

## Electromagnetic Emission

# FCC MEASUREMENT REPORT

### CERTIFICATION OF COMPLIANCE

### FCC Part 15 Certification Measurement

PRODUCT : OPTIZEN WIRELESS  
MODEL/Serial No. : WIRELESS MODULE 01 / Proto type  
MULTIPLE MODEL : -  
FCC ID : QI6-M3  
APPLICANT : MECASYS Co., Ltd.  
10F, 640-3, Banseok-Dong, Yuseong-Gu, Daejeon 305-325, Korea  
Attn.: Yong Kwan, Kim / Manager  
MANUFACTURER : MECASYS Co., Ltd.  
10F, 640-3, Banseok-Dong, Yuseong-Gu, Daejeon 305-325, Korea  
FCC CLASSIFICATION : DSS (Part 15 Spread Spectrum Transmitter)  
TYPE OF MODULATION : DSSS (CCK), OFDM (QAM)  
FREQUENCY CHANNEL : 2 412 MHz to 2 472 MHz and Channel Spacing 5 MHz (13 Ch)  
AIR DATE RATE : 11 Mbps (802.11b), 54 Mbps (802.11g), 65 Mbps (802.11n(HT20))  
ANTENNA TYPE : Chip Antenna (Integral)  
ANTENNA GAIN : 1.90 dBi max  
RF POWER : 6.592 mW  
RULE PART(S) : FCC Part 15 Subpart C  
FCC PROCEDURE : ANSI C63.4-2003  
TEST REPORT No. : ETLE120917.1083  
DATES OF TEST : September 26, 2012 to September 28, 2012  
REPORT ISSUE DATE : October 12, 2012  
TEST LABORATORY : ETL Inc. (FCC Designation Number : KR0022)

The OPTIZEN WIRELESS, Model WIRELESS MODULE 01 has been tested in accordance with the measurement procedures specified in ANSI C63.4-2003 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.247.

I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by:

Hoon Pyo, Lee (Test Engineer)

October 12, 2012

Reviewed by:

Kug Kyoung, Yoon (Chief Engineer)

October 12, 2012

**ETL Inc.**

**#371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea**

**Tel: 82-2-858-0786 Fax: 82-2-858-0788**

*The test report merely corresponds to the test sample(s).*

*This report shall not be reproduced, in whole or in part without the written approval of ETL Inc.*

## Table of Contents

### **FCC Measurement Report**

- 1. Introduction**
- 2. Product Information**
- 3. Description of Tests**
- 4. Test Condition**
- 5. Test Results**
  - 5.1 Summary of Test Results**
  - 5.2 6 dB Bandwidth**
  - 5.3 Maximum Peak Output Power**
  - 5.4 Bandwidth of Frequency Band Edges**
  - 5.5 Power Spectral Density**
  - 5.6 Spurious Emissions**
  - 5.7 Conducted Emissions Test**
  - 5.8 Radio Frequency Exposure**
- 6. Sample Calculation**
- 7. List of test Equipment used for Measurement**

**Appendix A. FCC ID Label and Location**

**Appendix B. Test Setup Photographs**

**Appendix C. External Photographs**

**Appendix D. Block Diagram**

**Appendix E. Circuit Diagram**

**Appendix F. User Manual**

**Appendix G. Operational Description**

**Appendix H. Antenna Requirement**

**Appendix I. Radio Frequency Exposure**

## FCC MEASUREMENT REPORT

**Scope** – Measurement and determination of electromagnetic emission (EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)

### General Information

|                       |                                                                   |
|-----------------------|-------------------------------------------------------------------|
| <b>Applicant Name</b> | : MECASYS Co., Ltd.                                               |
| <b>Address</b>        | : 10F, 640-3, Banseok-Dong, Yuseong-Gu,<br>Daejeon 305-325, Korea |
| <b>Attention</b>      | : Yong Kwan, Kim / Manager                                        |

- **EUT Type** : OPTIZEN WIRELESS
- **Model Number** : WIRELESS MODULE 01
- **S/N** : Proto type
- **Freq. Range** : 2 412 MHz - 2 472 MHz
- **Number of Channels** : 13
- **Modulation Technique** : DSSS (CCK), OFDM (QAM)
- **Frequency Channel** : 2 412 MHz to 2 472 MHz and Channel Spacing 5 MHz (13 Ch)
- **Air Data Rate** : 11 Mbps (802.11b), 54 Mbps (802.11g), 65 Mbps (802.11n(HT20))
- **Antenna Type** : Chip Antenna (Integral)
- **Antenna Gain** : 1.90 dBi max
- **RF Power** : 6.592 mW
- **FCC Rule Part(s)** : FCC Part 15 Subpart C
- **Test Procedure** : ANSI C63.4-2003
- **FCC Classification** : DSS (Part 15 Spread Spectrum Transmitter)
- **Place of Tests** : ETL Inc. Testing Lab.  
Radiated Emission test;  
#499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do,  
445-882, Korea  
  
Conducted Emission test;  
ETL Inc. Testing Lab.  
371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

## 1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.4-2003 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.4-2003 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2003) was used in determining radiated and conducted emissions from the MECASYS Co., Ltd. Model: WIRELESS MODULE 01

## 2. PRODUCT INFORMATION

### 2.1 Equipment Description

The Equipment Under Test (EUT) is the OPTIZEN WIRELESS (model: WIRELESS MODULE 01).

### 2.2 General Specification

| Item                   | Specification                |                                    |
|------------------------|------------------------------|------------------------------------|
| Input Power            | DC 3.3 V                     |                                    |
| Module Connection      | 60 pin, LGA                  |                                    |
| Dimensions             | 10.0 mm x 10.0 mm x 1.4 mm   |                                    |
| H/W Interface          | Wi-Fi                        | SDIO/SPI                           |
|                        | BT                           | UART                               |
| Standard               | Wi-Fi                        | 802.11b: DSSS                      |
|                        |                              | 802.11g/n: OFDM                    |
|                        | BT                           | Bluetooth 2.1 + EDR                |
| Data Rate              | Wi-Fi                        | 802.11b: 11 Mbps (Max)             |
|                        |                              | 802.11g: 54 Mbps (Max)             |
|                        |                              | 802.11n: 65 Mbps (Max)             |
|                        | BT                           | 2.0 (EDR) of 1, 2 & 3              |
| Frequency Range        | Wi-Fi                        | 802.11b/g/n: 2.412 GHz - 2.472 GHz |
|                        | BT                           | 2.402 GHz - 2.480 GHz              |
| RF Receive Sensitivity | Wi-Fi                        | 802.11b 11 Mbps: -87 dBm (Typ)     |
|                        |                              | 802.11g 54 Mbps: -72 dBm (Typ)     |
|                        |                              | 802.11n 65 Mbps: -69 dBm (Typ)     |
| RF Transmit Power      | Wi-Fi                        | 802.11b: < 13 dBm (Typ)            |
|                        |                              | 802.11g/n: < 15 dBm (Typ)          |
|                        | BT                           | < 2.0 dBm (Typ)                    |
| Security               | WEP (64 bits/128 bits)       |                                    |
|                        | WPA (TKIP + 802.1X)          |                                    |
|                        | 802.11i (AES, TKIP, 802.1X)  |                                    |
| Temperature Range      | Operating: (17.5 ± 37.5) °C  |                                    |
|                        | Storage: (22.5 ± 62.5) °C    |                                    |
| Humidity               | Max 95 % R.H. non-condensing |                                    |

## 3. DESCRIPTION OF TESTS

The tests documented in this report were performed in accordance with ANSI C63.4-2003 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209 and 15.247.

### 3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.4-2003 "Measurement of Intentional radiators" The measurements were performed over the frequency range of 30 MHz to 40 GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak, Quasi-peak, Average" within a bandwidth of 120 kHz and above 1 GHz is 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site at 3 m. The test equipment was laced on a wooden turn-table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The detector function was set to CISPR Quasi-peak mode and the bandwidth of the receiver was set to 120 kHz or 1 MHz depending on the frequency of type of signal. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8 m high nonmetallic 1.0 m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

## 3.2 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.4-2003 "measurement of intentional radiators". The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50  $\Omega$ /50  $\mu$ H LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1.5 m x 0.8 m wooden table which is placed 0.4 m away from the vertical wall and 1.5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner  $\phi$  1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.



## 3.3 FCC Part 15.205 Restricted Bands of Operations

(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       |
| <sup>1</sup> 0.495 - 0.505 | 16.694 75 - 16.695 25   | 608 - 614         | 5.35 - 5.46      |
| 2.173 5 - 2.190 5          | 16.804 25 - 16.804 75   | 960 - 1 240       | 7.25 - 7.75      |
| 4.125 - 4.128              | 25.5 - 25.67            | 1 300 - 1 427     | 8.025 - 8.5      |
| 4.177 25 - 4.177 75        | 37.5 - 38.25            | 1 435 - 1 626.5   | 9.0 - 9.2        |
| 4.207 25 - 4.207 75        | 73 - 74.6               | 1 645.5 - 1 646.5 | 9.3 - 9.5        |
| 6.215 - 6.218              | 74.8 - 75.2             | 1 660 - 1 710     | 10.6 - 12.7      |
| 6.267 75 - 6.268 25        | 108 - 121.94            | 1 718.8 - 1 722.2 | 13.25 - 13.4     |
| 6.311 75 - 6.312 25        | 123 - 138               | 2 200 - 2 300     | 14.47 - 14.5     |
| 8.291 - 8.294              | 149.9 - 150.05          | 2 310 - 2 390     | 15.35 - 16.2     |
| 8.362 - 8.366              | 156.524 75 - 156.525 25 | 2 483.5 - 2 500   | 17.7 - 21.4      |
| 8.376 25 - 8.386 75        | 156.7 - 156.9           | 2 690 - 2 900     | 22.01 - 23.12    |
| 8.414 25 - 8.414 75        | 162.012 5 - 167.17      | 3 260 - 3 267     | 23.6 - 24.0      |
| 12.29 - 12.293             | 167.72 - 173.2          | 3 332 - 3 339     | 31.2 - 31.8      |
| 12.519 75 - 12.520 25      | 240 - 285               | 3 345.8 - 3 358   | 36.43 - 36.5     |
| 12.576 75 - 12.577 25      | 322 - 335.4             | 3 600 - 4 400     | ( <sup>2</sup> ) |
| 13.36 - 13.41              |                         |                   |                  |

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490 MHz - 0.510 MHz.

<sup>2</sup> Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.



## 4. TEST CONDITION

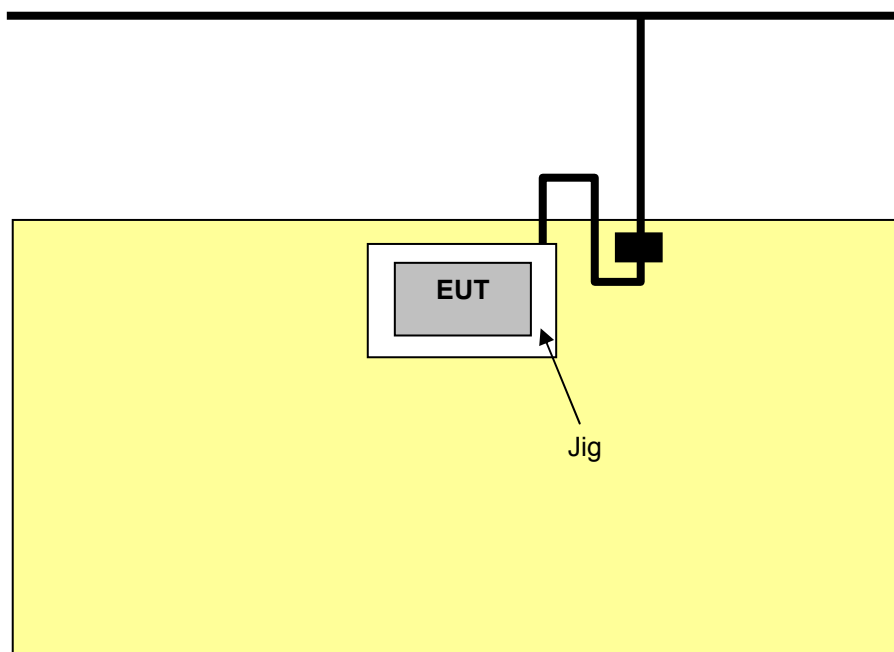
### 4.1 Test Configuration

The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the following conditions and configurations were used.

### 4.2 Description of Test modes

OPTIZEN WIRELESS that has the control software.

### 4.3 The setup drawing(s)



- : Signal line
- : Power line
- : Adapter

## 5. TEST RESULTS

### 5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

| 47 CFR Part 15, Subpart C | Measurement Required              | Result |
|---------------------------|-----------------------------------|--------|
| 15.247(a)(2)              | 6 dB Bandwidth                    | Pass   |
| 15.247(b)(3)              | Maximum Peak Output Power         | Pass   |
| 15.247(d)                 | Bandwidth of Frequency Band Edges | Pass   |
| 15.247(e)                 | Power Spectral Density            | Pass   |
| 15.209(a)                 | Spurious Emissions                | Pass   |
| 15.207                    | Conducted Emissions               | Pass   |
| 15.247(i)<br>1.1307(b)(1) | RF Exposure                       | Pass   |

The data collected shows that the **MECASYS Co., Ltd. / OPTIZEN WIRELESS / WIRELESS MODULE 01** complied with technical requirements of above rules part 15.207, 209 and 15.247 Limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

## 5.2 6 dB Bandwidth

|                     |                                                 |
|---------------------|-------------------------------------------------|
| EUT                 | OPTIZEN WIRELESS / WIRELESS MODULE 01           |
| Limit apply to      | FCC Part 15.247(a)(2)                           |
| Test Date           | September 26, 2012                              |
| Operating Condition | RF transmitting continuously during the tested. |
| Result              | Passed                                          |

### Limit

The maximum 6 dB bandwidth shall be at least 500 kHz.

### Test Data

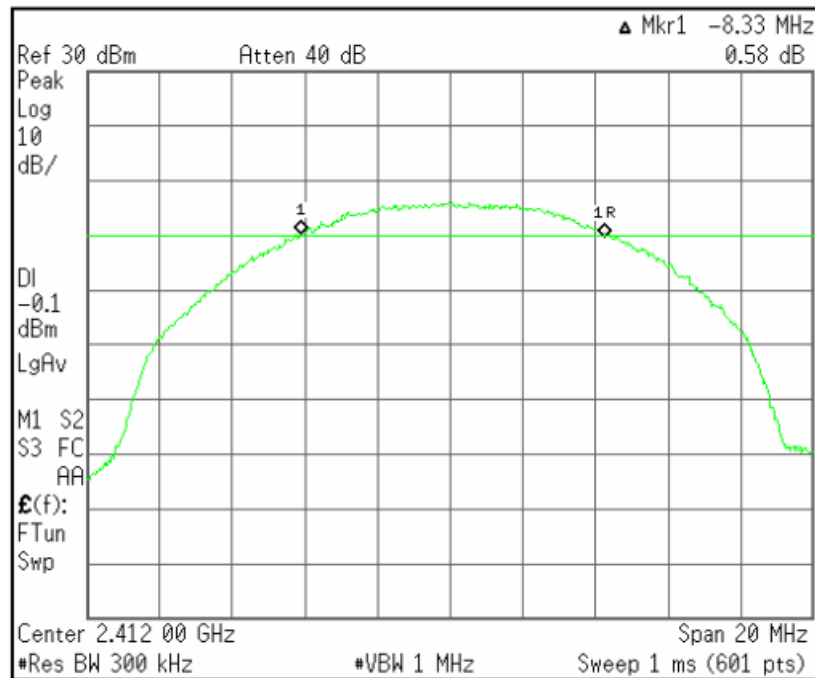
| Mode          | Frequency [MHz] | 6 dB Bandwidth [MHz] | Limit     |
|---------------|-----------------|----------------------|-----------|
| 802.11b       | 2 412           | 8.33                 | > 500 kHz |
|               | 2 442           | 8.67                 |           |
|               | 2 472           | 8.97                 |           |
| 802.11g       | 2 412           | 16.43                |           |
|               | 2 442           | 16.40                |           |
|               | 2 472           | 16.30                |           |
| 802.11n(HT20) | 2 412           | 17.40                |           |
|               | 2 442           | 17.47                |           |
|               | 2 472           | 17.50                |           |

### NOTES:

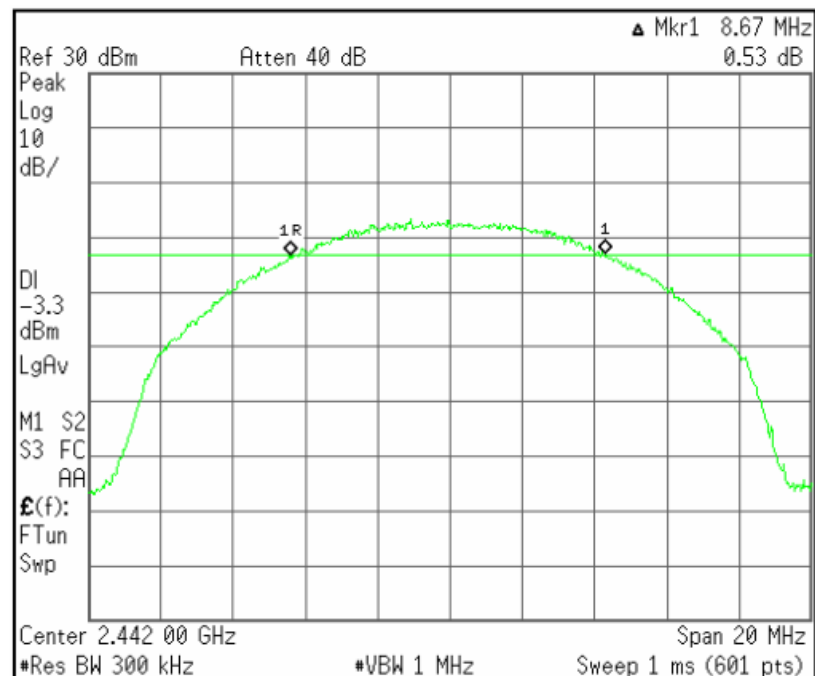
1. Measure frequency separation of relevant channel using spectrum analyzer.
2. RBW 300 kHz, VBW 1 MHz, Sweep time Auto.
3. Please see the measured plot in next page.

## Plots of 6 dB Bandwidth (802.11b)

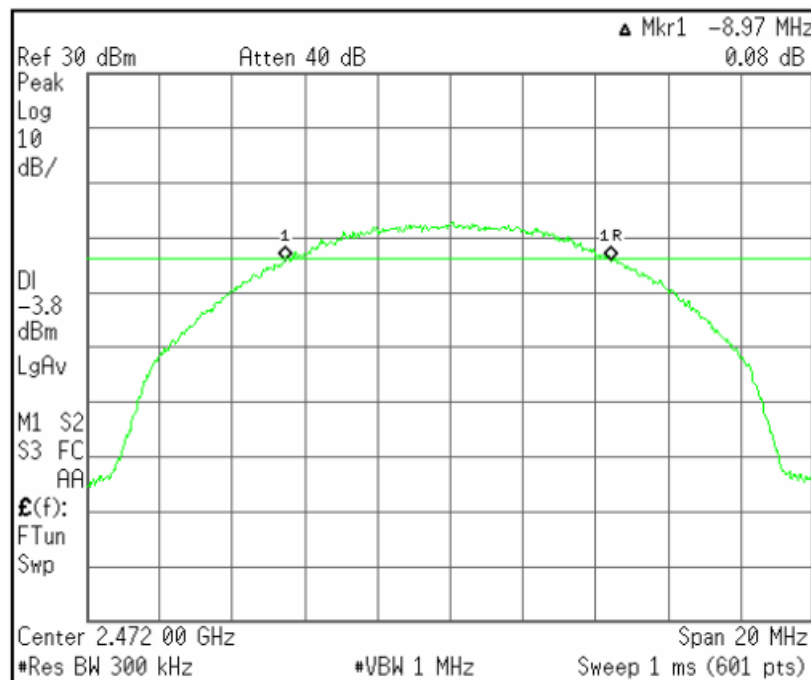
[2 412 MHz]



[2 442 MHz]

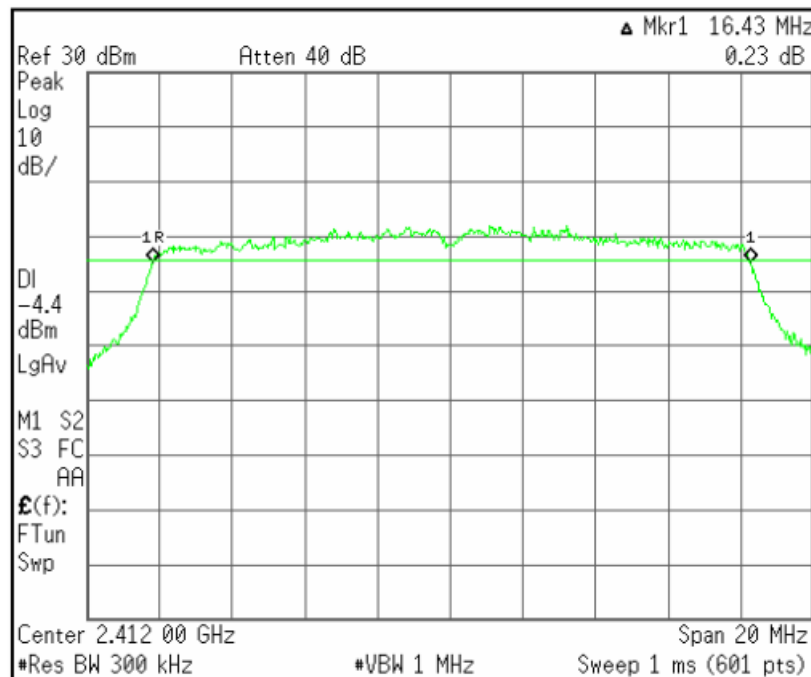


[2 472 MHz]

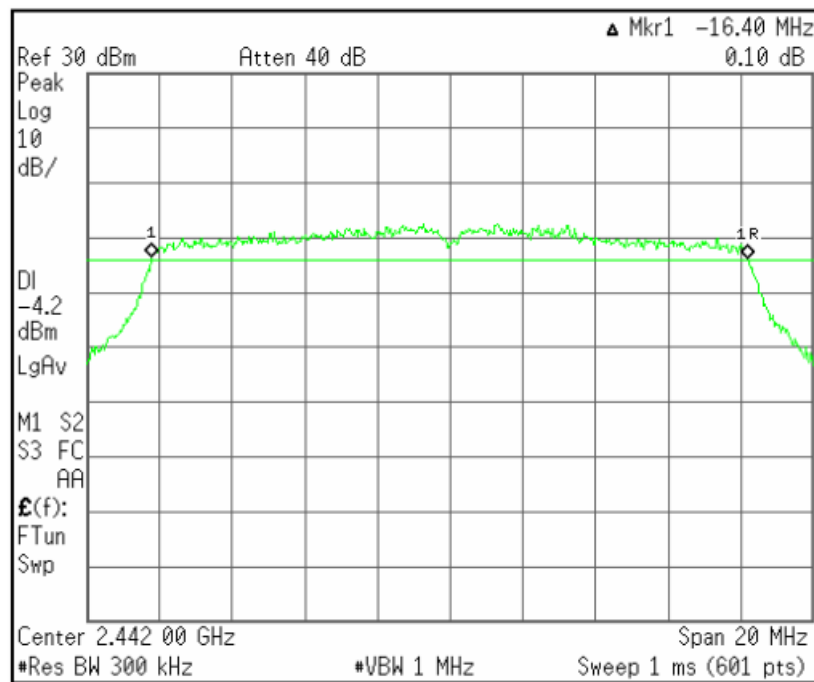


## Plots of 6 dB Bandwidth (802.11g)

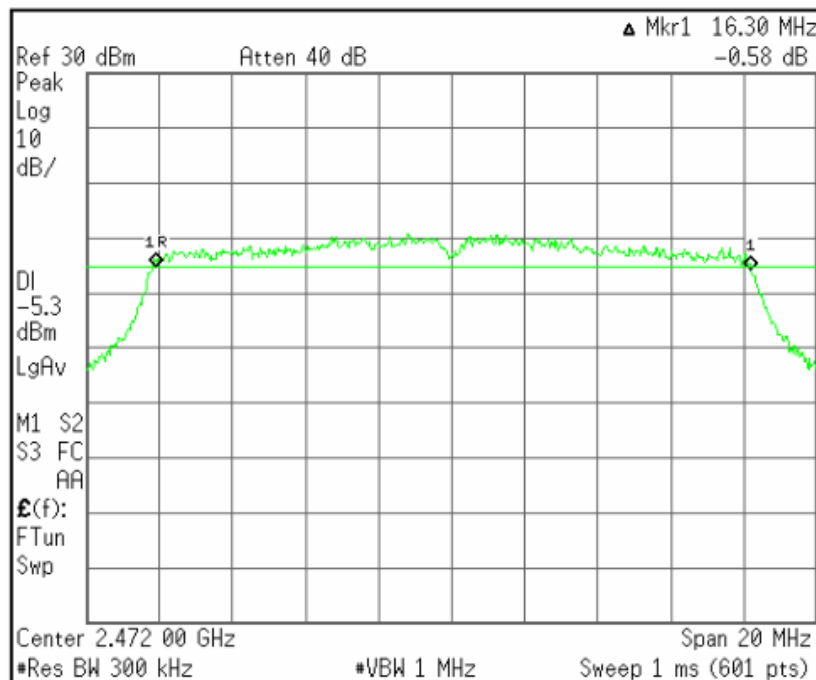
[2 412 MHz]



[2 442 MHz]

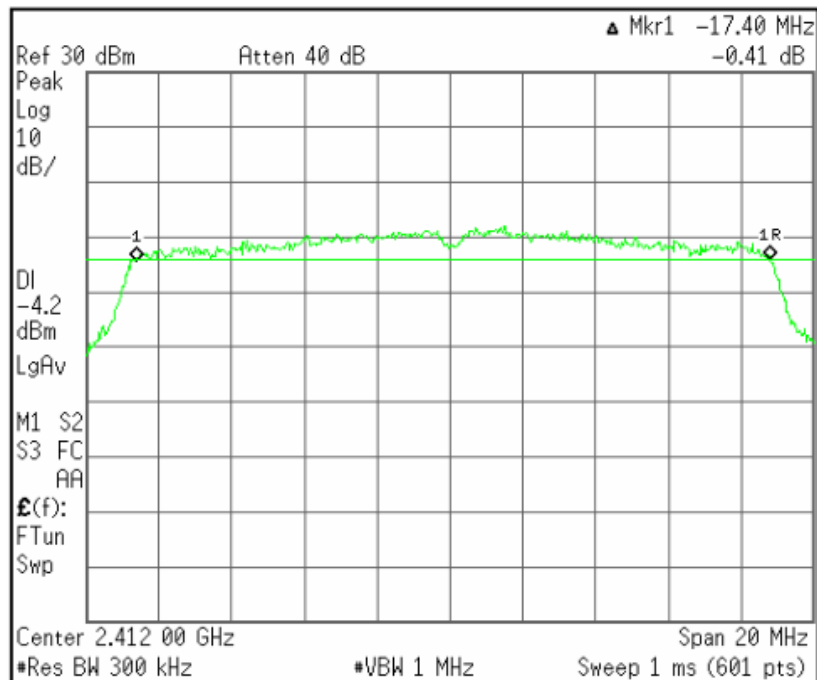


[2 472 MHz]

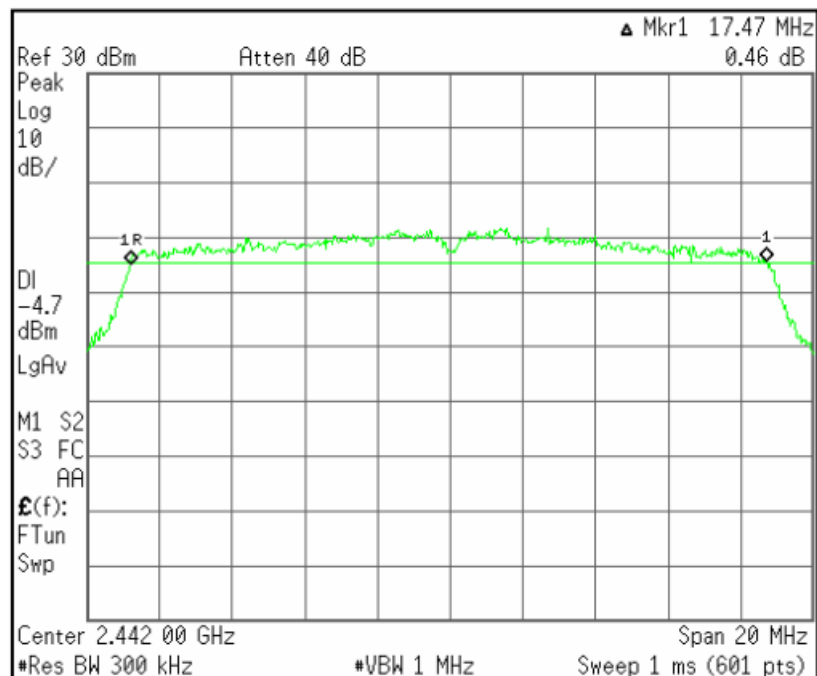


## Plots of 6 dB Bandwidth (802.11n(HT20))

[2 412 MHz]

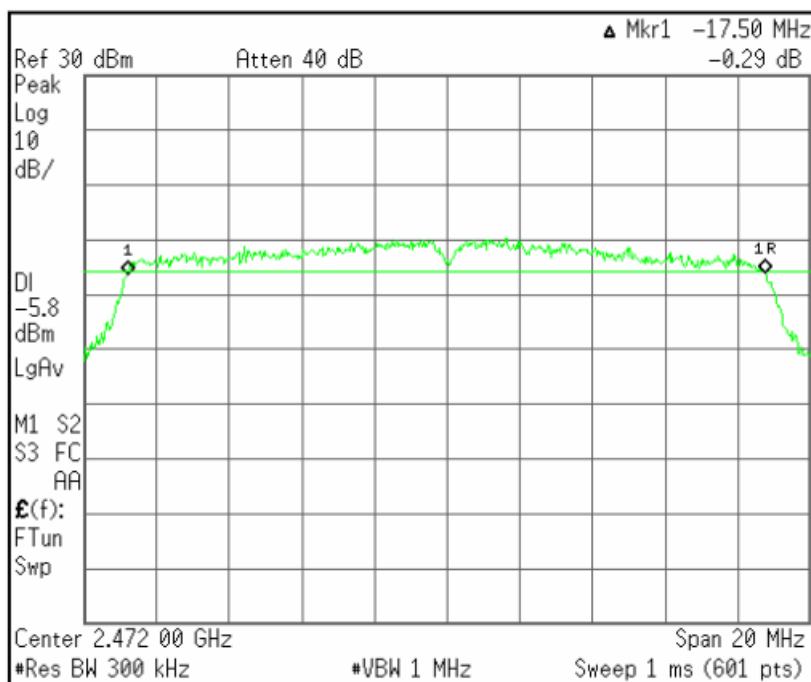


[2 442 MHz]





[2 472 MHz]



## 5.3 Maximum Peak Conducted Output Power

|                     |                                                 |
|---------------------|-------------------------------------------------|
| EUT                 | OPTIZEN WIRELESS / WIRELESS MODULE 01           |
| Limit apply to      | FCC Part 15.247(b)(3)                           |
| Test Date           | September 26, 2012                              |
| Operating Condition | RF transmitting continuously during the tested. |
| Result              | Passed                                          |

### Limit

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2 400.0 MHz - 2 483.5 MHz band: 1 Watt

### Test Data

| Mode          | Frequency [MHz] | Output Power [dBm] | Limit             |
|---------------|-----------------|--------------------|-------------------|
| 802.11b       | 2 412           | 8.19               | < 30.00 dBm (1 W) |
|               | 2 442           | 6.72               |                   |
|               | 2 472           | 5.62               |                   |
| 802.11g       | 2 412           | 5.45               |                   |
|               | 2 442           | 5.21               |                   |
|               | 2 472           | 3.98               |                   |
| 802.11n(HT20) | 2 412           | 6.17               |                   |
|               | 2 442           | 5.86               |                   |
|               | 2 472           | 4.50               |                   |

Maximum measured transmitter power (for RF Exposure):

- 802.11b mode

| Output Power |       | Max Antenna Gain<br>[dBi] | EIRP<br>[mW] |
|--------------|-------|---------------------------|--------------|
| [dBm]        | [mW]  |                           |              |
| 8.19         | 6.592 | 1.900                     | 10.209       |

- 802.11g mode

| Output Power |       | Max Antenna Gain<br>[dBi] | EIRP<br>[mW] |
|--------------|-------|---------------------------|--------------|
| [dBm]        | [mW]  |                           |              |
| 5.45         | 3.508 | 1.900                     | 5.433        |

- 802.11n(HT20) mode

| Output Power |       | Max Antenna Gain<br>[dBi] | EIRP<br>[mW] |
|--------------|-------|---------------------------|--------------|
| [dBm]        | [mW]  |                           |              |
| 6.17         | 4.140 | 1.900                     | 6.412        |

- Theory value for RF Exposure

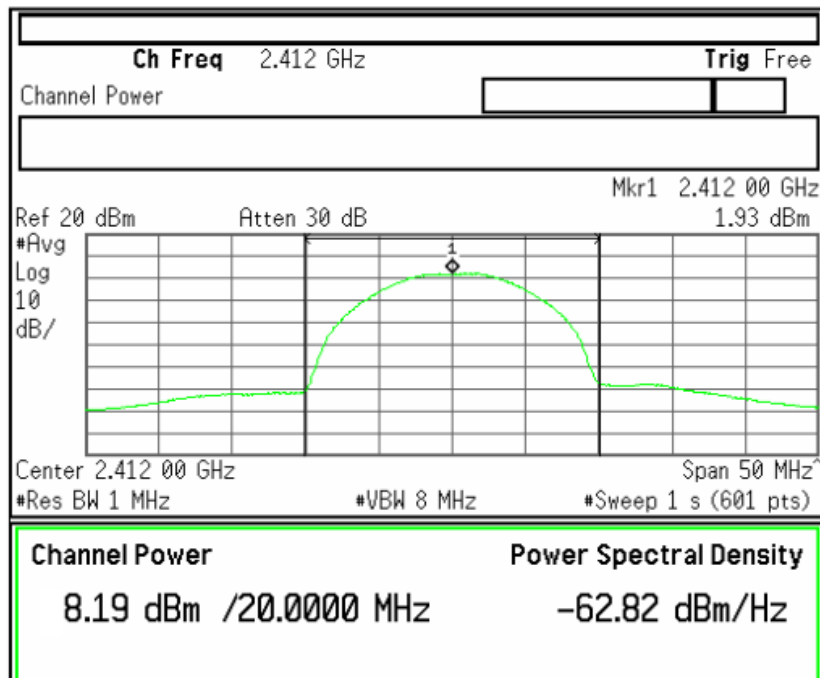
$$P_{e.i.r.p.}(mW) = A_{cond}(dBm) + G_{assembly\ antenna\ gain}(dBi)$$

NOTES:

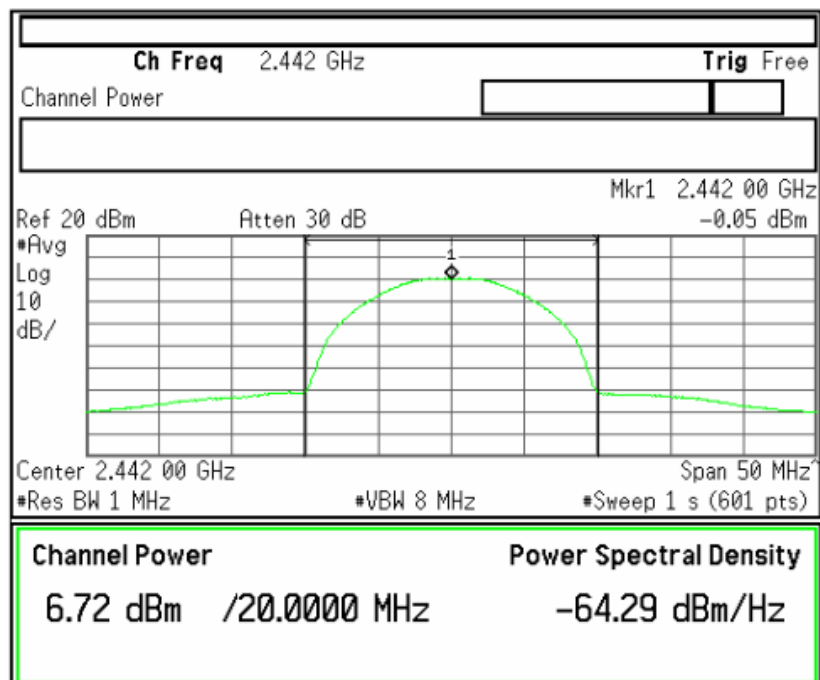
1. Measure conducted Channel power of relevant channel using Spectrum analyzer
2. RBW 1 MHz, VBW 8 MHz
3. Please see the measured plot in next page.

## Plots of Maximum Peak Output Power Bandwidth (802.11b)

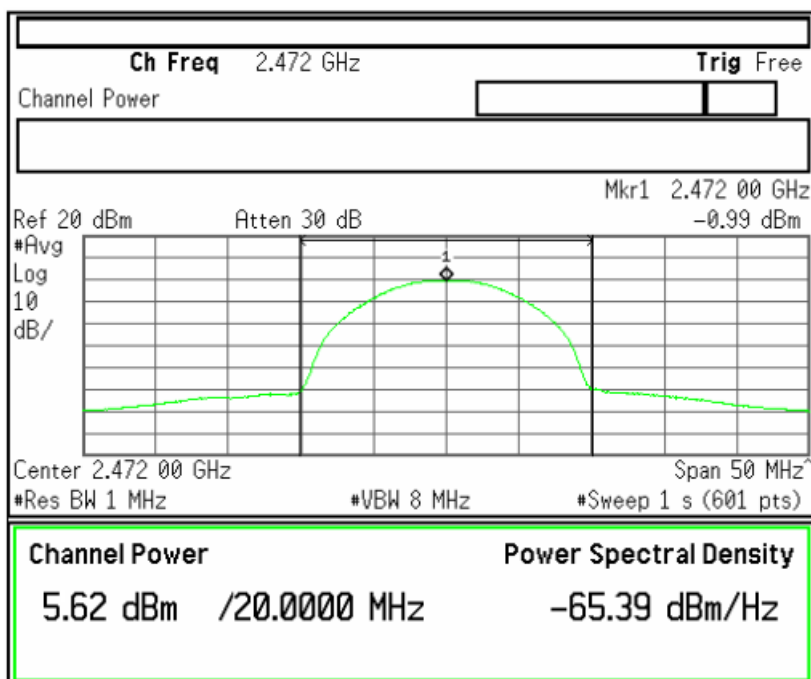
[2 412 MHz]



[2 442 MHz]

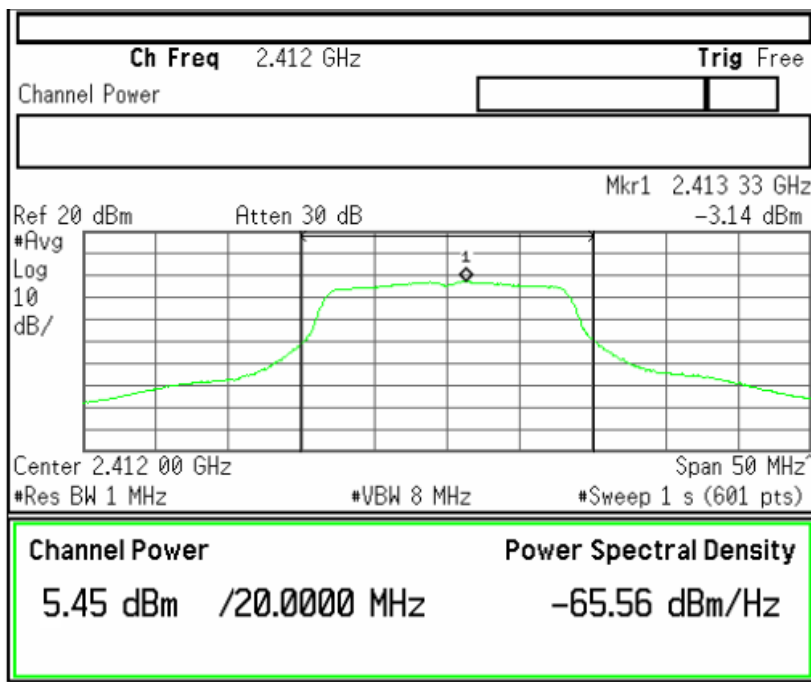


[2 472 MHz]

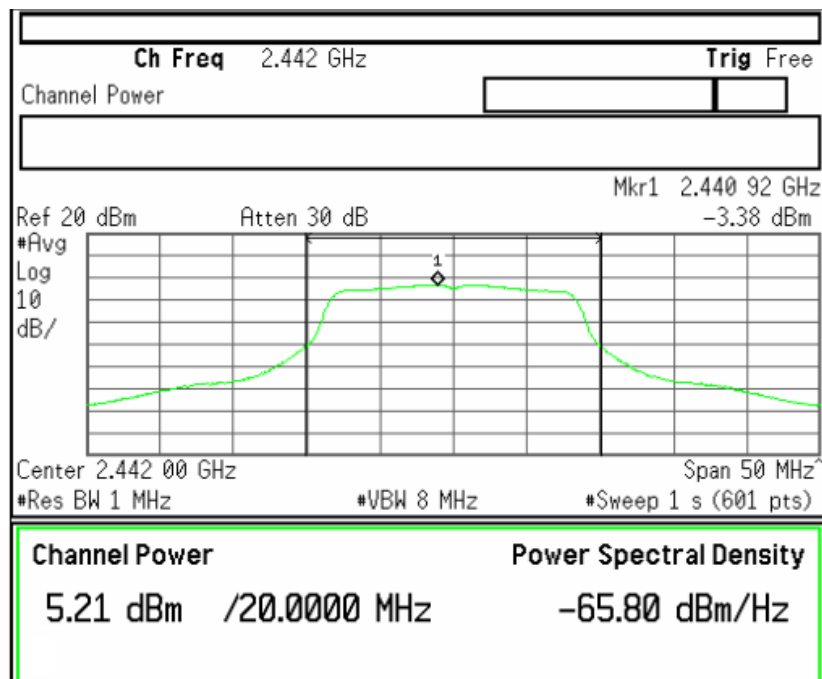


## Plots of Maximum Peak Output Power Bandwidth (802.11g)

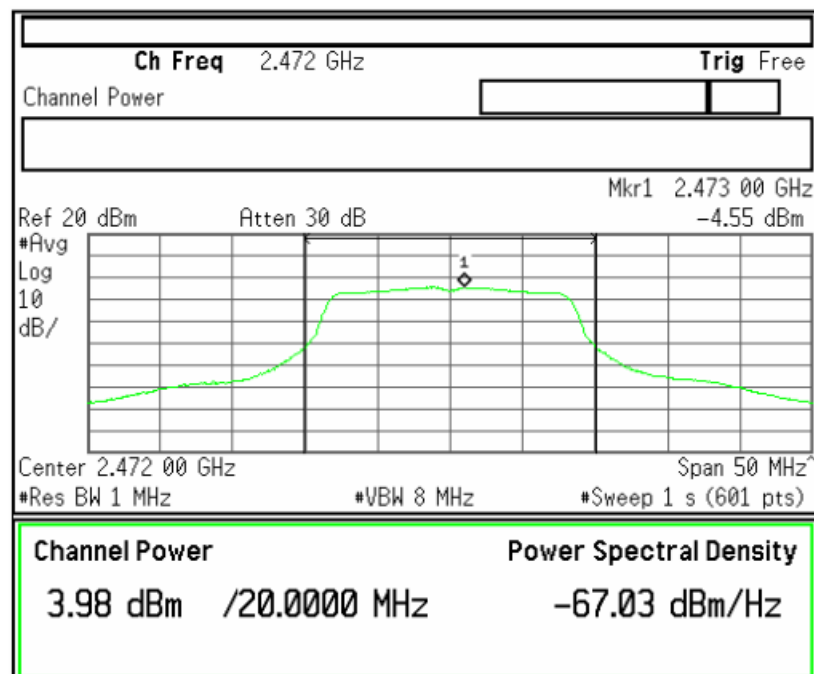
[2 412 MHz]



[2 442 MHz]

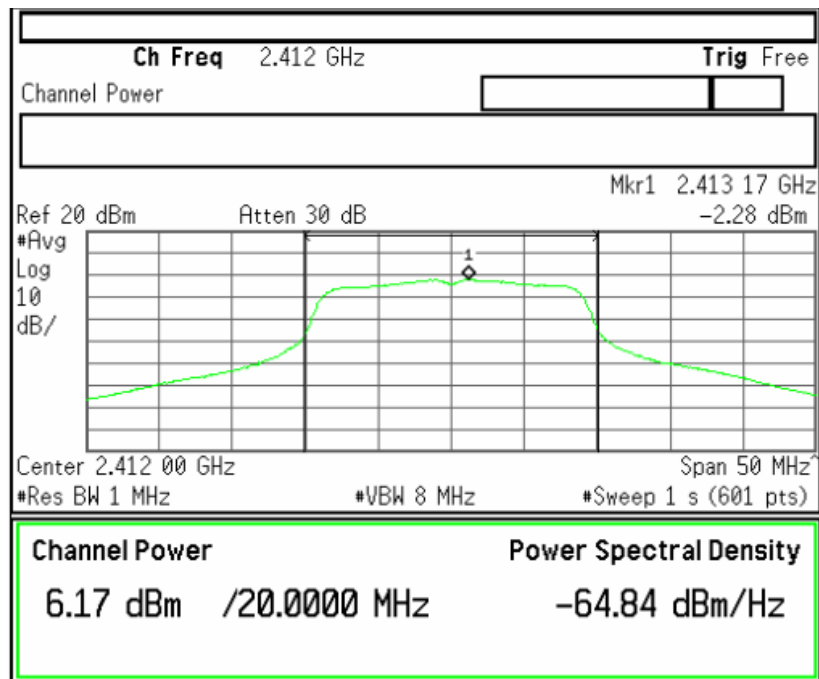


[2 472 MHz]

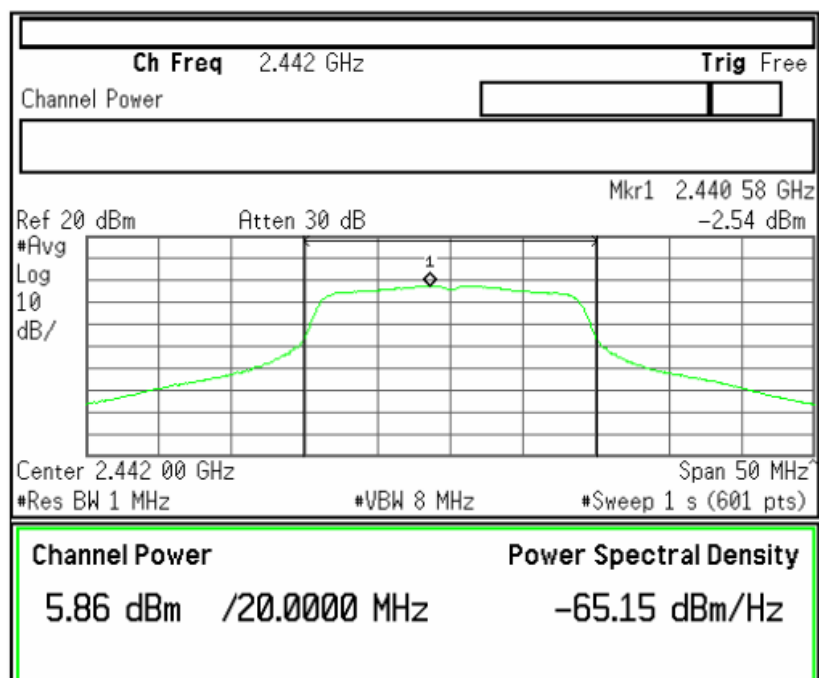


## Plots of Maximum Peak Output Power Bandwidth (802.11n(HT20))

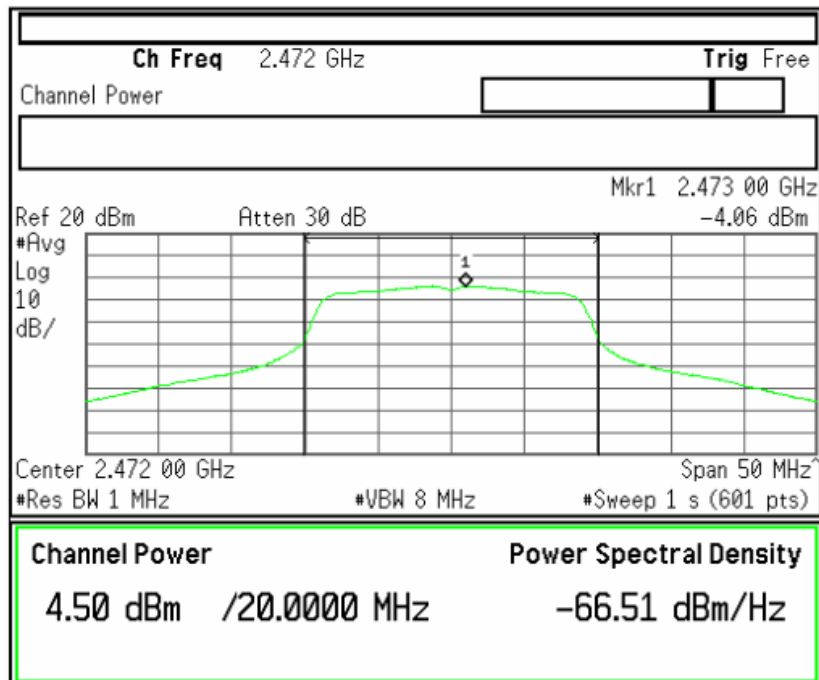
[2 412 MHz]



[2 442 MHz]



[2 472 MHz]





## 5.4 Bandwidth of Frequency Band Edges

|                     |                                                 |
|---------------------|-------------------------------------------------|
| EUT                 | OPTIZEN WIRELESS / WIRELESS MODULE 01           |
| Limit apply to      | FCC Part 15.247(d)                              |
| Test Date           | September 26, 2012 to September 27, 2012        |
| Operating Condition | RF transmitting continuously during the tested. |
| Result              | Passed                                          |

### Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in 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)).

### Test Results

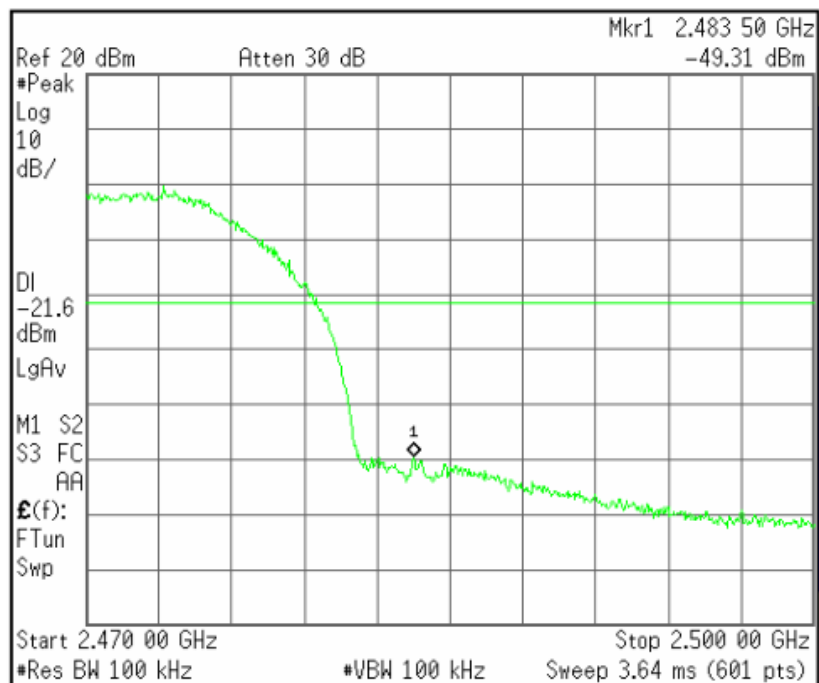
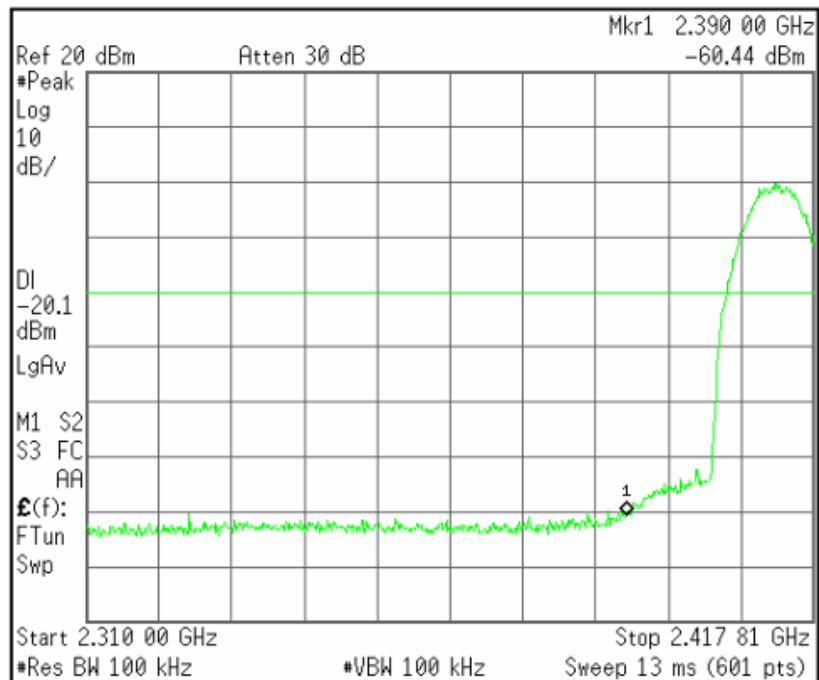
- Refer to see the measured plot in next page.

### NOTES:

1. The test was performed to make a direct field strength measurement at the band edge frequencies.

## Plots of Bandwidth of Frequency Band Edges (802.11b)

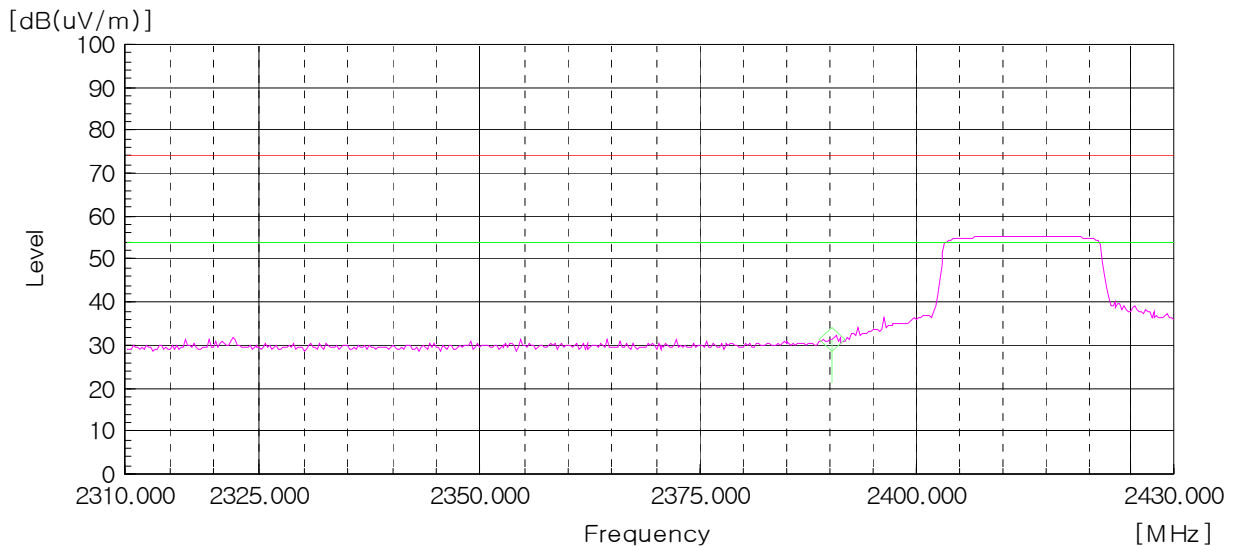
Conducted



## Radiated

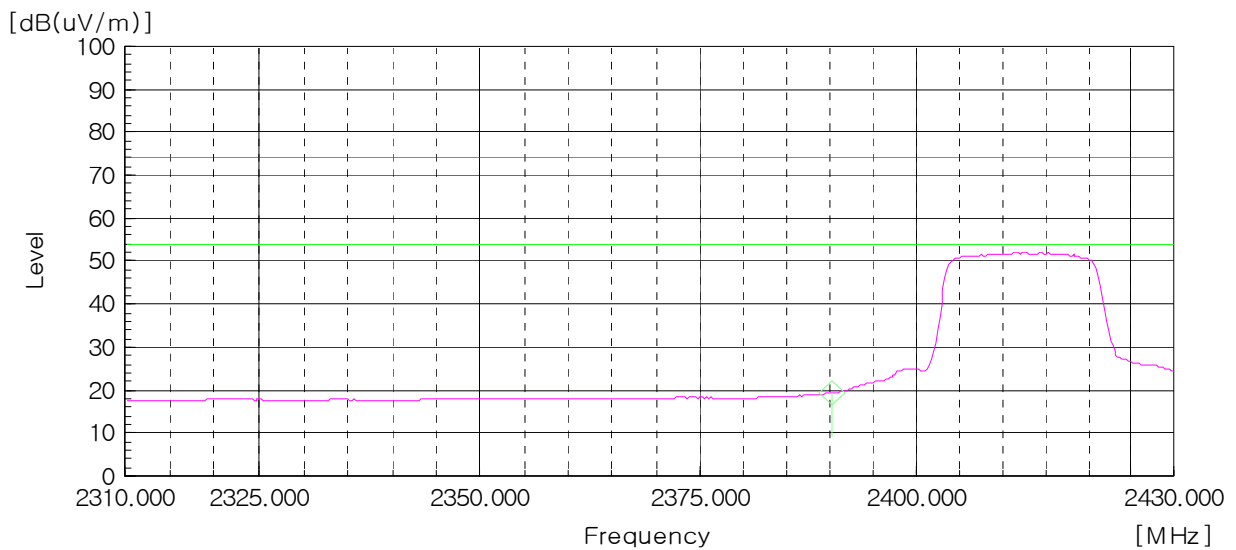
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)

— Peak Limit Line  
— AV Limit Line



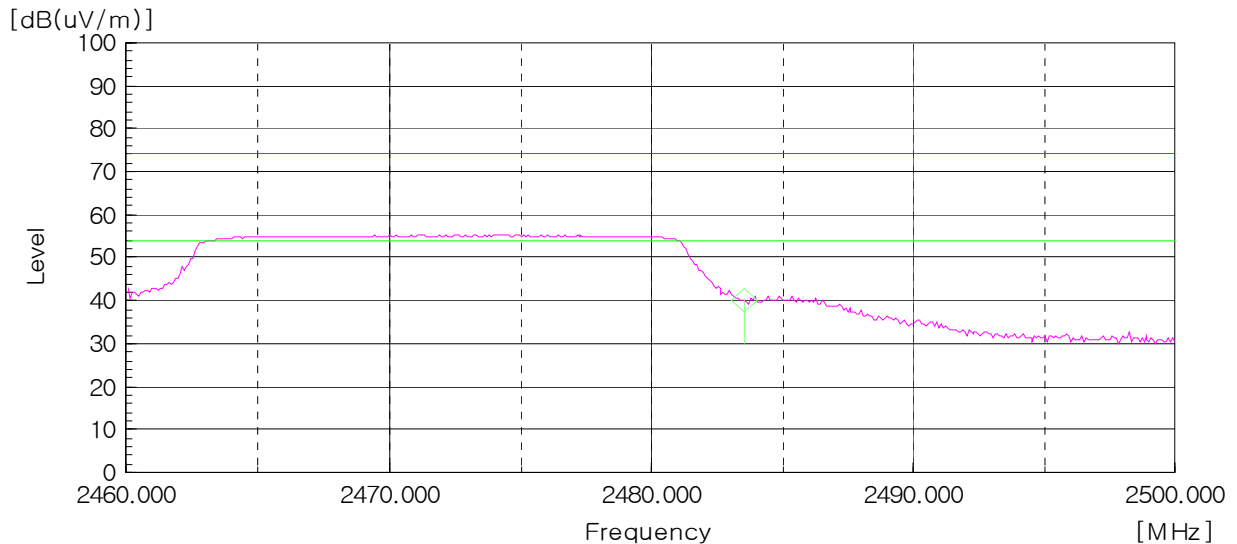
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)

— Peak Limit Line  
— AV Limit Line



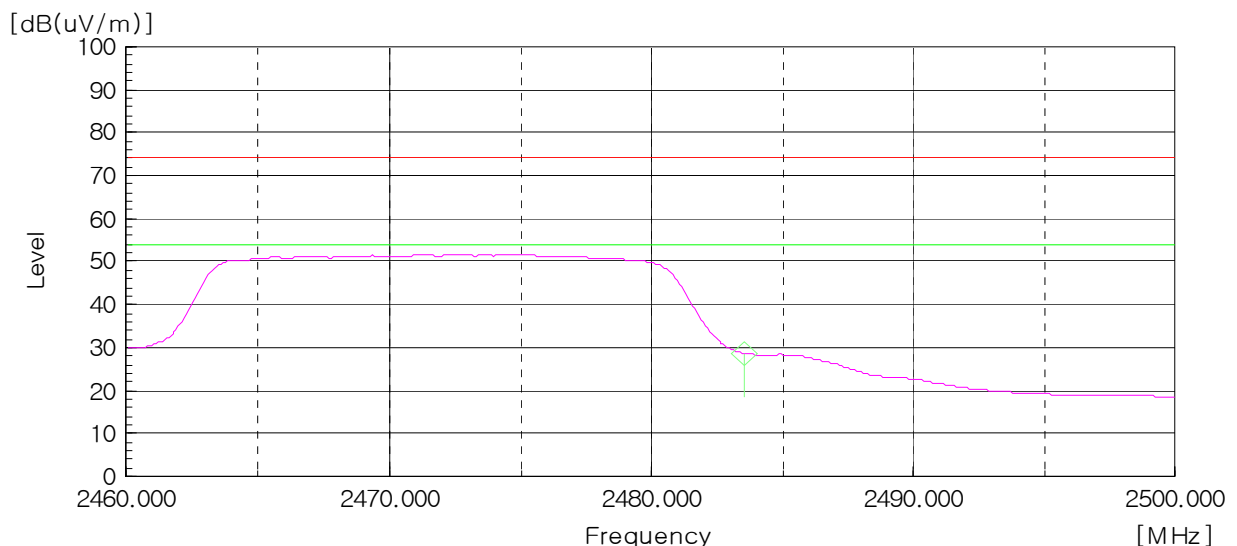
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)

— Peak Limit Line  
— AV Limit Line



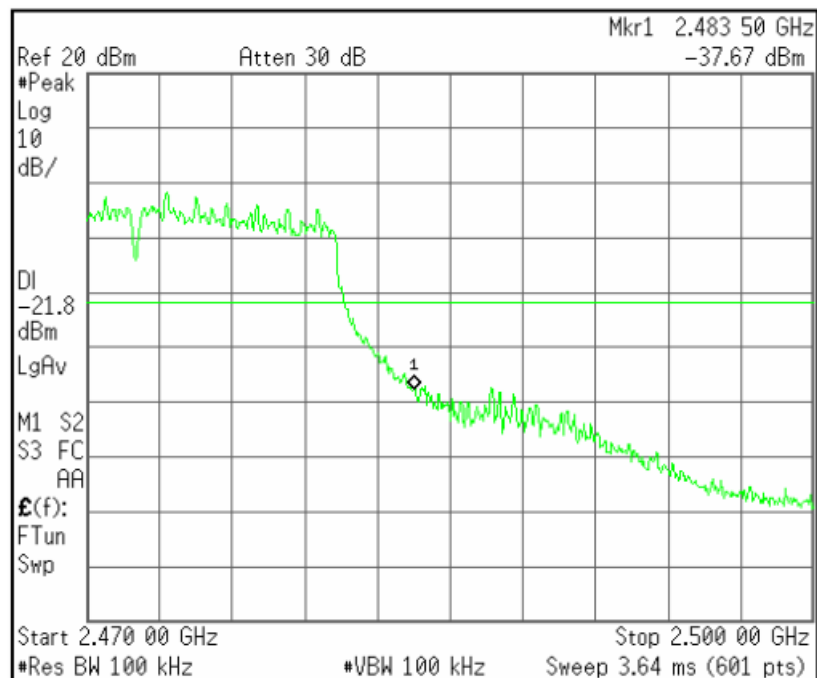
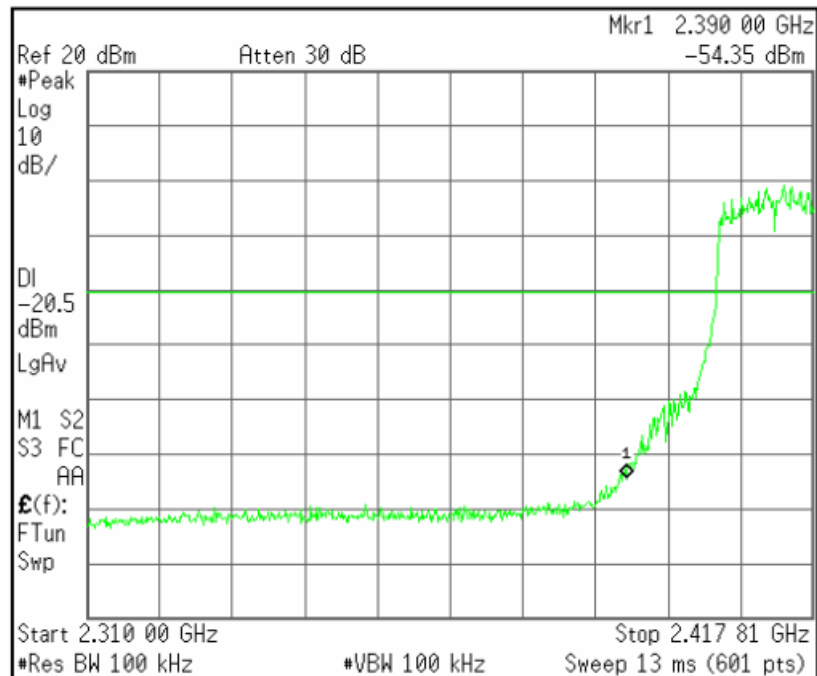
AV Detector: RBW: 1 MHz, VBW: 10 Hz ((2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)

— Peak Limit Line  
— AV Limit Line



## Plots of Bandwidth of Frequency Band Edges (802.11g)

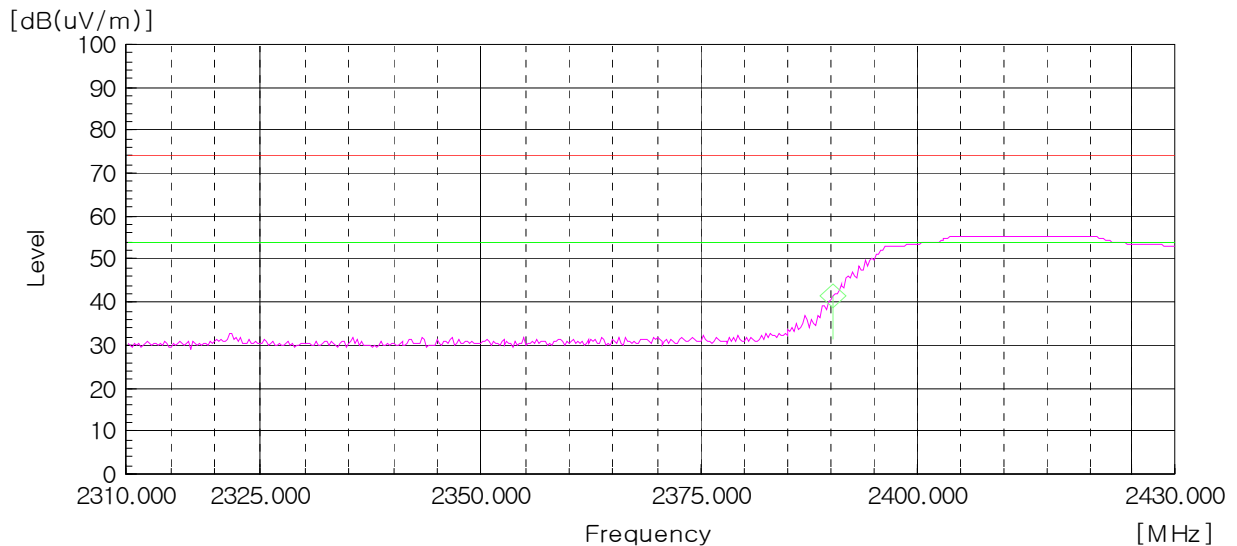
Conducted



## Radiated

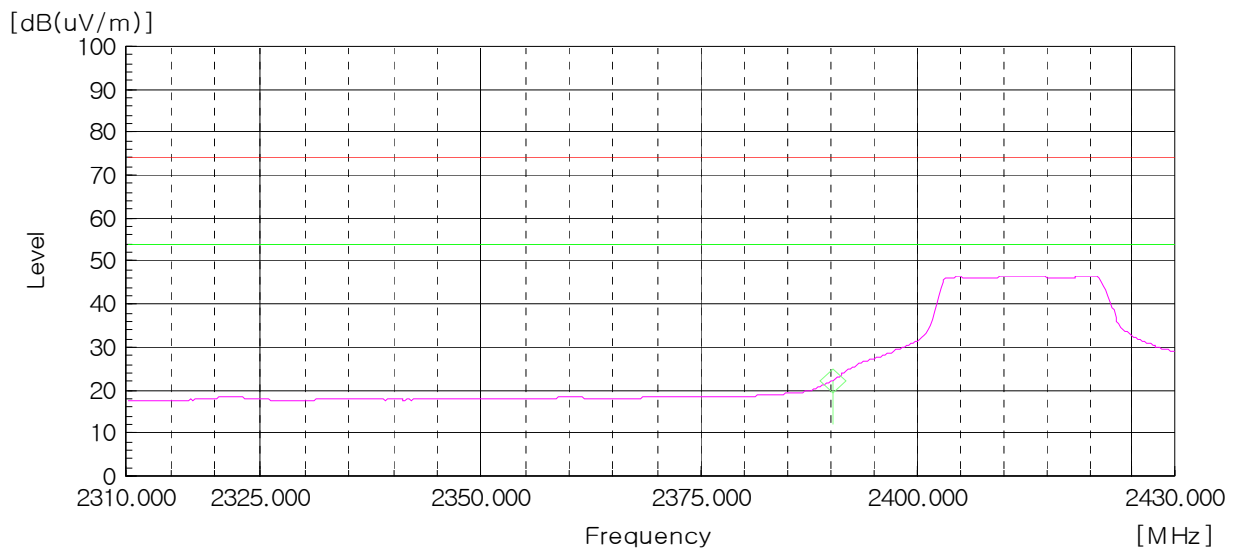
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)

— Peak Limit Line  
— AV Limit Line



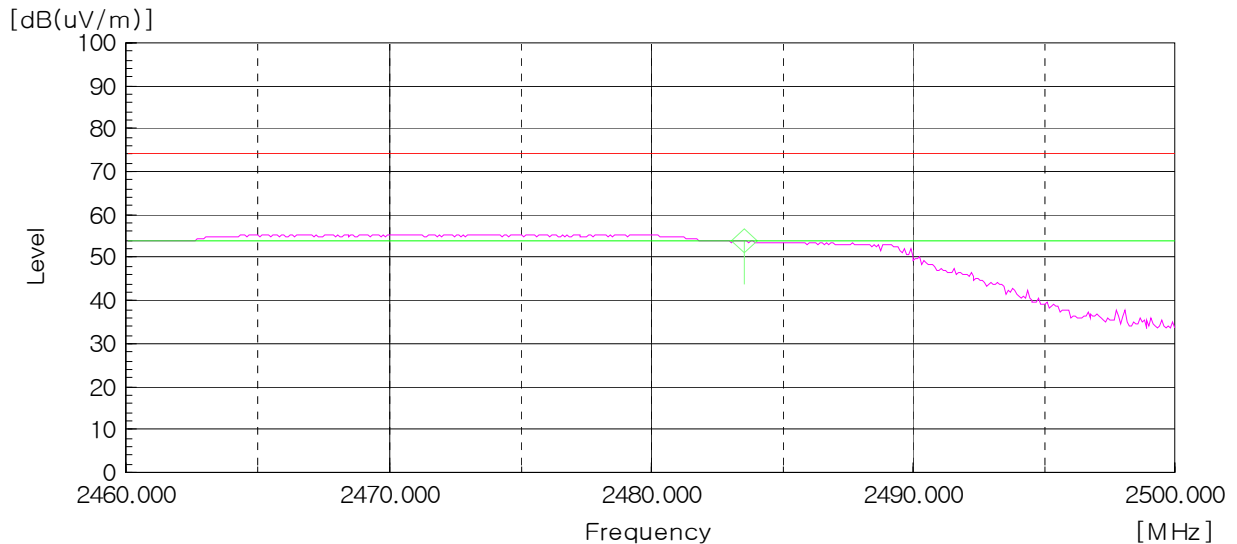
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)

— Peak Limit Line  
— AV Limit Line



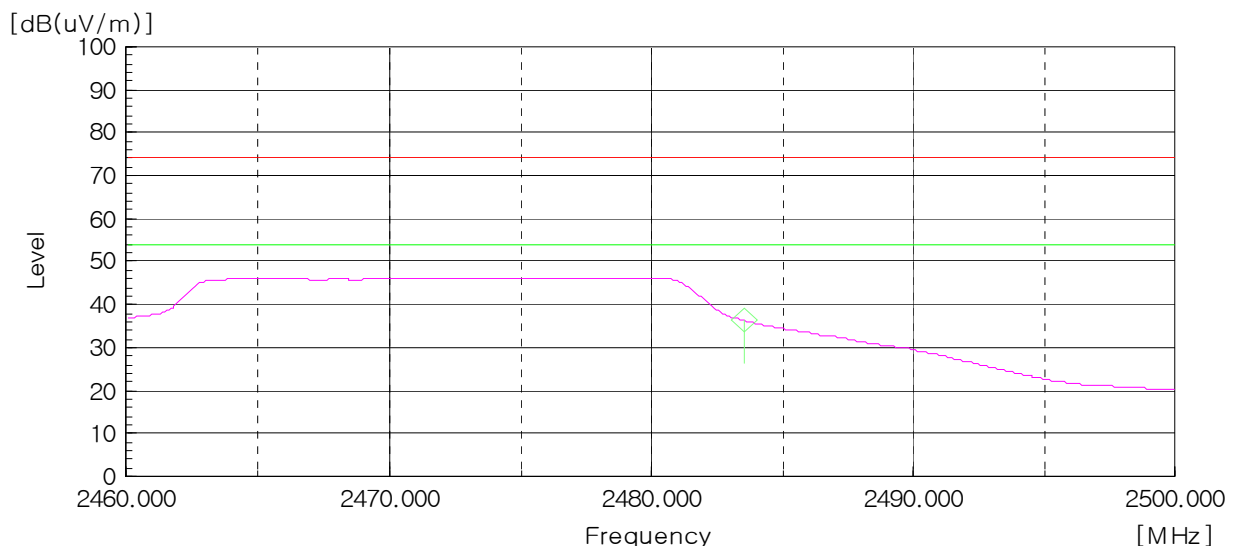
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)

— Peak Limit Line  
— AV Limit Line



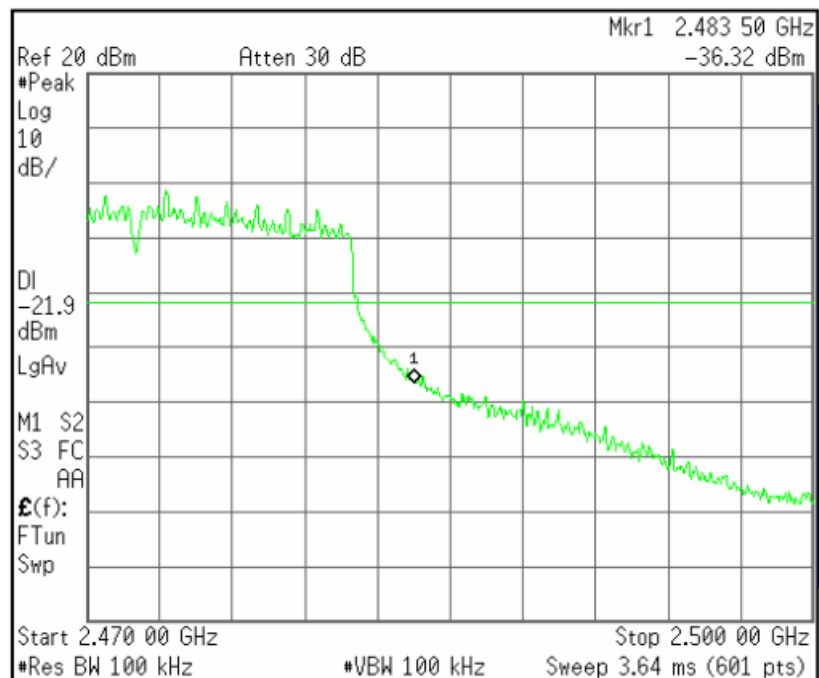
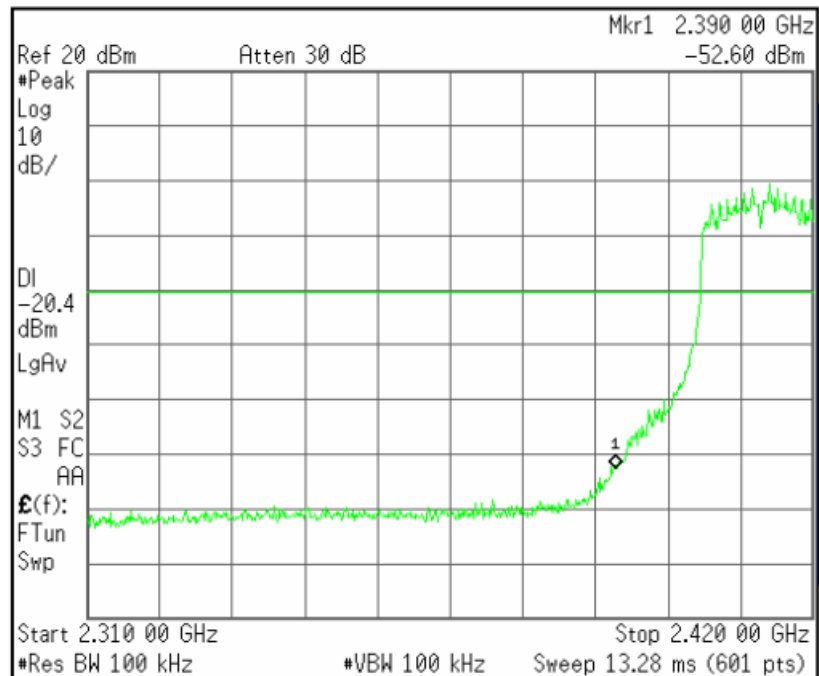
AV Detector: RBW: 1 MHz, VBW: 10 Hz ((2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)

— Peak Limit Line  
— AV Limit Line



## Plots of Bandwidth of Frequency Band Edges (802.11n(HT20))

Conducted

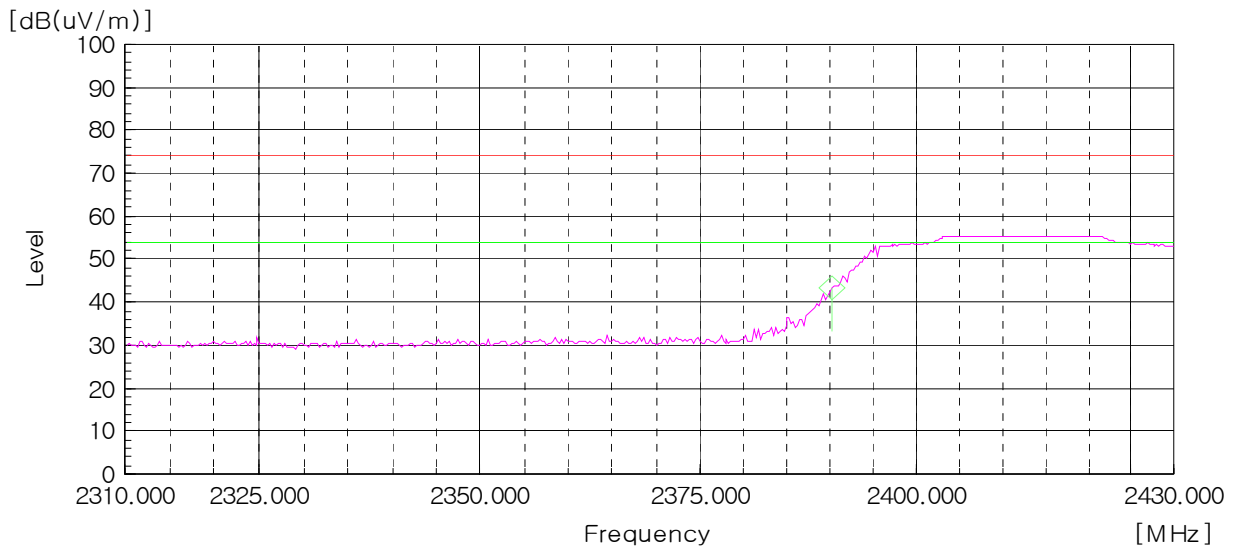




## Radiated

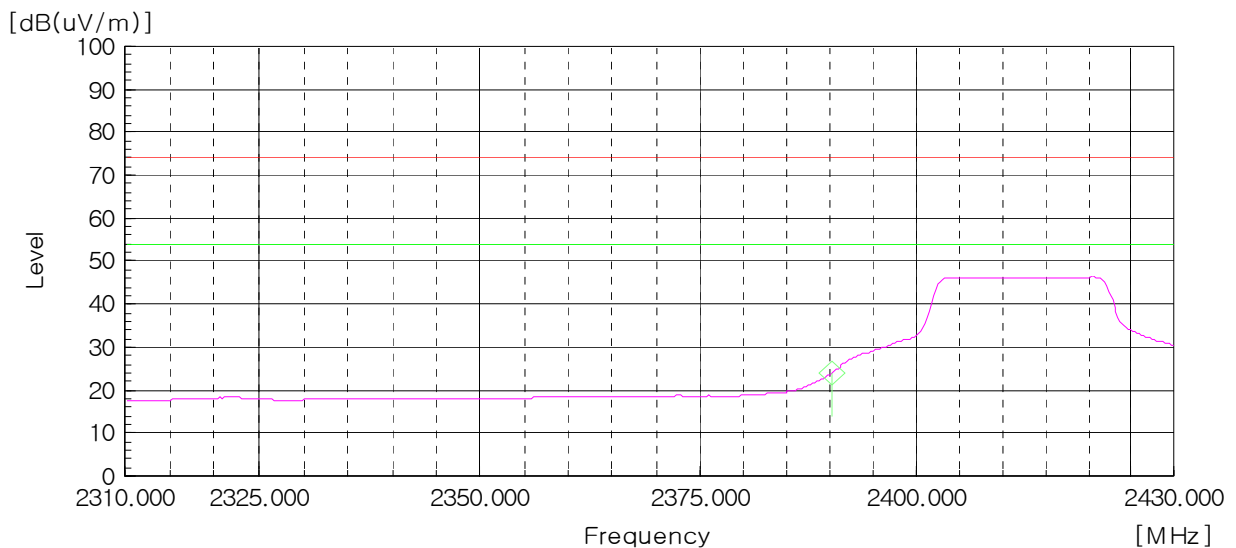
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)

— Peak Limit Line  
— AV Limit Line



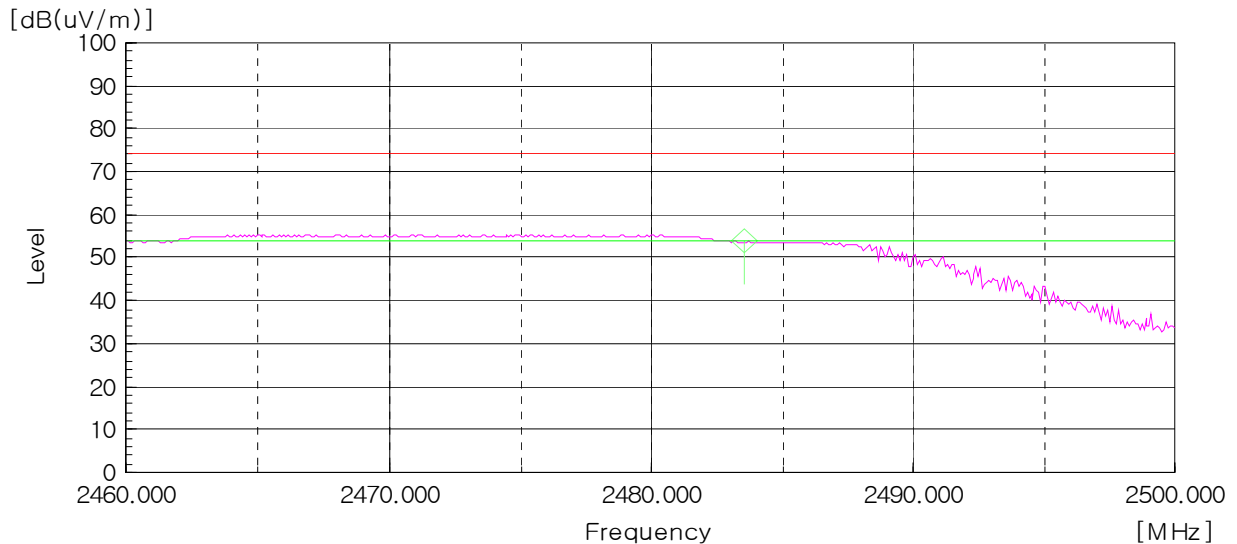
AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Horizontal)

— Peak Limit Line  
— AV Limit Line



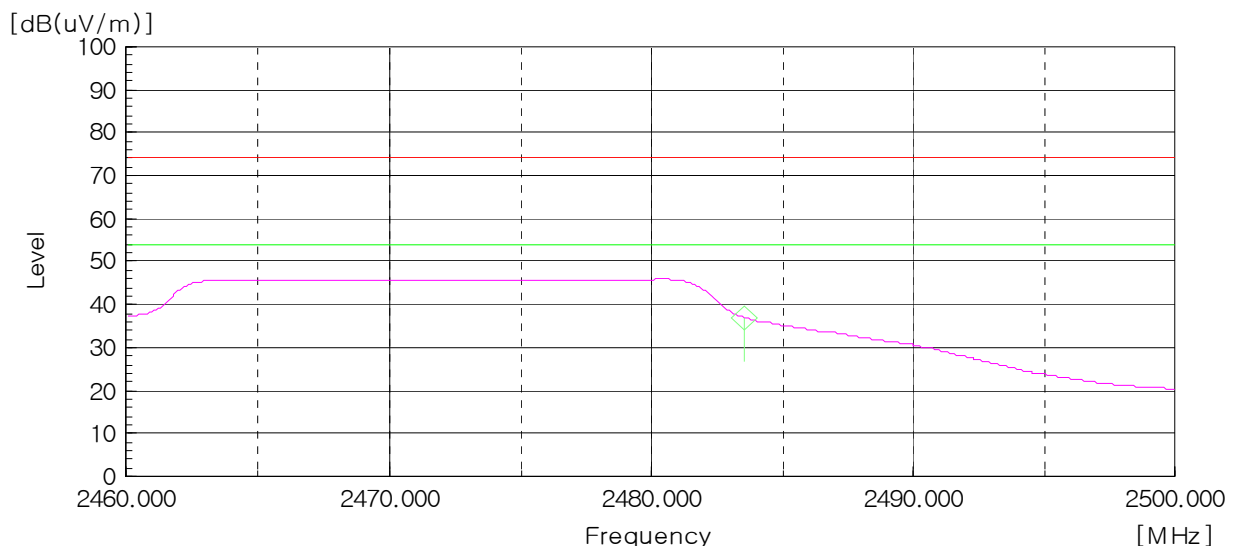
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)

— Peak Limit Line  
— AV Limit Line



AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)

— Peak Limit Line  
— AV Limit Line



## 5.5 Power Spectral Density

|                     |                                                 |
|---------------------|-------------------------------------------------|
| EUT                 | OPTIZEN WIRELESS / WIRELESS MODULE 01           |
| Limit apply to      | FCC Part 15.247(e)                              |
| Test Date           | September 26, 2012                              |
| Operating Condition | RF transmitting continuously during the tested. |
| Result              | Passed                                          |

### Limit

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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### Test Data

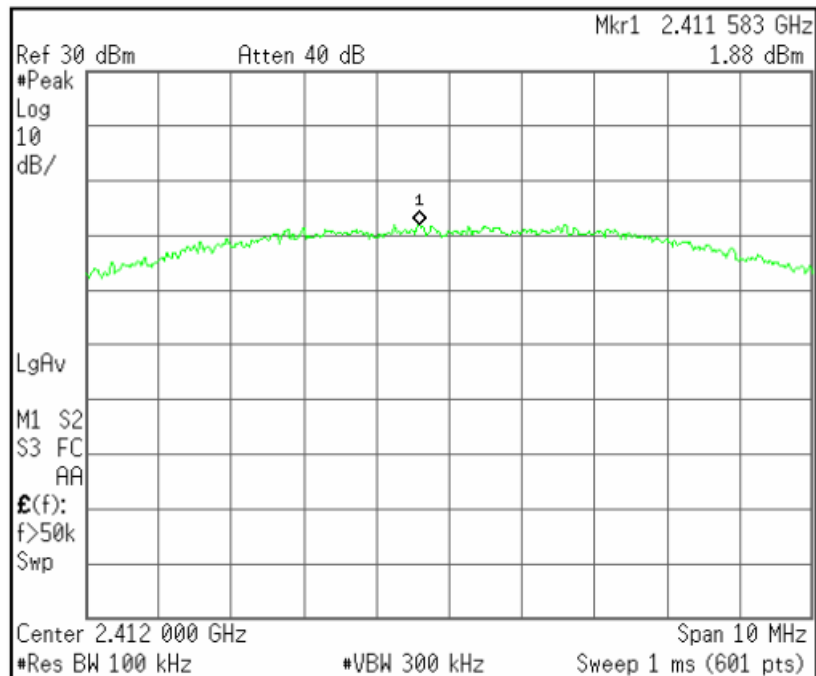
| Mode          | Frequency [MHz] | PSD [dBm] | Limit    |
|---------------|-----------------|-----------|----------|
| 802.11b       | 2 412           | -13.32    | 8.00 dBm |
|               | 2 442           | -14.76    |          |
|               | 2 472           | -16.69    |          |
| 802.11g       | 2 412           | -15.19    |          |
|               | 2 442           | -15.88    |          |
|               | 2 472           | -16.85    |          |
| 802.11n(HT20) | 2 412           | -15.72    |          |
|               | 2 442           | -15.73    |          |
|               | 2 472           | -16.42    |          |

### NOTES:

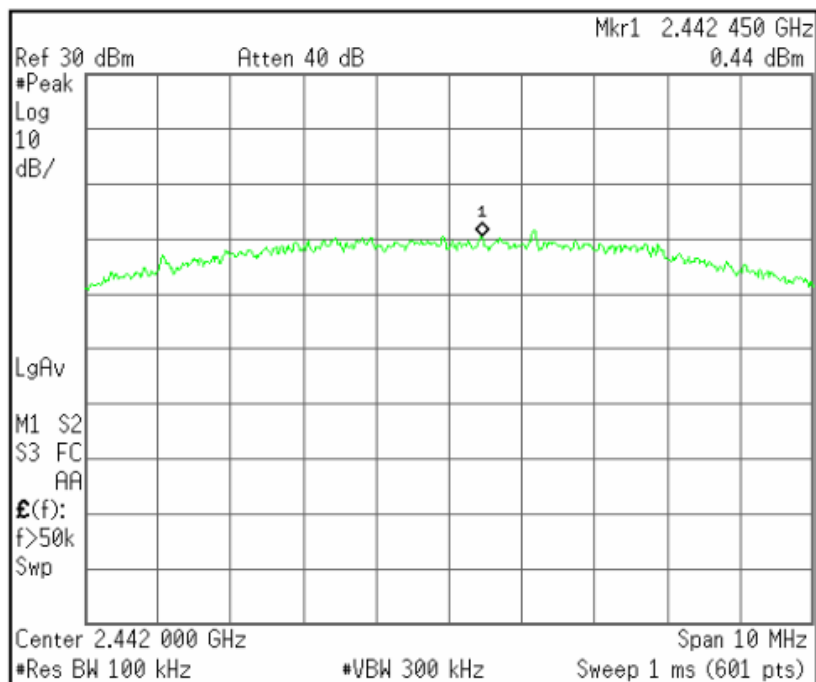
1. Measure power spectral density of relevant channel using spectrum analyzer.
2. RBW 100 kHz, VBW 300 kHz, span 1MHz, Sweep time (= span / 3 kHz).
3. Please see the measured plot in next page.

## Plots of Power Spectral Density (802.11b)

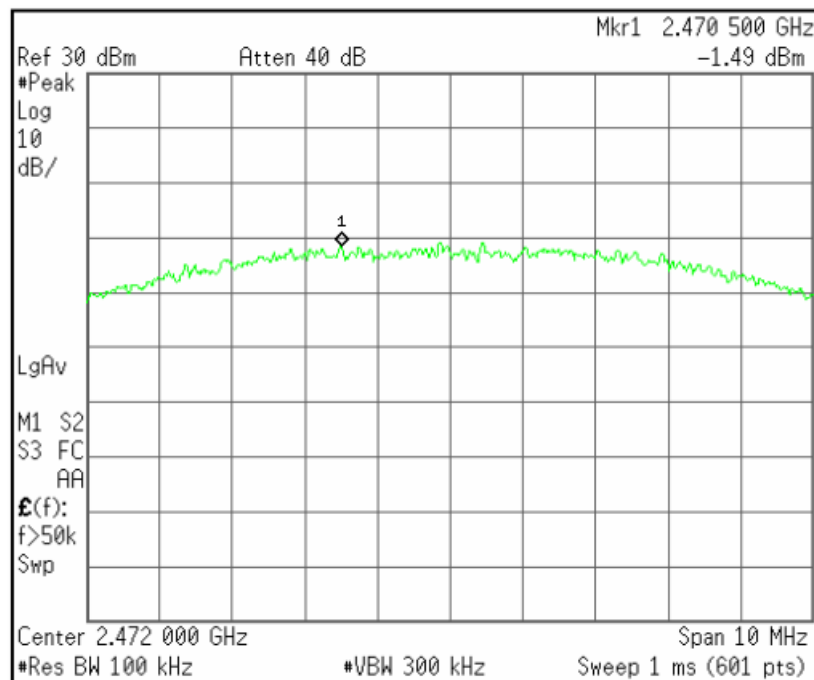
[2 412 MHz]



[2 442 MHz]

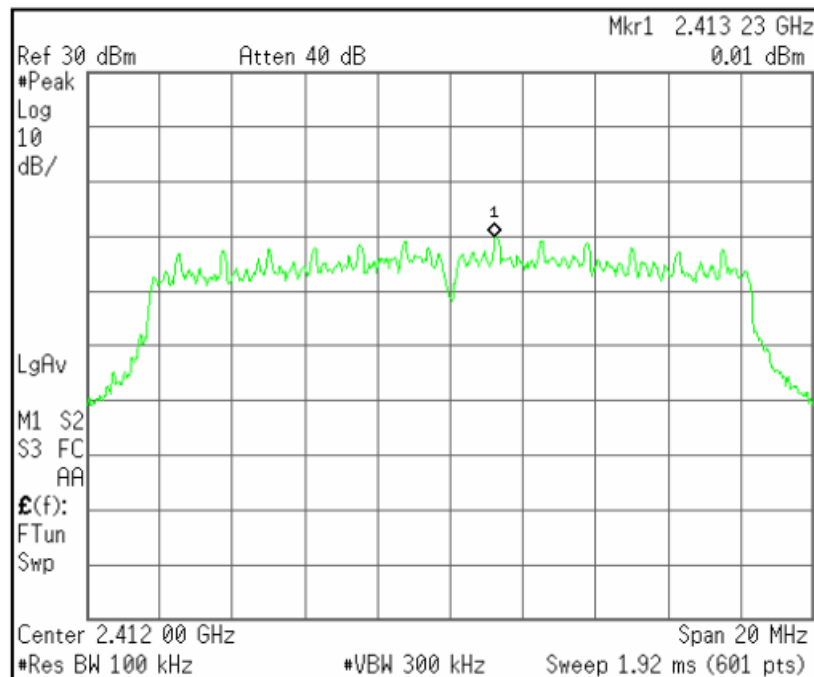


[2 472 MHz]

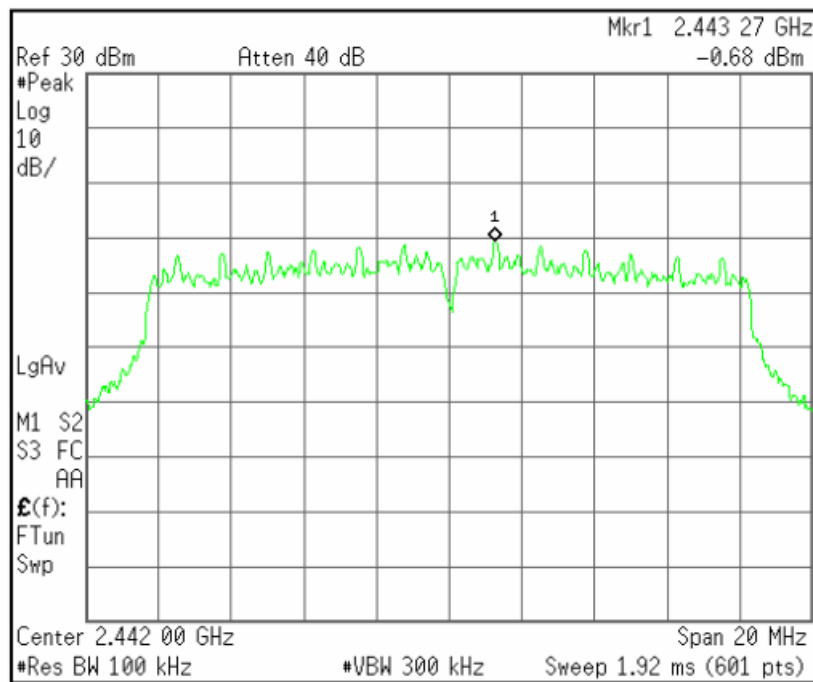


## Plots of Power Spectral Density (802.11g)

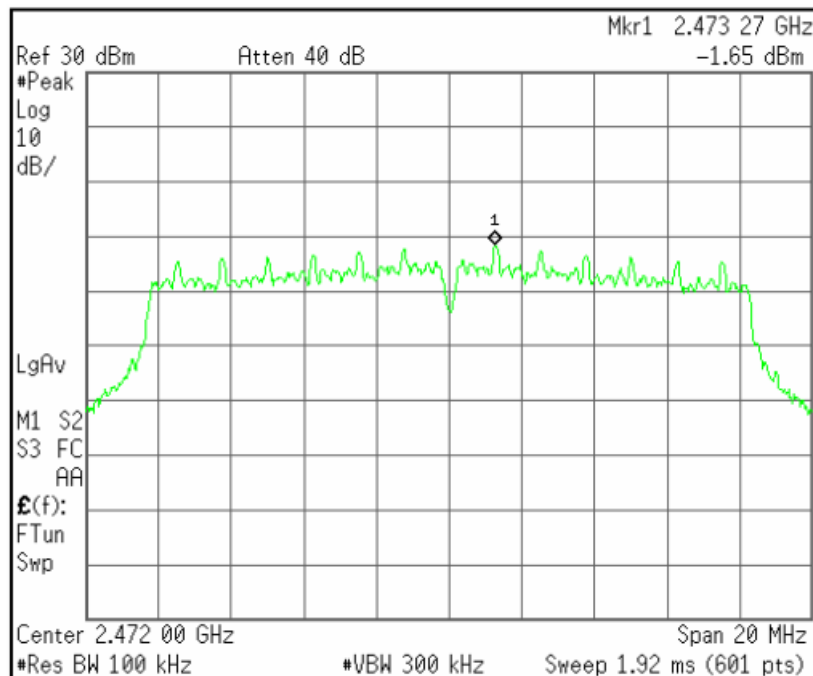
[2 412 MHz]



[2 442 MHz]

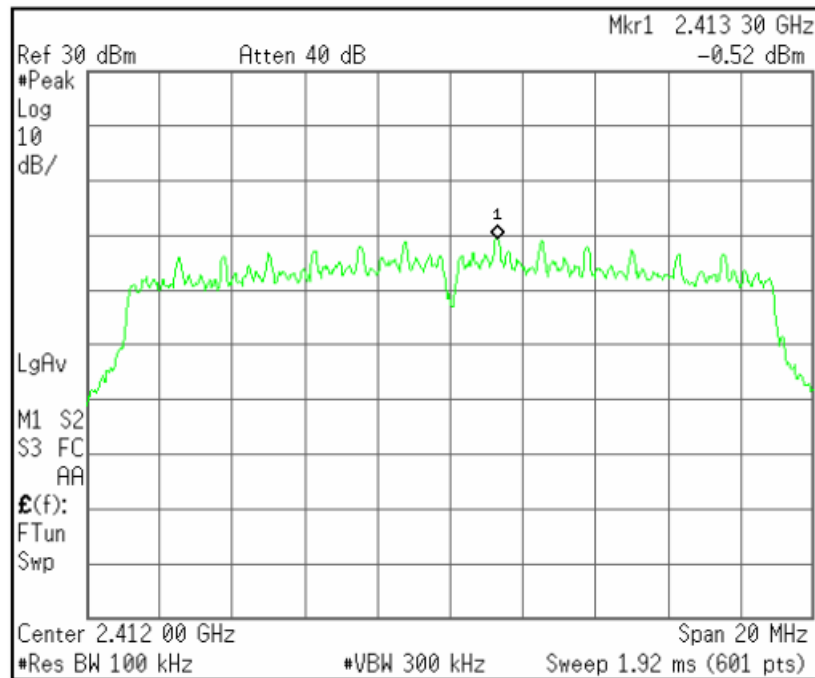


[2 472 MHz]

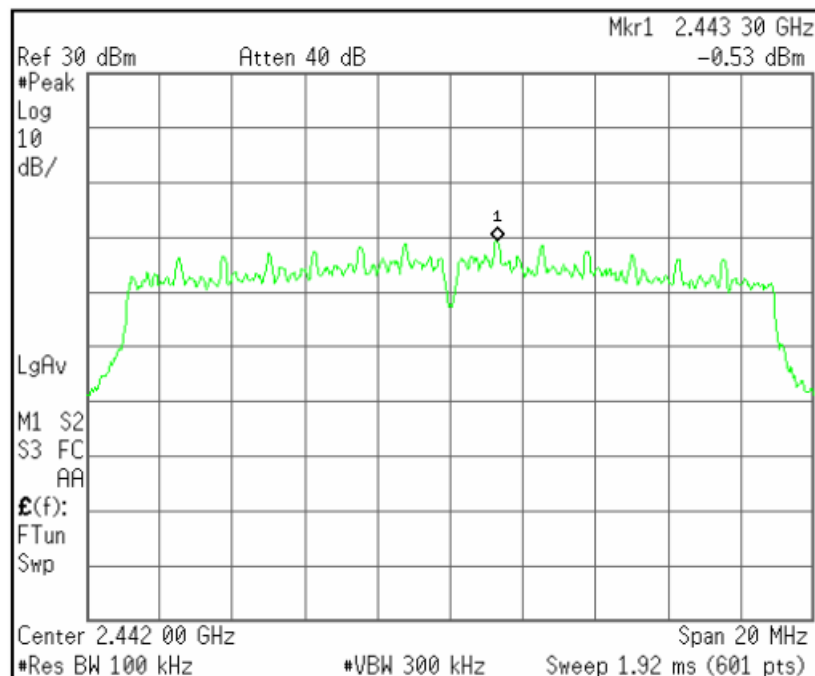


## Plots of Power Spectral Density (802.11n(HT20))

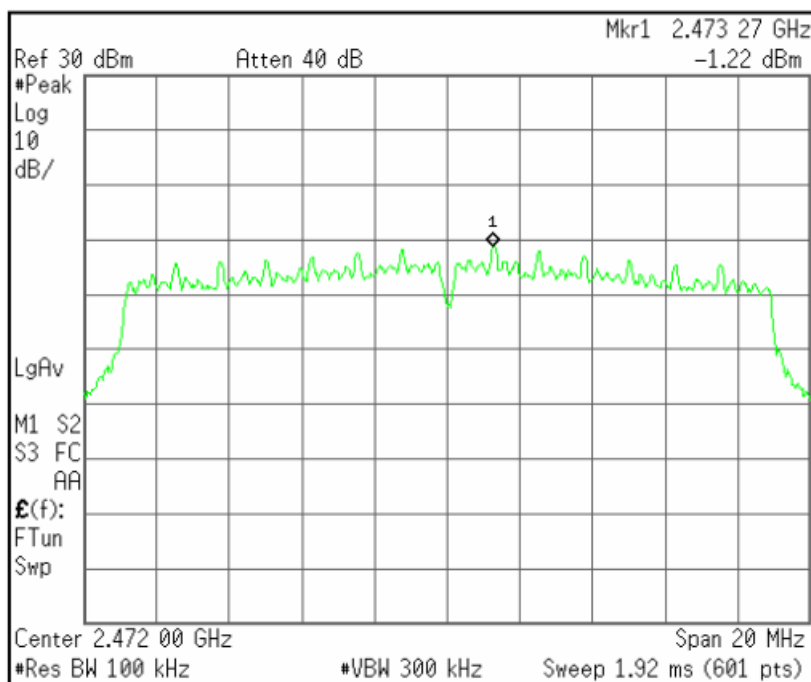
[2 412 MHz]



[2 442 MHz]



[2 472 MHz]





## 5.6 Spurious Emissions

|                     |                                          |
|---------------------|------------------------------------------|
| EUT                 | OPTIZEN WIRELESS / WIRELESS MODULE 01    |
| Limit apply to      | FCC Part 15.209                          |
| Test Date           | September 27, 2012 to September 27, 2012 |
| Operating Condition | Low CH, Middle CH, High CH Transmission  |
| Result              | Passed                                   |

### Limit

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

| Frequencies<br>[MHz] | Field Strength<br>[μV/m] | Measurement Distance<br>[m] |
|----------------------|--------------------------|-----------------------------|
| 0.009 - 0.490        | 2 400/F(kHz)             | 300                         |
| 0.490 - 1.705        | 24 000/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                           |

\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 MHz - 72 MHz, 76 MHz - 88 MHz, 174 MHz - 216 MHz or 470 MHz - 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

### Test Results

- Refer to see the measured plot in next page.

## Radiated Emissions Test data

### - 9 kHz to 30 MHz (802.11b, 802.11g, 802.11n(HT20) mode)

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.  
Detector mode: CISPR Quasi-Peak mode (100 Hz, 9 kHz)

| Frequency<br>[MHz] | Reading<br>[dB(μV)]                                                      | Polarization<br>(*H/**V) | Ant. Factor<br>[dB/m] | Cable Loss<br>[dB] | Result<br>[dB(μV/m)] | Limit<br>[dB(μV/m)] | Margin<br>[dB] |
|--------------------|--------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------|---------------------|----------------|
|                    |                                                                          |                          |                       |                    |                      |                     |                |
|                    | Emission attenuated more than<br>20 dB below the limit are not reported. |                          |                       |                    |                      |                     |                |
|                    |                                                                          |                          |                       |                    |                      |                     |                |
|                    |                                                                          |                          |                       |                    |                      |                     |                |

**Result: All emissions below noise floor of 20 dB(μV/m).**

#### NOTES:

- \* H : Horizontal polarization , \*\* V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin = Limit - Result
- The measurement was performed for the frequency range 9 kHz to 30 MHz according to FCC Part 15.209.

## - Below 1 GHz (30 MHz to 1 GHz) (802.11b, 802.11g, 802.11n(HT20) mode)

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.  
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 120 kHz)

| Frequency<br>[MHz] | Reading<br>[dB(μV)]                                                      | Polarization<br>(*H/**V) | Ant. Factor<br>[dB/m] | Cable Loss<br>[dB] | Result<br>[dB(μV/m)] | Limit<br>[dB(μV/m)] | Margin<br>[dB] |
|--------------------|--------------------------------------------------------------------------|--------------------------|-----------------------|--------------------|----------------------|---------------------|----------------|
|                    |                                                                          |                          |                       |                    |                      |                     |                |
|                    | Emission attenuated more than<br>20 dB below the limit are not reported. |                          |                       |                    |                      |                     |                |
|                    |                                                                          |                          |                       |                    |                      |                     |                |
|                    |                                                                          |                          |                       |                    |                      |                     |                |

**Result: All emissions below noise floor of 20 dB(μV/m).**

### NOTES:

- \* H : Horizontal polarization , \*\* V : Vertical polarization
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- The measurement was performed for the frequency range above 30 MHz according to FCC Part 15.209.

## - Above 1 GHz (1 GHz to 25 GHz)

- 802.11b mode

### 1. Low CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 823.84        | 36.80            | H                     | 4.70        | 41.50             | 74.00            | 32.50       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 823.84        | 25.61            | H                     | 4.70        | 30.31             | 54.00            | 23.69       |

### 2. Middle CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 884.19        | 38.60            | H                     | 4.90        | 43.50             | 74.00            | 30.50       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 884.19        | 26.60            | H                     | 4.90        | 31.50             | 54.00            | 22.50       |

### 3. High CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 944.10        | 34.80            | H                     | 5.00        | 39.80             | 74.00            | 34.20       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 960.95        | 23.70            | H                     | 5.00        | 28.70             | 54.00            | 25.30       |

**Result: No signal detect above second harmonic.**

- 802.11g mode

## 1. Low CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 822.00        | 34.50            | H                     | 4.70        | 39.20             | 74.00            | 34.80       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 822.00        | 25.80            | H                     | 4.70        | 30.50             | 54.00            | 23.50       |

## 2. Middle CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 884.21        | 35.60            | H                     | 4.90        | 40.50             | 74.00            | 33.50       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 884.21        | 26.70            | H                     | 4.90        | 31.60             | 54.00            | 22.40       |

## 3. High CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 945.63        | 33.50            | H                     | 5.00        | 38.50             | 74.00            | 35.50       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 945.63        | 25.60            | H                     | 5.00        | 30.60             | 54.00            | 23.40       |

**Result: No signal detect above second harmonic.**

- 802.11n(HT20) mode

## 1. Low CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 827.37        | 34.00            | H                     | 4.70        | 38.70             | 74.00            | 35.30       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 827.37        | 25.10            | H                     | 4.70        | 29.80             | 54.00            | 24.20       |

## 2. Middle CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 884.24        | 34.60            | H                     | 4.90        | 39.50             | 74.00            | 34.50       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 884.24        | 25.60            | H                     | 4.90        | 30.50             | 54.00            | 23.50       |

## 3. High CH

Detector mode: Peak mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 943.99        | 33.20            | H                     | 5.00        | 38.20             | 74.00            | 35.80       |

Detector mode: Average mode

| Frequency [MHz] | Reading [dB(μV)] | Polarization (*H/**V) | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|-----------------|------------------|-----------------------|-------------|-------------------|------------------|-------------|
| 4 943.99        | 25.00            | H                     | 5.00        | 30.00             | 54.00            | 24.00       |

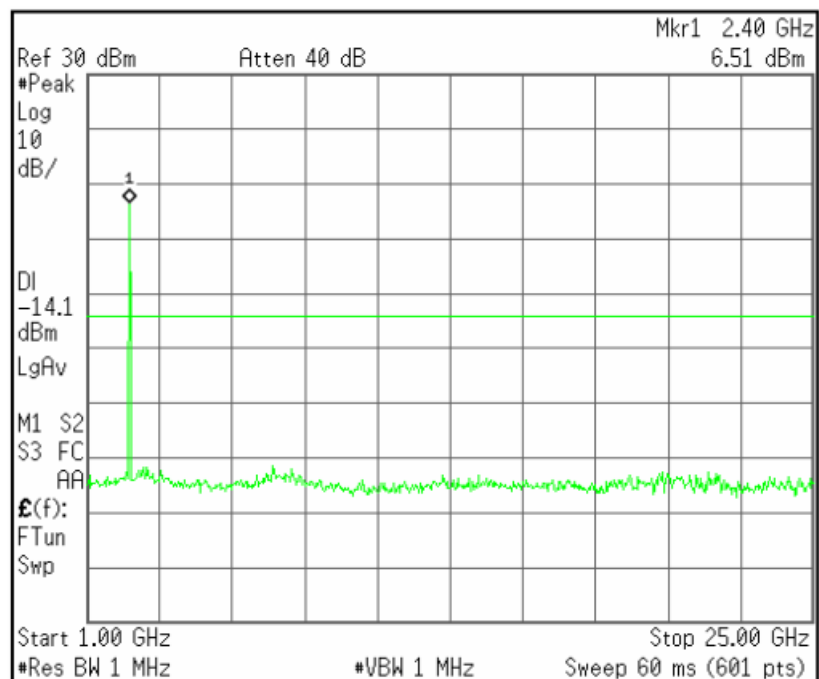
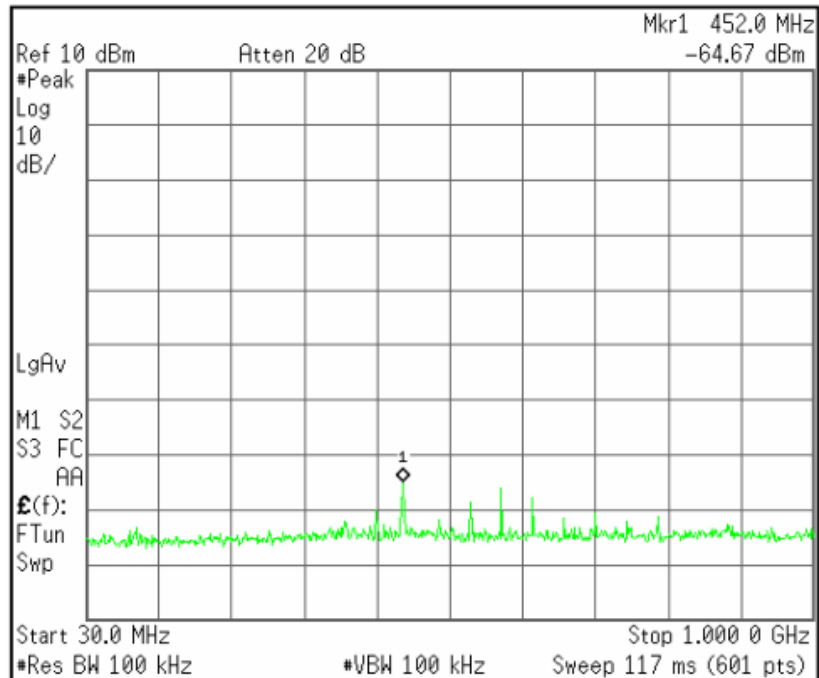
**Result: No signal detect above second harmonic.**

NOTES:

1. \* H : Horizontal polarization , \*\* V : Vertical polarization
2. Factor = Antenna factor + Cable loss + Preamp
3. Result = Reading + Factor
4. Margin = Limit - Result
5. Measuring frequencies from 1GHz to the 10<sup>th</sup> harmonic of highest fundamental frequency.
6. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
7. Spectrum setting:
  - a. Peak Setting 1 GHz to 10<sup>th</sup> harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
  - b. AV Setting 1 GHz to 10<sup>th</sup> harmonics of fundamental, RBW = 1 MHz, VBW = 10 Hz, Sweep = Auto

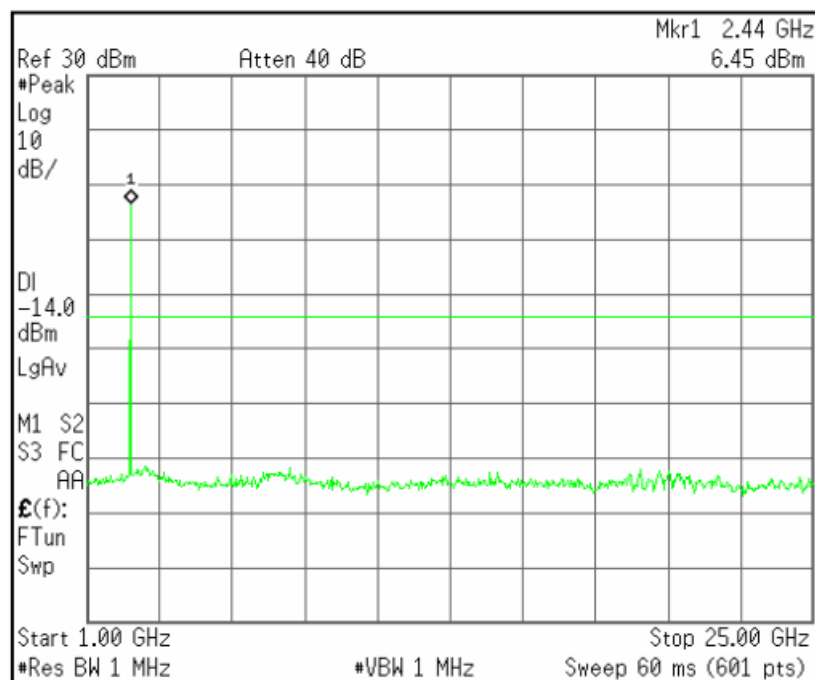
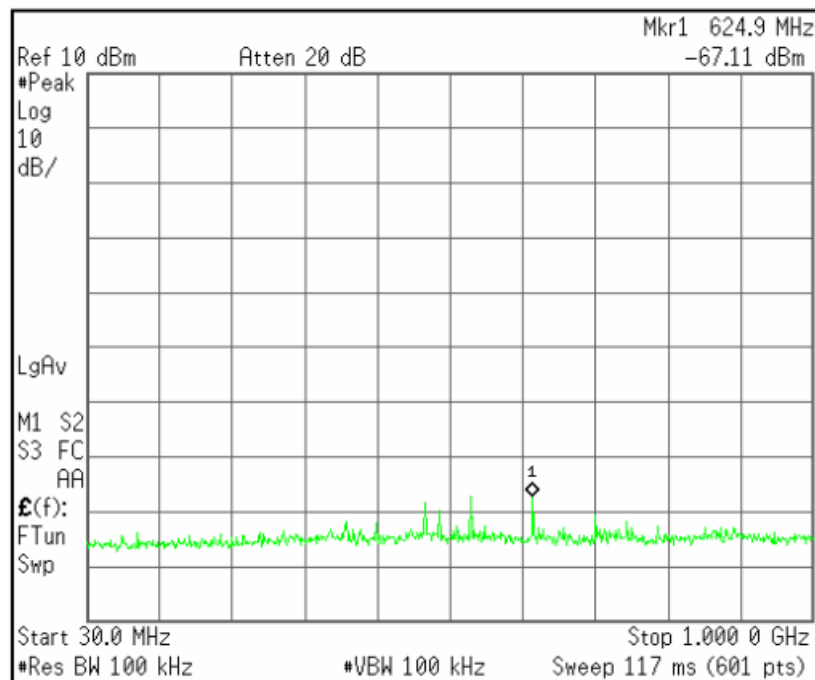
## Plots of Spurious Emissions (Conducted Measurement) (802.11b)

[CH Low]

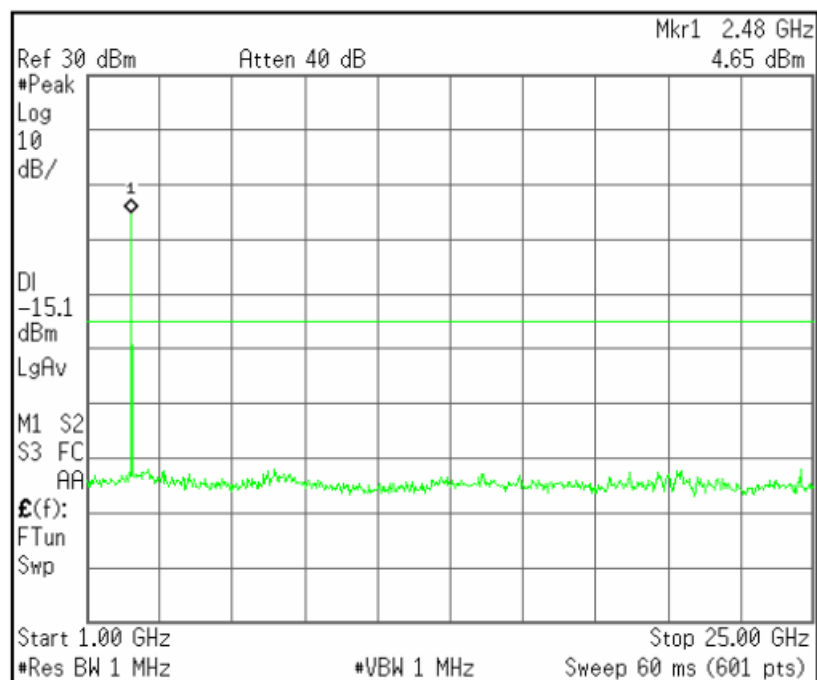
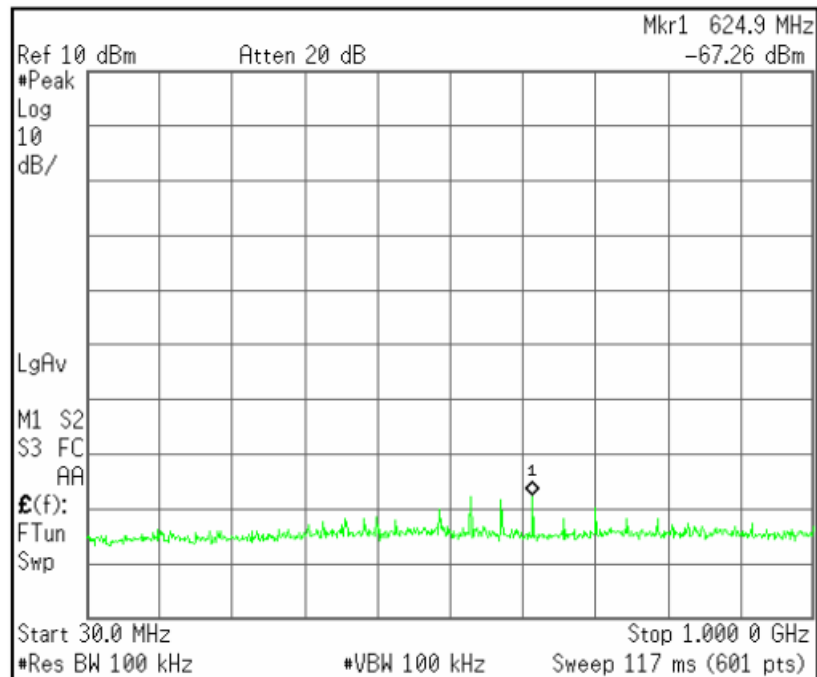




[CH Mid]

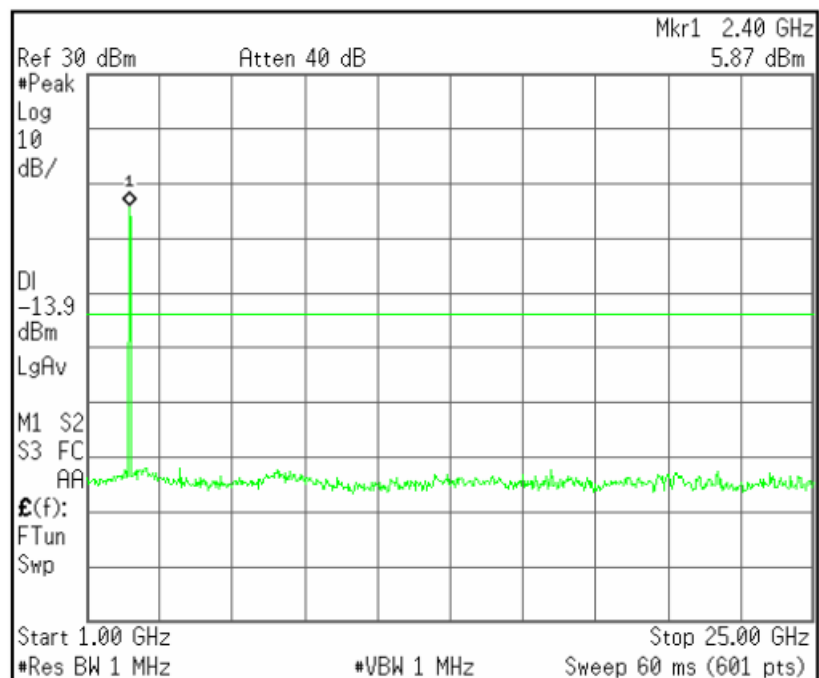
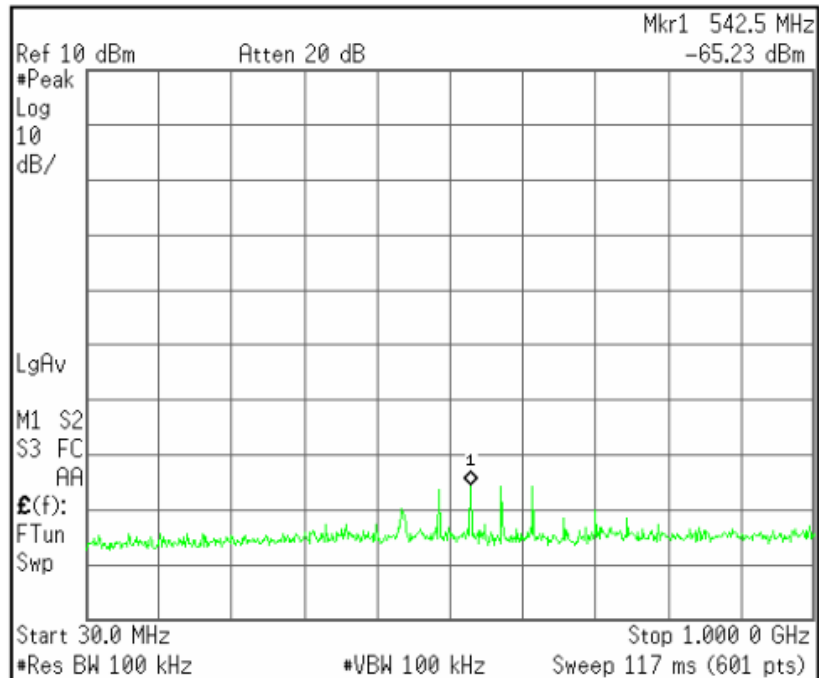


[CH High]

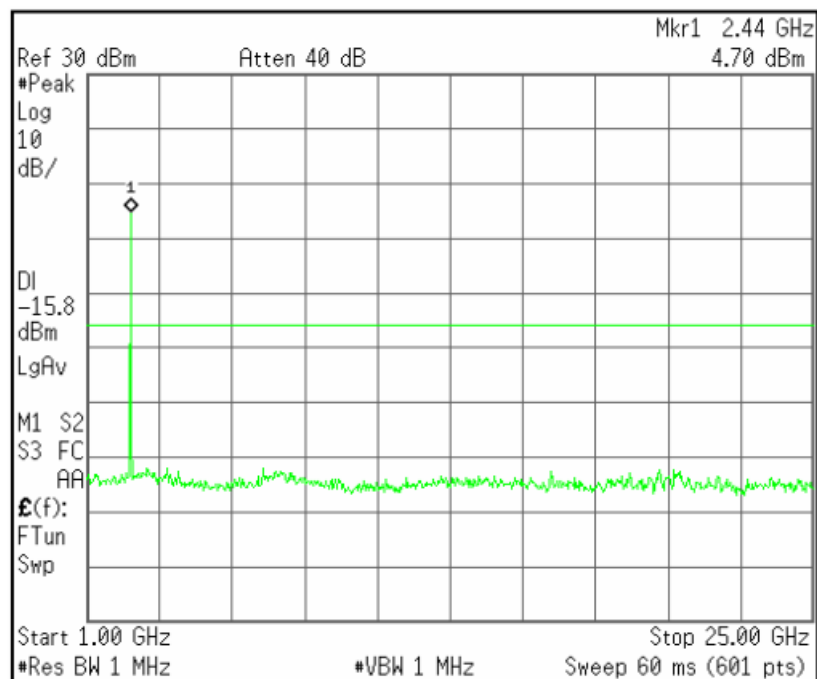
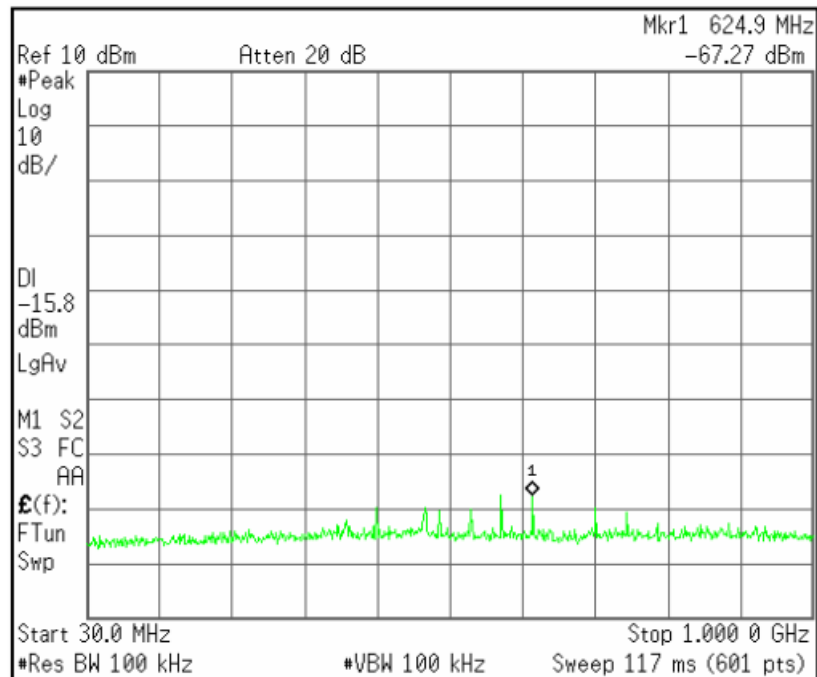


## Plots of Spurious Emissions (Conducted Measurement) (802.11g)

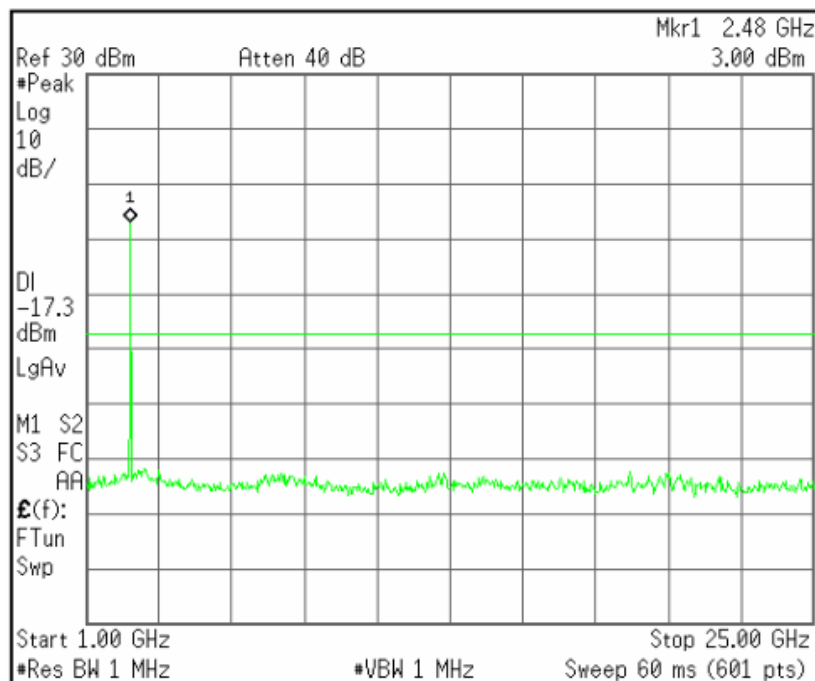
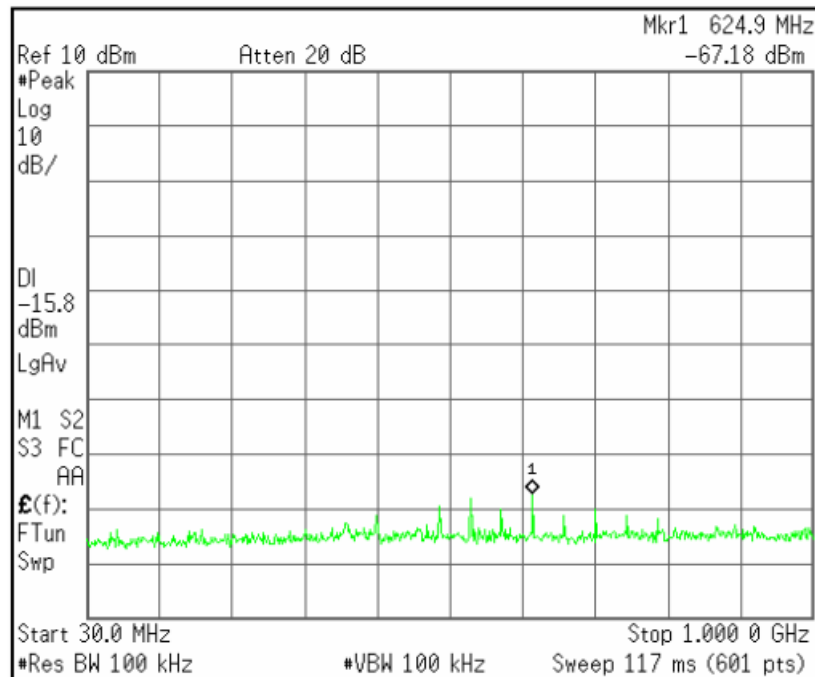
[CH Low]



[CH Mid]

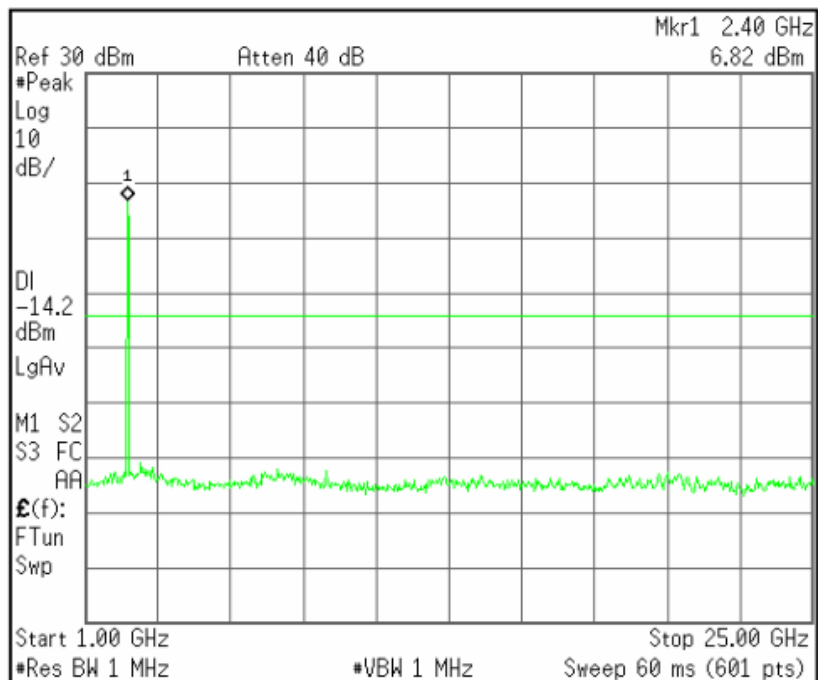
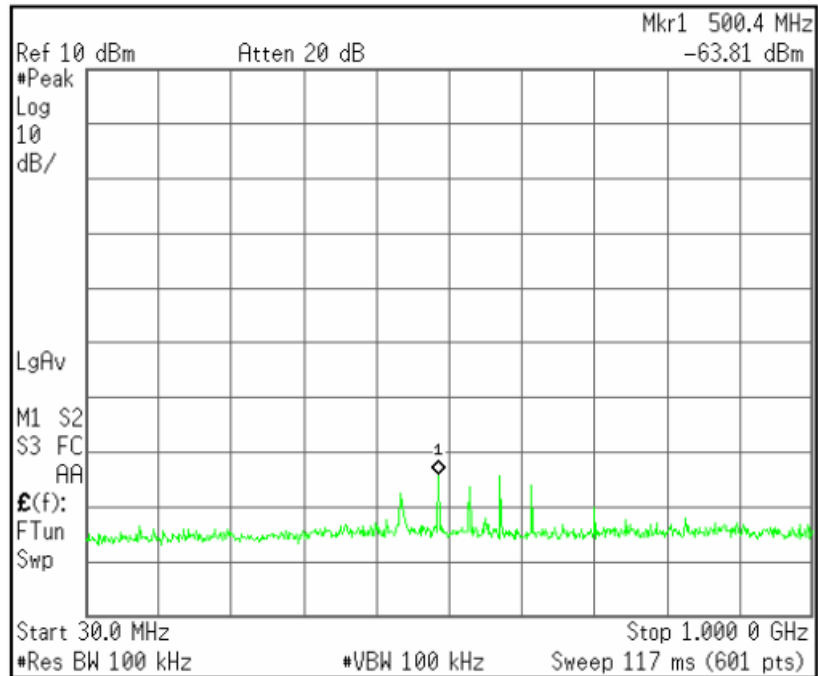


[CH High]

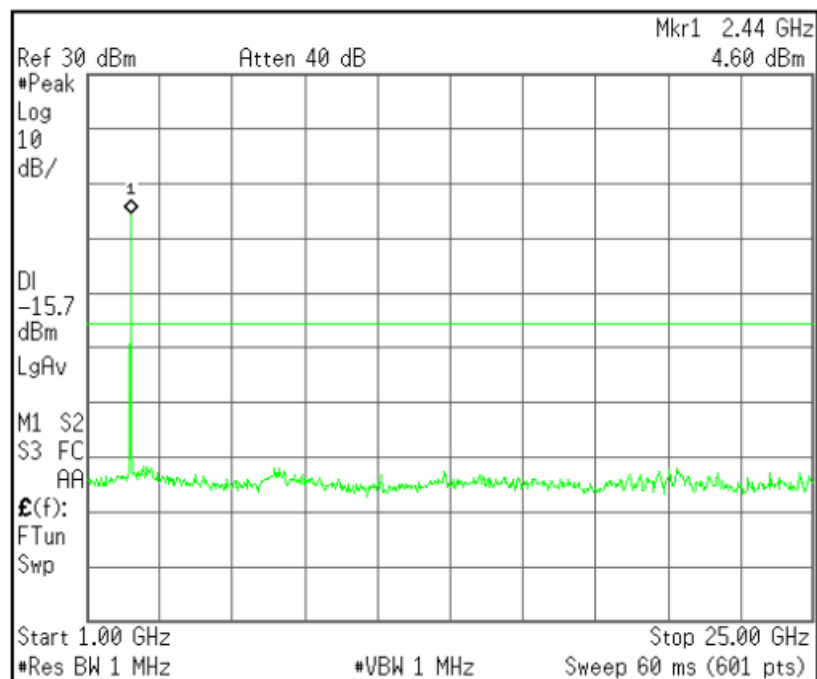
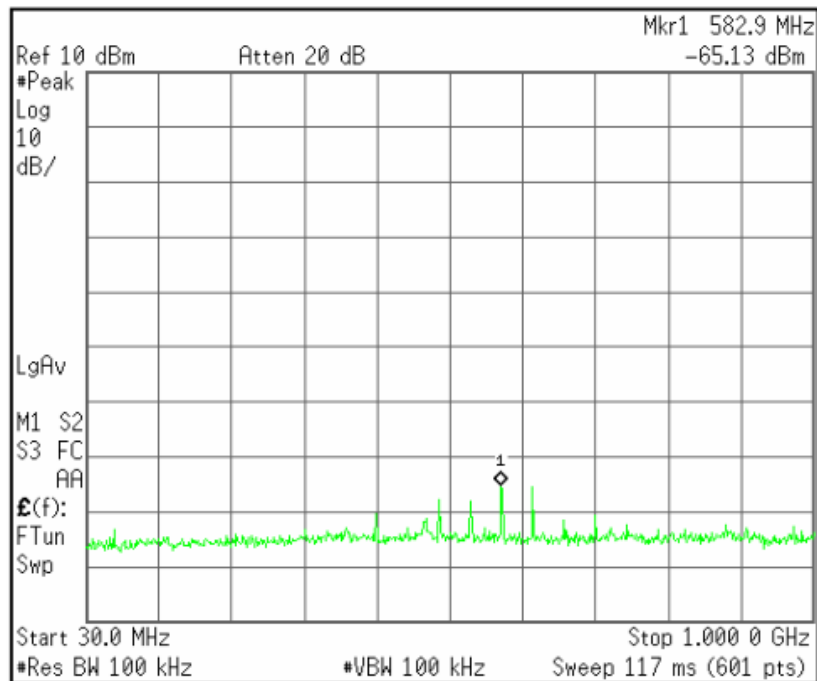


## Plots of Spurious Emissions (Conducted Measurement) (802.11n(HT20))

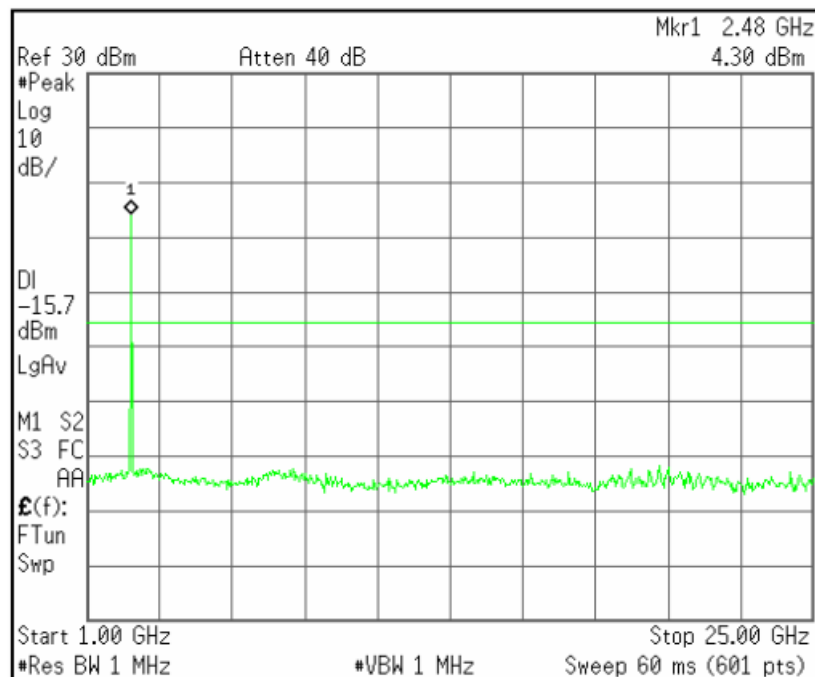
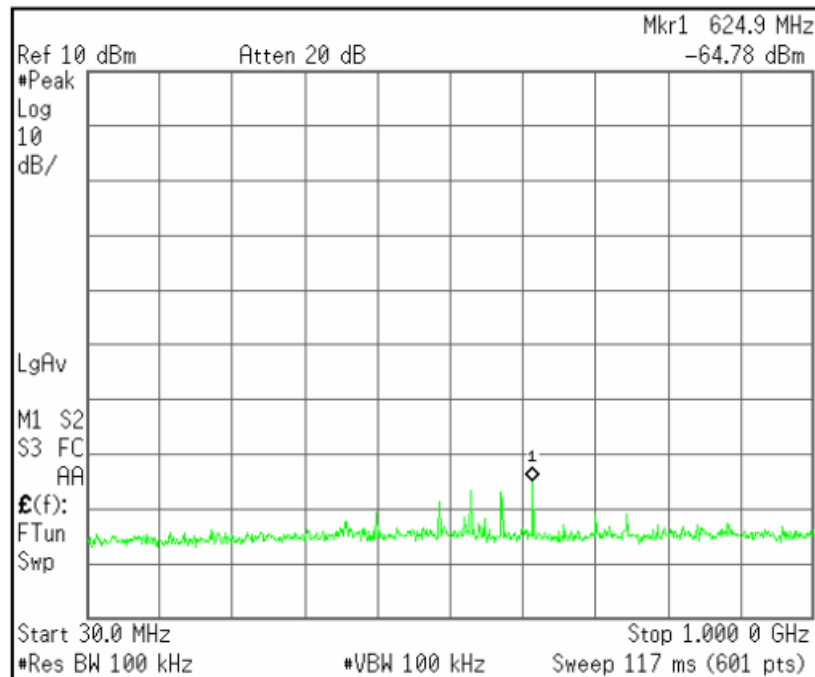
[CH Low]



[CH Mid]



[CH High]





## 5.7 Conducted Emissions Measurement

|                     |                                                 |
|---------------------|-------------------------------------------------|
| EUT                 | OPTIZEN WIRELESS / WIRELESS MODULE 01           |
| Limit apply to      | FCC Part 15.207                                 |
| Test Date           | September 28, 2012                              |
| Operating Condition | RF transmitting continuously during the tested. |
| Result              | Passed by 3.10 dB                               |

### Limit

For an intentional radiator that 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 the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

| Frequency of Emission<br>[MHz] | Conducted limit<br>[dB( $\mu$ V)] |            |
|--------------------------------|-----------------------------------|------------|
|                                | Quasi-peak                        | Average    |
| 0.15 - 0.5                     | 66 to 56 *                        | 56 to 46 * |
| 0.5 - 5                        | 56                                | 46         |
| 5 - 30                         | 60                                | 50         |

\* Decreases with the logarithm of the frequency.

### Test Results

- Refer to see the measured plot in next page.

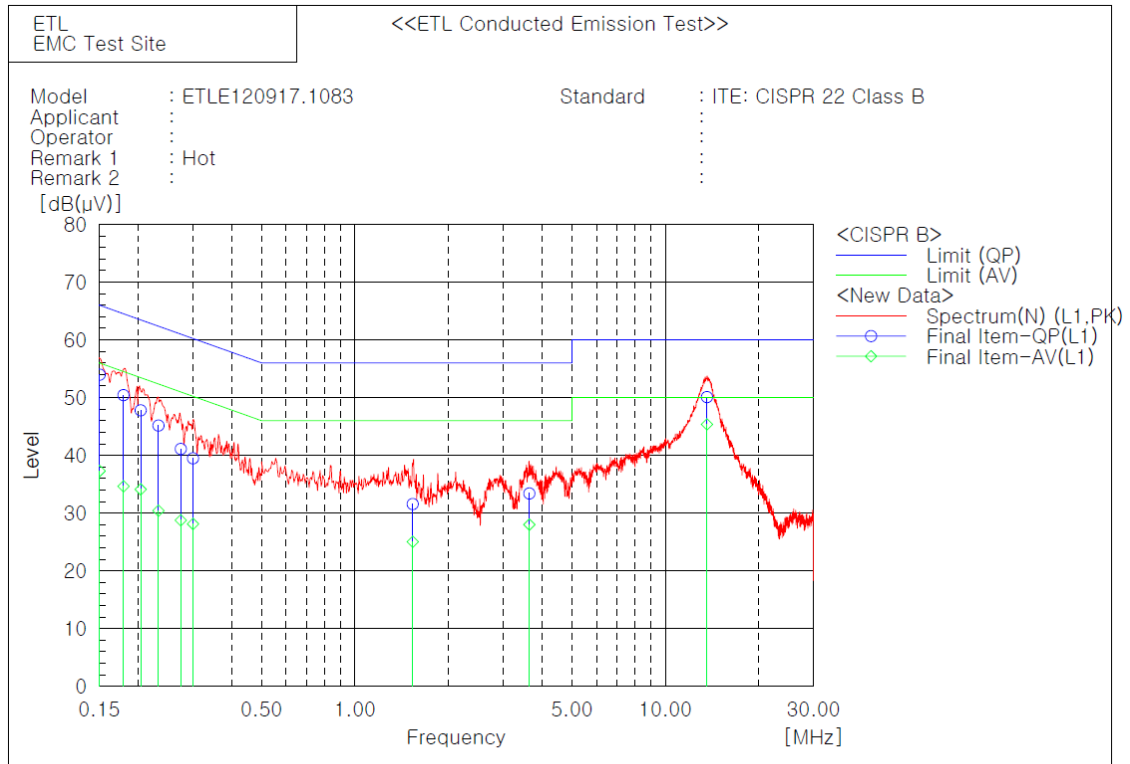
## Conducted Emission Test Data

The following graph shows the highest levels of conducted emissions on both polarizations of hot and neutral line.  
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

### NOTES:

1. Please see the measured data and graph in next page.
2. The c.f value was included the antenna factor and cable loss.
3. Result value = Reading + c.f
4. Margin = Limit - Result
5. Measurements were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15 Class B.

Line: HOT

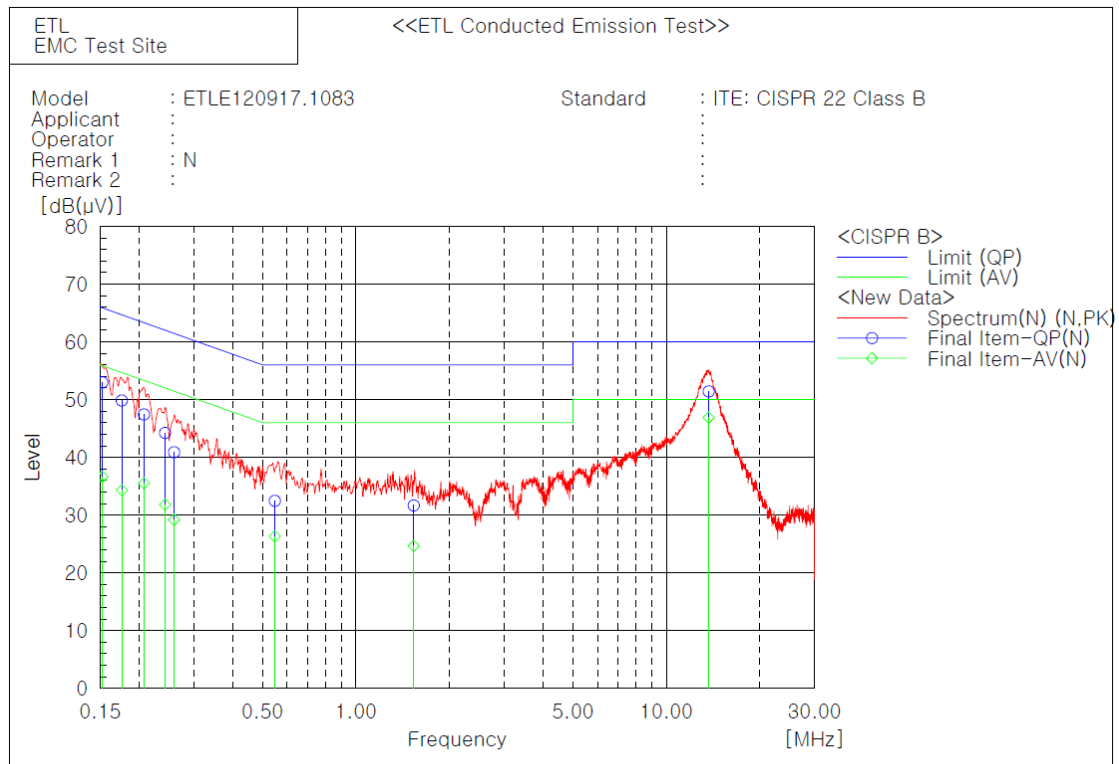


Final Result

— L1 Phase —

| No. | Frequency<br>[MHz] | Reading<br>QP<br>[dB(μV)] | Reading<br>AV<br>[dB(μV)] | c.f<br>[dB] | Result<br>QP<br>[dB(μV)] | Result<br>AV<br>[dB(μV)] | Limit<br>QP<br>[dB(μV)] | Limit<br>AV<br>[dB(μV)] | Margin<br>QP<br>[dB] | Margin<br>AV<br>[dB] |
|-----|--------------------|---------------------------|---------------------------|-------------|--------------------------|--------------------------|-------------------------|-------------------------|----------------------|----------------------|
| 1   | 0.15053            | 44.3                      | 27.6                      | 9.7         | 54.0                     | 37.3                     | 66.0                    | 56.0                    | 12.0                 | 18.7                 |
| 2   | 0.17967            | 40.7                      | 24.9                      | 9.7         | 50.4                     | 34.6                     | 64.5                    | 54.5                    | 14.1                 | 19.9                 |
| 3   | 0.20405            | 38.1                      | 24.4                      | 9.7         | 47.8                     | 34.1                     | 63.4                    | 53.4                    | 15.6                 | 19.3                 |
| 4   | 0.23288            | 35.5                      | 20.7                      | 9.7         | 45.2                     | 30.4                     | 62.3                    | 52.3                    | 17.1                 | 21.9                 |
| 5   | 0.27472            | 31.4                      | 19.1                      | 9.7         | 41.1                     | 28.8                     | 61.0                    | 51.0                    | 19.9                 | 22.2                 |
| 6   | 0.30082            | 29.8                      | 18.4                      | 9.7         | 39.5                     | 28.1                     | 60.2                    | 50.2                    | 20.7                 | 22.1                 |
| 7   | 1.5353             | 21.9                      | 15.3                      | 9.7         | 31.6                     | 25.0                     | 56.0                    | 46.0                    | 24.4                 | 21.0                 |
| 8   | 3.64548            | 23.6                      | 18.2                      | 9.8         | 33.4                     | 28.0                     | 56.0                    | 46.0                    | 22.6                 | 18.0                 |
| 9   | 13.6156            | 40.1                      | 35.4                      | 10.0        | 50.1                     | 45.4                     | 60.0                    | 50.0                    | 9.9                  | 4.6                  |

## Line: Neutral



### Final Result

— N Phase —

| No. | Frequency | Reading<br>QP<br>[dB(μV)] | Reading<br>AV<br>[dB(μV)] | c.f  | Result<br>QP<br>[dB(μV)] | Result<br>AV<br>[dB(μV)] | Limit<br>QP<br>[dB(μV)] | Limit<br>AV<br>[dB(μV)] | Margin<br>QP<br>[dB] | Margin<br>AV<br>[dB] |
|-----|-----------|---------------------------|---------------------------|------|--------------------------|--------------------------|-------------------------|-------------------------|----------------------|----------------------|
|     | [MHz]     |                           |                           | [dB] |                          |                          |                         |                         |                      |                      |
| 1   | 0.15251   | 43.3                      | 26.9                      | 9.7  | 53.0                     | 36.6                     | 65.9                    | 55.9                    | 12.9                 | 19.3                 |
| 2   | 0.17603   | 40.1                      | 24.6                      | 9.7  | 49.8                     | 34.3                     | 64.7                    | 54.7                    | 14.9                 | 20.4                 |
| 3   | 0.20749   | 37.7                      | 25.8                      | 9.7  | 47.4                     | 35.5                     | 63.3                    | 53.3                    | 15.9                 | 17.8                 |
| 4   | 0.24283   | 34.5                      | 22.1                      | 9.7  | 44.2                     | 31.8                     | 62.0                    | 52.0                    | 17.8                 | 20.2                 |
| 5   | 0.25958   | 31.2                      | 19.5                      | 9.7  | 40.9                     | 29.2                     | 61.4                    | 51.4                    | 20.5                 | 22.2                 |
| 6   | 0.5481    | 22.8                      | 16.6                      | 9.7  | 32.5                     | 26.3                     | 56.0                    | 46.0                    | 23.5                 | 19.7                 |
| 7   | 1.5354    | 22.0                      | 15.0                      | 9.7  | 31.7                     | 24.7                     | 56.0                    | 46.0                    | 24.3                 | 21.3                 |
| 8   | 13.692    | 41.4                      | 36.9                      | 10.0 | 51.4                     | 46.9                     | 60.0                    | 50.0                    | 8.6                  | 3.1                  |

## 5.8 Radio Frequency Exposure

According to §15.247(e)(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to TCB Exclusions list, no SAR required if power is lower than the flowing threshold:

| Frequency Range        |                         | Center Frequency<br>[MHz] | 60/f SAR Limitation<br>[mW] |
|------------------------|-------------------------|---------------------------|-----------------------------|
| Low Frequency<br>[MHz] | High Frequency<br>[MHz] |                           |                             |
| 2 412                  | 2 472                   | 2 442                     | 24.570                      |

Maximum measured transmitter power:

- 802.11b mode

| Output Power |       | Max Antenna Gain<br>[dBi] | EIRP<br>[mW] |
|--------------|-------|---------------------------|--------------|
| [dBm]        | [mW]  |                           |              |
| 8.19         | 6.592 | 1.900                     | 10.209       |

- 802.11g mode

| Output Power |       | Max Antenna Gain<br>[dBi] | EIRP<br>[mW] |
|--------------|-------|---------------------------|--------------|
| [dBm]        | [mW]  |                           |              |
| 5.45         | 3.508 | 1.900                     | 5.433        |

- 802.11n(HT20) mode

| Output Power |       | Max Antenna Gain<br>[dBi] | EIRP<br>[mW] |
|--------------|-------|---------------------------|--------------|
| [dBm]        | [mW]  |                           |              |
| 6.17         | 4.140 | 1.900                     | 6.412        |

## 6. SAMPLE CALCULATION

### Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.  
The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF$$

Where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

$$dB(\mu V) = 20 \log_{10} (\mu V) : \text{Equation}$$

$$dB(\mu V) = dBm + 107$$

Example : @ 4 884.21 MHz

$$\text{Class B Limit} = 54.00 \text{ dB}(\mu V/m)$$

$$\text{Reading} = 26.70 \text{ dB}(\mu V)$$

$$\text{Antenna Factor} + \text{Cable Loss} + \text{Preamp} = 4.90 \text{ dB}(\mu V/m)$$

$$\text{Total} = 31.60 \text{ dB}(\mu V/m)$$

$$\text{Margin} = 54.00 - 31.60 = 22.40 \text{ dB}$$

$$= 22.40 \text{ dB below Limit}$$

## 7. List of test equipments used for measurements

|                                     | Test Equipment               | Model                             | Mfg.                        | Serial No. | Cal. Date | Cal. Due Date |
|-------------------------------------|------------------------------|-----------------------------------|-----------------------------|------------|-----------|---------------|
| <input checked="" type="checkbox"/> | EMI Test Receiver            | ESVS 10                           | R&S                         | 835165/001 | 12.03.20  | 13.03.20      |
| <input checked="" type="checkbox"/> | EMI Test Receiver            | ESPI3                             | R&S                         | 100478     | 12.09.05  | 13.09.05      |
| <input checked="" type="checkbox"/> | Two-Line V-Network           | ENV216                            | R&S                         | 958599/106 | 12.03.19  | 13.03.19      |
| <input checked="" type="checkbox"/> | Loop Antenna                 | AL-130                            | COM-POWER                   | 121025     | 12.06.14  | 14.06.14      |
| <input checked="" type="checkbox"/> | LogBicon Antenna             | VULB9160                          | Schwarzbeck                 | 3128       | 12.02.22  | 14.02.22      |
| <input checked="" type="checkbox"/> | Horn Antenna                 | BBHA 9120D                        | Schwarzbeck                 | 277        | 11.03.22  | 13.03.22      |
| <input checked="" type="checkbox"/> | Spectrum Analyzer            | E7405A                            | H.P.                        | US41160290 | 12.09.05  | 13.09.05      |
| <input checked="" type="checkbox"/> | PSA Series Spectrum Analyzer | E4440A                            | Agilent                     | MY46185482 | 12.08.06  | 13.08.06      |
| <input checked="" type="checkbox"/> | Amplifier                    | AFS42-01001800-28-10P-42          | MITEQ Inc.                  | 1565819    | 12.02.06  | 13.02.06      |
| <input checked="" type="checkbox"/> | Band Reject Filter           | WRCGV 2402/2480-2382/2500-52/10SS | Wainwright Instruments GmbH | 2          | 12.09.06  | 13.09.06      |
| <input checked="" type="checkbox"/> | Power Meter                  | NRVS                              | R&S                         | 834053/060 | 12.09.06  | 13.09.06      |
| <input checked="" type="checkbox"/> | Controller                   | HD2000                            | HD GmbH                     | C/125      | N/A       | N/A           |
| <input checked="" type="checkbox"/> | Antenna Master               | MA2400                            | HD GmbH                     | N/A        | N/A       | N/A           |
| <input checked="" type="checkbox"/> | Turn-Table                   | MFT-120S                          | Max-Full Antenna Corp       | -          | N/A       | N/A           |
| <input checked="" type="checkbox"/> | Antenna Master               | MFA-440E                          | Max-Full Antenna Corp       | -          | N/A       | N/A           |