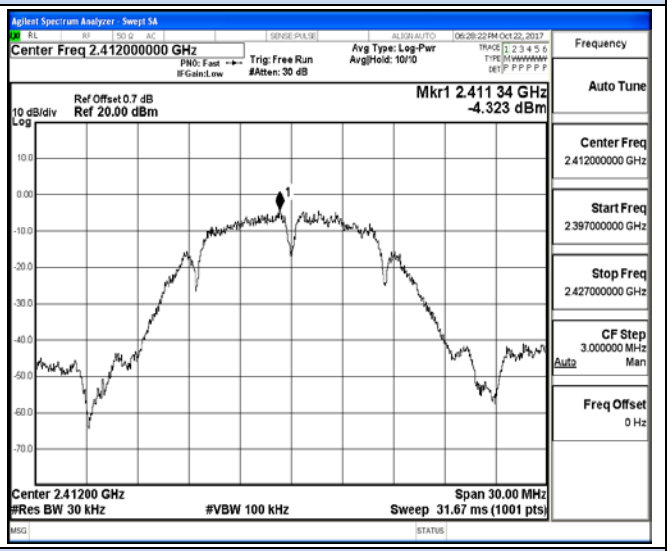
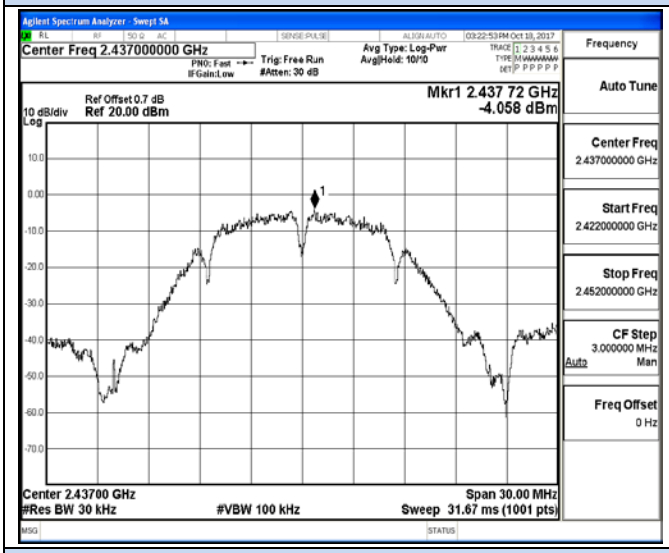
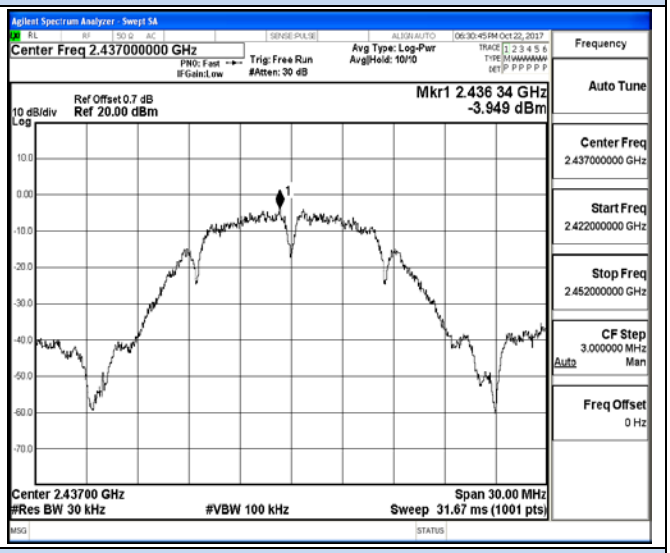
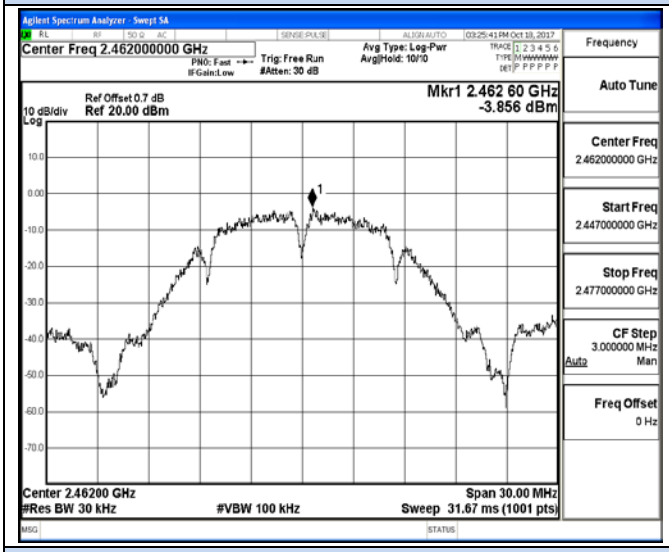
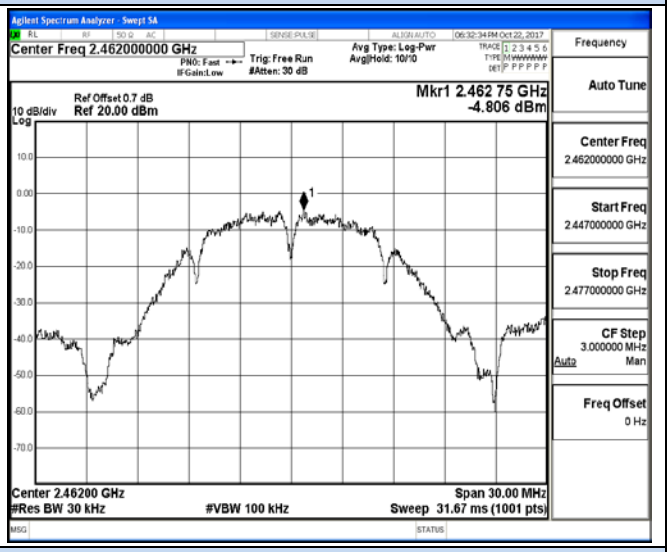
| Test Mode | Channel | Frequency (MHz) | Measured Peak Power Spectral Density (dBm/3KHz) | | | Limits (dBm/3KHz) | Verdict |
|---|---|---|---|---|---|---|---|
| | | | Antenna 0 | Antenna 1 | Sum | | |
| BT – LE | 0 | 2402 | -15.060 | -/- | -/- | 8 | PASS |
| | 19 | 2440 | -15.818 | -/- | -/- | | |
| | 39 | 2480 | -15.440 | -/- | -/- | | |

*Remark:*

1. *Measured peak power spectrum density 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 no need measured or sum as cannot work at MIMO mode;*
5. *Bluetooth Lower Energy can only work at Antenna 0 port;*
6. *Directional Gain = $G_{ANT}$ + 10 log($N_{ANT}$) dBi = -1.0 +10 log(2) dBi = 2.00 dBi;*
7. *Power spectrum density limit no need reduce if Direction gain less than 6dBi;*
8. *Please refer to following plots;*

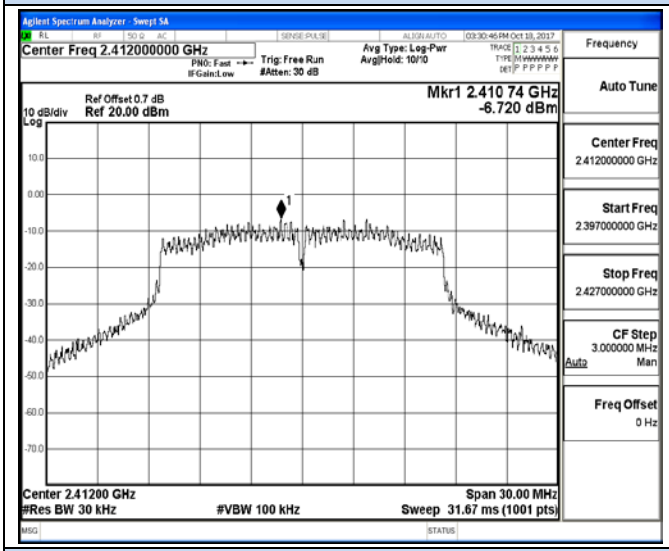
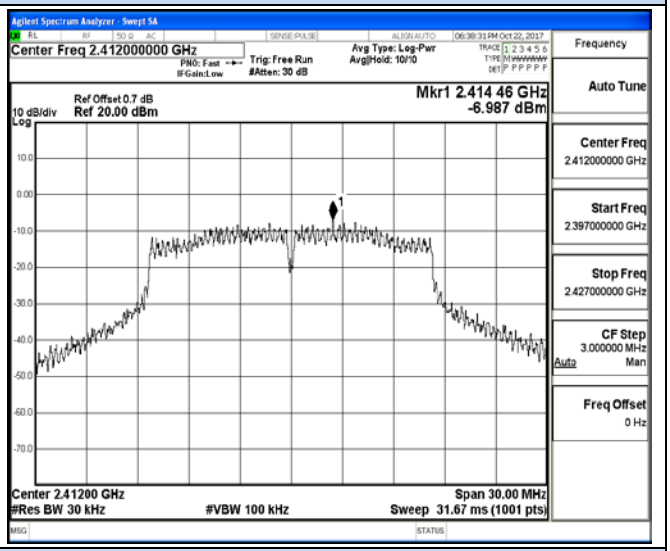
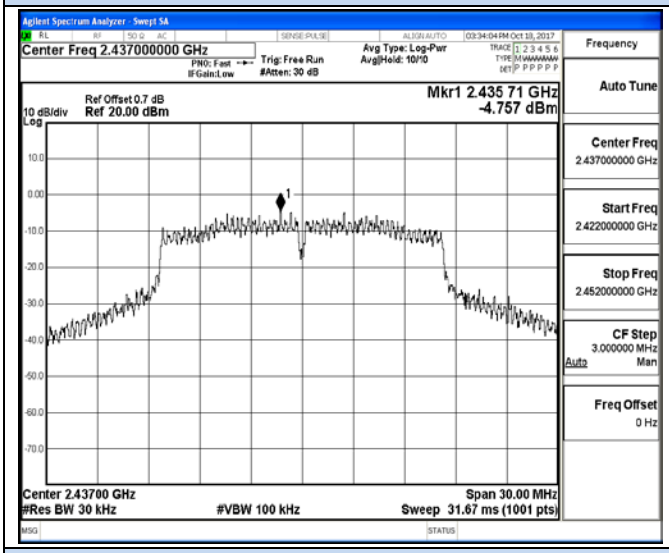
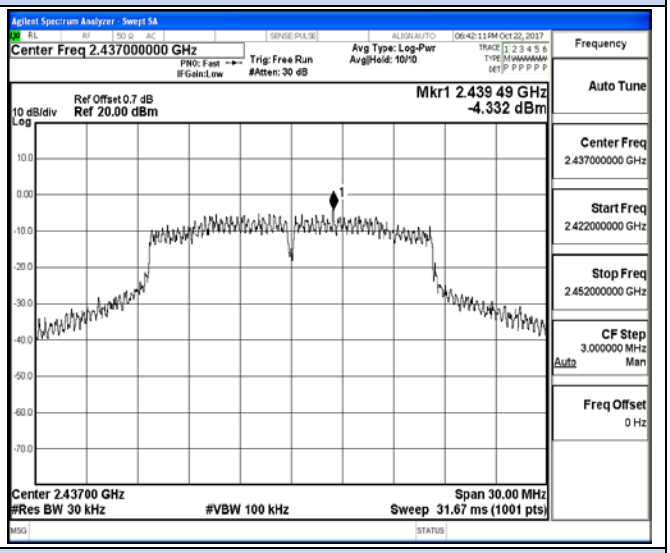
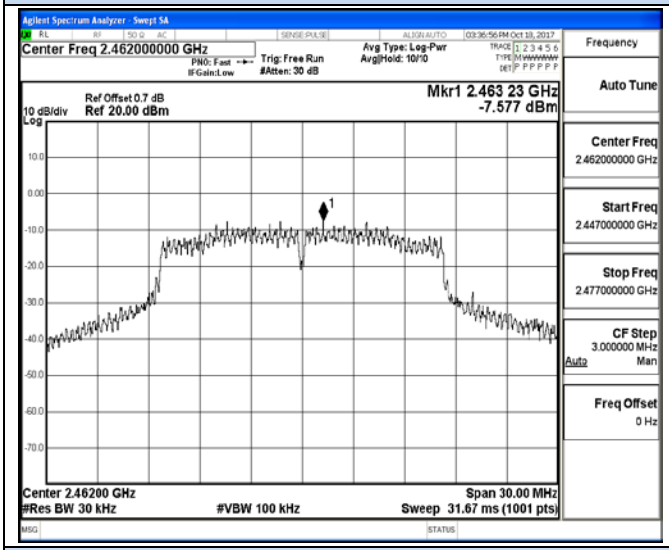
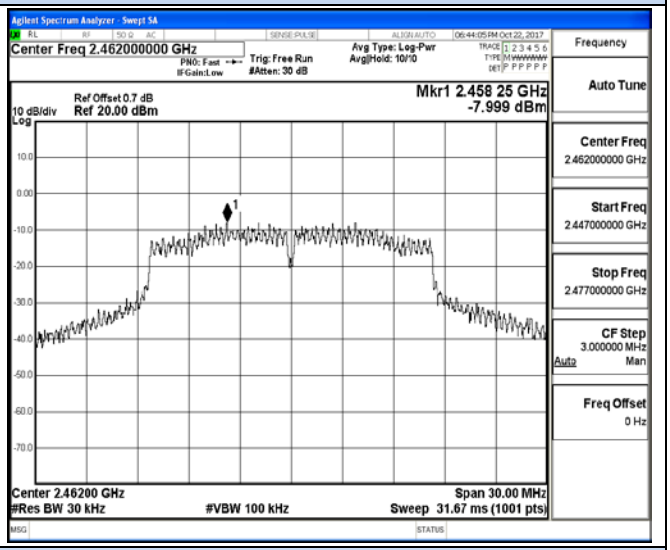
## Power Spectral Density

### IEEE 802.11b

| Antenna 0 | Antenna 1 |
|---|---|
|  |  |
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| Channel 11 / 2462 MHz | Channel 11 / 2462 MHz |

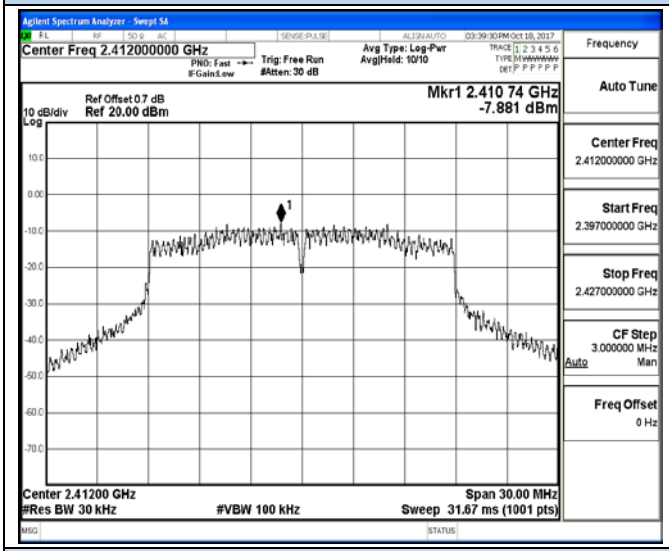
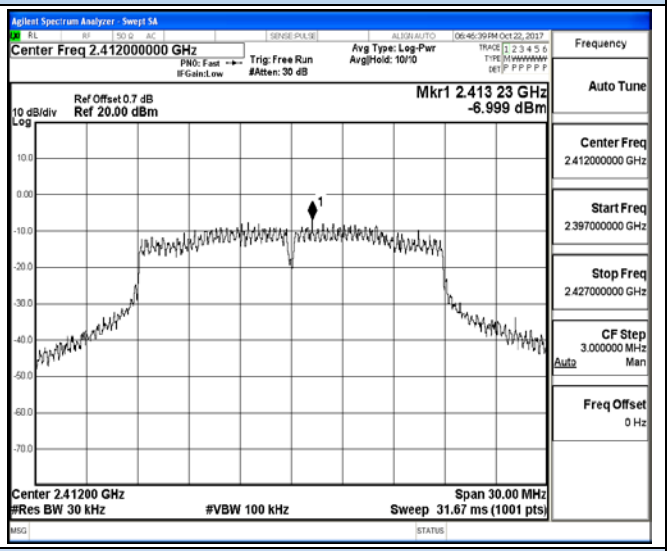
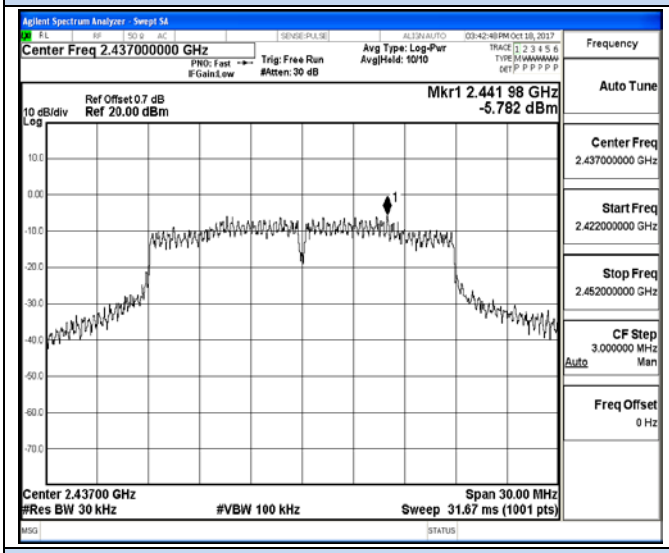
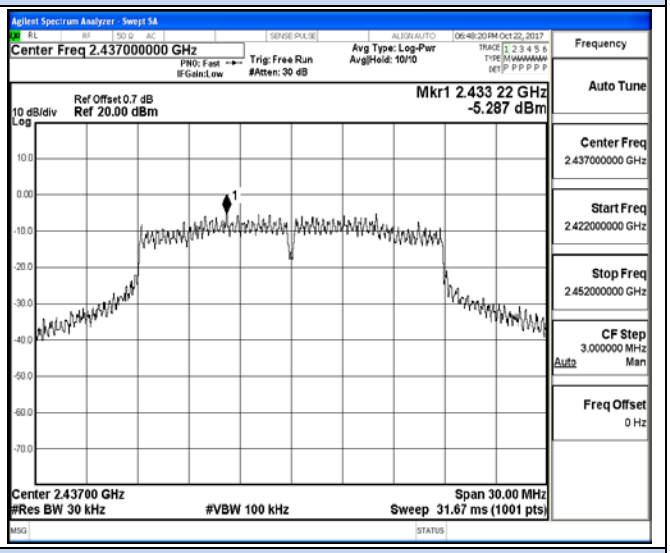
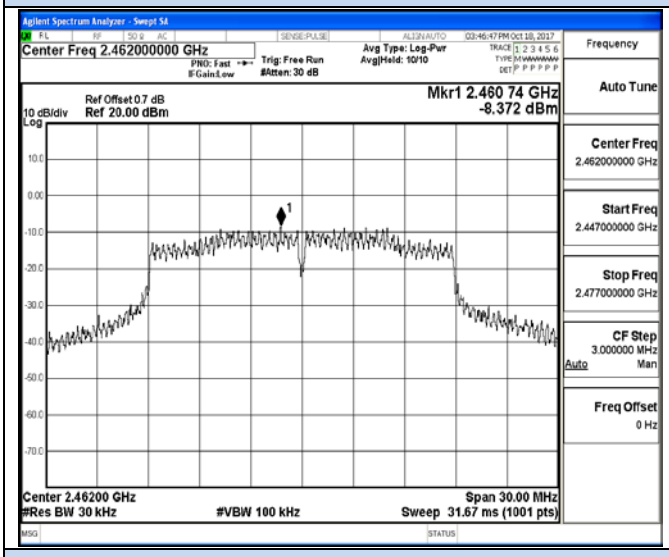
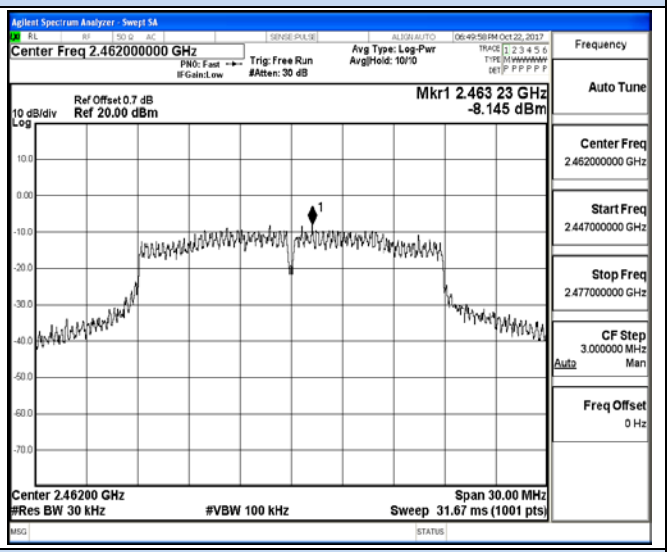
## Power Spectral Density

### IEEE 802.11g

| Antenna 0 | Antenna 1 |
|---|---|
|  |  |
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| Channel 11 / 2462 MHz | Channel 11 / 2462 MHz |

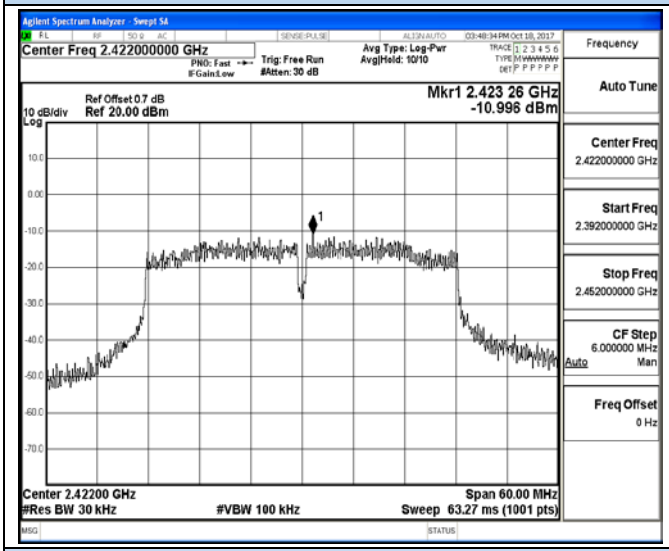
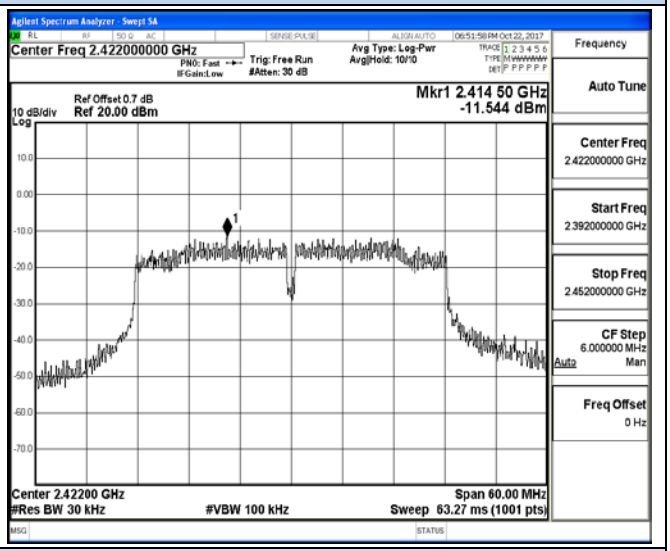
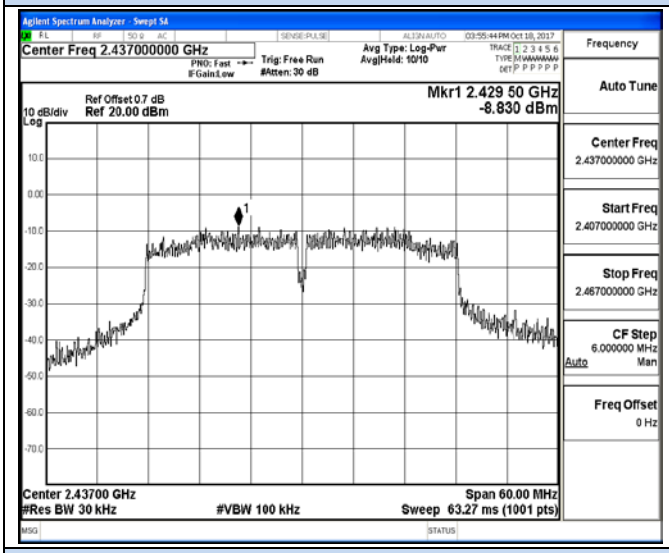
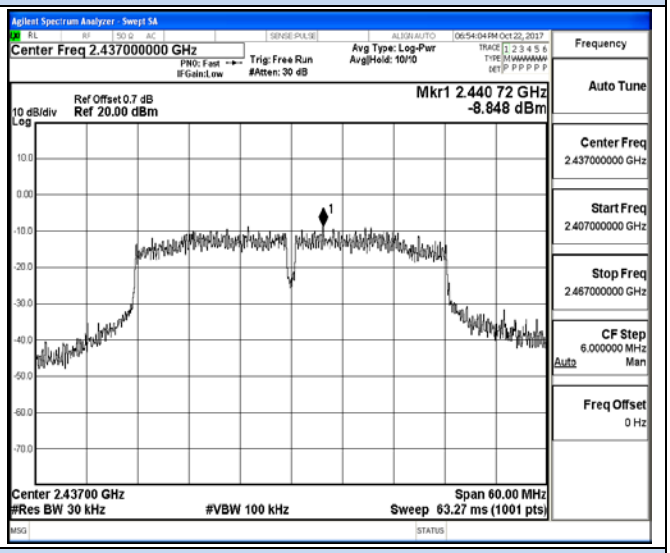
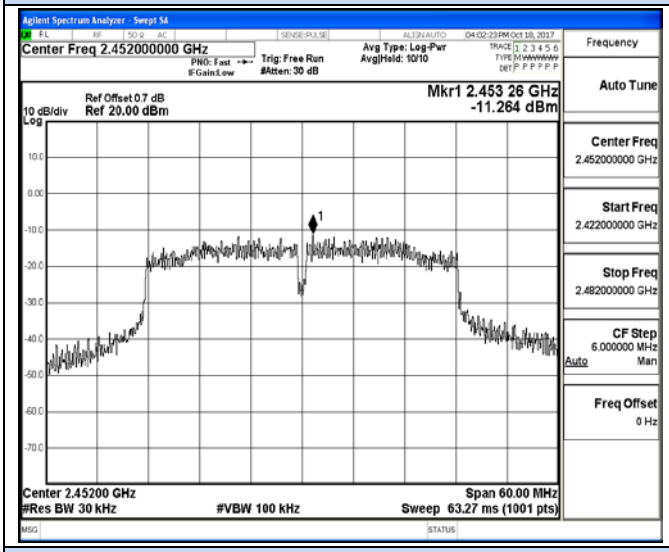
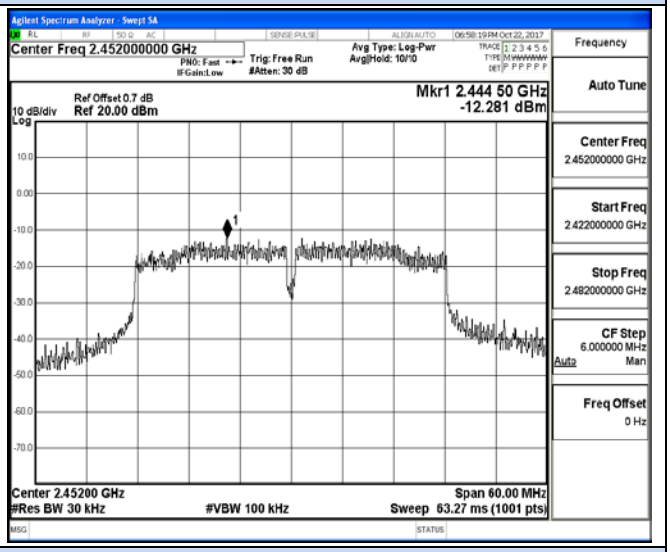
## Power Spectral Density

### IEEE 802.11n HT20

| Antenna 0 | Antenna 1 |
|---|---|
|  |  |
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| Channel 11 / 2462 MHz | Channel 11 / 2462 MHz |

## Power Spectral Density

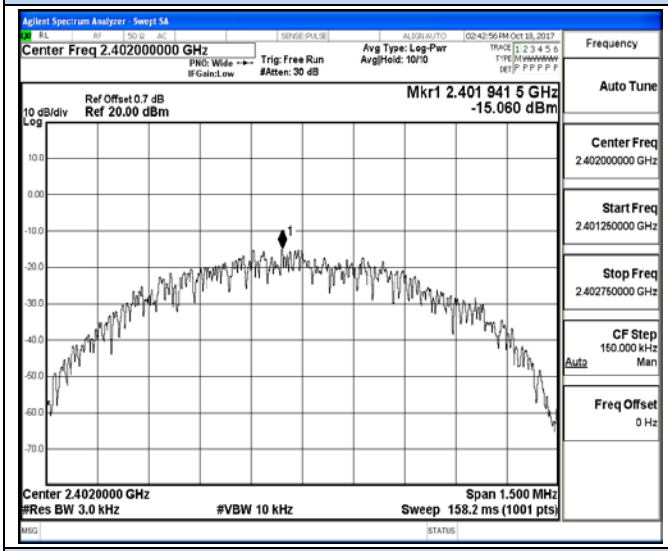
### IEEE 802.11n HT40

| Antenna 0 | Antenna 1 |
|---|---|
|  |  |
| Channel 3 / 2422 MHz | Channel 3 / 2422 MHz |
|  |  |
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| Channel 9 / 2452 MHz | Channel 9 / 2452 MHz |

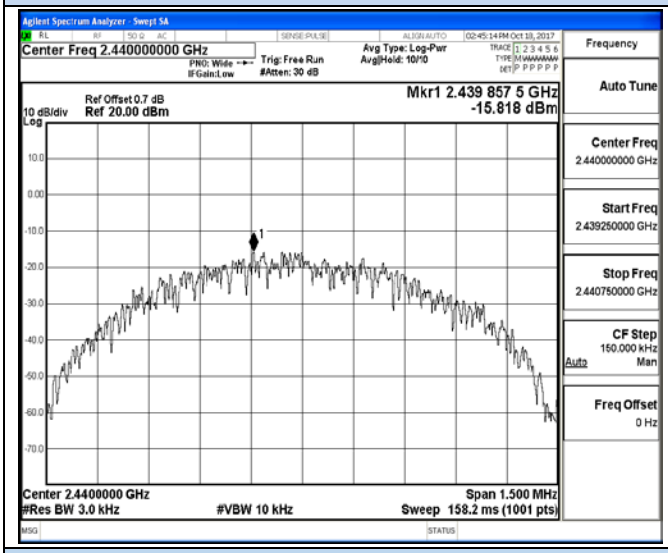
## Power Spectral Density

### BT – LE

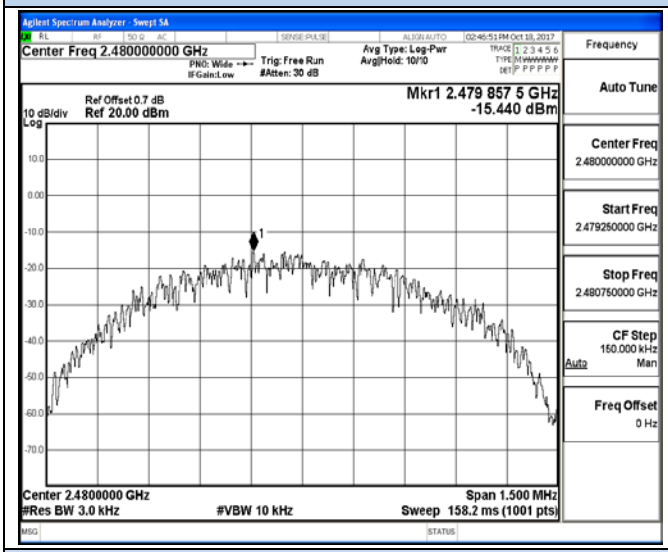
#### Antenna 0




#### Channel 0 / 2402 MHz




#### Channel 19 / 2440 MHz




#### Channel 39 / 2480 MHz

## 5.4. 6 dB Spectrum Bandwidth Measurement

### 5.4.1. Standard Applicable

According to §15.247(a) (2): For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 KHz.

### 5.4.2. Measuring Instruments and Setting

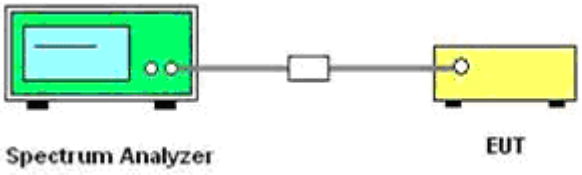
Please refer to equipment's list in this report. The following table is the setting of the Spectrum Analyzer.

| Spectrum Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Span Frequency | > RBW |
| Detector | Peak |
| Trace | Max Hold |
| Sweep Time | Auto |

### 5.4.3. Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The resolution bandwidth and the video bandwidth were set according to KDB558074.
3. Measured the spectrum width with power higher than 6dB below carrier.

### 5.4.4. Test Setup Layout




### 5.4.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

### 5.4.6. Test Result of 6dB Spectrum Bandwidth

| Temperature | 25℃ | Humidity | 60% |
|---|---|---|---|
| Test Engineer | Jayden Zhuo | Configurations | IEEE 802.11b/g/n & BT LE |

| Test Mode | Channel | Frequency (MHz) | 6dB Bandwidth (MHz) | | Limits (MHz) | Verdict |
|---|---|---|---|---|---|---|
| | | | Antenna 0 | Antenna 1 | | |
| IEEE 802.11b | 1 | 2412 | 9.131 | 9.132 | 0.500 | PASS |
| | 6 | 2437 | 9.146 | 9.140 | | |
| | 11 | 2462 | 9.179 | 9.567 | | |
| IEEE 802.11g | 1 | 2412 | 15.150 | 15.140 | 0.500 | PASS |
| | 6 | 2437 | 15.150 | 15.140 | | |
| | 11 | 2462 | 15.100 | 15.630 | | |
| IEEE 802.11n HT20 | 1 | 2412 | 15.150 | 15.150 | 0.500 | PASS |
| | 6 | 2437 | 15.390 | 15.160 | | |
| | 11 | 2462 | 15.150 | 15.140 | | |
| IEEE 802.11n HT40 | 3 | 2422 | 35.150 | 35.150 | 0.500 | PASS |
| | 6 | 2437 | 35.160 | 35.170 | | |
| | 9 | 2452 | 35.130 | 35.160 | | |
| BT - LE | 0 | 2402 | 0.6503 | -/- | 0.500 | PASS |
| | 19 | 2440 | 0.6553 | -/- | | |
| | 39 | 2480 | 0.6669 | -/- | | |

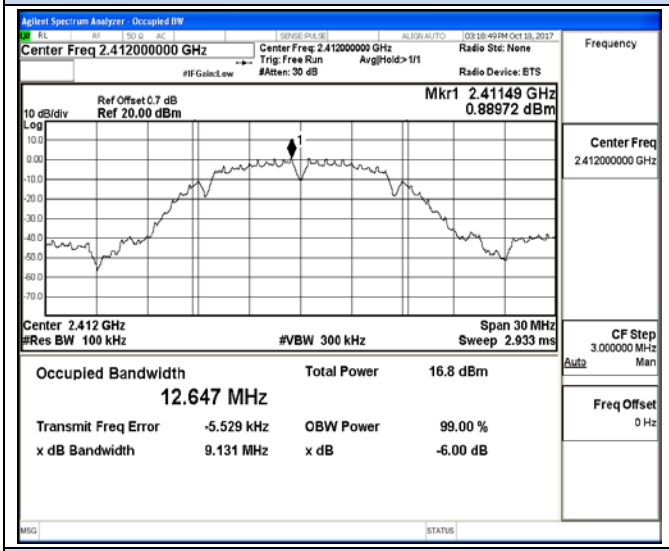
*Remark:*

1. *Measured 6dB bandwidth 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 no need measured or sum as cannot work at MIMO mode;*
5. *Bluetooth Lower Energy can only work at Antenna 0 port;*
6. *Please refer to following plots;*

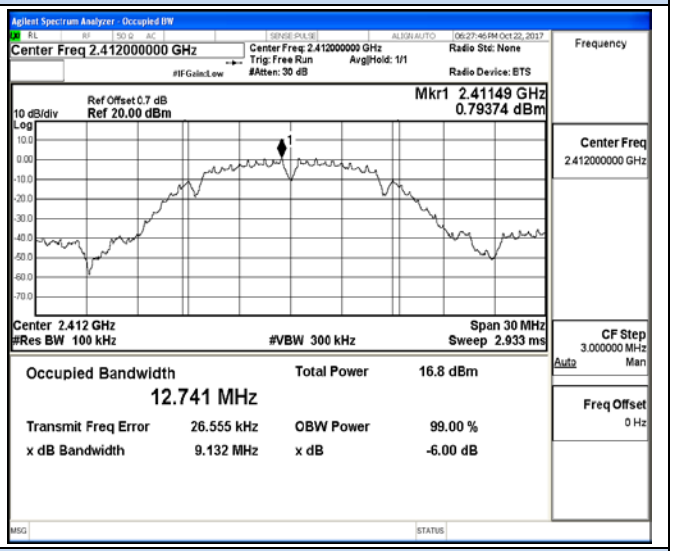
## 6 dB Bandwidth

## IEEE 802.11b

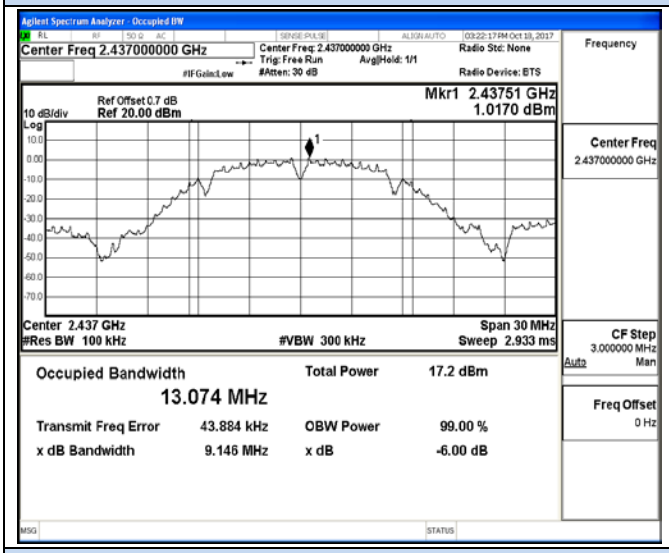
### Antenna 0



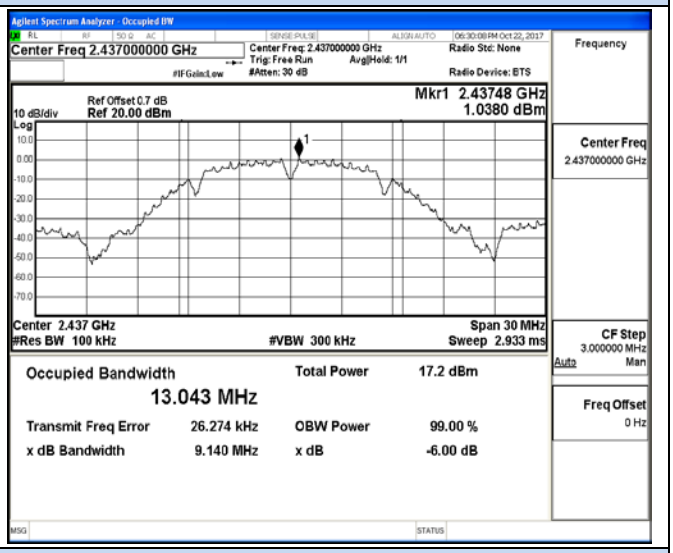

### Antenna 1



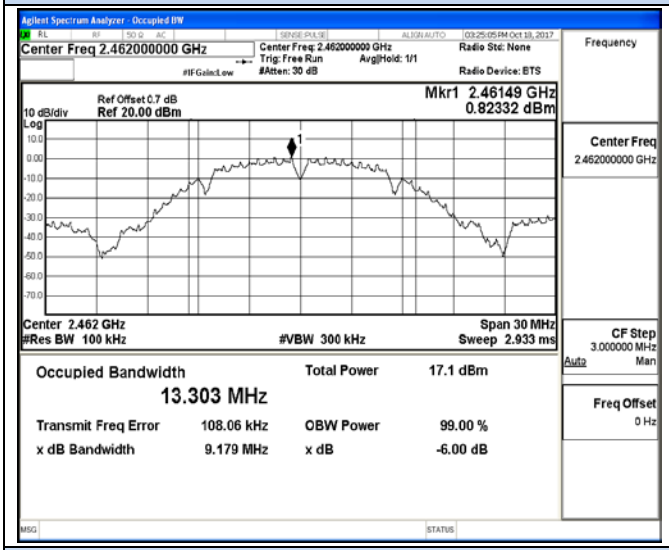

### Channel 1 / 2412 MHz



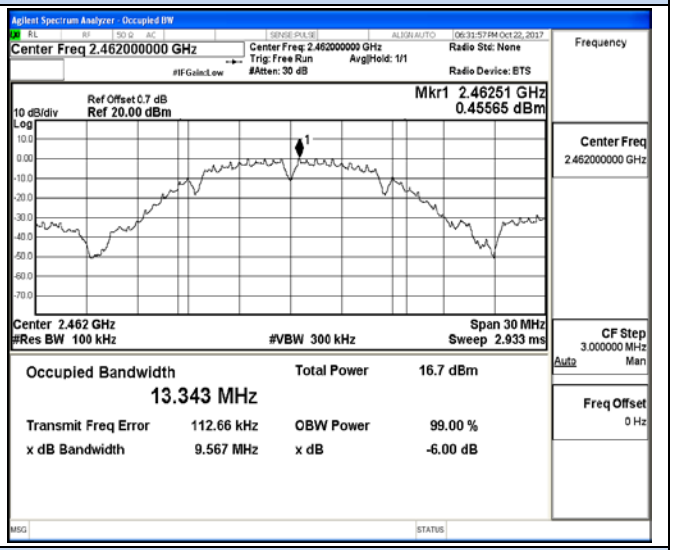

### Channel 1 / 2412 MHz




### Channel 6 / 2437 MHz




### Channel 6 / 2437 MHz

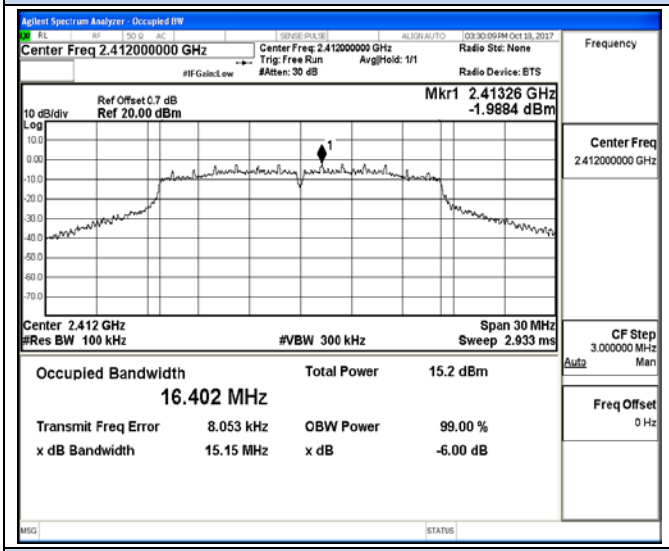
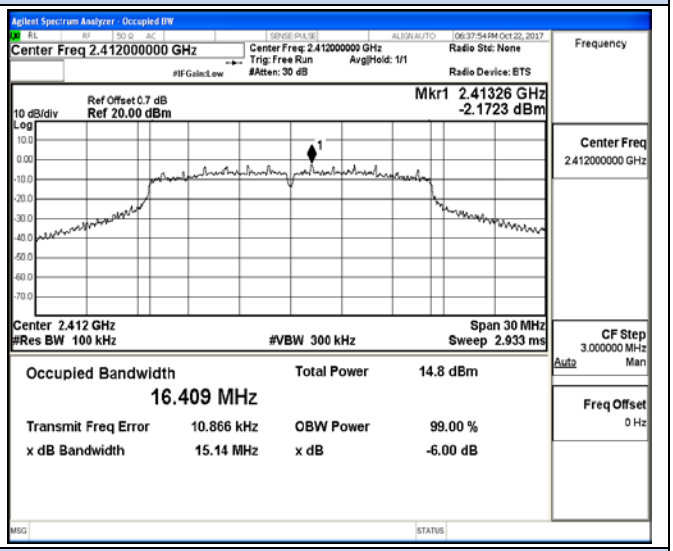
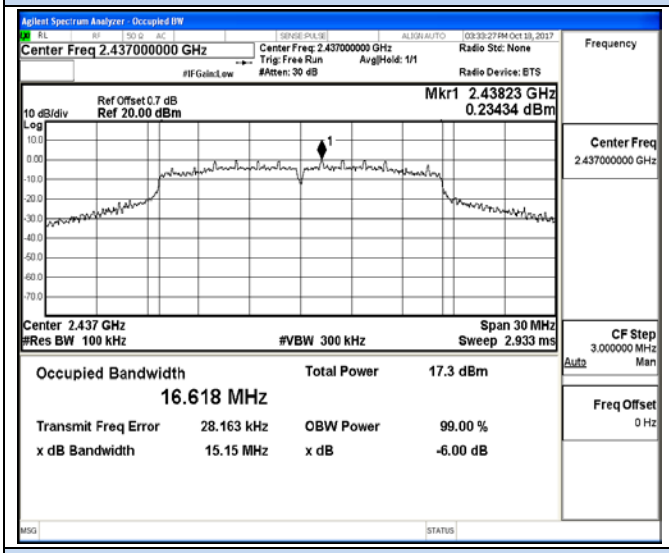
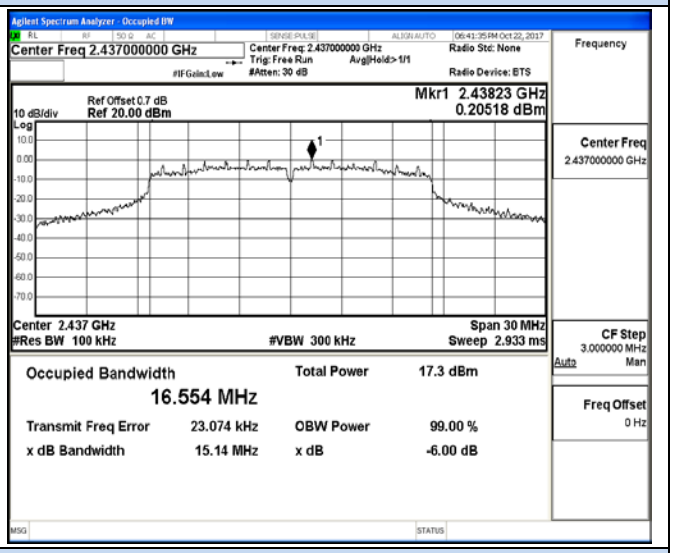
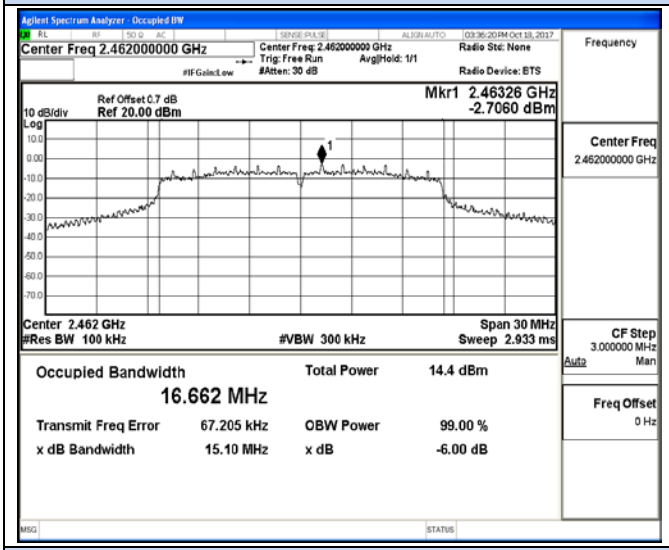
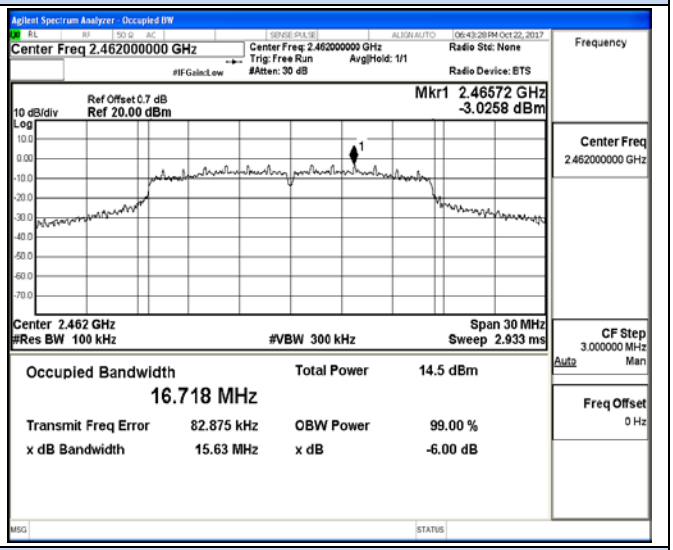



### Channel 11 / 2462 MHz

### Channel 11 / 2462 MHz

## 6 dB Bandwidth

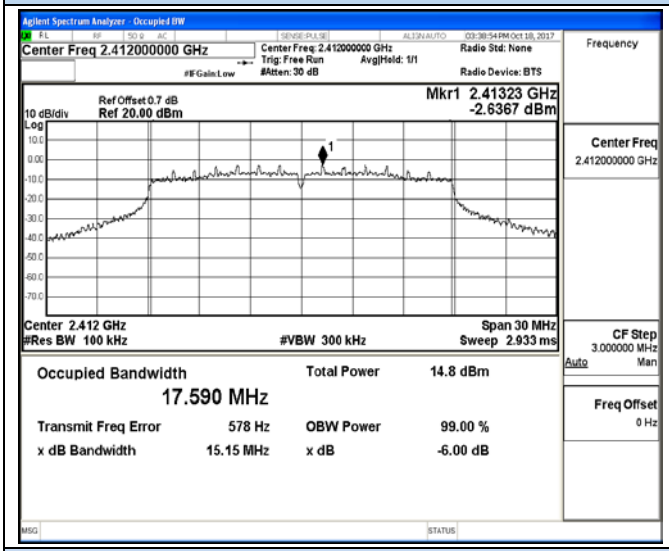
### IEEE 802.11g

| Antenna 0 | Antenna 1 |
|---|---|
|  |  |
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| Channel 11 / 2462 MHz | Channel 11 / 2462 MHz |

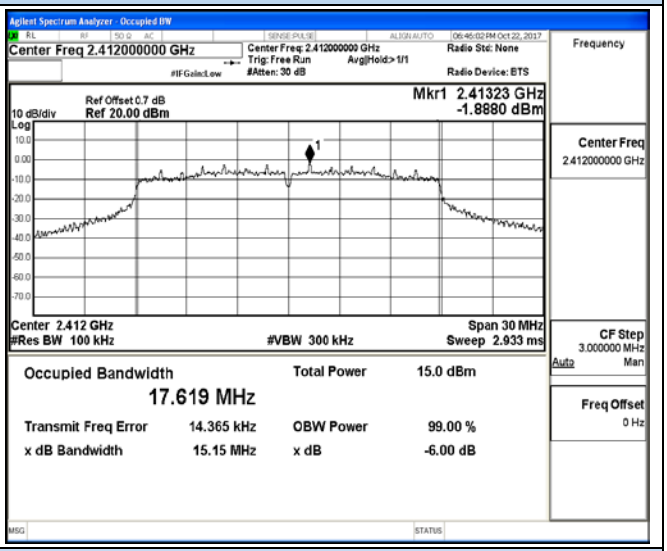
## 6 dB Bandwidth

## IEEE 802.11n HT20

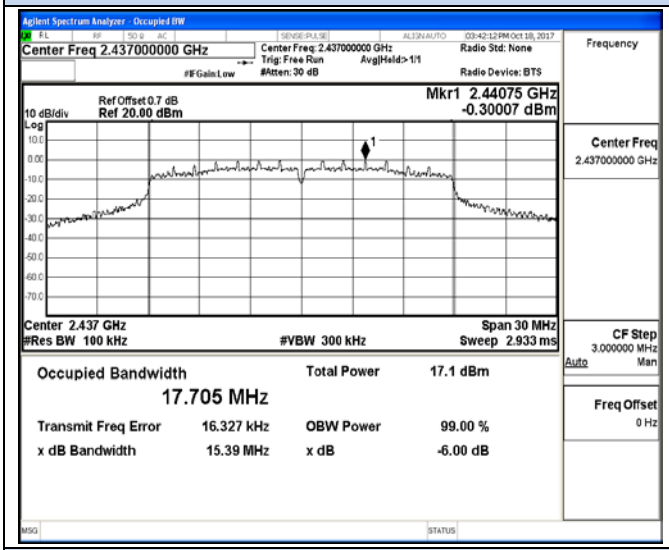
### Antenna 0



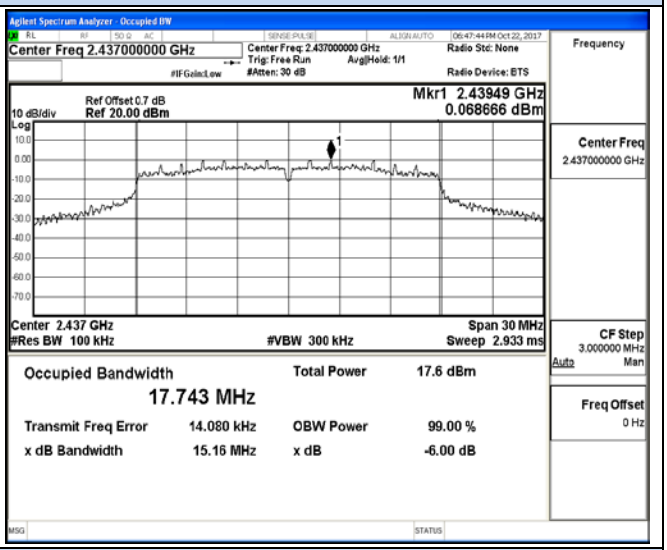

### Antenna 1



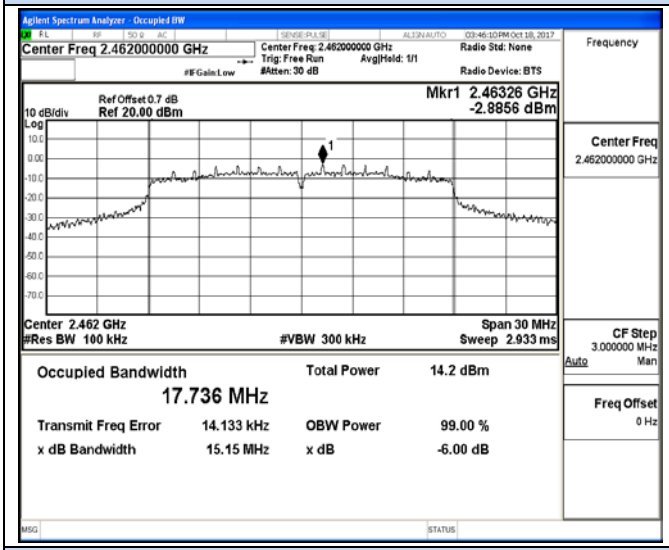

### Channel 1 / 2412 MHz



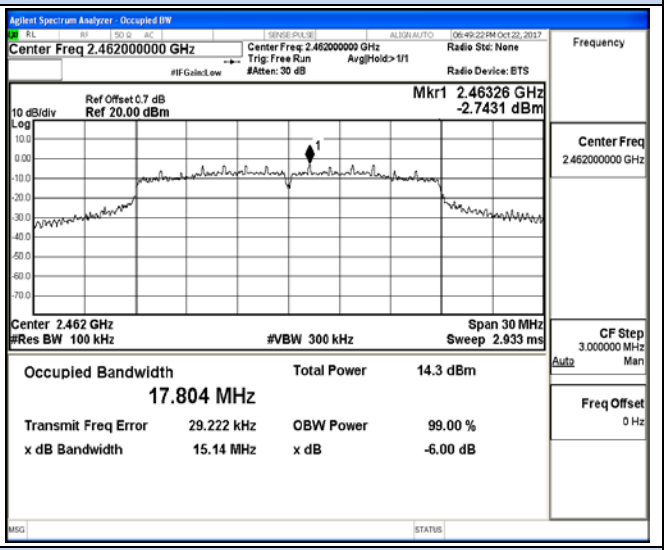

### Channel 1 / 2412 MHz




### Channel 6 / 2437 MHz




### Channel 6 / 2437 MHz

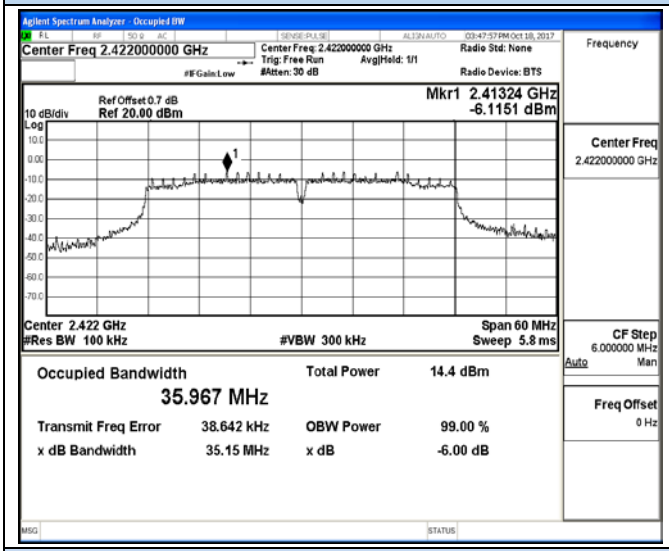
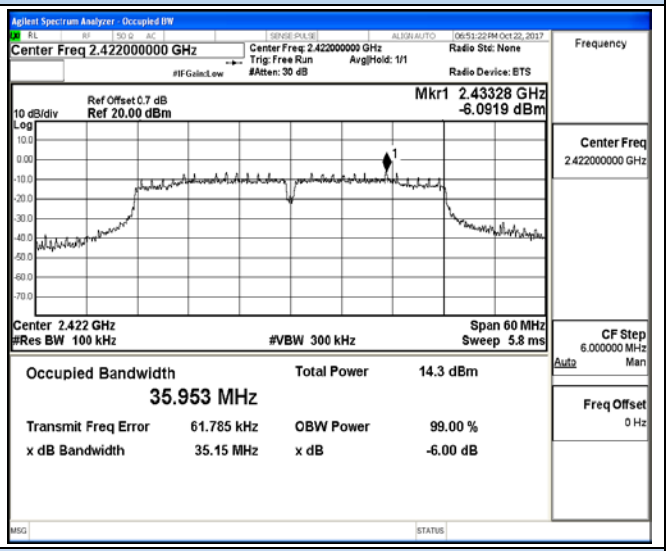
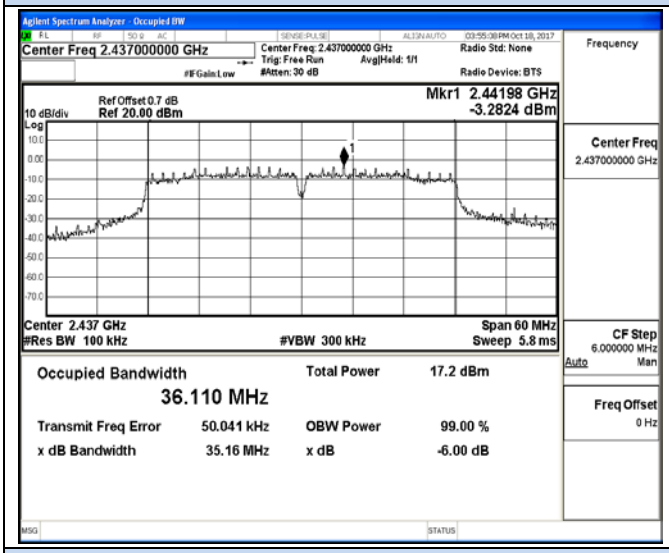
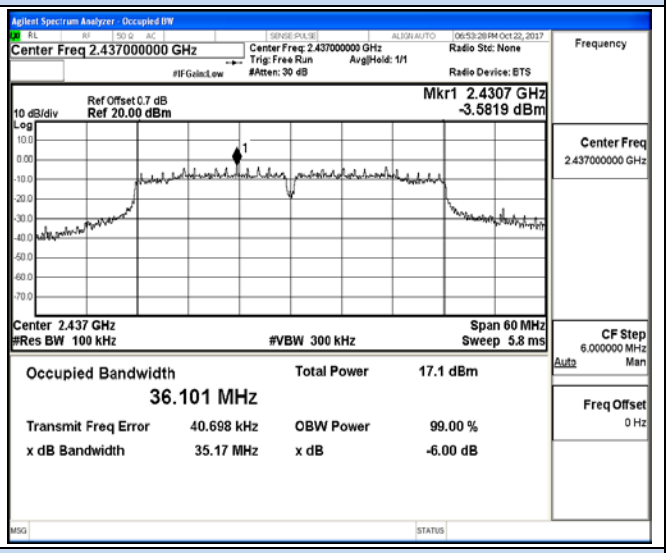
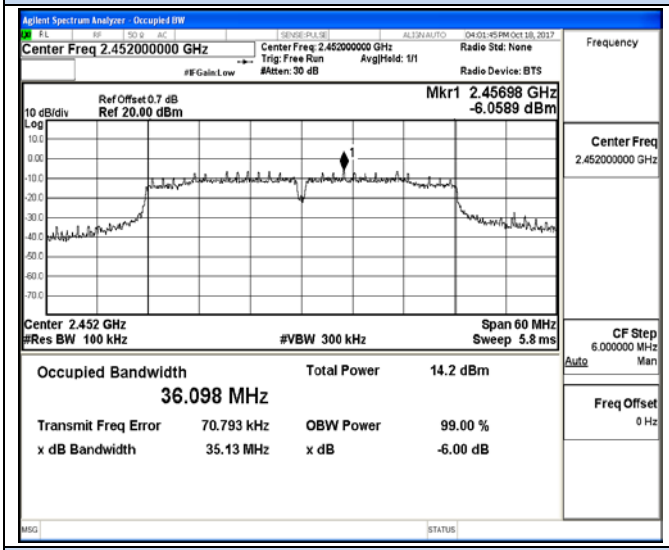
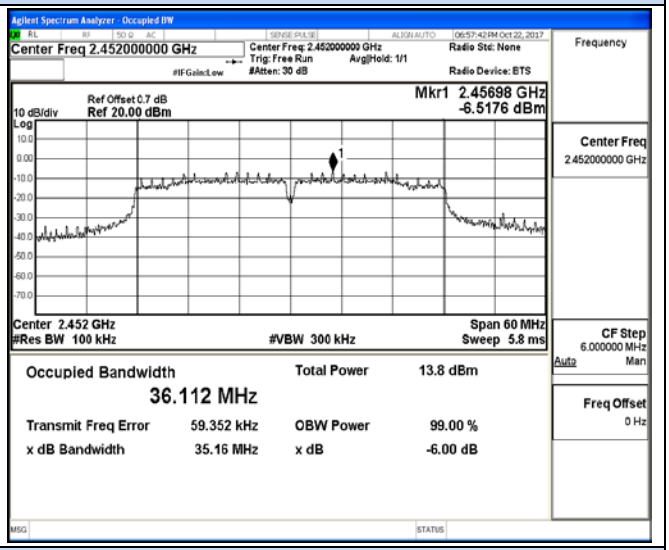


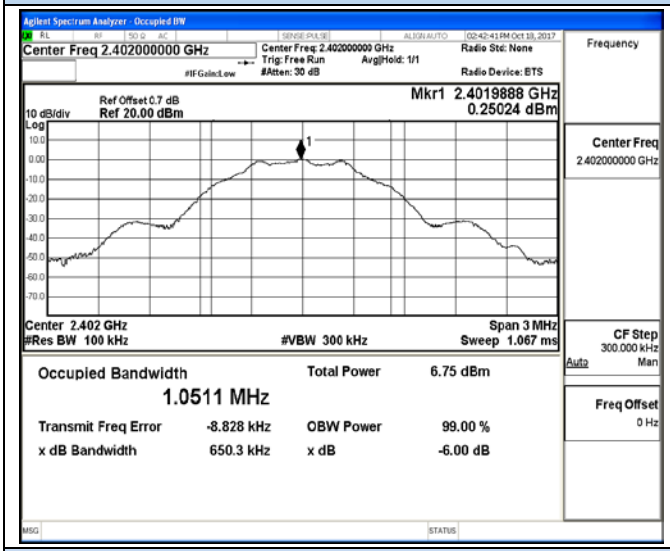
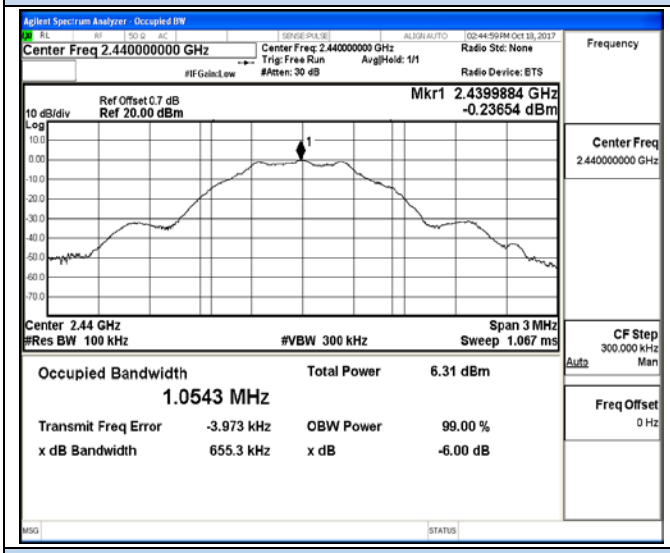
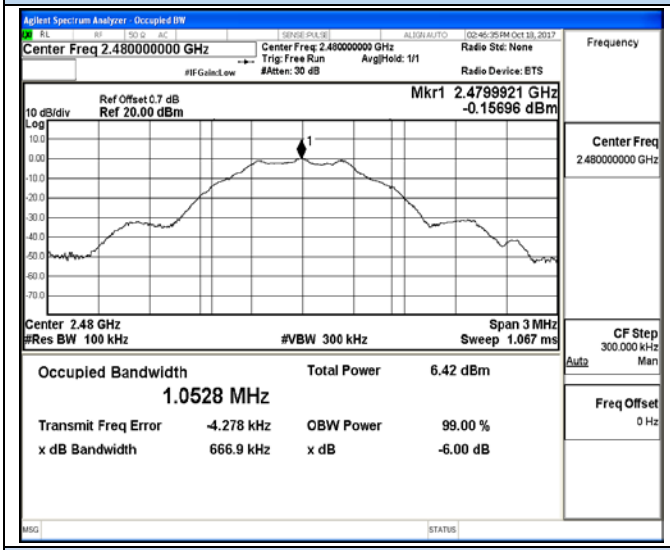

### Channel 11 / 2462 MHz

### Channel 11 / 2462 MHz

## 6 dB Bandwidth

### IEEE 802.11n HT40

| Antenna 0 | Antenna 1 |
|---|---|
|  |  |
| Channel 3 / 2422 MHz | Channel 3 / 2422 MHz |
|  |  |
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| Channel 9 / 2452 MHz | Channel 9 / 2452 MHz |

| 6 dB Bandwidth | |
|---|---|
| BT – LE | |
| Antenna 0 | Antenna 1 |
|  | |
| Channel 0 / 2402 MHz | |
|  | |
| Channel 19 / 2440 MHz | |
|  | |
| Channel 39 / 2480 MHz | |

## 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 equipment 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 / 1/B kHz for Average |
| RB / VB (Emission in non-restricted band) | 1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average |

| Receiver Parameter | Setting |
|---|---|
| Attenuation | Auto |
| Start ~ Stop Frequency | 9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG |
| Start ~ Stop Frequency | 150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB/VB 120kHz/1MHz 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.

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**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:**

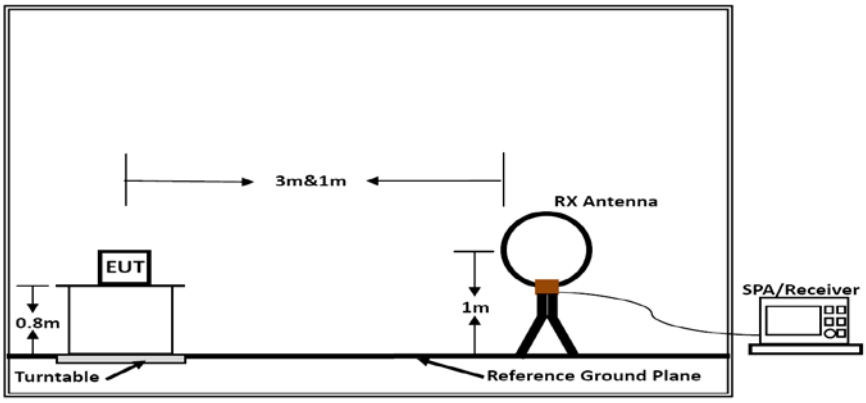
--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

**Final measurement:**

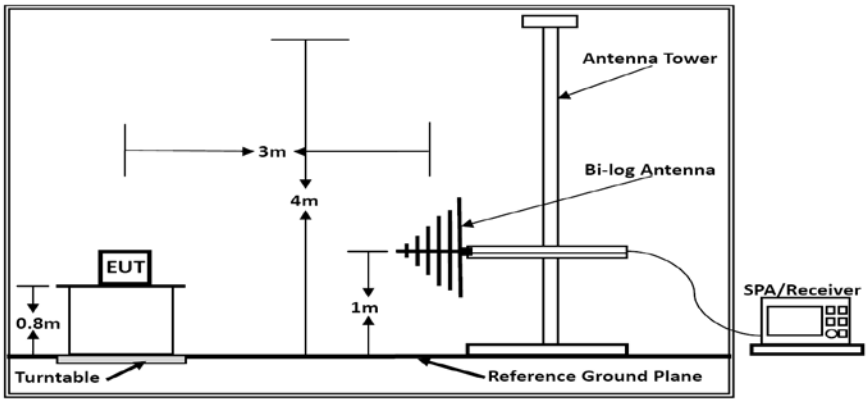
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- 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.

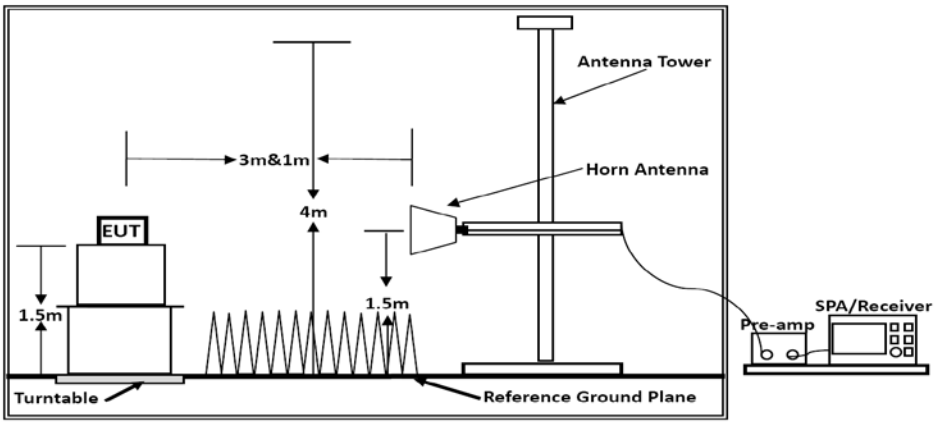
5.5.4. Test Setup Layout




Below 30MHz




Below 1GHz




Above 1GHz

Above 18 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1m]) (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 (9 KHz~30MHz)

| Temperature | 25 ℃ | Humidity | 60% |
|---|---|---|---|
| Test Engineer | Jayden Zhuo | Configurations | IEEE 802.11b/g/n & BT LE |

| 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.

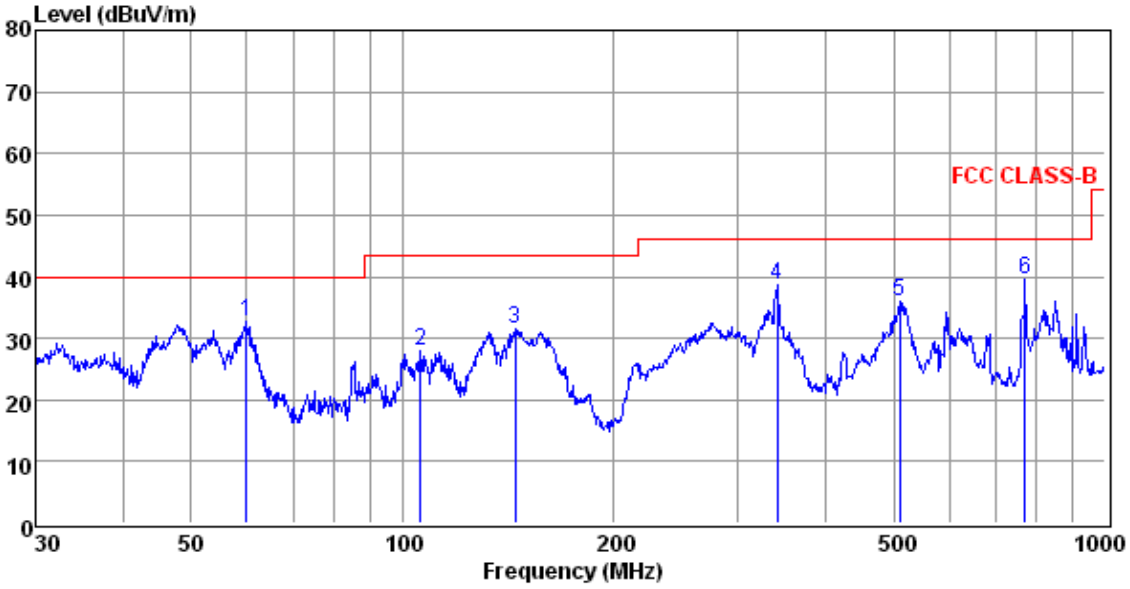
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

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

| Temperature | 25 ℃ | Humidity | 60% |
|---|---|---|---|
| Test Engineer | Jayden Zhuo | Configurations | IEEE 802.11b (Mid CH) |

*Test result for IEEE 802.11b (Mid Channel) @ Antenna 0*

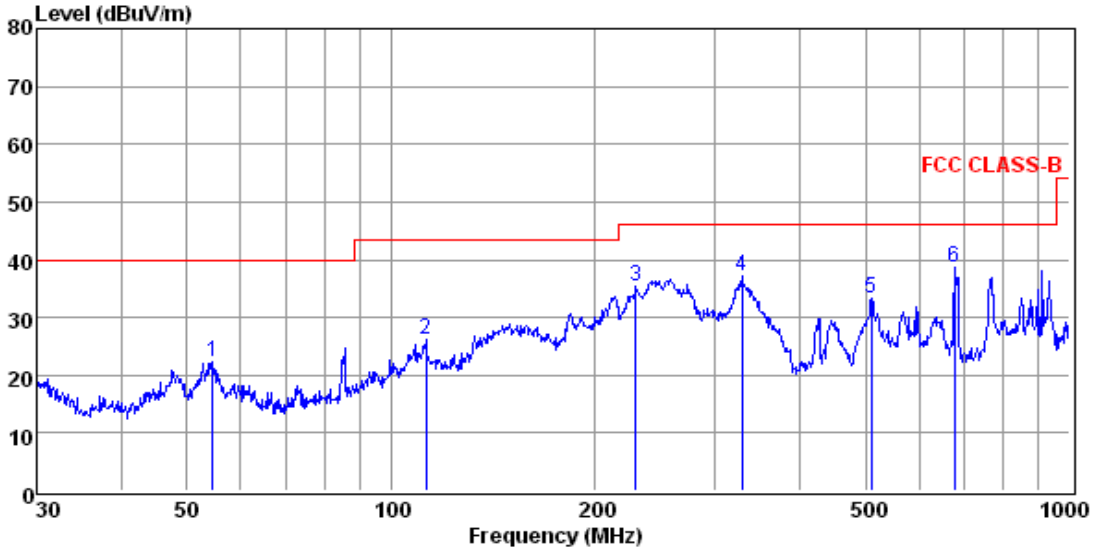
*Vertical*




| | Freq MHz | Reading dBuV | CabLos dB | Antfac dB/m | Measured dBuV/m | Limit dBuV/m | Over dB | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 59.86 | 19.59 | 0.49 | 12.70 | 32.78 | 40.00 | -7.22 | QP |
| 2 | 106.01 | 14.67 | 0.68 | 12.61 | 27.96 | 43.50 | -15.54 | QP |
| 3 | 144.84 | 22.52 | 0.77 | 8.22 | 31.51 | 43.50 | -11.99 | QP |
| 4 | 341.98 | 23.38 | 1.12 | 14.15 | 38.65 | 46.00 | -7.35 | QP |
| 5 | 510.04 | 17.70 | 1.49 | 16.77 | 35.96 | 46.00 | -10.04 | QP |
| 6 | 768.75 | 18.08 | 1.76 | 19.67 | 39.51 | 46.00 | -6.49 | 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

*Horizontal*




| | Freq MHz | Reading dBuV | CabLos dB | Antfac dB/m | Measured dBuV/m | Limit dBuV/m | Over dB | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | 54.45 | 8.66 | 0.46 | 13.05 | 22.17 | 40.00 | -17.83 | QP |
| 2 | 112.52 | 13.68 | 0.65 | 11.80 | 26.13 | 43.50 | -17.37 | QP |
| 3 | 229.29 | 22.73 | 0.93 | 11.61 | 35.27 | 46.00 | -10.73 | QP |
| 4 | 329.04 | 22.28 | 1.17 | 13.69 | 37.14 | 46.00 | -8.86 | QP |
| 5 | 510.04 | 14.96 | 1.49 | 16.77 | 33.22 | 46.00 | -12.78 | QP |
| 6 | 677.58 | 18.34 | 1.73 | 18.73 | 38.80 | 46.00 | -7.20 | 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 modes and recorded the worst case results in this report (IEEE 802.11b (Middle Channel)). Emission level (dBuV/m) = 20 log Emission level (uV/m).*
*2). Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.*
*3). Pre-scan at both antenna 0 and antenna 1, recorded worst case at antenna 0;*

5.5.8. Results for Radiated Emissions (Above 1GHz)

*IEEE 802.11b*

*Antenna 0*

*Channel 1 / 2412 MHz*

| 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 | 56.98 | 33.06 | 35.14 | 3.98 | 58.88 | 74.00 | -15.12 | Peak | Horizontal |
| 4824.00 | 37.52 | 33.06 | 35.14 | 3.98 | 39.42 | 54.00 | -14.58 | Average | Horizontal |
| 4824.00 | 57.74 | 33.06 | 35.14 | 3.98 | 59.64 | 74.00 | -14.36 | Peak | Vertical |
| 4824.00 | 43.66 | 33.06 | 35.14 | 3.98 | 45.56 | 54.00 | -8.44 | Average | Vertical |

*Channel 6 / 2437 MHz*

| 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 | 53.58 | 33.16 | 35.15 | 3.96 | 55.55 | 74.00 | -18.45 | Peak | Horizontal |
| 4874.00 | 40.97 | 33.16 | 35.15 | 3.96 | 42.94 | 54.00 | -11.06 | Average | Horizontal |
| 4874.00 | 58.30 | 33.16 | 35.15 | 3.96 | 60.27 | 74.00 | -13.73 | Peak | Vertical |
| 4874.00 | 43.05 | 33.16 | 35.15 | 3.96 | 45.02 | 54.00 | -8.98 | Average | Vertical |

*Channel 11 / 2462 MHz*

| 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 | 55.80 | 33.26 | 35.14 | 3.98 | 57.90 | 74.00 | -16.10 | Peak | Horizontal |
| 4924.00 | 40.66 | 33.26 | 35.14 | 3.98 | 42.76 | 54.00 | -11.24 | Average | Horizontal |
| 4924.00 | 59.92 | 33.26 | 35.14 | 3.98 | 62.02 | 74.00 | -11.98 | Peak | Vertical |
| 4924.00 | 40.72 | 33.26 | 35.14 | 3.98 | 42.82 | 54.00 | -11.18 | Average | Vertical |

*IEEE 802.11g*

*Antenna 0*

*Channel 1 / 2412 MHz*

| 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 | 55.59 | 33.06 | 35.14 | 3.98 | 57.49 | 74.00 | -16.51 | Peak | Horizontal |
| 4824.00 | 40.27 | 33.06 | 35.14 | 3.98 | 42.17 | 54.00 | -11.83 | Average | Horizontal |
| 4824.00 | 58.13 | 33.06 | 35.14 | 3.98 | 60.03 | 74.00 | -13.97 | Peak | Vertical |
| 4824.00 | 40.13 | 33.06 | 35.14 | 3.98 | 42.03 | 54.00 | -11.97 | Average | Vertical |

*Channel 6 / 2437 MHz*

| 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 | 53.09 | 33.16 | 35.15 | 3.96 | 55.06 | 74.00 | -18.94 | Peak | Horizontal |
| 4874.00 | 39.61 | 33.16 | 35.15 | 3.96 | 41.58 | 54.00 | -12.42 | Average | Horizontal |
| 4874.00 | 60.90 | 33.16 | 35.15 | 3.96 | 62.87 | 74.00 | -11.13 | Peak | Vertical |
| 4874.00 | 42.30 | 33.16 | 35.15 | 3.96 | 44.27 | 54.00 | -9.73 | Average | Vertical |

*Channel 11 / 2462 MHz*

| 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 | 55.98 | 33.26 | 35.14 | 3.98 | 58.08 | 74.00 | -15.92 | Peak | Horizontal |
| 4924.00 | 38.12 | 33.26 | 35.14 | 3.98 | 40.22 | 54.00 | -13.78 | Average | Horizontal |
| 4924.00 | 57.13 | 33.26 | 35.14 | 3.98 | 59.23 | 74.00 | -14.77 | Peak | Vertical |
| 4924.00 | 40.06 | 33.26 | 35.14 | 3.98 | 42.16 | 54.00 | -11.84 | Average | Vertical |

*IEEE 802.11n HT20*

*Combined Antenna 0 and Antenna 1*

*Channel 1 / 2412 MHz*

| 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 | 48.96 | 33.06 | 35.14 | 3.98 | 50.86 | 74.00 | -23.14 | Peak | Horizontal |
| 4824.00 | 33.70 | 33.06 | 35.14 | 3.98 | 35.60 | 54.00 | -18.40 | Average | Horizontal |
| 4824.00 | 56.58 | 33.06 | 35.14 | 3.98 | 58.48 | 74.00 | -15.52 | Peak | Vertical |
| 4824.00 | 36.72 | 33.06 | 35.14 | 3.98 | 38.62 | 54.00 | -15.38 | Average | Vertical |

*Channel 6 / 2437 MHz*

| 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 | 50.62 | 33.16 | 35.15 | 3.96 | 52.59 | 74.00 | -21.41 | Peak | Horizontal |
| 4874.00 | 35.28 | 33.16 | 35.15 | 3.96 | 37.25 | 54.00 | -16.75 | Average | Horizontal |
| 4874.00 | 54.43 | 33.16 | 35.15 | 3.96 | 56.40 | 74.00 | -17.60 | Peak | Vertical |
| 4874.00 | 38.99 | 33.16 | 35.15 | 3.96 | 40.96 | 54.00 | -13.04 | Average | Vertical |

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*Channel 11 / 2462 MHz*

| 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 | 49.39 | 33.26 | 35.14 | 3.98 | 51.49 | 74.00 | -22.51 | Peak | Horizontal |
| 4924.00 | 35.92 | 33.26 | 35.14 | 3.98 | 38.02 | 54.00 | -15.98 | Average | Horizontal |
| 4924.00 | 55.34 | 33.26 | 35.14 | 3.98 | 57.44 | 74.00 | -16.56 | Peak | Vertical |
| 4924.00 | 37.43 | 33.26 | 35.14 | 3.98 | 39.53 | 54.00 | -14.47 | Average | Vertical |

*IEEE 802.11n HT40*

*Combined Antenna 0 and Antenna 1*

*Channel 3 / 2422 MHz*

| 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 | 48.92 | 33.06 | 35.14 | 3.98 | 50.82 | 74.00 | -23.18 | Peak | Horizontal |
| 4844.00 | 34.75 | 33.06 | 35.14 | 3.98 | 36.65 | 54.00 | -17.35 | Average | Horizontal |
| 4844.00 | 55.75 | 33.06 | 35.14 | 3.98 | 57.65 | 74.00 | -16.35 | Peak | Vertical |
| 4844.00 | 36.23 | 33.06 | 35.14 | 3.98 | 38.13 | 54.00 | -15.87 | Average | Vertical |

*Channel 6 / 2437 MHz*

| 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 | 50.98 | 33.16 | 35.15 | 3.96 | 52.95 | 74.00 | -21.05 | Peak | Horizontal |
| 4874.00 | 33.62 | 33.16 | 35.15 | 3.96 | 35.59 | 54.00 | -18.41 | Average | Horizontal |
| 4874.00 | 55.00 | 33.16 | 35.15 | 3.96 | 56.97 | 74.00 | -17.03 | Peak | Vertical |
| 4874.00 | 36.52 | 33.16 | 35.15 | 3.96 | 38.49 | 54.00 | -15.51 | Average | Vertical |

*Channel 9 / 2452 MHz*

| 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 | 50.95 | 33.26 | 35.14 | 3.98 | 53.05 | 74.00 | -20.95 | Peak | Horizontal |
| 4904.00 | 33.86 | 33.26 | 35.14 | 3.98 | 35.96 | 54.00 | -18.04 | Average | Horizontal |
| 4904.00 | 54.10 | 33.26 | 35.14 | 3.98 | 56.20 | 74.00 | -17.80 | Peak | Vertical |
| 4904.00 | 39.80 | 33.26 | 35.14 | 3.98 | 41.90 | 54.00 | -12.10 | Average | Vertical |

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*BT LE*

*Antenna 0*

*Channel 0 / 2402 MHz*

| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4804.00 | 47.07 | 33.06 | 35.04 | 3.94 | 49.03 | 74.00 | -24.97 | Peak | Horizontal |
| 4804.00 | 32.20 | 33.06 | 35.04 | 3.94 | 34.16 | 54.00 | -19.84 | Average | Horizontal |
| 4804.00 | 47.16 | 33.06 | 35.04 | 3.94 | 49.12 | 74.00 | -24.88 | Peak | Vertical |
| 4804.00 | 33.93 | 33.06 | 35.04 | 3.94 | 35.89 | 54.00 | -18.11 | Average | Vertical |

*Channel 19 / 2440 MHz*

| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4880.00 | 47.37 | 33.16 | 35.15 | 3.96 | 49.34 | 74.00 | -24.66 | Peak | Horizontal |
| 4880.00 | 33.07 | 33.16 | 35.15 | 3.96 | 35.04 | 54.00 | -18.96 | Average | Horizontal |
| 4880.00 | 49.68 | 33.16 | 35.15 | 3.96 | 51.65 | 74.00 | -22.35 | Peak | Vertical |
| 4880.00 | 35.62 | 33.16 | 35.15 | 3.96 | 37.59 | 54.00 | -16.41 | Average | Vertical |

*Channel 39 / 2480 MHz*

| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark | Pol. |
|---|---|---|---|---|---|---|---|---|---|
| 4960.00 | 49.25 | 33.26 | 35.14 | 3.98 | 51.35 | 74.00 | -22.65 | Peak | Horizontal |
| 4960.00 | 32.16 | 33.26 | 35.14 | 3.98 | 34.26 | 54.00 | -19.74 | Average | Horizontal |
| 4960.00 | 48.61 | 33.26 | 35.14 | 3.98 | 50.71 | 74.00 | -23.29 | Peak | Vertical |
| 4960.00 | 36.04 | 33.26 | 35.14 | 3.98 | 38.14 | 54.00 | -15.86 | Average | Vertical |

Notes:

1. *Measuring frequencies from 9 KHz~10$^{th}$ 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 9 KHz~10$^{th}$ 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;*
4. *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;*
5. *Pre-scan at Antenna 0 and Antenna 1 for IEEE 802.11b and IEEE 802.11g mode, pre-scan at Antenna 0, Antenna 1 and Combined Antenna 0 and Antenna 1 for IEEE 802.11n, recorded worst case;*

## 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 equipment 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 9 KHz 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

| Temperature | 25℃ | Humidity | 60% |
|---|---|---|---|
| Test Engineer | Jayden Zhuo | Configurations | IEEE 802.11b/g/n & BT LE |

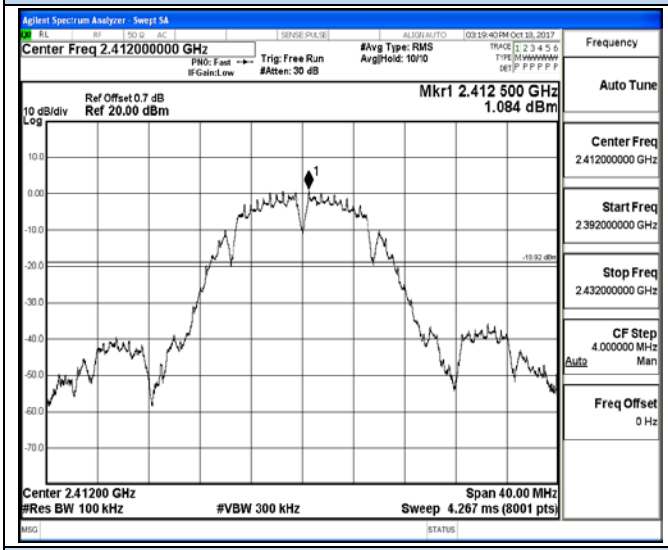
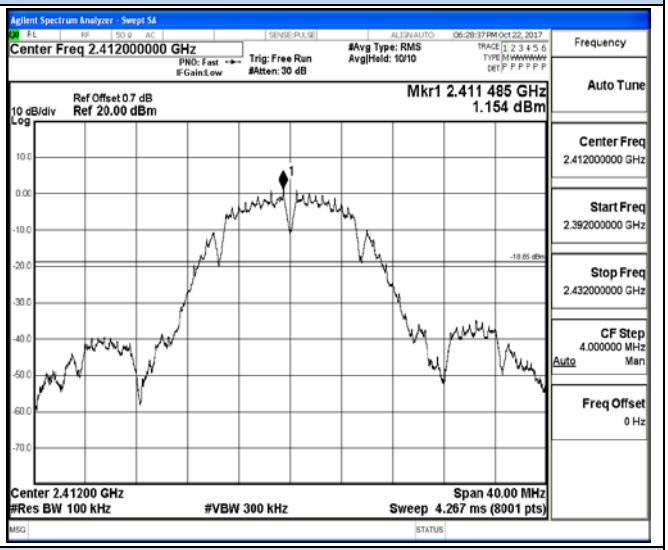
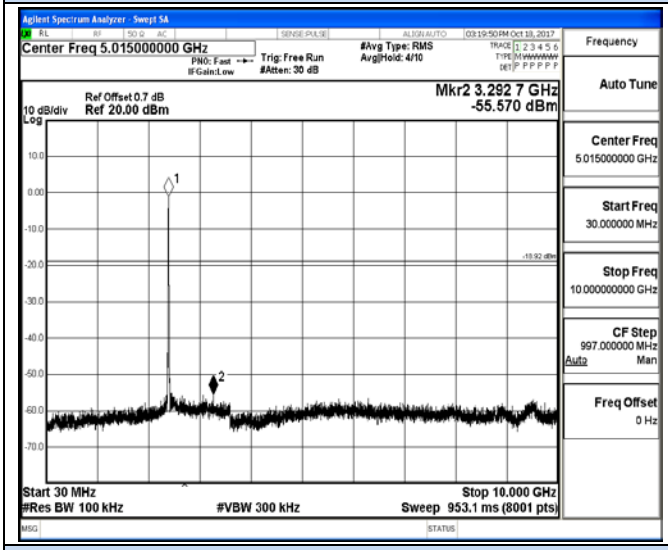
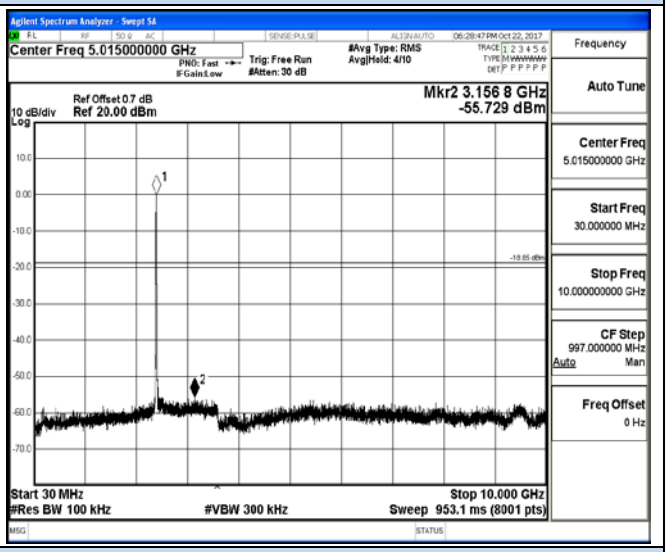
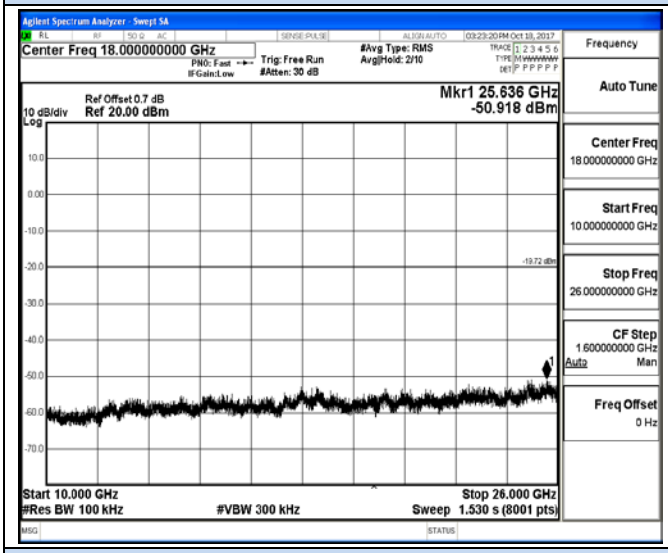
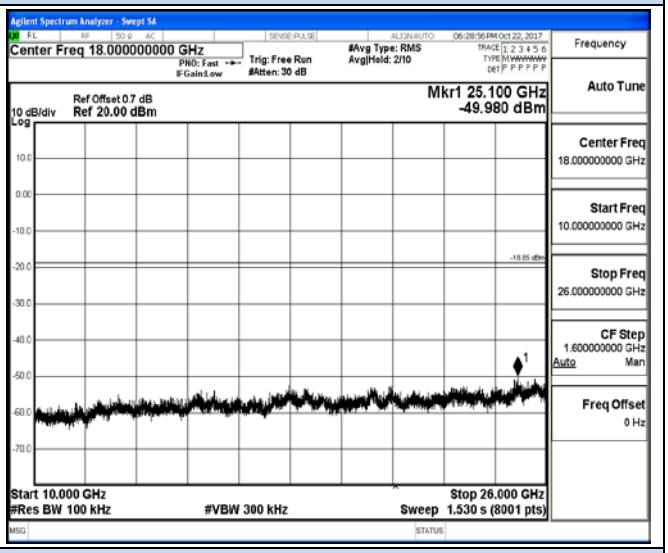
| Test Mode | Channel | Frequency (MHz) | Measured Frequency Range | Spurious RF Conducted Emission (dBc) | | Limits (dBc) | Verdict |
|---|---|---|---|---|---|---|---|
| | | | | Antenna 0 | Antenna 1 | | |
| IEEE 802.11b | 1 | 2412 | 9 KHz – 26.5 GHz | <-20 | <-20 | -20 | PASS |
| | 6 | 2437 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| | 11 | 2462 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| IEEE 802.11g | 1 | 2412 | 9 KHz – 26.5 GHz | <-20 | <-20 | -20 | PASS |
| | 6 | 2437 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| | 11 | 2462 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| IEEE 802.11n HT20 | 1 | 2412 | 9 KHz – 26.5 GHz | <-20 | <-20 | -20 | PASS |
| | 6 | 2437 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| | 11 | 2462 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| IEEE 802.11n HT40 | 3 | 2412 | 9 KHz – 26.5 GHz | <-20 | <-20 | -20 | PASS |
| | 6 | 2437 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| | 9 | 2452 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| BT – LE | 0 | 2402 | 9 KHz – 26.5 GHz | <-20 | <-20 | -20 | PASS |
| | 19 | 2440 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |
| | 39 | 2480 | 9 KHz – 26.5 GHz | <-20 | <-20 | | |

*Remark:*

1. *Measured RF conducted spurious 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. *For conducted emission below 30MHz, no emission was found, therefore, it's not recorded.*
6. *Please refer to following plots;*

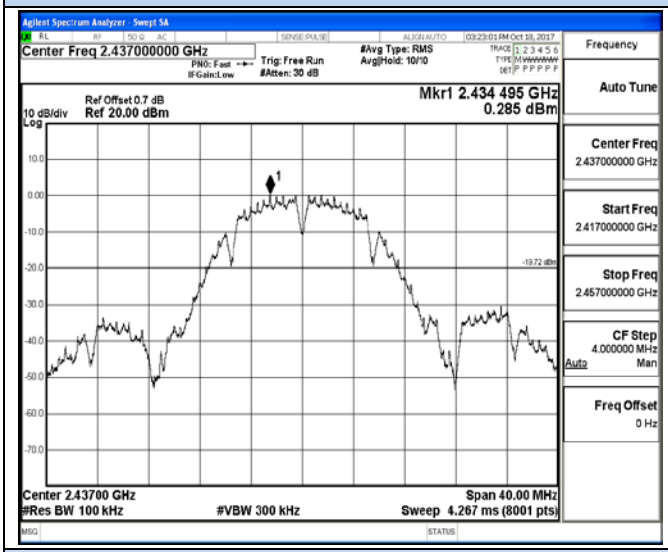
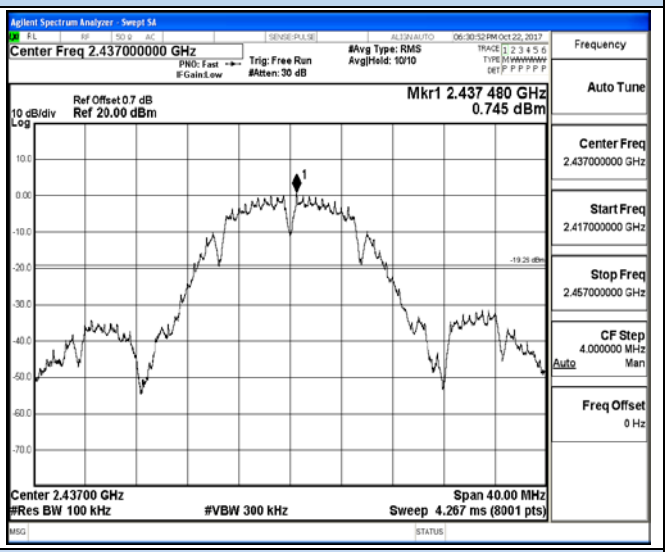
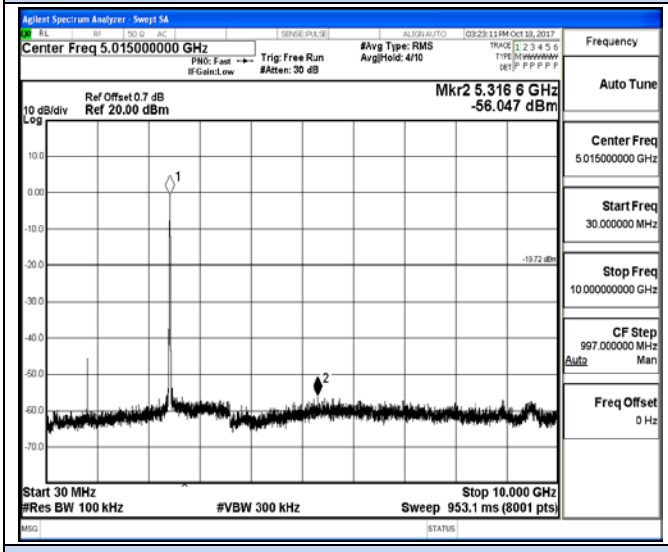
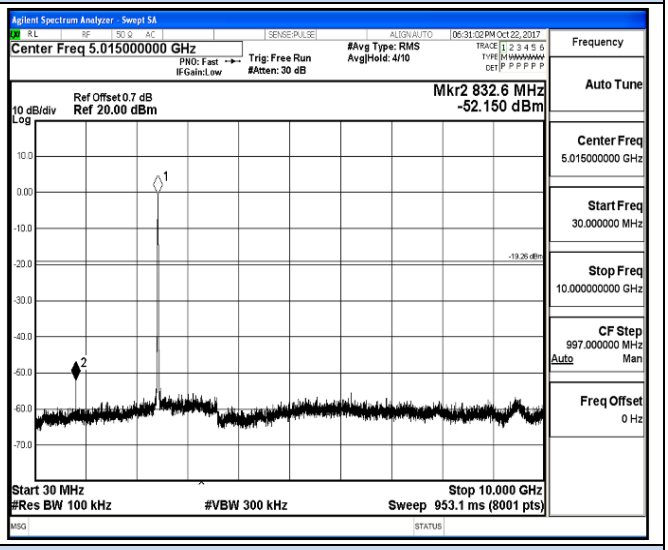
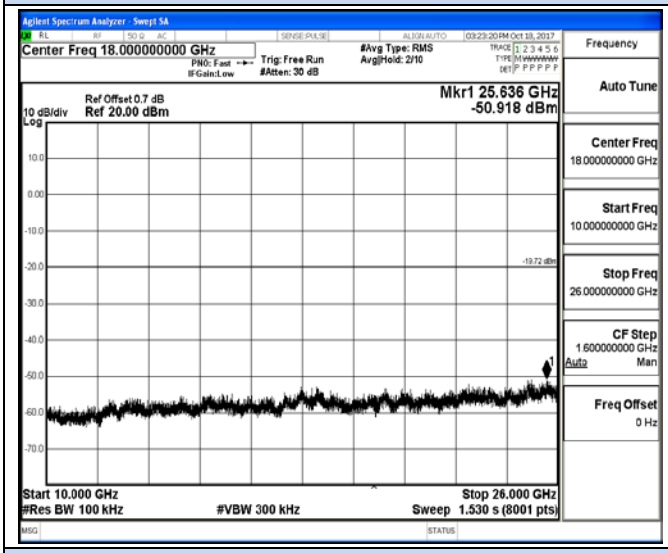
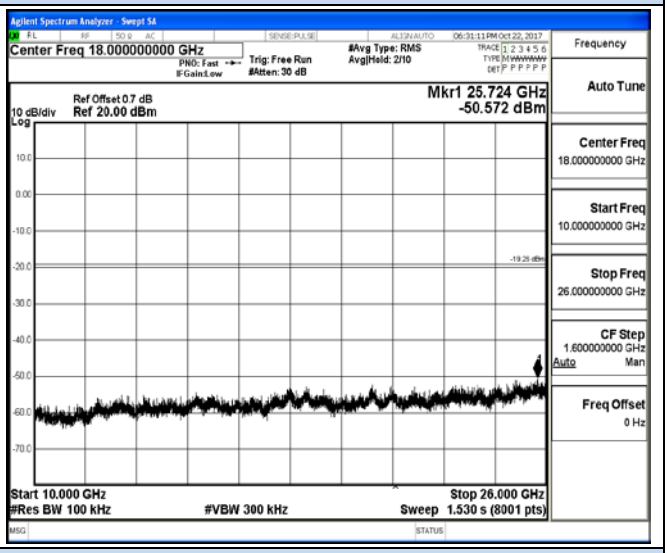
## RF Conducted Spurious Emission

### IEEE 802.11b

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| 2392 MHz – 2432 MHz | 2392 MHz – 2432 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |

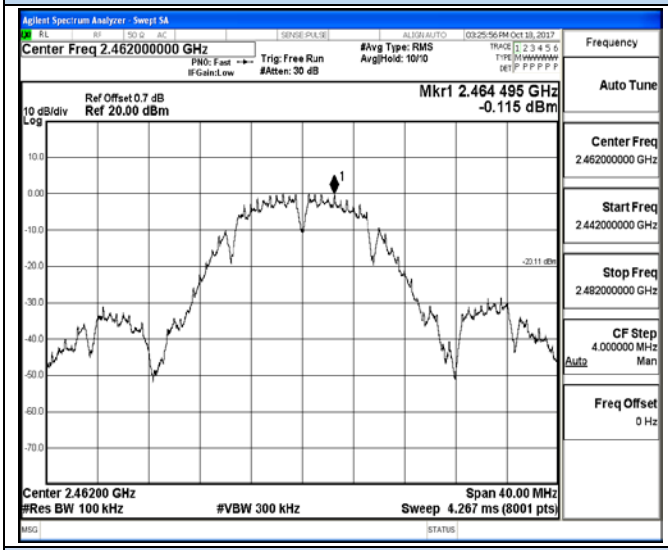
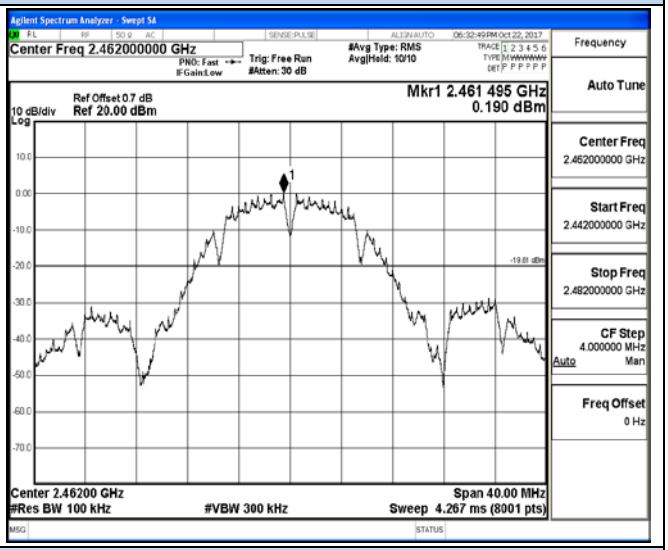
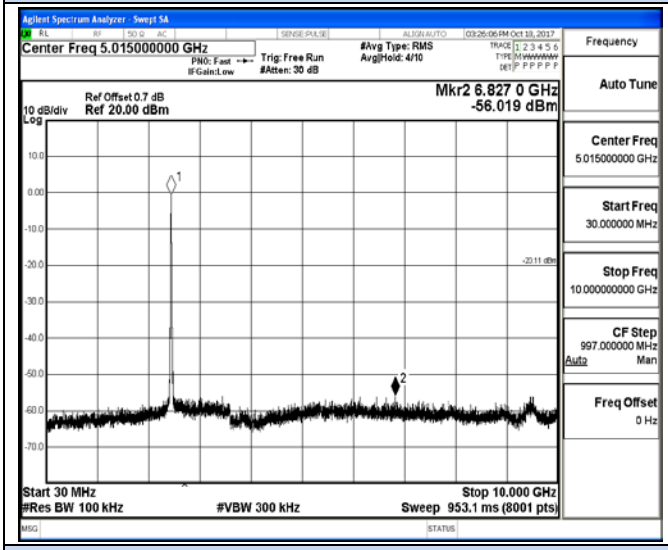
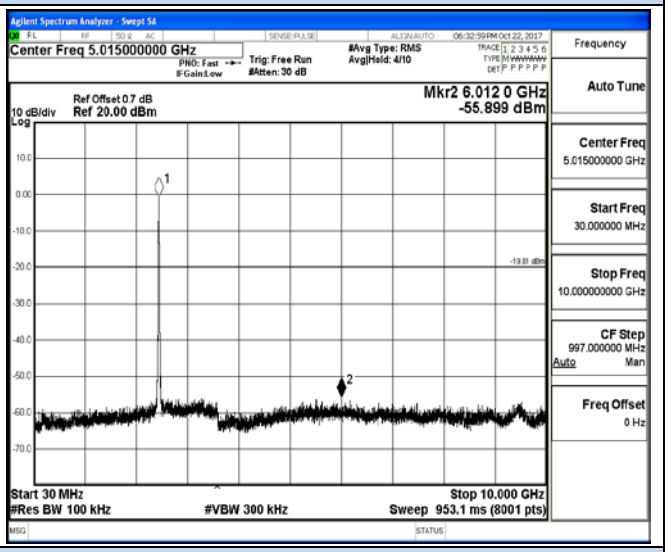
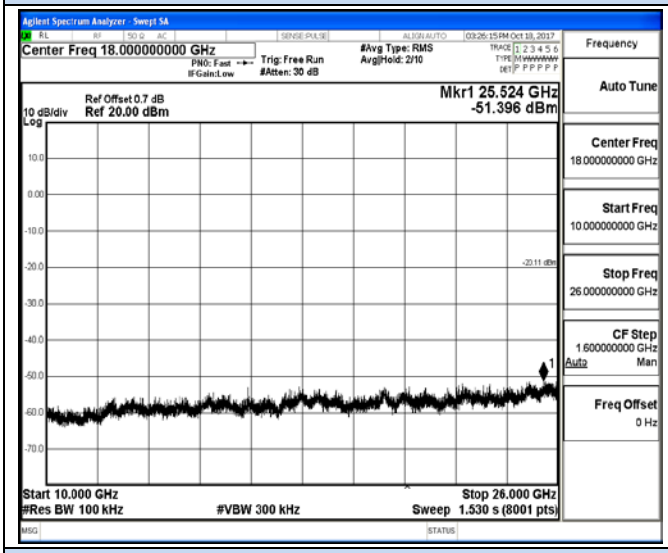
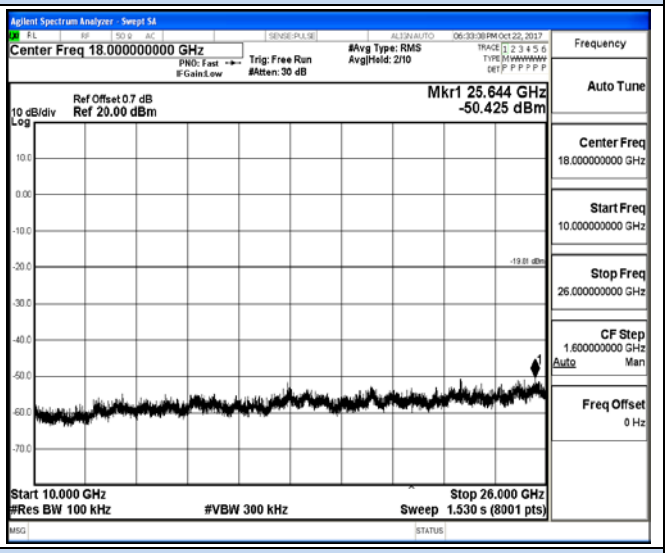
## RF Conducted Spurious Emission

### IEEE 802.11b

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 3 / 2437 MHz | Channel 3 / 2437 MHz |
|  |  |
| 2417 MHz – 2457 MHz | 2417 MHz – 2457 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |

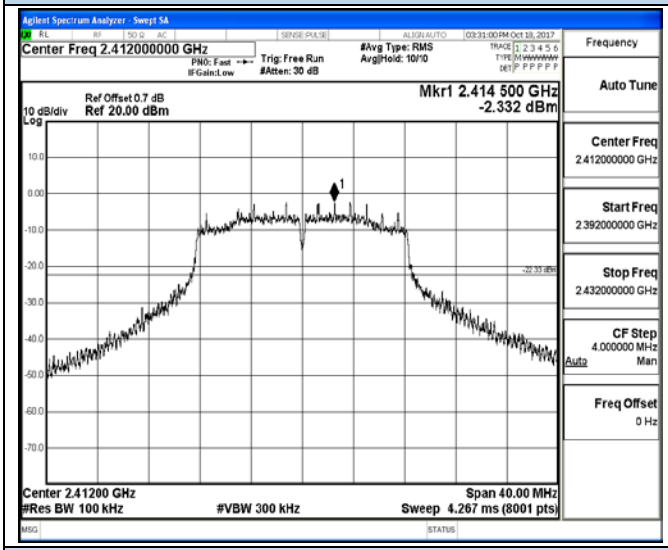
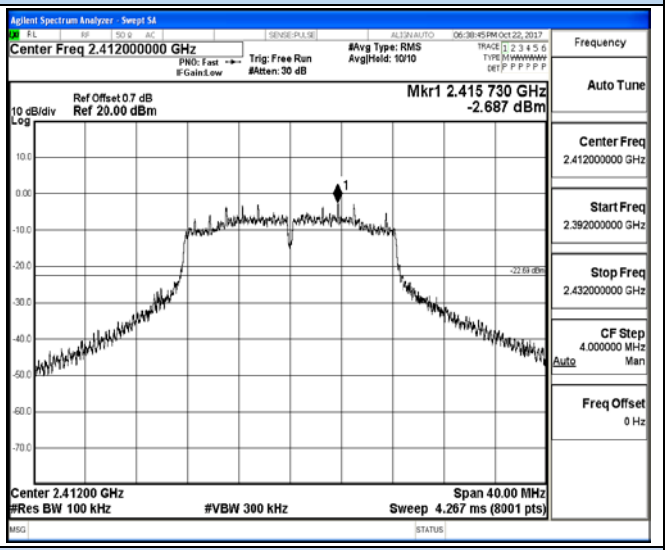
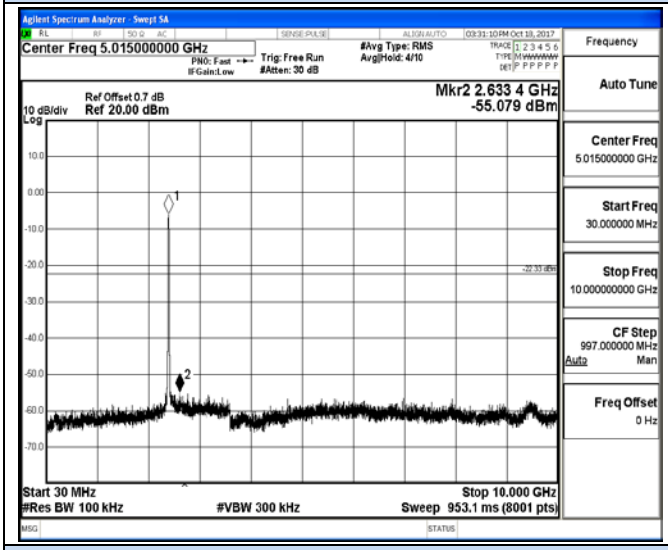
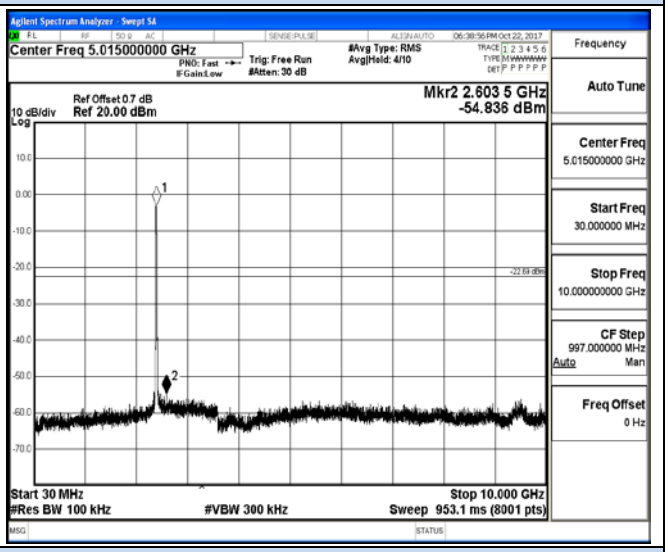
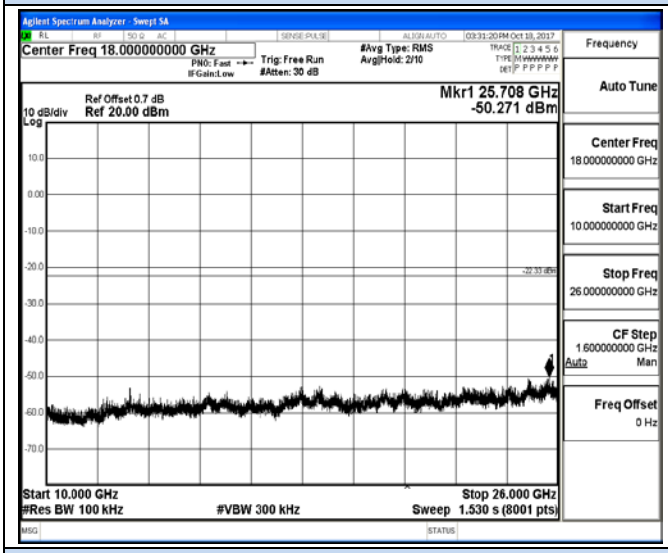
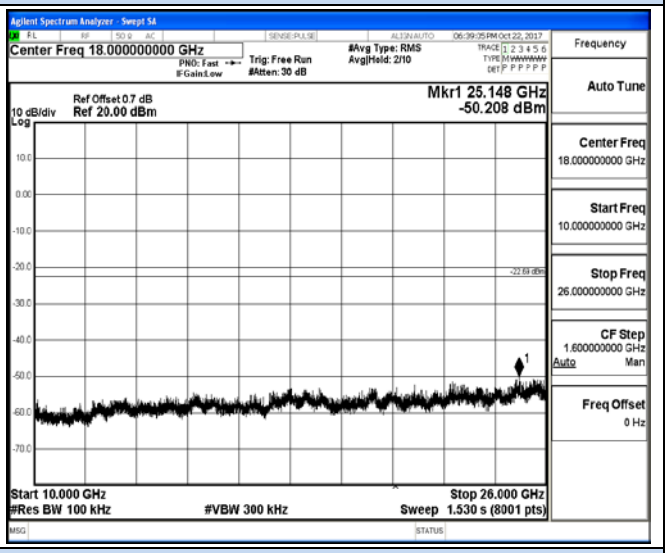
## RF Conducted Spurious Emission

### IEEE 802.11b

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 11 / 2462 MHz | Channel 11 / 2462 MHz |
|  |  |
| 2442 MHz – 2482 MHz | 2417 MHz – 2457 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |

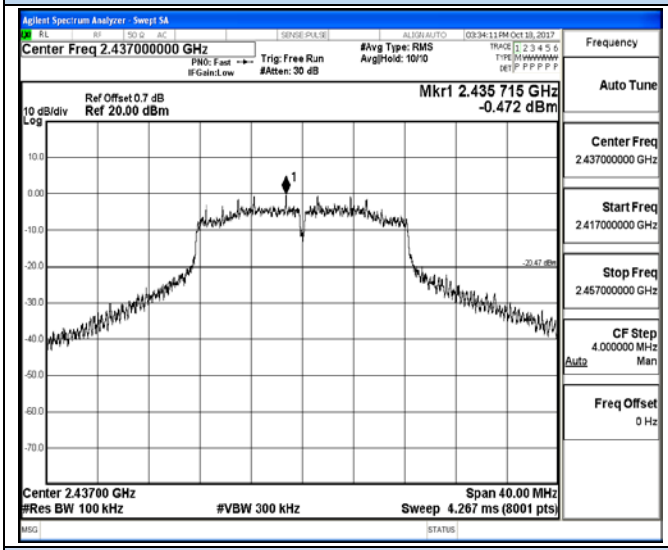
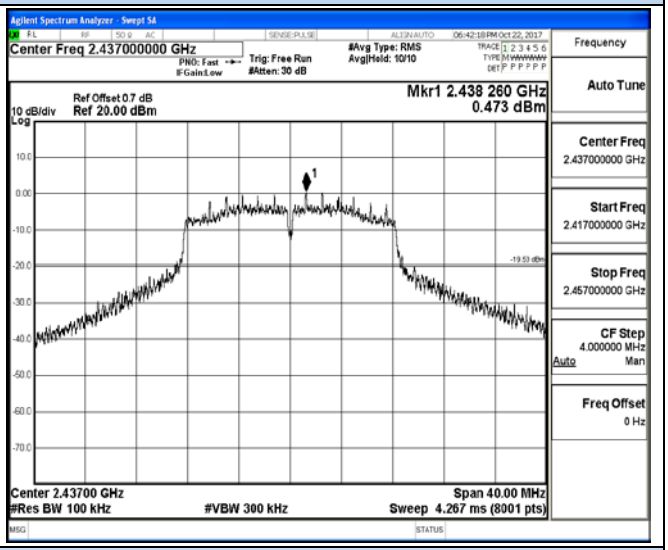
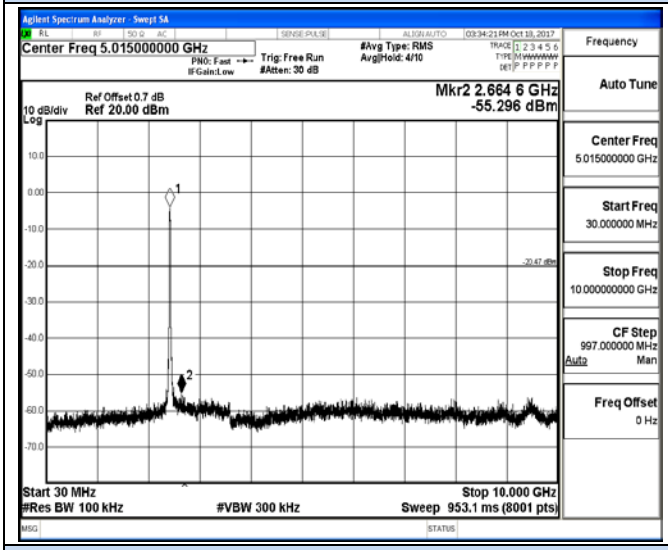
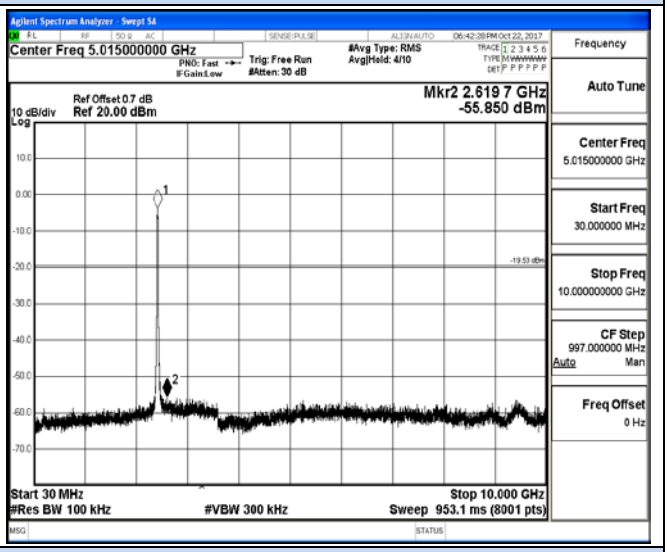
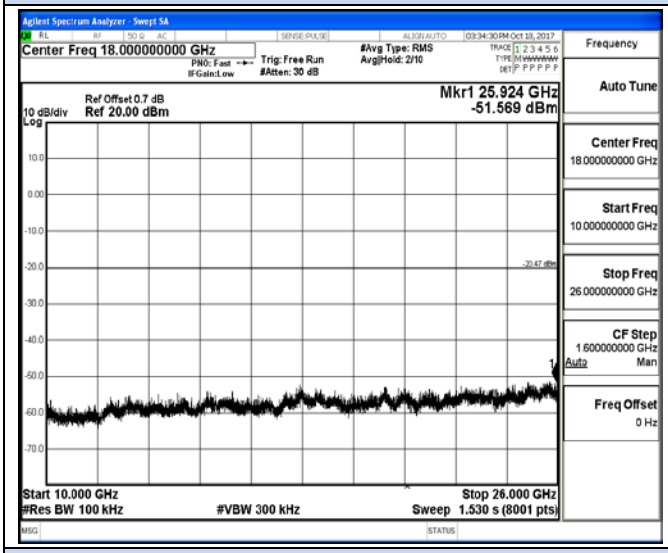
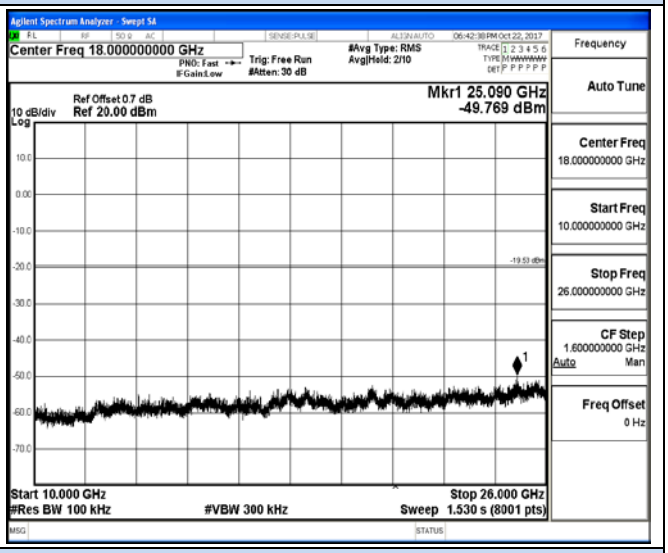
## RF Conducted Spurious Emission

### IEEE 802.11g

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| 2392 MHz – 2432 MHz | 2392 MHz – 2432 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |

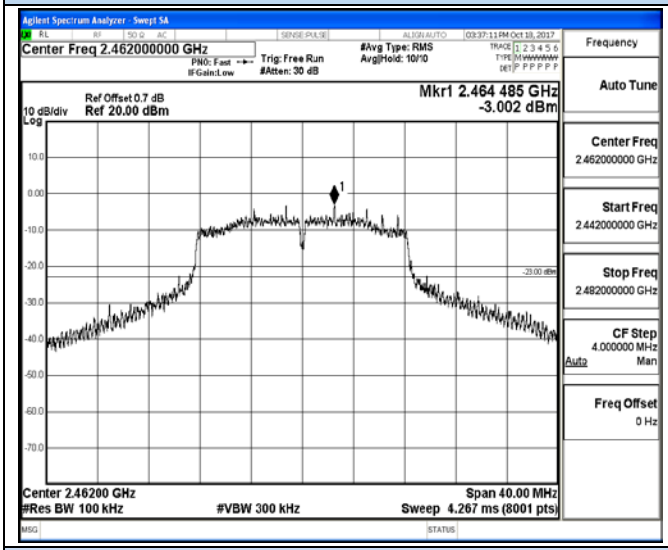
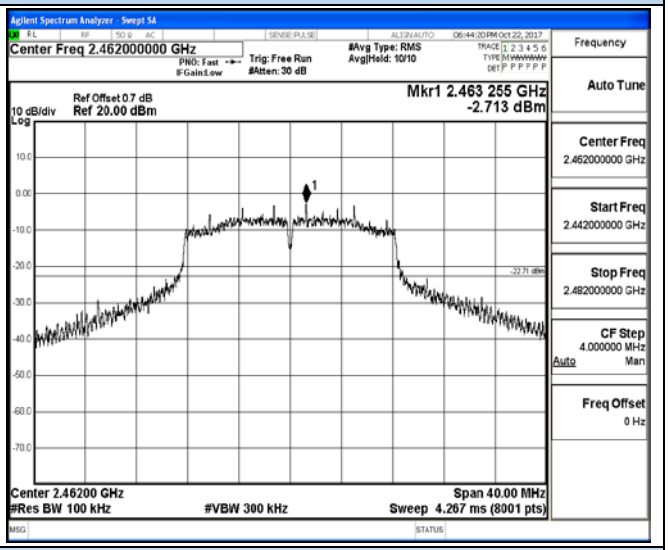
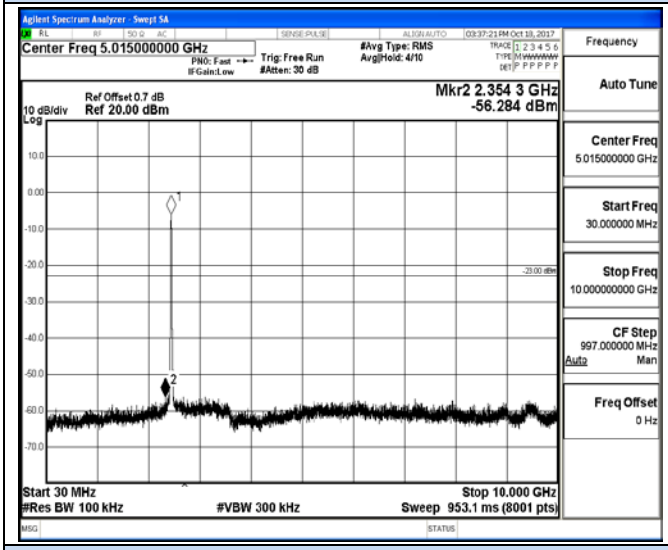
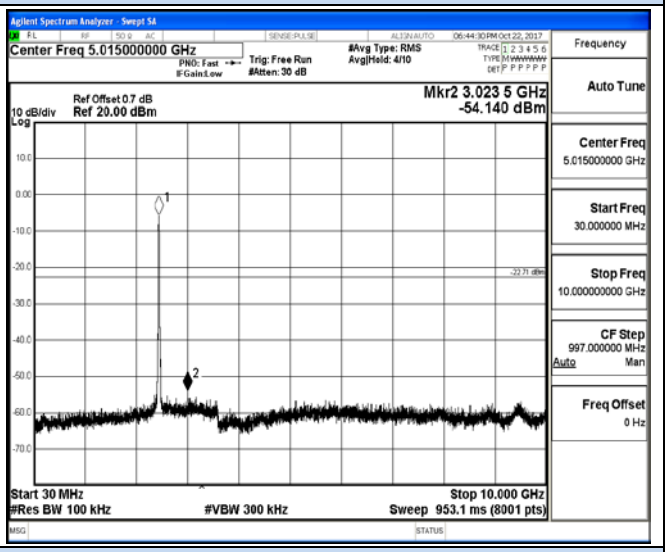
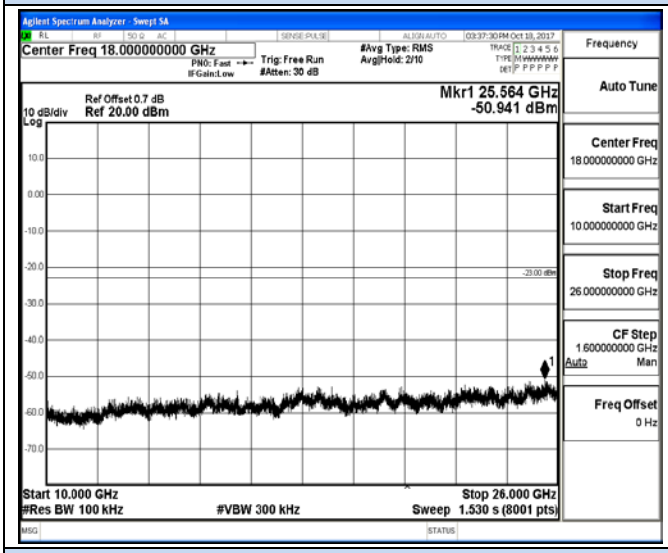
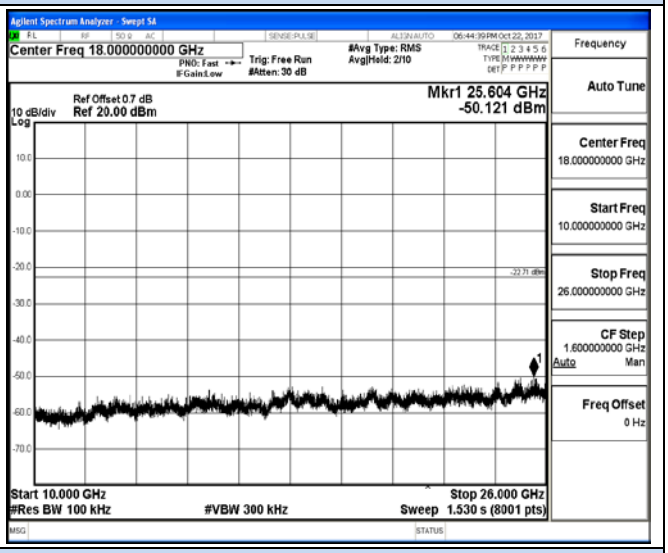
## RF Conducted Spurious Emission

### IEEE 802.11g

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 6 / 2437 MHz | Channel 6 / 2437 MHz |
|  |  |
| 2417 MHz – 2457 MHz | 2417 MHz – 2457 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |

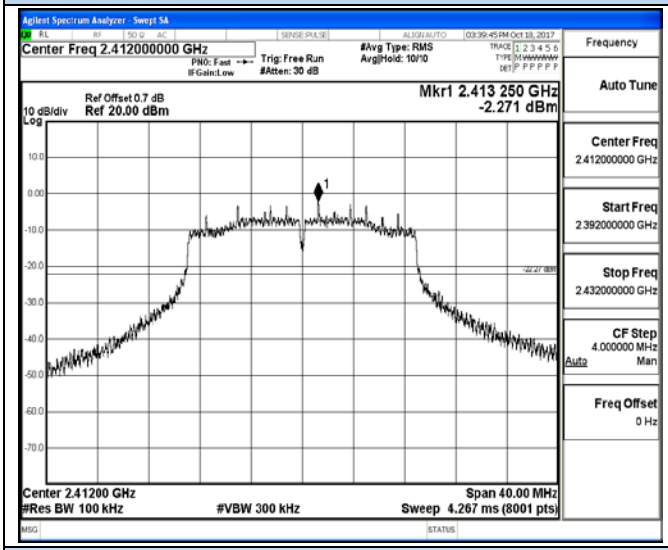
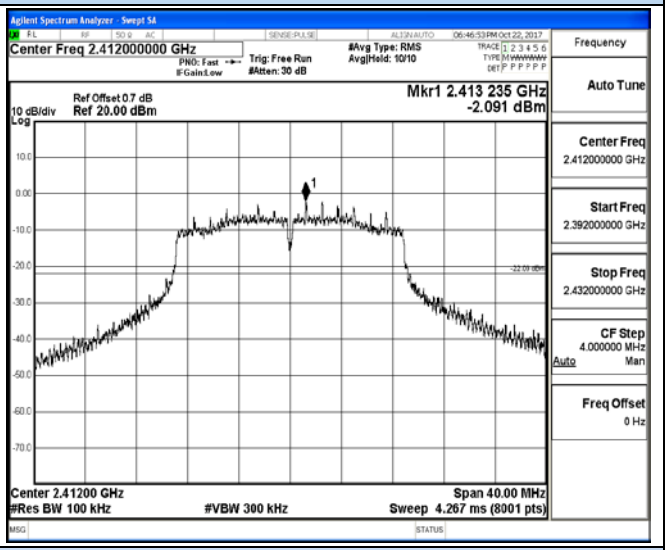
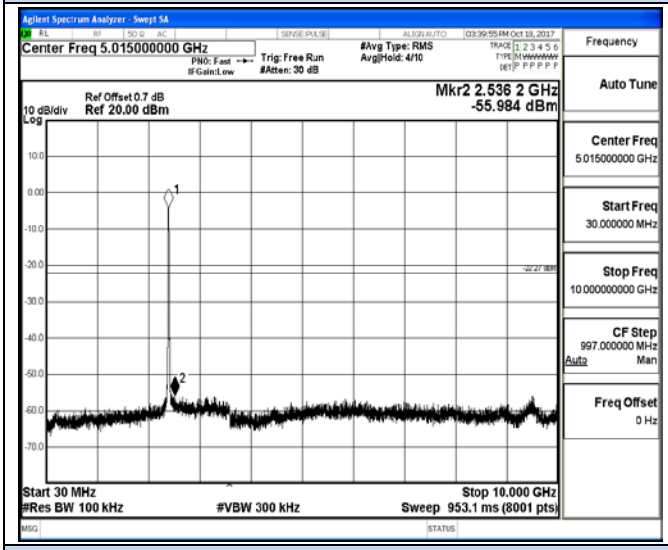
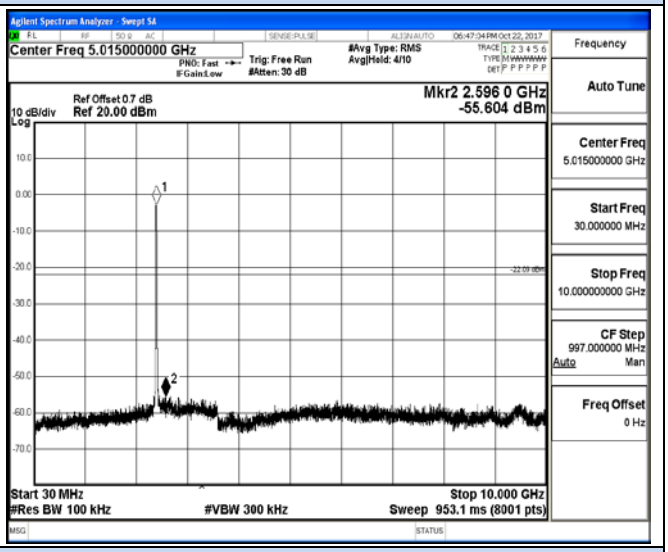
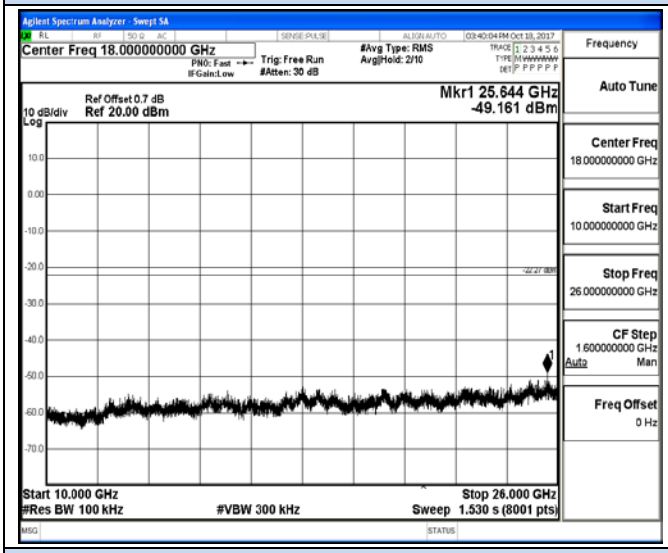
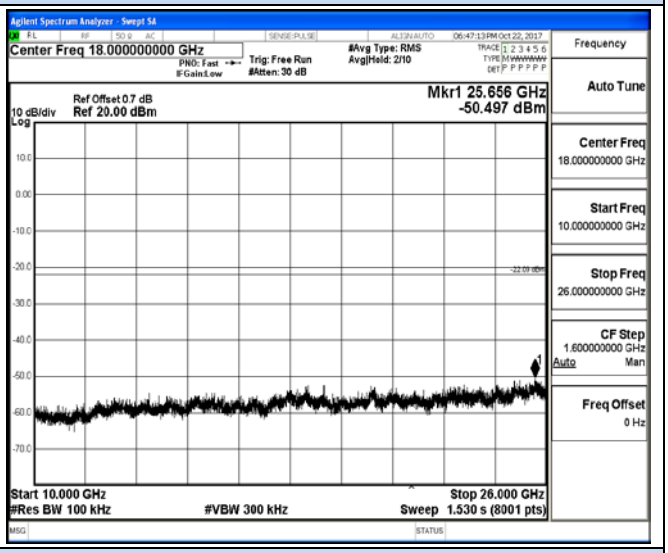
## RF Conducted Spurious Emission

### IEEE 802.11g

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 11 / 2462 MHz | Channel 11 / 2462 MHz |
|  |  |
| 2442 MHz – 2482 MHz | 2417 MHz – 2457 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |

## RF Conducted Spurious Emission

### IEEE 802.11n HT20

| Antenna 0 | Antenna 1 |
|---|---|
| Channel 1 / 2412 MHz | Channel 1 / 2412 MHz |
|  |  |
| 2392 MHz – 2432 MHz | 2392 MHz – 2432 MHz |
|  |  |
| 30 MHz – 10 GHz | 30 MHz – 10 GHz |
|  |  |
| 10 GHz – 26 GHz | 10 GHz – 26 GHz |