# TEST REPORT

**Report Number: 101503629DEN-001C**
**Project Number: G101503629**

**Report Issue Date: 2/24/2014**

**Product Designation:** **Model: W2400-01 with RadioWaves SEC-25V-60-17HP (60° Sector Antenna)**

**Standards:** **FCC Part 15 Subpart C (15.247)**
Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
**IC RSS-210, Issue 8: 2010**
**IC RSS-GEN, Issue 3: 2010**

Tested by:
Intertek Testing Services NA, Inc.
1795 Dogwood St. Suite 200
Louisville, CO 80027

Client:
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5395 Pearl Parkway, Suite 100
Boulder, CO 80301

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# 1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 3.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded **the product tested complies with the requirements of the standard(s) indicated.** The results obtained in this test report pertain only to the item(s) tested.

## 1.1 Test Report Scope

The scope of this report was to qualify the existing approved radio module Model: W2400-01 with new antennas. This specific report covers the following antenna:

- Model: RadioWaves SEC-25V-60-17HP (60°Sector antenna)

This radio operates in the following 802.11 b/g/n Tx Band: 2400 – 2483.5MHz.

The Model: W2400-01 has previously been fully qualified and documented in the following SPORTON LAB test reports:

- FCC Test Report Number: FR362202
- IC Test Report Number: CR362202-01

Below is a summary of Intertek Test Reports initiated for the above Class II Permissive Change.

- 4' Parabolic "Dish" Antenna (2.4GHz): 101503629DEN-001A
- Directional Panel Antenna (2.4GHz): 101503629DEN-001B
- **60º Sector Antenna (2.4GHz): 101503629DEN-001C (This Report)**

## 1.2 Test Methodology

All measurements were performed according to the procedures in the following documents:

- ANSI C63.10:2013 – ANSI Standard for Testing Unlicensed Wireless Devices
- FCC Publication 558074, April 9, 2013 (Guidelines for Compliance Measurements on DTS Operating Under 15.247)

Radiated emissions tests were performed at an antenna-to-product distance of 3-meters.

## 1.3 Test Facility

Intertek Denver's testing facilities are located at 1795 Dogwood St. Suite 200 Louisville, CO 80027. The testing facility is ISO17025:2005 accredited by A2LA, our lab code is 2506.02, our VCCI registration numbers are. R-1643, C-1752 and T-1558, our FCC designation no. US1121 and our IC lab no. 2042N.

Testing contained in this test report may not be covered under the laboratories scope of accreditation. A note will be placed in the specific test section for testing not coved under the laboratories scope.

## 2 Test Summary

| TEST SECTION | TESTS | FCC/IC REFERENCE | TEST DATE | RESULT |
|---|---|---|---|---|
| 5 | AC Voltage Variation | FCC 15.31(e) | ----- | N/A |
| 6 | Antenna Requirement | FCC 15.203 | ----- | N/A |
| 7 | DTS Requirement | FCC 15.247(a)<br>RSS-210 A8.2 | ----- | N/A |
| 8 | 6dB Bandwidth | FCC 15.247(a)(2)<br>RSS-210 A8.2(a) | ----- | N/A |
| 9 | RF Conducted Output Power<br>(includes requirements for antenna gain > 6dBi) | FCC 15.247(b)(3)(4)<br>FCC 15.247(c)(1)<br>RSS-210 A8.4(4) | ----- | N/A |
| 10 | RF Conducted Spurious Emissions (-20dBc)<br>Includes Band Edge | FCC 15.247(d)<br>RSS-210 A8.5 | ----- | N/A |
| 11 | Transmitter Radiated Spurious Emissions<br>(Restricted Bands – Band Edge) | FCC 15.247(d)<br>FCC 15.209/ 15.205<br>RSS-210 A8.5<br>RSS-Gen 7.2.5 | 02/05/2014<br>to<br>02/06/2014 | Complies |
| 12 | Power Spectral Density (PSD) | FCC 15.247(e)<br>RSS-210 A8.2(b) | ----- | N/A |
| 13 | Radiated Emissions – Digital Receiver | FCC 15.109<br>RSS-Gen 6.1 | ----- | N/A |
| 14 | Tx AC Line Conducted Emissions | FCC 15.207<br>RSS-Gen 7.2.4 | ----- | N/A |
| 15 | RF Exposure Requirement | FCC 15.247(i)<br>FCC 15.1.1307(b)(1)<br>RSS 102 | ----- | N/A |
| 16 | Duty Cycle/ Duty Cycle Correction Factor | FCC 15.35(c)<br>RSS-Gen 4.5 | ----- | N/A |

Notes:

1) All Tx Radiated Emission measurements in this report utilized the transmit channels and worst-case 802.11 band(s), modulation and data rates reported in the FCC and IC test reports listed on page 3 of this report. Note HT20/HT40 and both SISO and MIMO Tx operating modes were tested.
2) Only selected testing required for the specific Class II Permissive change was performed.

**General Radio Test Notes:**

- ANSI C63.10, Section 4.2.3.2/ FCC 15.35: Measurement detector functions and bandwidths utilized in this testing were per the preceding guidelines.

- ANSI C63.10, Section 4.2.3.2.2/ FCC 15.35(b): When an average limit is specified, the peak emission must also be measured to ensure the emissions is less than 20dB above the average limit and/or below the peak limit specified. This report includes both average and peak test data.

- ANSI C63.10, Section 5.3/ FCC 15.31: All radiated field strength measurements taken at an antenna-to-product test distance of 3-meters.

ANSI C63.10, Section 6.3/ FCC 15.31(m): Measurements were taken at the lowest, near the middle and highest channels of the product tested.

## 3 Description of Product Under Test

| | |
|---|---|
| **Model:** | W2400-01 (2.4GHz) |
| **Type of EUT:** | 802.11 b/g/n PCIe Module |
| **Serial Number:** | DEN1402111313 |
| **FCC ID:** | KNYASM1101CR |
| **Industry Canada ID:** | IC ID: 2329B-ASM1101CR |
| **Related Submittal(s) Grants:** | ----- |
| **Company:** | FreeWave Technologies, Inc. |
| **Customer:** | FreeWave Technologies, Inc. |
| **Address:** | 5395 Pearl Parkway, Suite 100 |
| **Phone:** | (303) 962-7879 |
| **Fax:** | ----- |
| **e-mail:** | dbusch@freewave.com |
| **Test Standards:** | ☒ 47 CFR, Part 15C:§15.247 DTS<br>☒ RSS–210, Issue 8, 2010<br>☒ RSS-Gen, Issue 3, 2010<br>☐ 47 CFR, Part 15C:§15.207<br>☐ Other |
| **Type of radio:** | ☐ Stand -alone ☒ Module ☐ Hybrid |
| **Date Sample Submitted:** | 01/27/2014 |
| **Test Work Started:** | 02/05/2014 |
| **Test Work Completed:** | 02/06/2014 |
| **Test Sample Conditions:** | ☐ Damaged ☐ Poor (Usable) ☒ Good |

| | |
|---|---|
| **Product Description:** | |
| **Transmitter Type:** | ☐ FHSS ☒ Digital Modulation ☐ WiFi ☐ Blue Tooth |
| **Operating Frequency Range(s):** | 2412MHz to 2462MHz |
| **Number of Channels:** | IEEE 802.11b, IEEE 802.11g, 802.11n HT20, 11-Channels<br>802.11n HT40, 1-Channel<br>2400 – 2483.5 MHz |
| **Modulation:** | 802.11b: DSSS-DBPSK, DQPSK, CCK<br>802.11 g/n: OFDM-BPSK, QPSK, 16QAM, 64QAM |
| **Emission Designator:** | |
| **Antenna(s) Info:** | Antenna: Type: 2.4GHz (60° Sector) Gain: +17.5 dBi<br>Connector Type: "N"<br>External Antenna(s) (Dedicated) – Point-to-Point |
| **Rated Power:** | EIRP 27.86 dBm (610.94 mW) |
| **Antenna Installation:** | ☐ User ☒ Professional ☐ Factory |
| **Transmitter power configuration:** | ☐ Internal battery ☒ External power source |
| **Special Test Arrangement:** | Mounted on antenna tripod |
| **Test Facility Accreditation:** | A2LA (Certificate No. 2506.02) |
| **Test Methodology:** | Measurements performed according to the procedures in ANSI C63.10-2013 and FCC Guidance Publication 558074 |

## 3.1 Channel Configurations

| CHANNELS IN THE 2400 – 2483.5 MHZ BAND | | | | | |
|---|---|---|---|---|---|
| **Channel Number** | **Frequency (MHz)** | **802.11n HT20** | **802.11n HT40** | **SISO $N_{TX=1}$** | **MIMO $N_{TX=3}$** |
| 1 | 2412 | xt | --- | tested | --- |
| 2 | 2417 | x | --- | x | --- |
| 3 | 2422 | x | --- | x | --- |
| 4 | 2427 | x | --- | x | --- |
| 5 | 2432 | x | --- | x | --- |
| 6 | 2437 | xt | xt | tested | tested |
| 7 | 2442 | x | --- | x | --- |
| 8 | 2447 | x | --- | x | --- |
| 9 | 2452 | x | --- | x | --- |
| 10 | 2457 | x | --- | x | --- |
| 11 | 2462 | xt | --- | tested | --- |

Note: x = available channels xt = tested channels

## 3.2 Product Description – Detailed

| Description of Equipment Under Test (provided by client) |
|---|
| The system tested is the Model: W2400-01 (2.4GHz) radio module configured with:<br>▪ Model: RadioWaves SEC-25V-60-17HP (60° Sector antenna)<br><br>The product is a wireless router utilized in M2M industrial applications<br><br>Signal & I/O Cables: Ethernet<br><br>The product is powered from an external power source. |

For the testing of this specific test report, the product supports the following data rates in the 2400 – 2483.5 MHz band:

- IEEE 802.11n HT20: MCS0-MCS15
- IEEE 802.11n HT40: MSC0-MCS15

In 802.11n HT20 mode, the nominal bandwidth is 20MHz.
In 802.11n HT40 mode, the nominal bandwidth is 40MHz.

The product operates in both SISO (1-transmit chain) and MIMO (2-transmit chains) modes.

| Equipment Under Test Power Configuration | | | |
|---|---|---|---|
| Rated Voltage | Rated Current | Rated Frequency | Number of Phases |
| AC Adapter Input: 100-240VAC | 0.9 A | 50/60 | 1 |
| AC Adapter Output: 12VDC | 3.0 A | --- | --- |

| Descriptions of EUT Exercising |
|---|
| ☐ Standby/Idle Mode |
| ☐ Continuous transmission, un-modulated carrier (CW) |
| ☒ Continuous transmission, modulated carrier (CW) |
| ☐ Continuous Receive Mode |

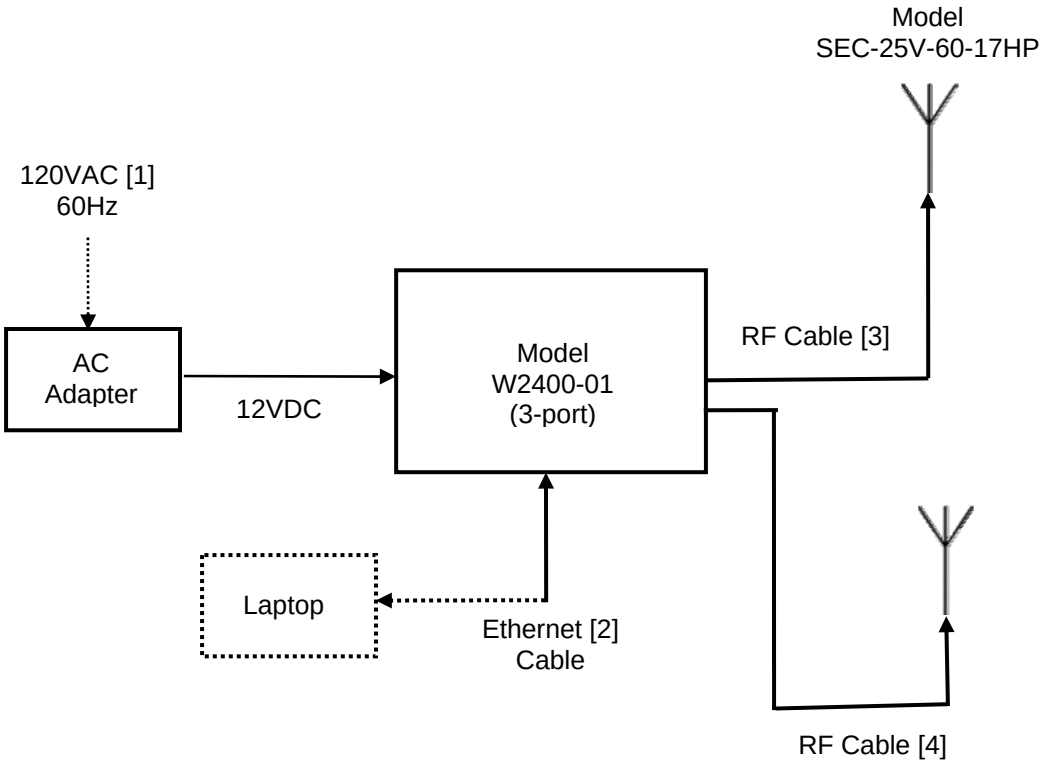
Note: The chosen mode of operation described above is dependent upon the specific test to be performed.

## 4 System setup including cable interconnection details, support equipment and simplified block diagram

### 4.1 Method:

Record the details of EUT cabling, document the support equipment, and show the interconnections in a block diagram.

### 4.2 EUT Block Diagram: 60º Sector Antenna (1-port)




Note: Dashed lines indicate auxiliary/support equipment outside the test area. Ethernet cable was routed partially outside the test chamber with ~ 1-meter inside the test chamber – connected to the Model W2400-01 Ethernet port.

## 4.3 Antenna Specifications:

| 2.4 GHz | | | | | |
|---|---|---|---|---|---|
| **Model** | **Type** | **Gain (dBi)** | **Beamwidth (degrees)** | **Polarization** | **Datasheet** |
| RadioWaves SEC-25V-60-17HP | 60 degree sector | 17.5 | 60 | Single | Appendix A of this report |

## 4.4 Determination of RF Power supplied to antenna input for testing

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

Antenna tested:

- Model SEC-25V-60-17HP (60º Sector Antenna) Gain: 17.5dBi

==========

Maximum Peak Conducted Output Power: If $G_{Tx} > 6$dBi, then $P_{Out} = 30 – ((G_{Tx} – 6)/3)$ dBm

Where:

$P_{Out}$ = maximum peak conducted output power (dBm)

$G_{Tx}$ = maximum transmitting antenna directional gain (dBi)

==========

$P_{Out} = 30 – ((G_{Tx} – 6)/3)$ dBm = 30 – ((17.5-6)/3) dBm = 26.17 dBm

All Radiated measurements taken with the Model: W2400-01 transmitting at 26.17 dBm.
This represents the absolute worst-case output power allowed to be delivered to the antenna port(s).

Actual Rated Output Power: 27.86dBm (610.94 mW)

### 4.5 Support Data:

| ID | Description/ Function | Shield Type | Length | Connector | Connection | Ferrites |
|---|---|---|---|---|---|---|
| 1 | DC Cable (ac adapter) | none | 0.5 meter | DC | VDC – Model W2400-01 | none |
| 2 | Ethernet Cable | none | 4-meter | RJ45 | RJ-45 – Model W2400-01 | none |
| 3-4 | RF Cable(s) | Braid | 3-meter | SMA-to-N | Model W2400-01 to Antenna | none |
| | | | | | | |

| Support Equipment | | | |
|---|---|---|---|
| Description | Manufacturer | Model Number | Serial Number |
| Laptop | HP | --- | --- |
| Switching Power Supply | Sceptre Power | S036CQ1200300 | --- |

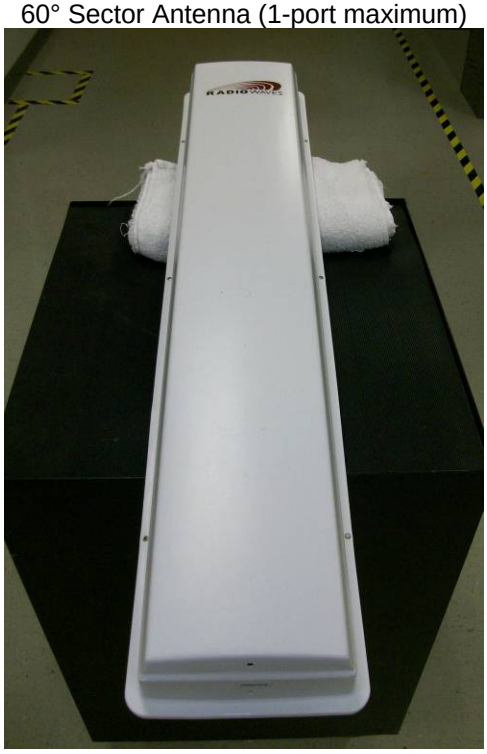
Notes:

1) The laptop was utilized only to configure the product during testing (i.e. set channel, modulation, data rates, etc.).
2) The product has RF ports and Ethernet Cable ports.

## 4.6 Photograph: Product Tested - 60° Sector Antenna

Model W2400-01 Radio Module (3-port maximum)

60° Sector Antenna (1-port maximum)



## 4.7 Photograph: Product Tested - 60° Sector Antenna

## 5 AC Voltage Variation/ Battery Requirement

### 5.1 Results:

Test not required for Class II Permissive Change.

## 6 Antenna Requirement

### 6.1 Results:

Test not required for Class II Permissive Change.

## 7 DTS Requirement

### 7.1 Results:

Test not required for Class II Permissive Change.

## 8 DTS Bandwidth (6dB Bandwidth)

### 8.1 Test Results:

Test not required for Class II Permissive Change.

## 9 RF Conducted Output Power

### 9.1 Results:

Not required for Class II permissive change. However, the software utility utilized to configure the radio output power supplied to the antenna(s) during testing was verified to provide at least the minimum output power selected for testing.

## 10 RF Conducted Spurious Emissions (-20dBc) – Including Band Edge

### 10.1 Test Results:

Test not required for Class II Permissive Change.

# 11 Transmitter Radiated Spurious Emissions – Restricted Band/ Band Edge

## 11.1 Method

Unless otherwise stated no deviations were made from FCC Part 15.209/205.

This testing was performed at Intertek Denver, located at 1795 Dogwood St. Suite 200, Louisville, CO 80027.

## 11.2 Test Requirement/ Specification:

Radiated emissions which fall in the restricted bands, as defined in FCC Part 15.205(a), must also comply with the radiated emission limits specified in Part 15.209(a) and Part 15.205(c). Measurements in the restricted bands include both peak detector and average detector measurements.
Measurements in non-restricted bands include peak detector measurements.

Unwanted emissions below 1GHz must comply with the general field strength limits defined in FCC Part 15.209, when measured with a quasi-peak detector.

## 11.3 Test Equipment Used:

| Asset ID | Description | Manufacturer | Model | Serial | Cal Date | Cal Due |
|---|---|---|---|---|---|---|
| DEN-073 | EMI Receiver (10Hz – 26.5GHz) | RHODE & SCHWARZ | ESU 26 | 100265 | 01/29/2014 | 01/29/2015 |
| 18913 | Spectrum Analyzer | Hewlett-Packard | E7405A | My44211889 | 07/26/2013 | 07/26/2014 |
| 18912 | 9 kHz- 1.3GHz Pre Amp | Hewlett-Packard | 8447F | 3113A05545 | 06/07/2013 | 06/07/2014 |
| 18906 | RF Pre-Amp (1-4GHz) | Mini-Circuits Lab | ZHL-42 | N052792-2 | 06/10/2013 | 06/10/2014 |
| DEN-032 | 4-18GHz Preamp (LNA) | Narda | DBL-0618N615 | 031 | 03/07/2013 | 03/07/2014 |
| DEN - 154 | 2.4GHz Notch Filter | Micro-Tronics | BRM50702 | 151 | 09/24/2013 | 09/24/2014 |
| 19937 | Bilog Antenna 30MHz – 6GHz | Sunol Sciences | JB6 | A050707-2 | 03/20/2013 | 03/20/2014 |
| 18887 | Horn Antenna 1-18GHz | EMCO | 3115 | 9205-3886 | 03/19/2013 | 03/19/2014 |
| SW-6 | Software for Radiated and Conducted emissions. | Intertek | OATS vba | V. 3.0 | VBU | VBU |

## 11.4 Test Procedure:

The Resolution Bandwidth is 120 kHz or greater for frequencies 30 MHz -1000 MHz and 1 MHz for frequencies above 1000 MHz. The Video Bandwidth was at least 3x the RBW.

The EUT is placed on a plastic turntable that is 80 cm in height. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables are manipulated to produce worst-case emissions. The signal is maximized by rotating the turntable through a 360º rotation. The antenna height is varied from 1-4 meters. Both vertical and horizontal antenna configurations are utilized in the testing.

Radiated emissions 30MHz to 18GHz are taken at 3-meter antenna-to-product test distance.

Radiated emissions above 18GHz are taken using a harmonic mixer antenna/pre-amp setup at 1-meter antenna-to-product test distance.

Data is included for the worst-case configuration - the configuration which resulted in the highest emission levels.

The following procedures described in FCC Publication 558074 (Guidelines for Compliance Measurements on DTS Operating Under 15.247), were used:

- 558074, Section 12.1 & 13.1
- ANSI C63.10: 2009 – General Guidance

### 11.5 Test Results:

The sample tested was found to Comply.

## 11.6 Test Summary – Worst-Case Measurements

### Test Data Summary: Tx Radiated Spurious Emissions in Restricted Band

SISO Mode of Operation: 802.11n HT20

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Average | FCC 15.35(b) Peak | (MHz) |
| **Measurements: Mid Channel 1GHz to 18GHz, Average/Peak, RBW 1MHz, VBW 3MHz, max hold** | | | | | | | | | | | | | |
| 4874.0000 | 69.15 | **Pk** | 5.20 | 32.98 | 39.08 | 0.00 | 68.25 | V | 1.33 | 7.0 | N/A | - 5.75 | 1.000 |
| 4874.0000 | 52.53 | **Av** | 5.20 | 32.98 | 39.08 | 0.00 | 51.63 | V | 1.33 | 7.0 | - 2.35 | NA | 1.000 |
| | | | | | | | | | | | | | |

### Test Data Summary: Tx Spurious Emissions – Band Edge/Restricted Band

SISO Mode of Operation: 802.11n HT20

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Average | FCC 15.35(b) Peak | (MHz) |
| **Measurements: Upper Band Edge, Average/Peak, RBW 1MHz, VBW 3MHz, max hold** | | | | | | | | | | | | | |
| 2483.5000 | 52.10 | **Av** | 3.58 | 28.69 | 37.67 | 5.76 | 52.46 | V | 1.51 | 11.0 | - 1.52 | NA | 1.000 |
| 2483.5000 | 63.99 | **Pk** | 3.58 | 28.69 | 37.67 | 5.76 | 64.35 | V | 1.51 | 11.0 | NA | - 9.65 | 1.000 |
| | | | | | | | | | | | | | |

### Test Data Summary: Tx Radiated Spurious Emissions in Restricted Band

MIMO Mode of Operation: 802.11n HT20

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Average | N/A | (MHz) |
| **Measurements: Mid Channel 30MHz to 1000MHz, Quasi-peak, RBW 120kHz, VBW 300kHz, max hold** | | | | | | | | | | | | | |
| 500.0004 | 52.33 | **Qp** | 1.53 | 17.70 | 28.60 | 0.00 | 42.96 | V | 1.26 | 41.9 | - 3.06 | NA | 0.120 |
| | | | | | | | | | | | | | |

### Test Data Summary: Tx Spurious Emissions – Band Edge/Restricted Band

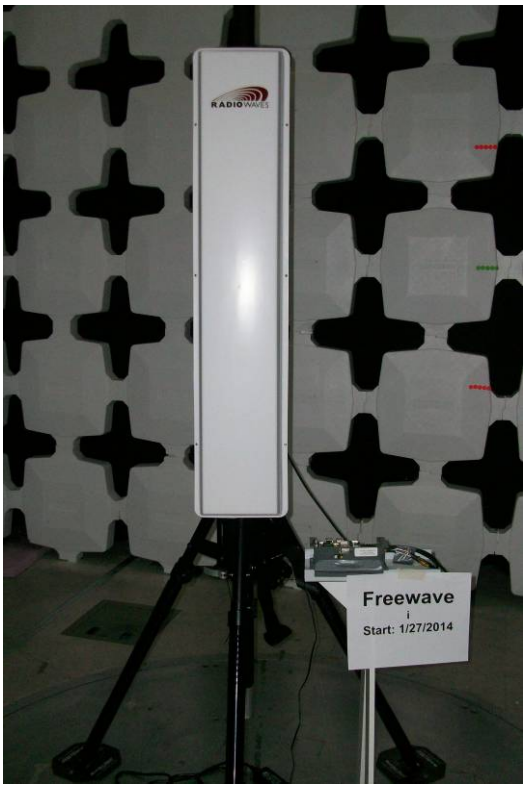
MIMO Mode of Operation: 802.11n HT20

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Average | FCC 15.35(b) Peak | (MHz) |
| **Measurements: Lower Band Edge, Average/Peak, RBW 1MHz, VBW 3MHz, max hold** | | | | | | | | | | | | | |
| 2483.5000 | 52.10 | **Av** | 3.58 | 28.69 | 37.67 | 5.76 | 52.46 | V | 1.51 | 11.0 | - 1.52 | NA | 1.000 |
| 2483.5000 | 63.99 | **Pk** | 3.58 | 28.69 | 37.67 | 5.76 | 64.35 | V | 1.51 | 11.0 | NA | - 9.65 | 1.000 |
| | | | | | | | | | | | | | |

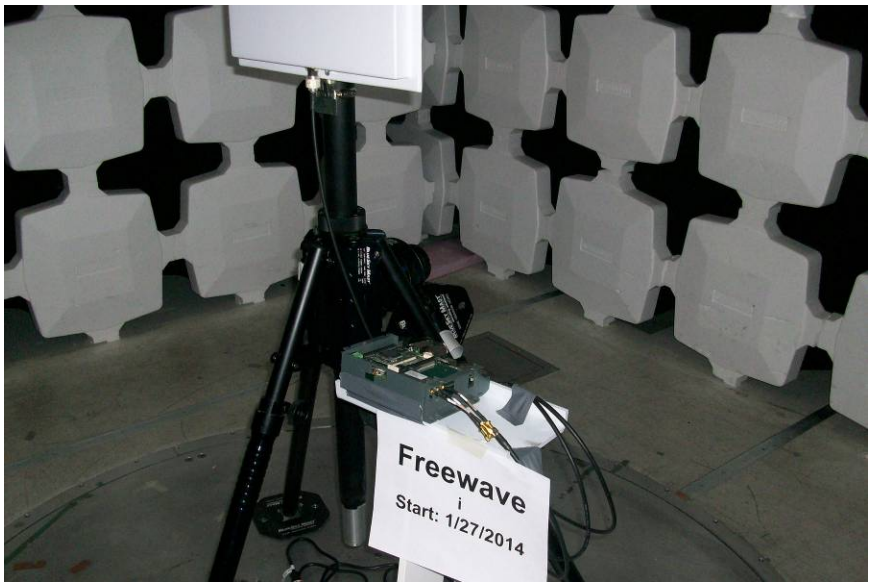
Note: The above represents the worst-case measurements.

## 11.7 Setup Photographs: SISO Mode of Operation

Transmitter Spurious Radiated Emissions - Test Setup (Front View)

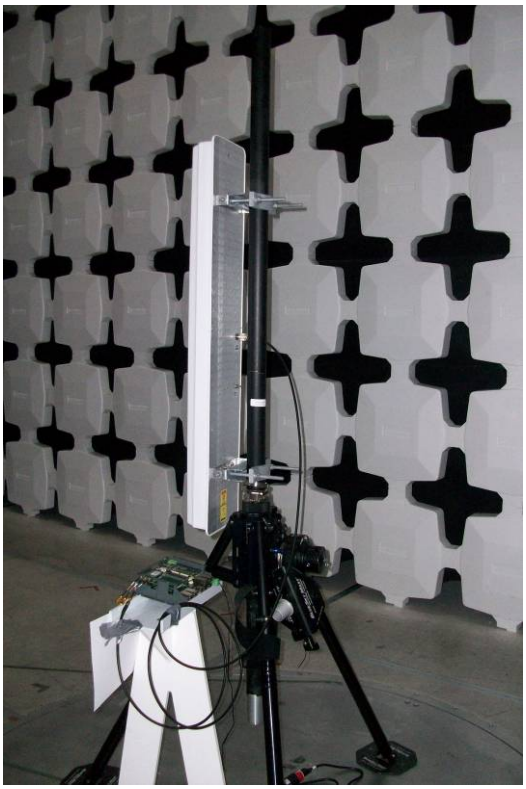



Model W2400-01

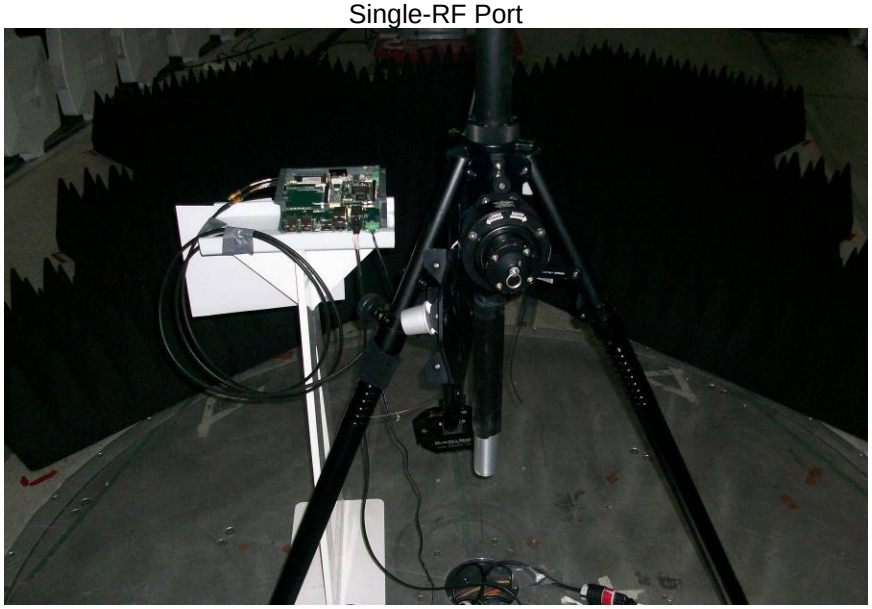


## 11.8 Setup Photographs: SISO Mode of Operation

Transmitter Spurious Radiated Emissions - Test Setup (Rear View)

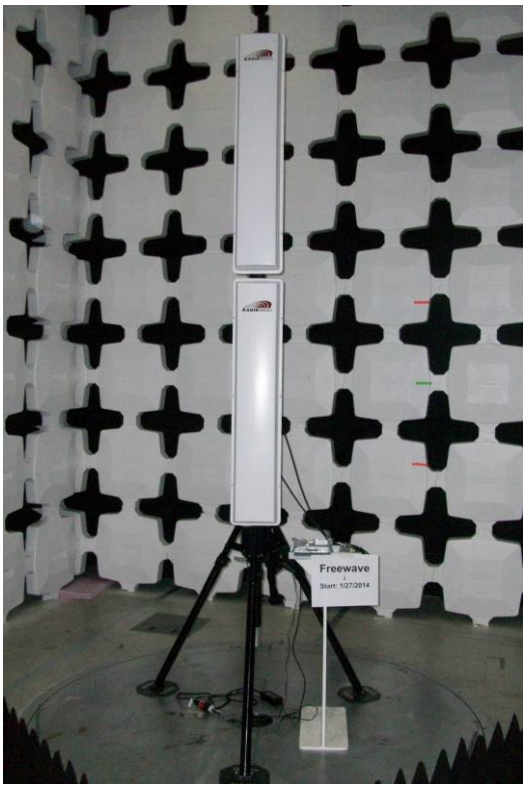


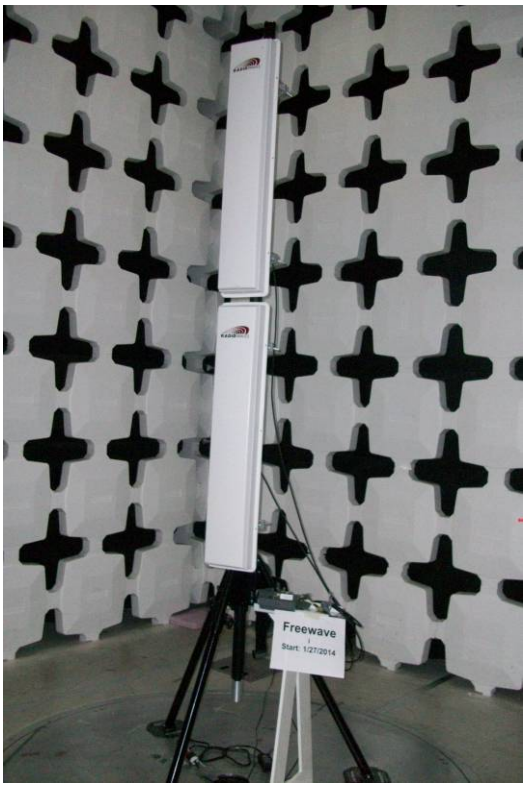
Single-RF Port



## 11.9 Setup Photographs: MIMO Mode of Operation

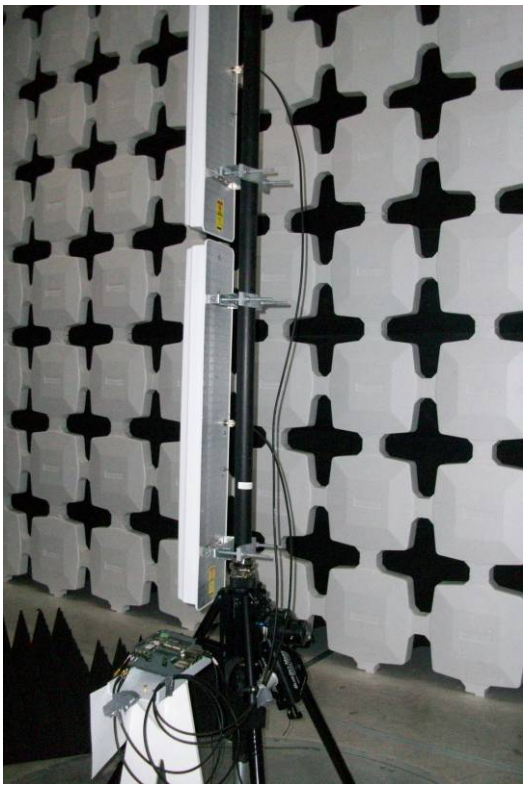
Transmitter Spurious Radiated Emissions - Test Setup (Front View)



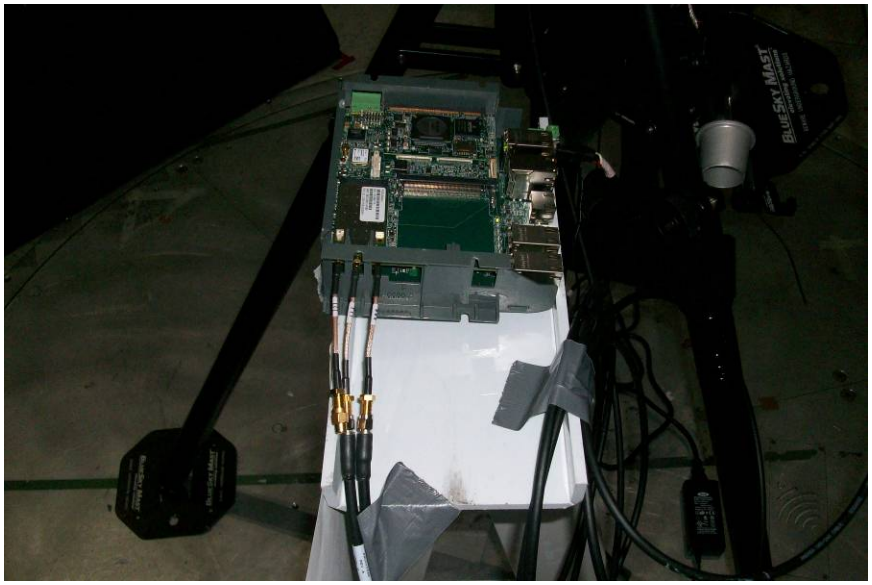



## 11.10 Setup Photographs: MIMO Mode of Operation

Transmitter Spurious Radiated Emissions - Test Setup (Rear View)

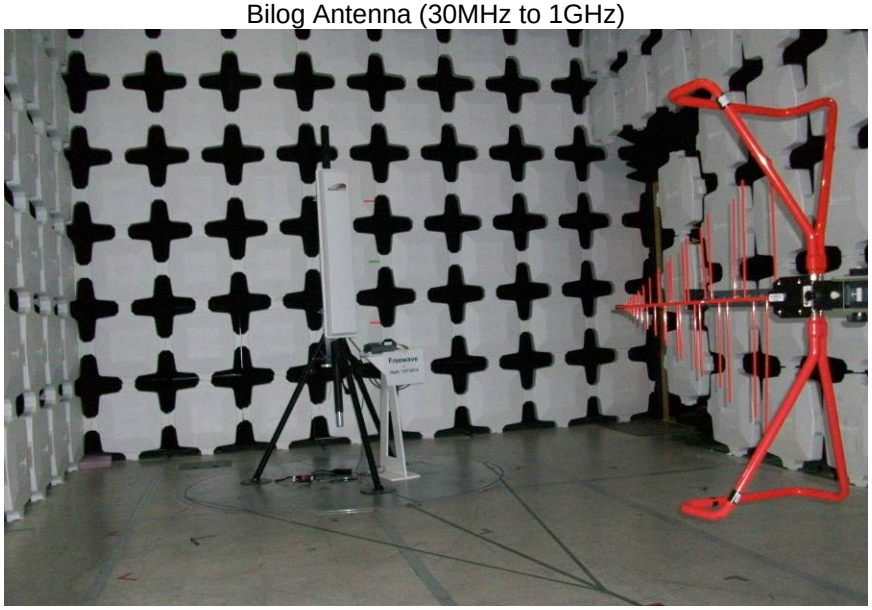


3-RF Port

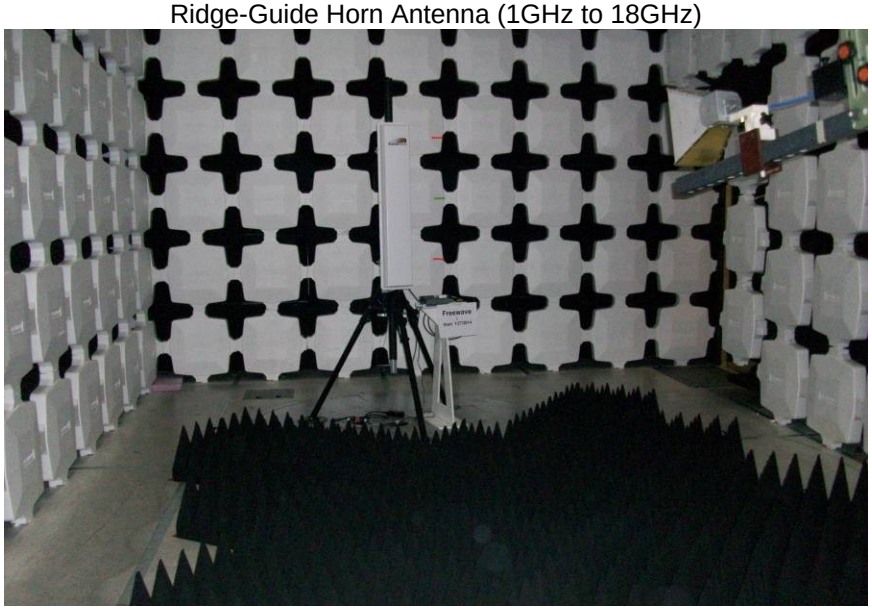


## 11.11 Antenna Setups:

Bilog Antenna (30MHz to 1GHz)



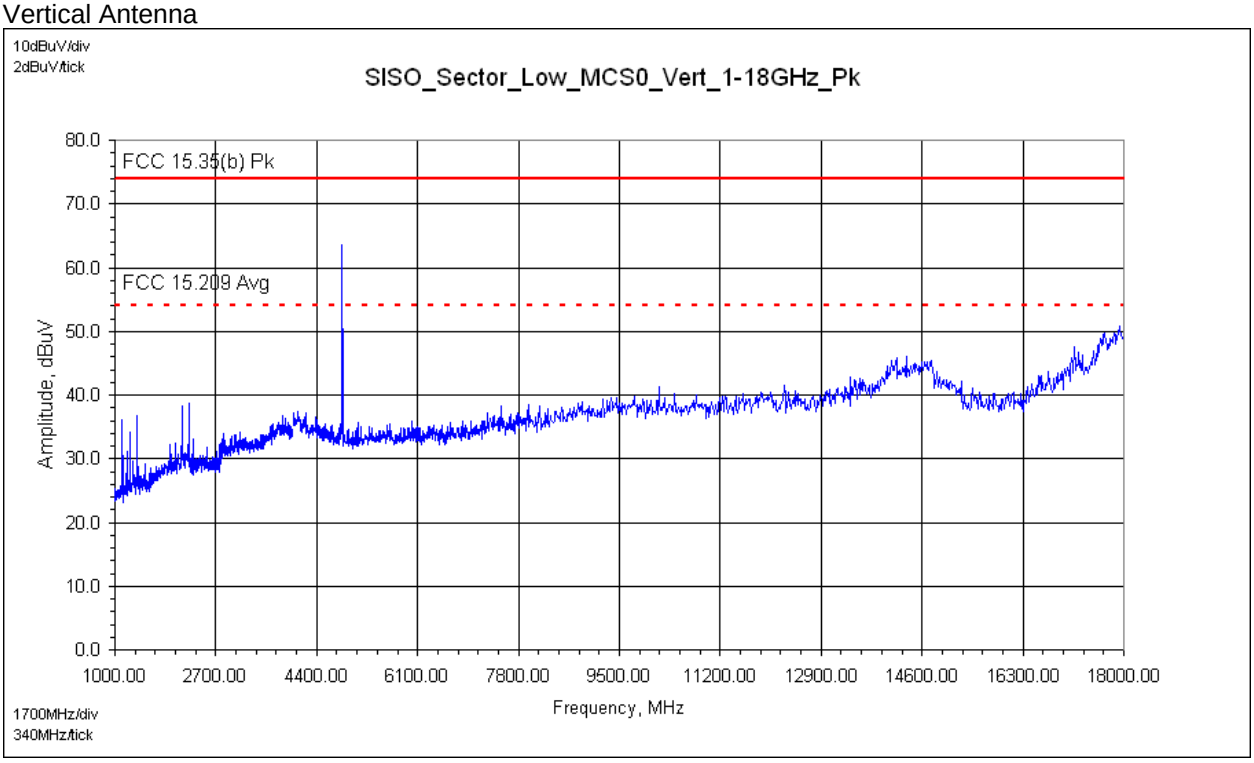
Ridge-Guide Horn Antenna (1GHz to 18GHz)



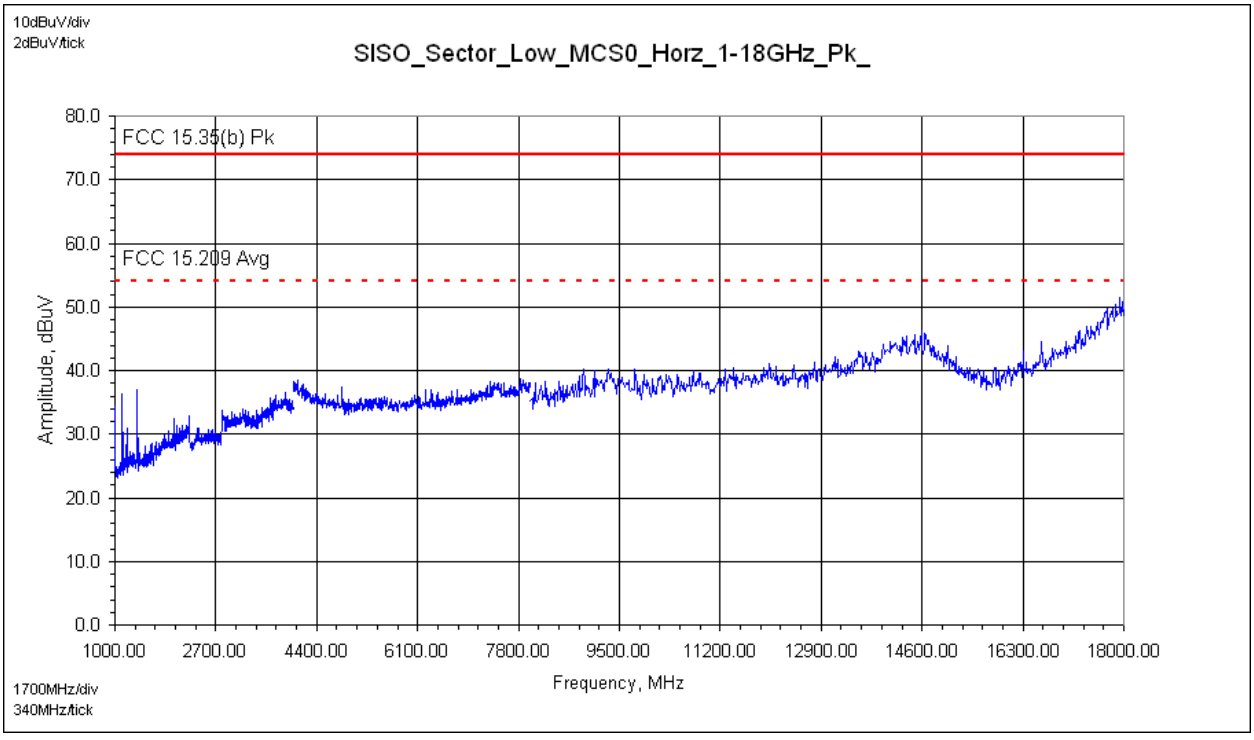
## 11.12 Plots: SISO Mode of Operation – HT20 Low Channel: 2412 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna

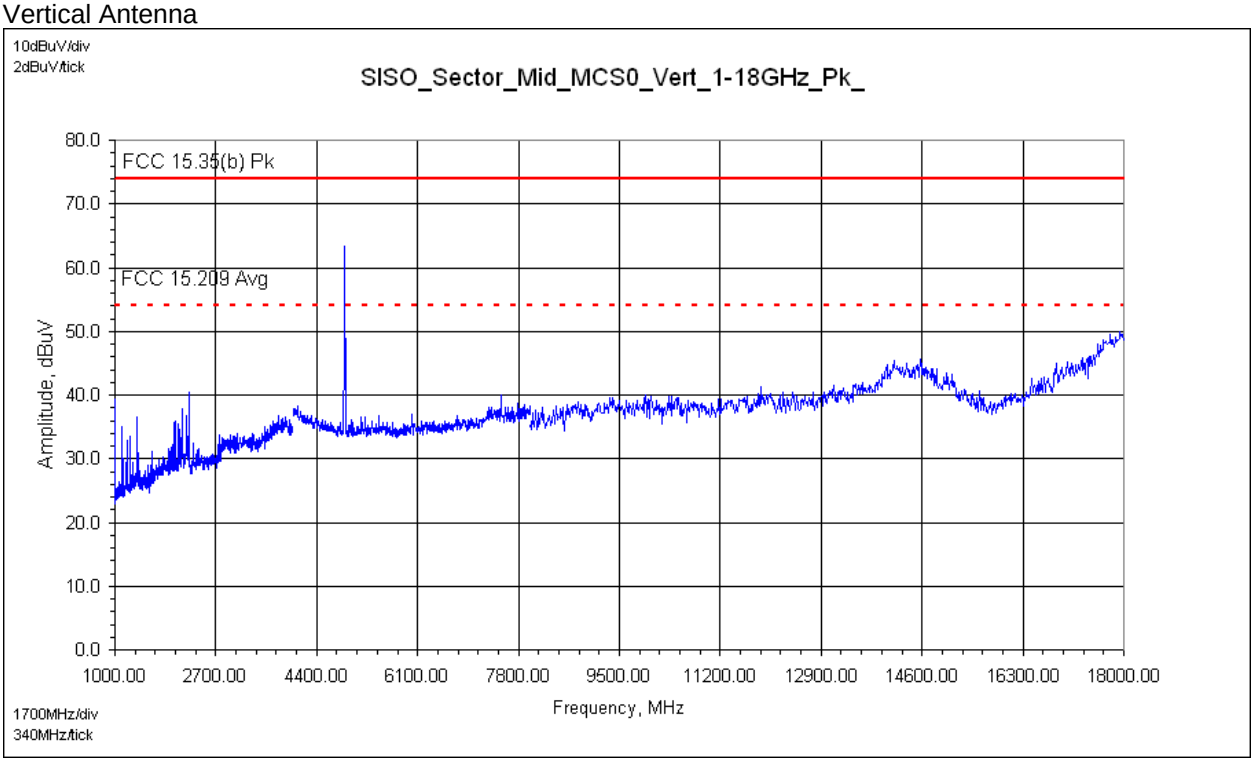



Reference only – max hold peak detector measurements referenced to average & peak limits

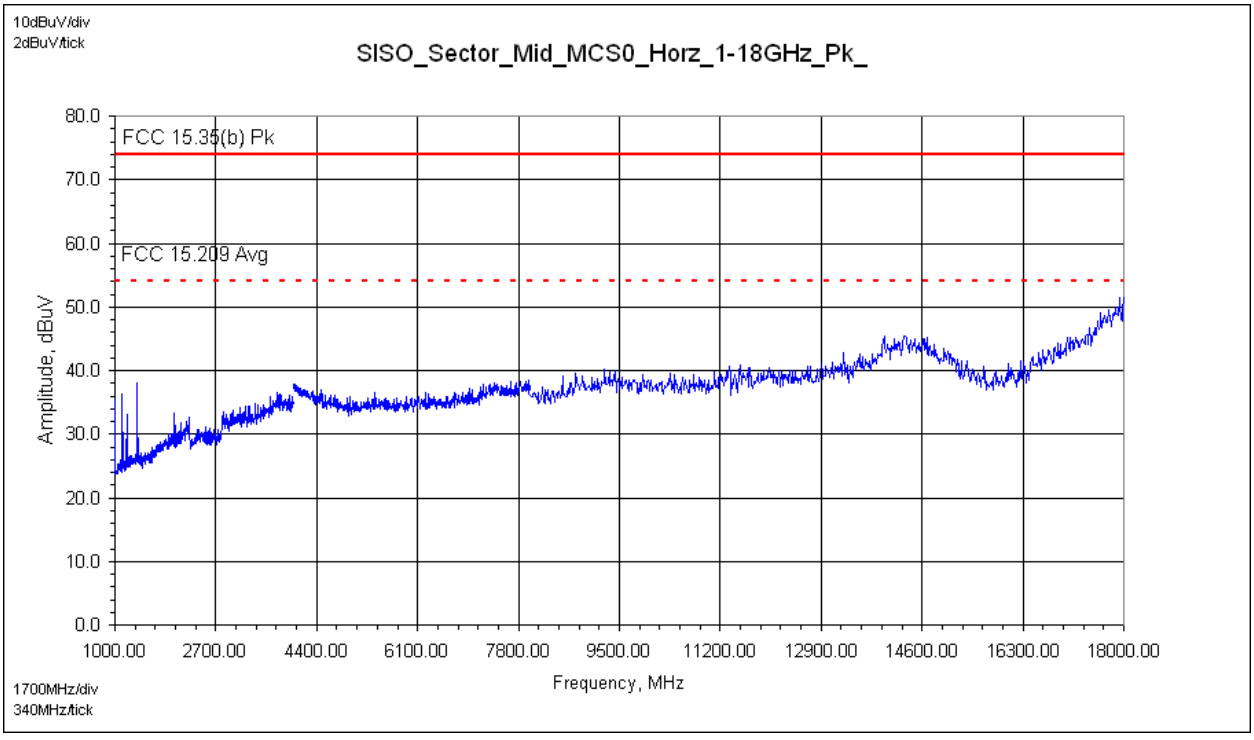
## 11.13 Plots: SISO Mode of Operation – HT20 Mid Channel: 2437 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna

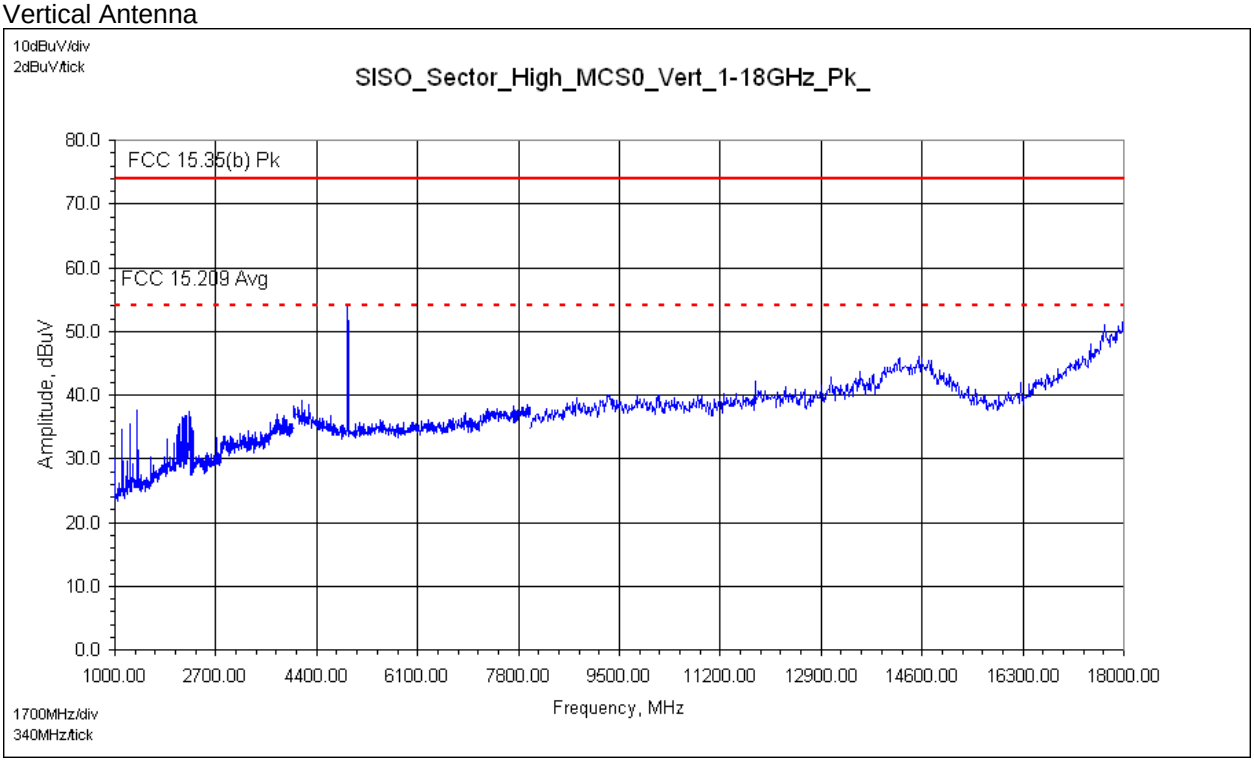



Reference only – max hold peak detector measurements referenced to average & peak limits

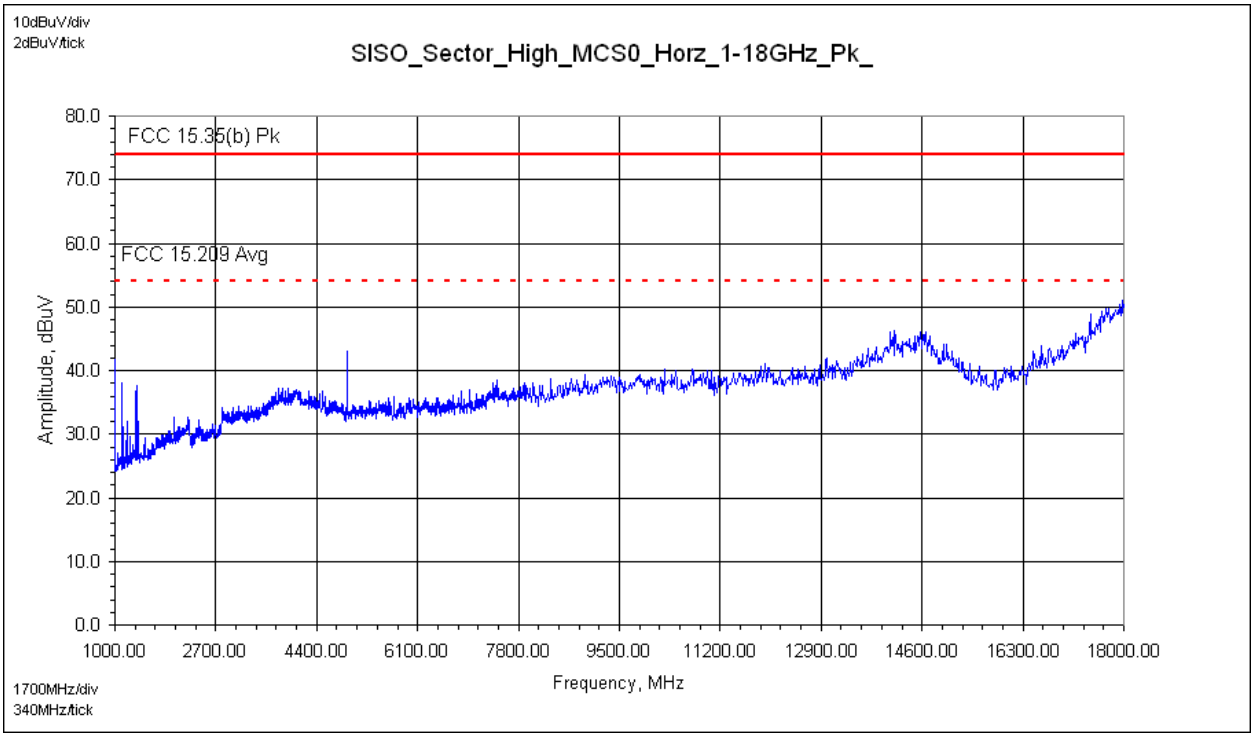
## 11.14 Plots: SISO Mode of Operation – HT20 High Channel: 2462 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna

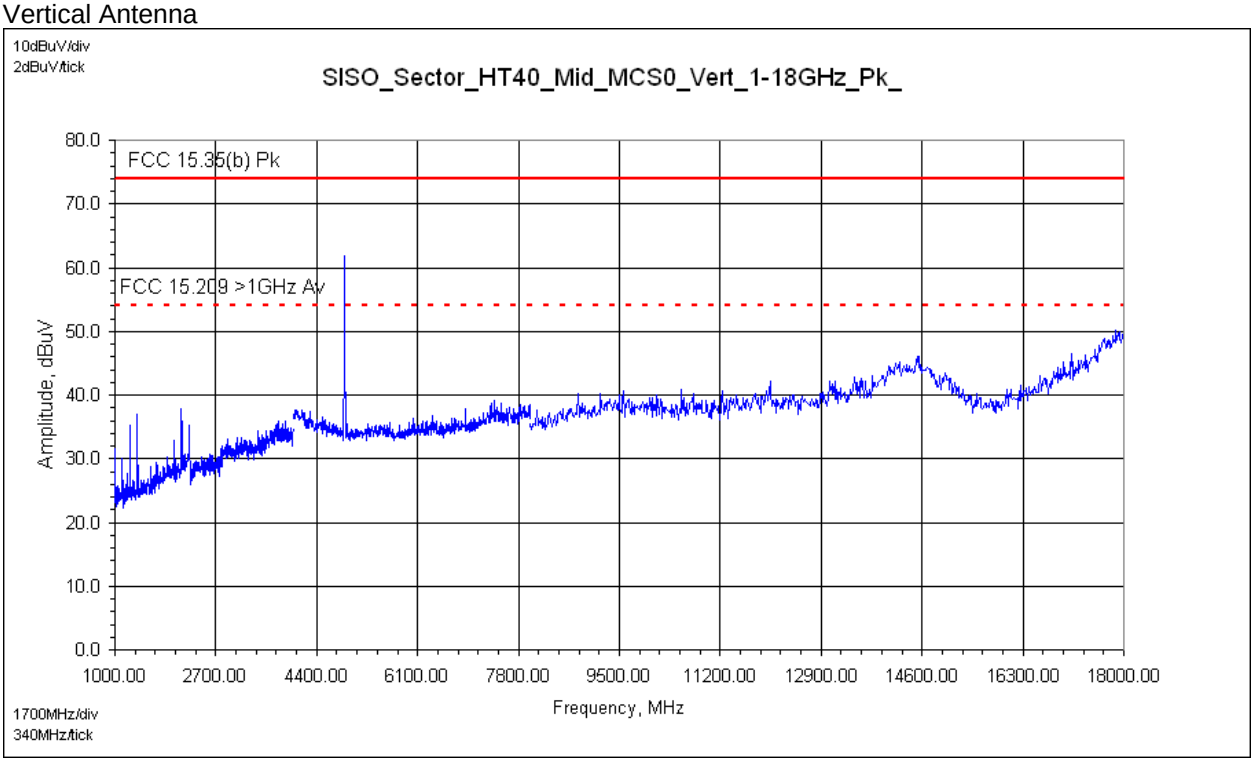



Reference only – max hold peak detector measurements referenced to average & peak limits

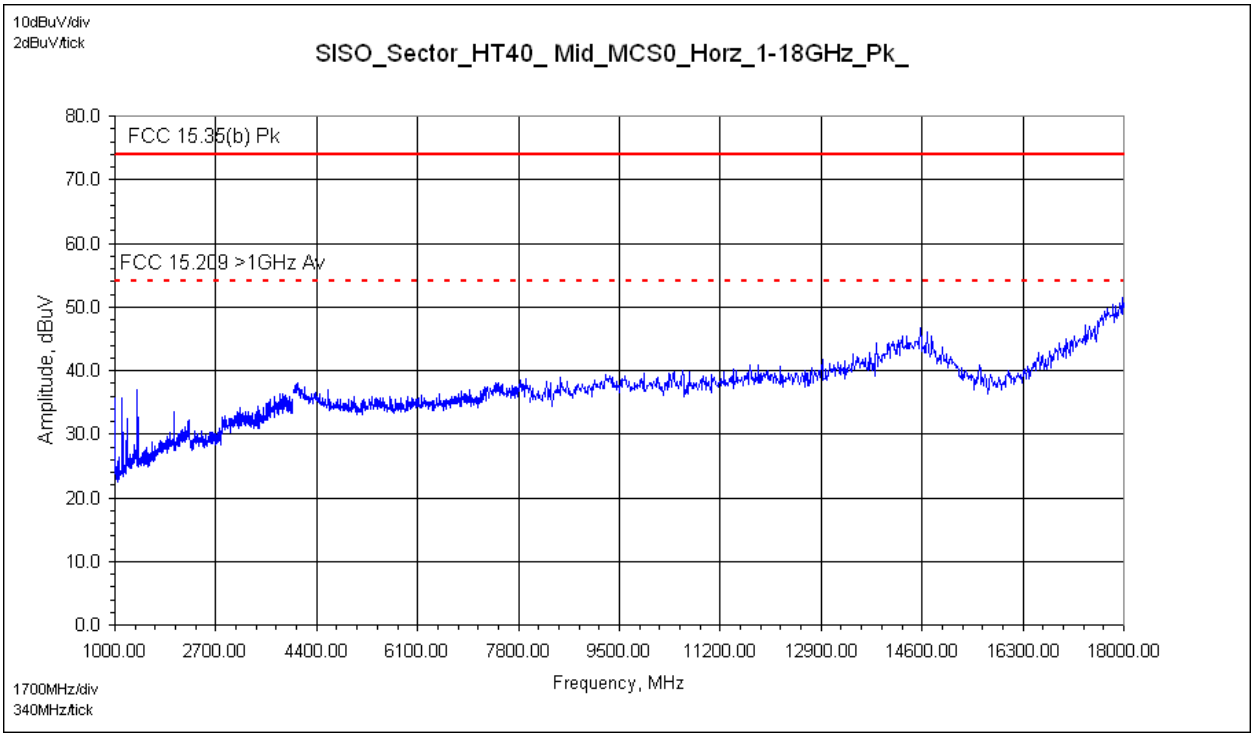
## 11.15 Plots: SISO Mode of Operation – HT40Channel: 2437 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna




Reference only – max hold peak detector measurements referenced to average & peak limits

## 11.16 Test Data: SISO Mode of Operation

# Tx Spurious Radiated Electromagnetic Emissions

| | | | | | |
|---|---|---|---|---|---|
| Test Report #: | **G101503629** | Test Area: | CC1 Radiated | Temperature: | 23.5 °C |
| Test Method: | FCC 15.209/ 15.205/ 15.35(b) | Test Date: | 02/05/2014<br>02/06/2014 | Relative Humidity: | 19.3 % |
| EUT Model #: | Radio Module: W2400-01<br>60°Sector Antenna:<br>SEC-25V-60-17HP | EUT Power: | 120VAC/60Hz | Air Pressure: | 83.8 kPa |

EUT Serial #: Radio Module: DEN1402111313
60°Sector Antenna: 40847, 40848

Manufacturer: FreeWave Technologies, Inc.

EUT Description: Wireless router utilized in M2M industrial applications

Notes: Product tested in SISO mode: single transmit chain/port – single antenna

Product continuously transmitting during all testing – worst-case modulation/data

SISO mode of Operation, MCS0 Data Rate, 26.17dBm power (worst-case power)

| Level Key |
|---|
| Pk – Peak |
| Qp – Quasi Peak |
| Av - Average |

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Avg | FCC 15.35(b) Pk | (MHz) |
| **Radio System: Model W2400-01 Radio Module with 60°Sector Antenna – SISO Mode of Operation** | | | | | | | | | | | | | |
| **Measurements: 1GHz to 18GHz – HT20 Low Channel 2412 MHz** | | | | | | | | | | | | | |
| 1124.9700 | 53.34 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 43.45 | V | 1.15 | 8.4 | N/A | - 30.55 | 1.000 |
| 1124.9700 | 47.67 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 37.78 | V | 1.15 | 8.4 | - 16.20 | NA | 1.000 |
| 1374.9800 | 53.97 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 45.42 | V | 1.02 | 0.9 | N/A | - 28.58 | 1.000 |
| 1374.9800 | 47.47 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 38.92 | V | 1.02 | 0.9 | - 15.06 | NA | 1.000 |
| 2124.9550 | 55.03 | **Pk** | 3.29 | 27.82 | 37.26 | 1.23 | 50.11 | V | 1.39 | 1.3 | N/A | - 23.89 | 1.000 |
| 2124.9550 | 42.29 | **Av** | 3.29 | 27.82 | 37.26 | 1.23 | 37.37 | V | 1.39 | 1.3 | - 16.61 | NA | 1.000 |
| | | | | | | | | | | | | | |
| 1124.9700 | 56.73 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 46.84 | H | 1.34 | 0.0 | N/A | - 27.16 | 1.000 |
| 1124.9700 | 46.47 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 36.58 | H | 1.34 | 0.0 | - 17.40 | NA | 1.000 |
| 1374.9800 | 54.84 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 46.29 | H | 1.50 | 93.3 | N/A | - 27.71 | 1.000 |
| 1374.9800 | 49.12 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 40.57 | H | 1.50 | 93.3 | - 13.41 | NA | 1.000 |
| 4874.0000 | 69.15 | **Pk** | 5.20 | 32.98 | 39.08 | 0.00 | 68.25 | V | 1.33 | 7.0 | N/A | - 5.75 | 1.000 |
| 4874.0000 | 52.53 | **Av** | 5.20 | 32.98 | 39.08 | 0.00 | 51.63 | V | 1.33 | 7.0 | - 2.35 | NA | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: 1GHz to 18GHz – HT20 Mid Channel 2437 MHz** | | | | | | | | | | | | | |
| 2250.0000 | 61.81 | Pk | 3.39 | 27.86 | 37.45 | 3.51 | 59.12 | V | 1.08 | 0.0 | N/A | - 14.88 | 1.000 |
| 2250.0000 | 45.93 | Av | 3.39 | 27.86 | 37.45 | 3.51 | 43.24 | V | 1.08 | 0.0 | - 10.74 | NA | 1.000 |
| 1124.9700 | 52.12 | Pk | 2.36 | 24.63 | 37.26 | 0.38 | 42.23 | V | 1.85 | 8.1 | N/A | - 31.77 | 1.000 |
| 1124.9700 | 45.92 | Av | 2.36 | 24.63 | 37.26 | 0.38 | 36.03 | V | 1.85 | 8.1 | - 17.95 | NA | 1.000 |
| 1374.9800 | 52.96 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 44.41 | V | 1.68 | 3.2 | N/A | - 29.59 | 1.000 |
| 1374.9800 | 45.88 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 37.33 | V | 1.68 | 3.2 | - 16.65 | NA | 1.000 |
| 2124.9550 | 51.93 | **Pk** | 3.29 | 27.82 | 37.26 | 1.23 | 47.01 | V | 1.81 | 11.9 | N/A | - 26.99 | 1.000 |
| 2124.9550 | 40.95 | **Av** | 3.29 | 27.82 | 37.26 | 1.23 | 36.03 | V | 1.81 | 11.9 | - 17.95 | NA | 1.000 |
| | | | | | | | | | | | | | |
| 1124.9700 | 59.88 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 49.99 | H | 1.33 | 43.7 | N/A | - 24.01 | 1.000 |
| 1124.9700 | 45.82 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 35.93 | H | 1.33 | 43.7 | - 18.05 | NA | 1.000 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1374.9800 | 55.25 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 46.70 | H | 1.60 | 93.0 | N/A | - 27.30 | 1.000 |
| 1374.9800 | 49.42 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 40.87 | H | 1.60 | 93.0 | - 13.11 | NA | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: 1GHz to 18GHz – HT20 High Channel 2462 MHz** | | | | | | | | | | | | | |
| 1000.0100 | 61.02 | **Pk** | 2.21 | 23.82 | 37.13 | 0.34 | 50.26 | H | 1.25 | 36.0 | N/A | - 23.74 | 1.000 |
| 1000.0100 | 53.10 | **Av** | 2.21 | 23.82 | 37.13 | 0.34 | 42.34 | H | 1.25 | 36.0 | - 11.64 | NA | 1.000 |
| 1124.9700 | 59.38 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 49.49 | H | 1.19 | 71.0 | N/A | - 24.51 | 1.000 |
| 1124.9700 | 48.29 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 38.40 | H | 1.19 | 71.0 | - 15.58 | NA | 1.000 |
| | | | | | | | | | | | | | |
| 1374.9800 | 53.53 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 44.98 | V | 1.02 | 0.0 | N/A | - 29.02 | 1.000 |
| 1374.9800 | 47.12 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 38.57 | V | 1.02 | 0.0 | - 15.41 | NA | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: 1GHz to 18GHz – HT40 Channel 2437 MHz** | | | | | | | | | | | | | |
| 1000.0100 | 61.97 | **Pk** | 2.21 | 23.82 | 37.13 | 0.34 | 51.21 | H | 2.20 | 3.0 | N/A | - 22.79 | 1.000 |
| 1000.0100 | 52.02 | **Av** | 2.21 | 23.82 | 37.13 | 0.34 | 41.26 | H | 2.20 | 3.0 | - 12.72 | NA | 1.000 |
| 1124.9700 | 59.20 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 49.31 | H | 2.10 | 54.0 | N/A | - 24.69 | 1.000 |
| 1124.9700 | 50.86 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 40.97 | H | 2.10 | 54.0 | - 13.01 | NA | 1.000 |
| | | | | | | | | | | | | | |
| 1374.9800 | 54.90 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 46.35 | V | 1.04 | 5.0 | N/A | - 27.65 | 1.000 |
| 1374.9800 | 47.00 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 38.45 | V | 1.04 | 5.0 | - 15.53 | NA | 1.000 |
| 4874.0000 | 66.46 | **Pk** | 5.20 | 32.98 | 39.08 | 0.00 | 65.56 | V | 1.38 | 11.0 | N/A | - 8.44 | 1.000 |
| 4874.0000 | 51.13 | **Av** | 5.20 | 32.98 | 39.08 | 0.00 | 50.23 | V | 1.38 | 11.0 | - 3.75 | NA | 1.000 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

Example calculation:

| **Measured Level** | + | **Cable Loss** | + | **Antenna Factor** | - | **Pre-Amp** | + | **Atten** | = | **Final Corrected Reading** | **Specification Limit** | - | **Final Corrected Reading** | = | **Delta Specification** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (dBμV) | | (dB) | | (dB) | | (dB) | | (dB) | | (dBμV/m) | (dBμV/m) | | (dBμV/m) | | |
| **20.0** | | **3.0** | | **5.0** | | **10.0** | | **0.0** | | **18.0** | **40.0** | | **18.0** | | **- 22.0** |

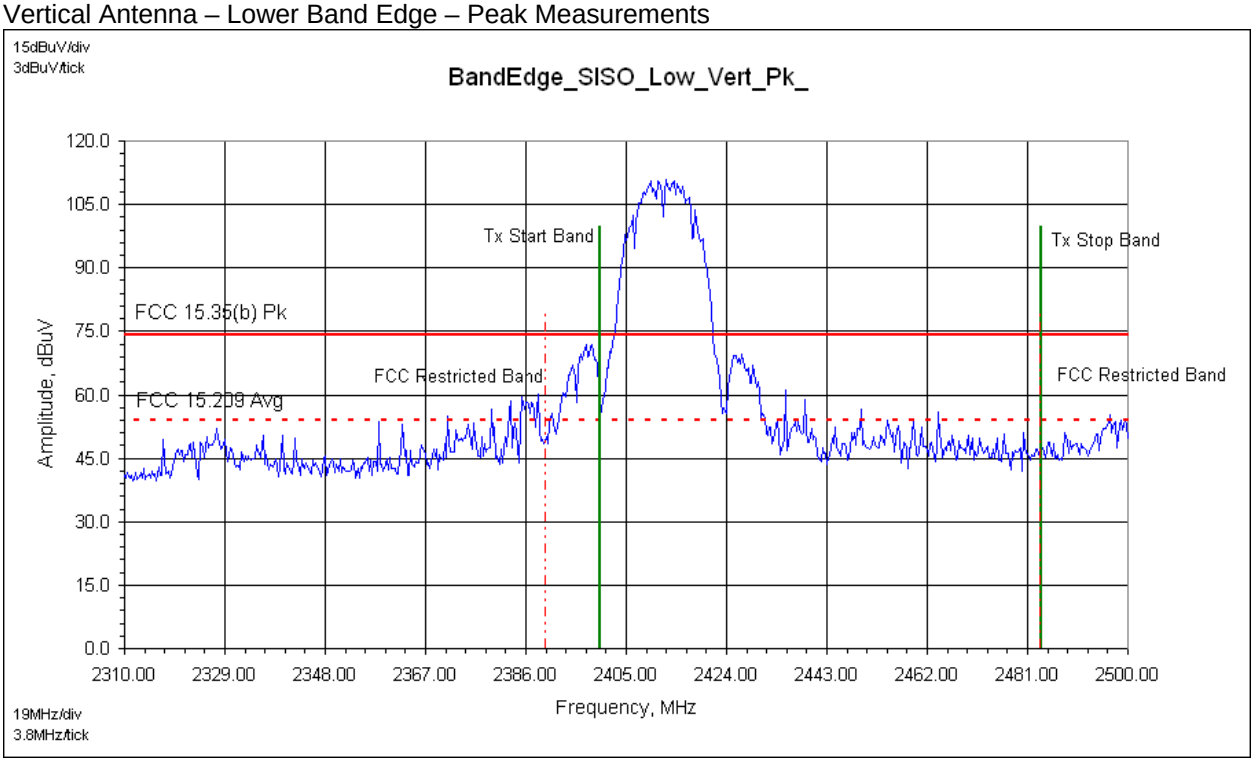
Notes:

1) The highest signals – as determined from pre-scan plots – were fully-maximized and measured.
2) For the general pre-scan plots 1-4GHz, a notch filter was utilized. Note the notch filter was not used during band edge plots/measurements.
3) 802.11 HT20/HT40 included in measurements as well as both SISO/MIMO modes of Tx operation.

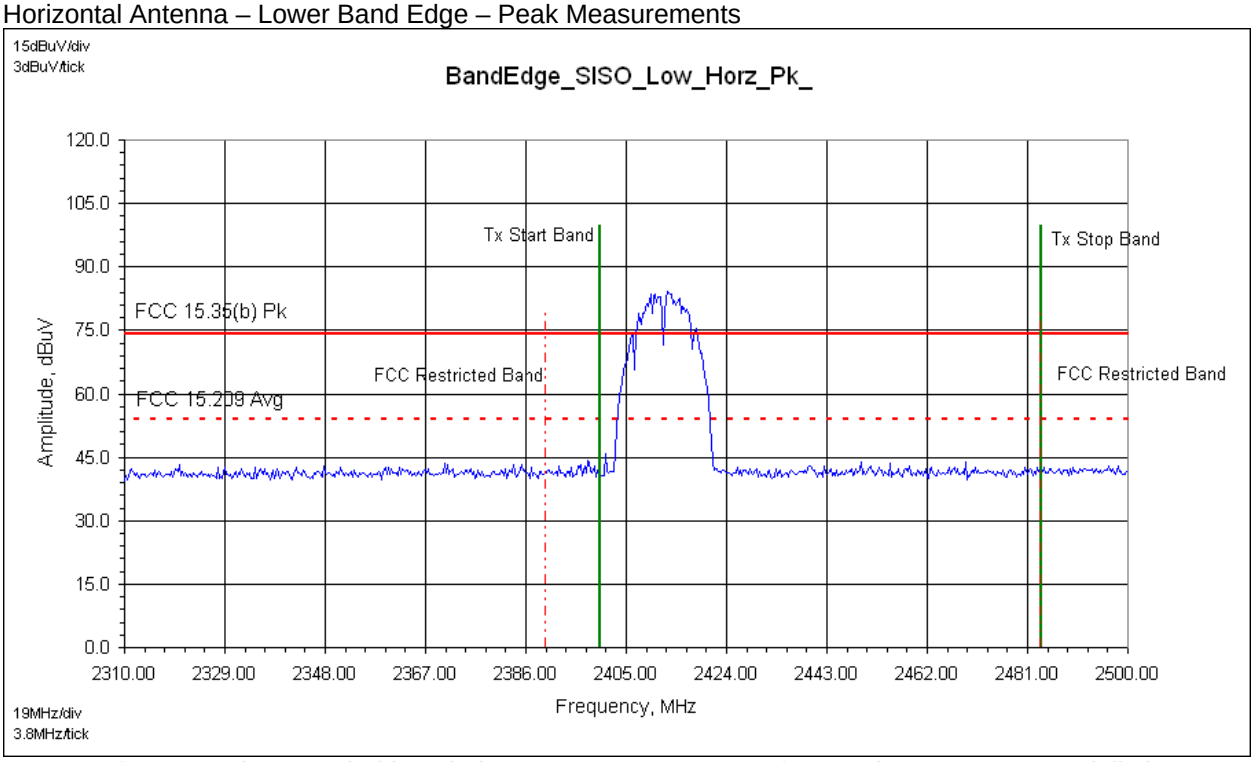
Deviations, Additions, or Exclusions: None

## 11.17 Band Edge Plots: SISO Mode of Operation – HT20 Low Channel 2412 MHz

Vertical Antenna – Lower Band Edge – Peak Measurements




Horizontal Antenna – Lower Band Edge – Peak Measurements

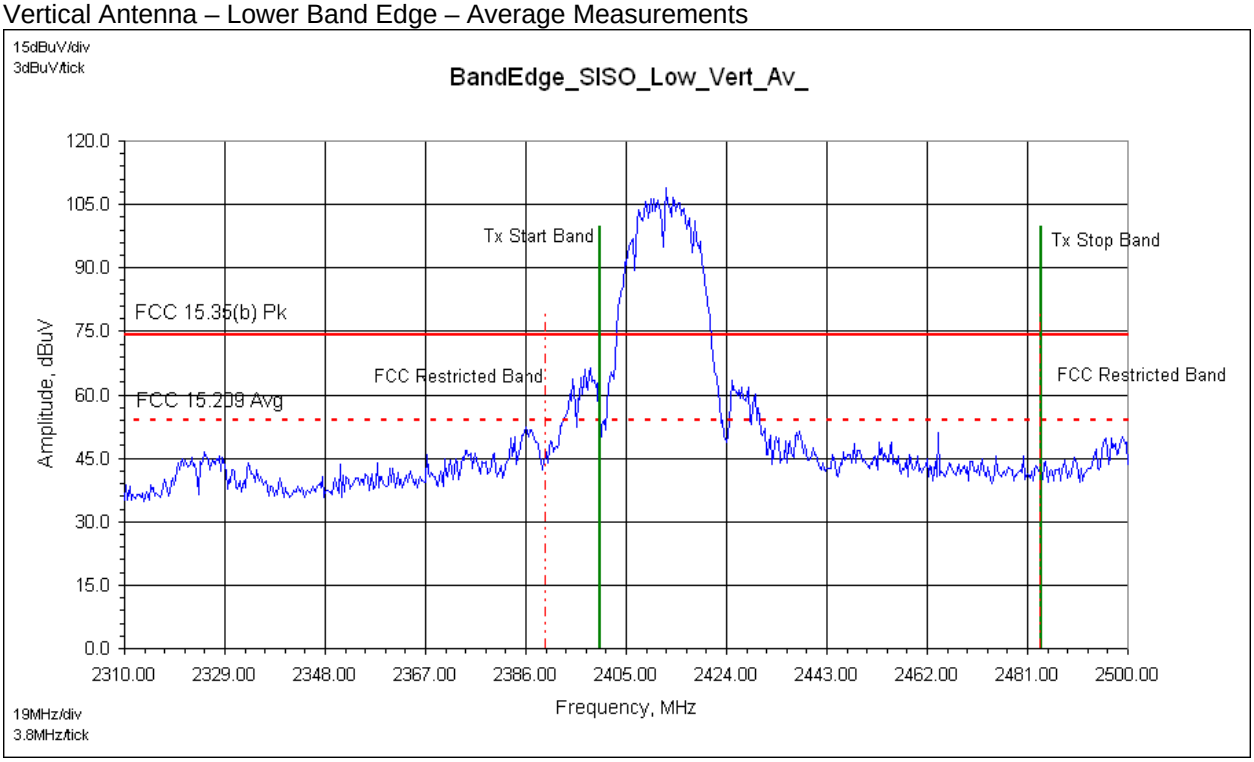



Reference only – max hold peak detector measurements referenced to average & peak limits

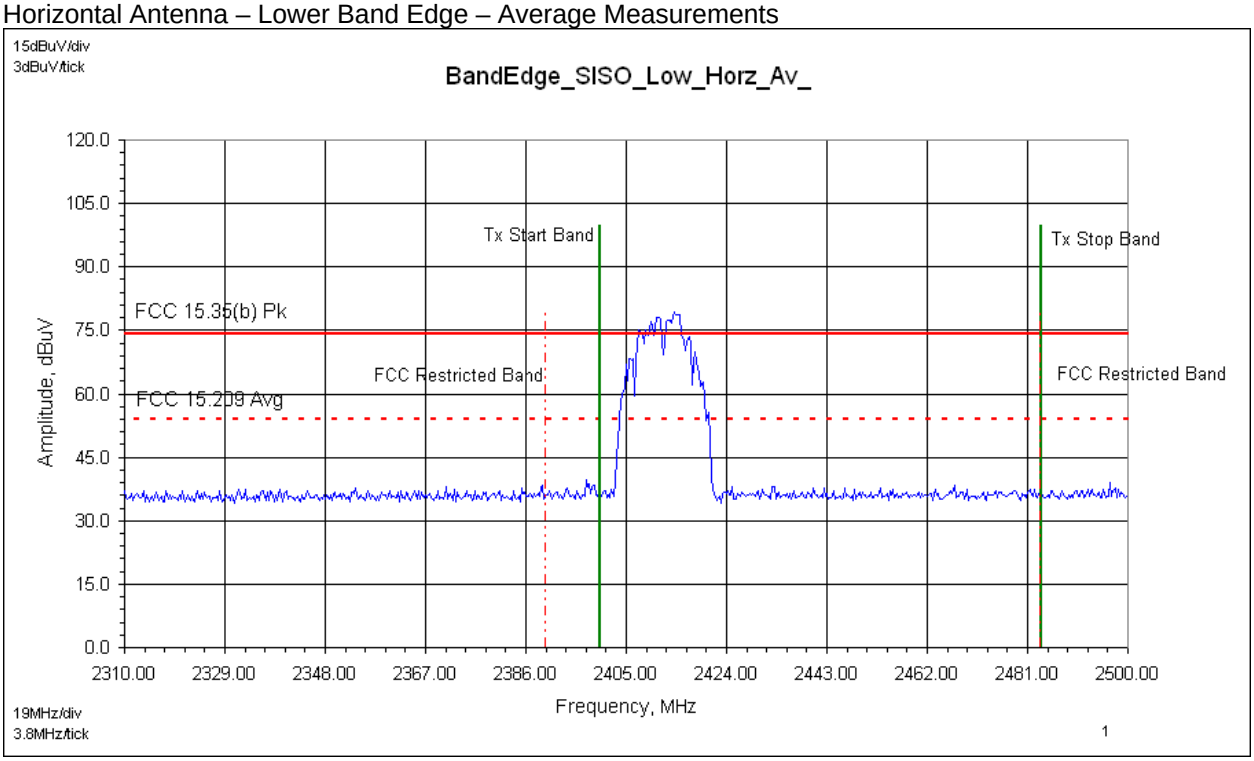
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Dashed-Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.18 Band Edge Plots: SISO Mode of Operation – HT20 Low Channel 2412 MHz

Vertical Antenna – Lower Band Edge – Average Measurements




Horizontal Antenna – Lower Band Edge – Average Measurements

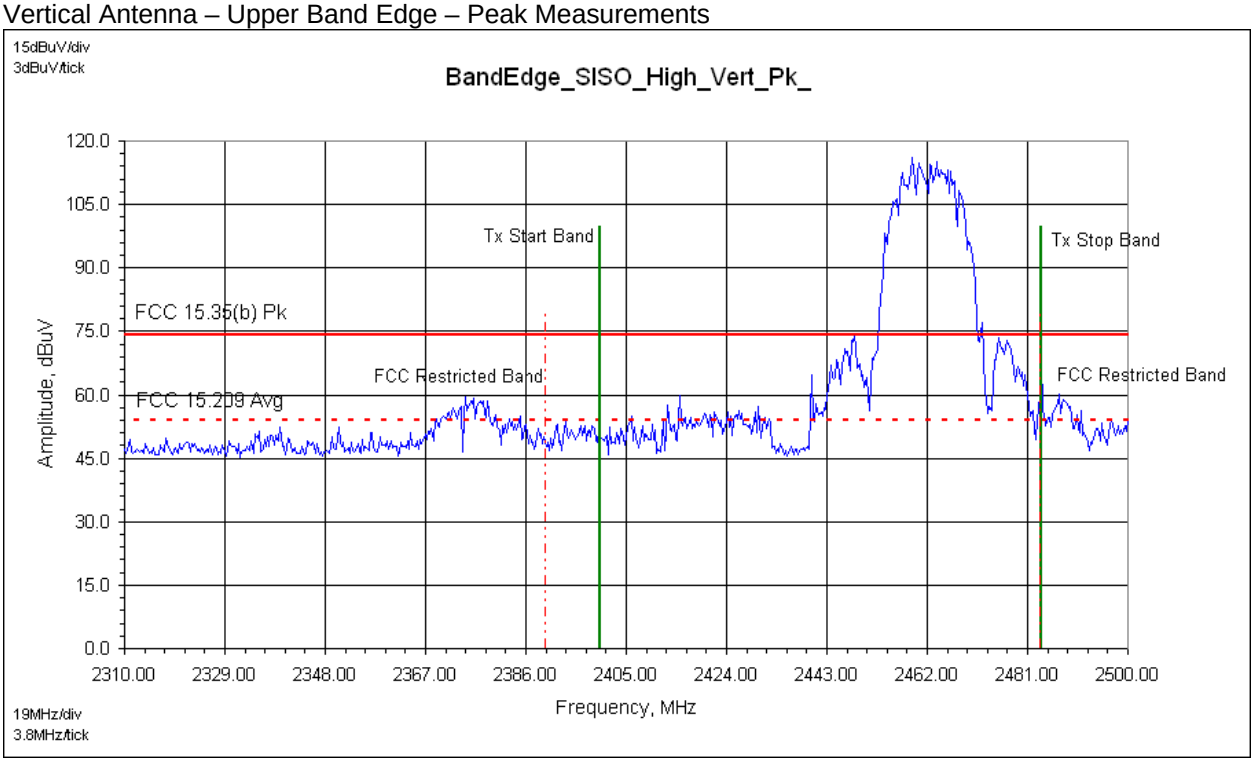



Reference only – max hold peak detector measurements referenced to average & peak limits

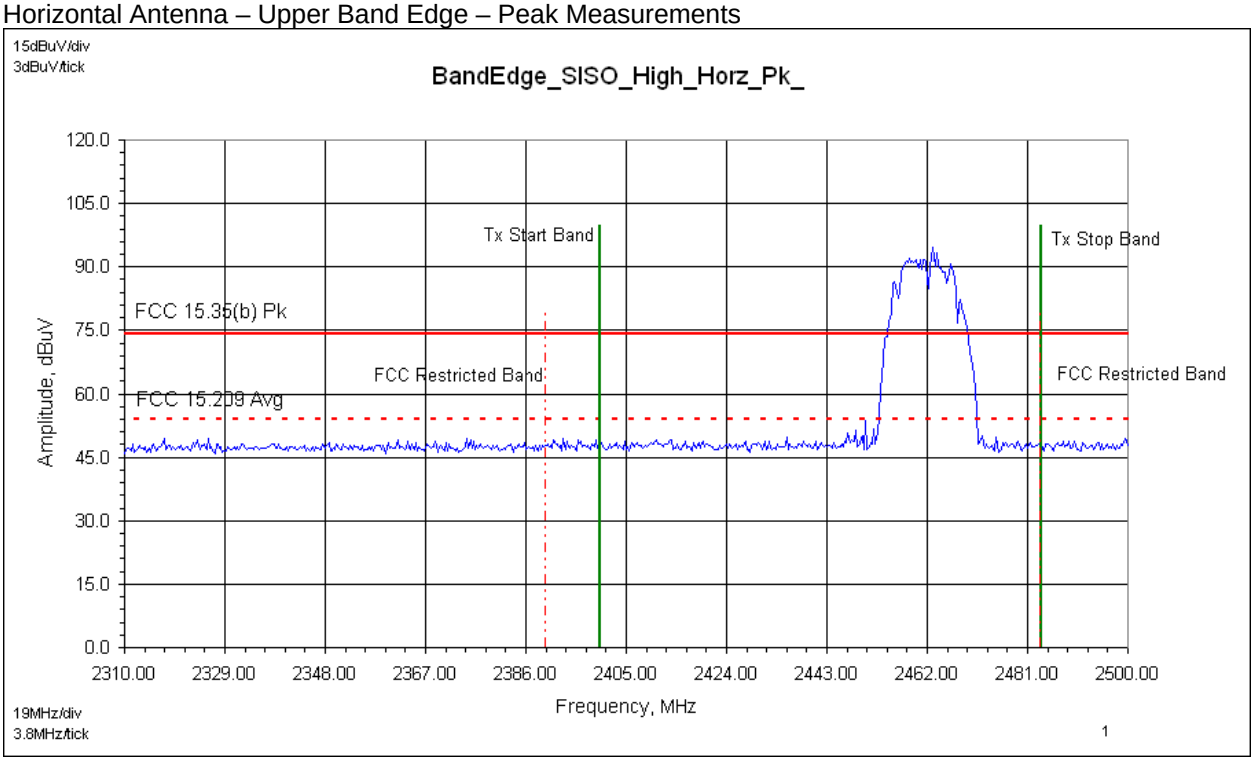
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Dashed-Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.19 Band Edge Plots: SISO Mode of Operation – HT20 High Channel 2462 MHz

Vertical Antenna – Upper Band Edge – Peak Measurements




Horizontal Antenna – Upper Band Edge – Peak Measurements

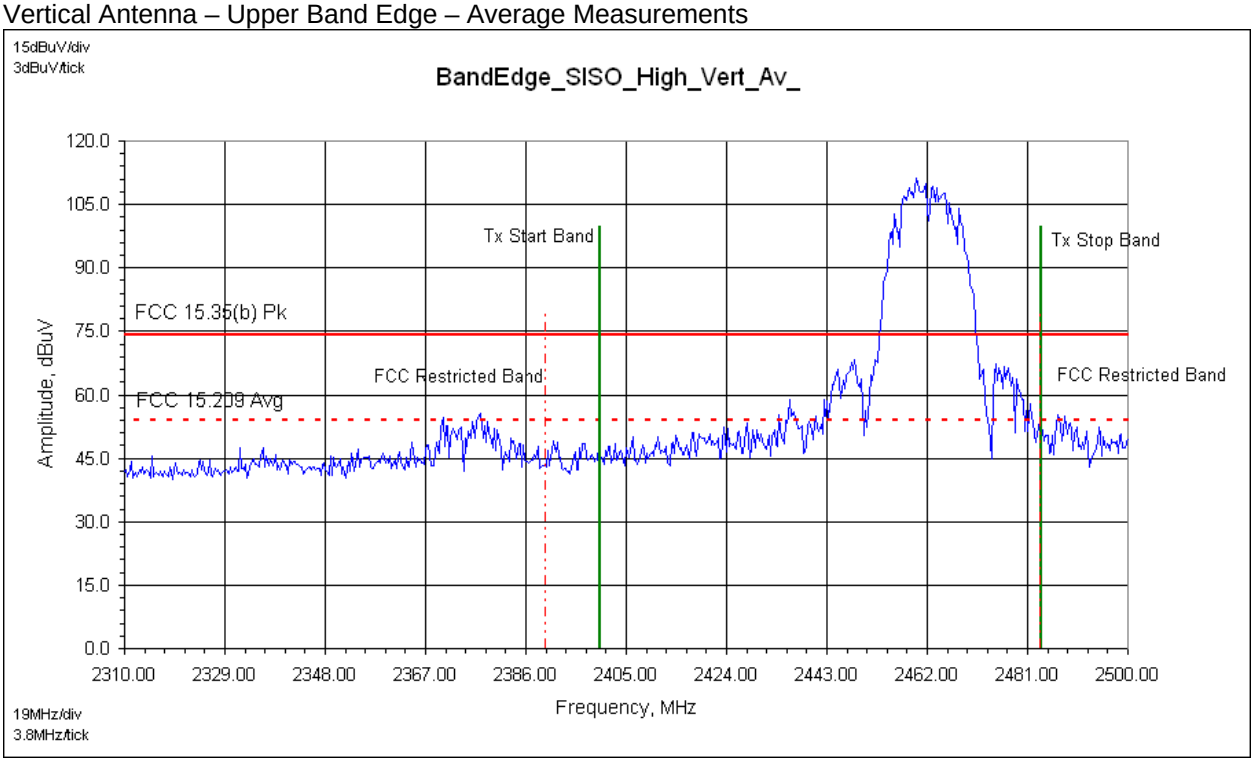



Reference only – max hold peak detector measurements referenced to average & peak limits

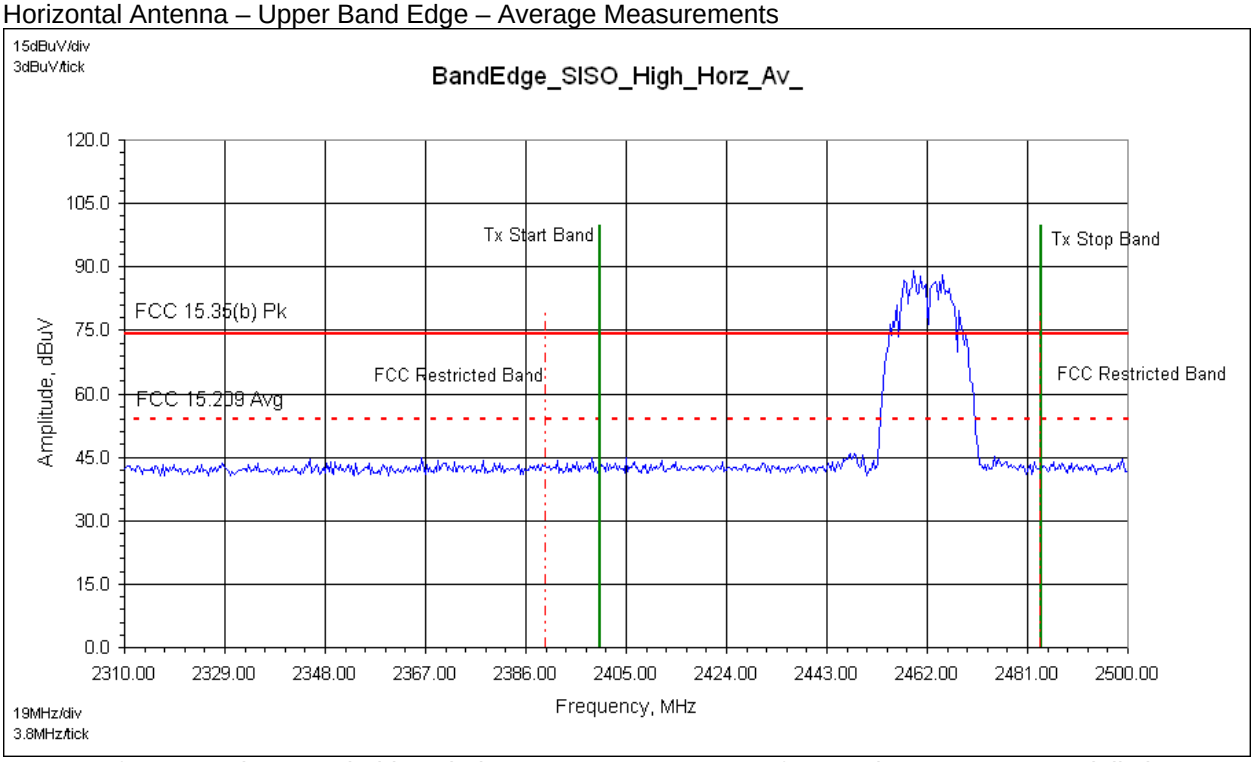
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.20 Band Edge Plots: SISO Mode of Operation – HT20 High Channel 2462 MHz

Vertical Antenna – Upper Band Edge – Average Measurements




Horizontal Antenna – Upper Band Edge – Average Measurements

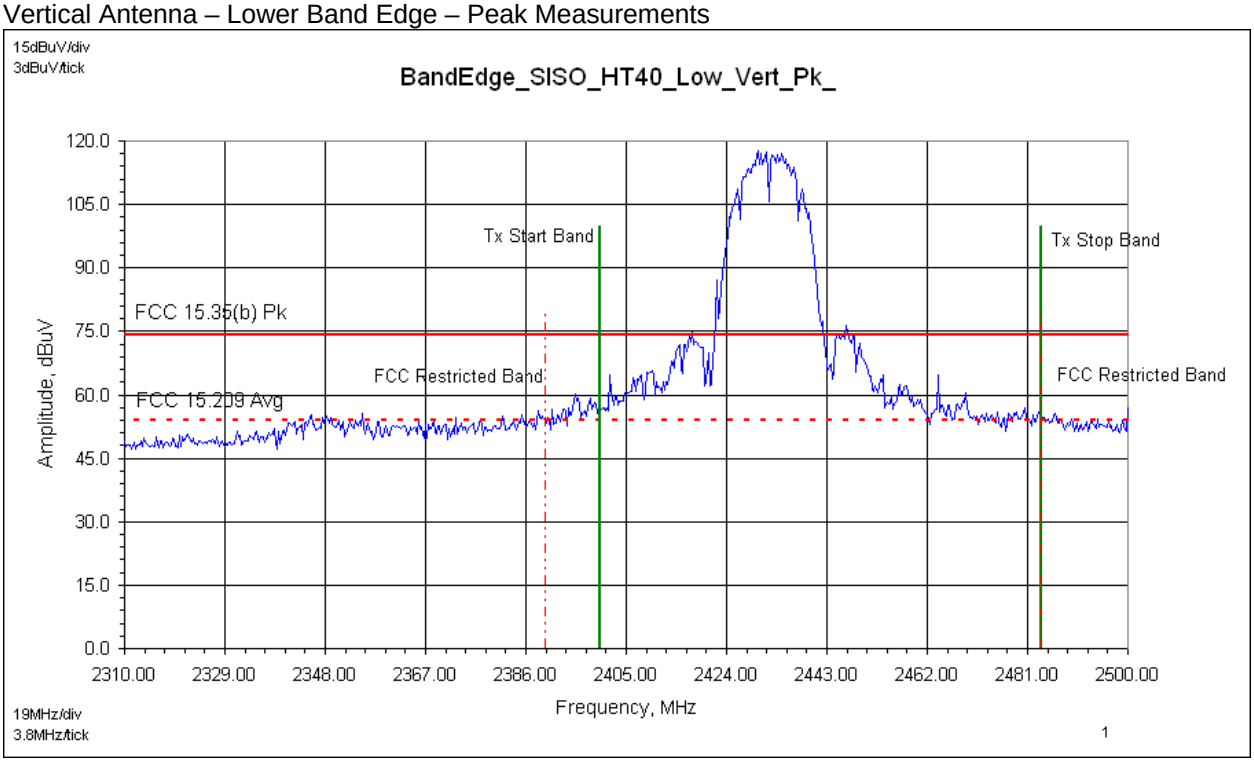



Reference only – max hold peak detector measurements referenced to average & peak limits

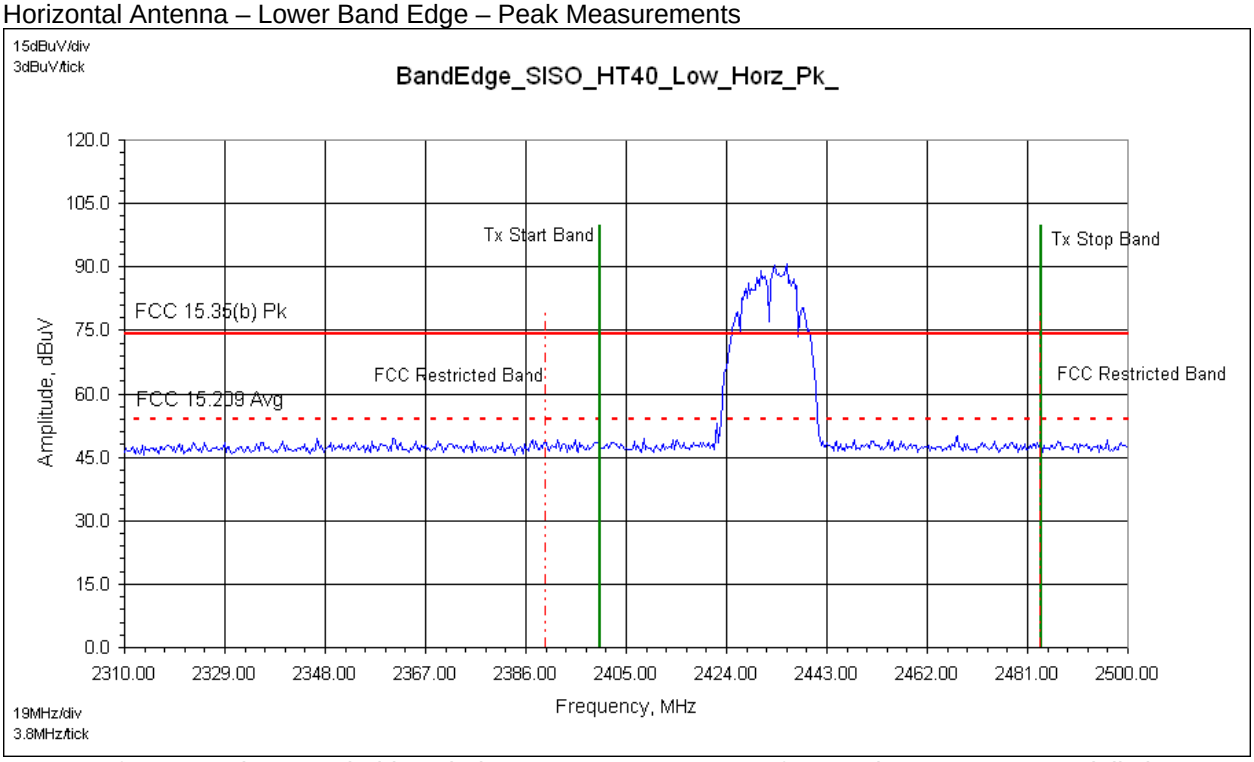
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.21 Band Edge Plots: SISO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Lower Band Edge – Peak Measurements




Horizontal Antenna – Lower Band Edge – Peak Measurements

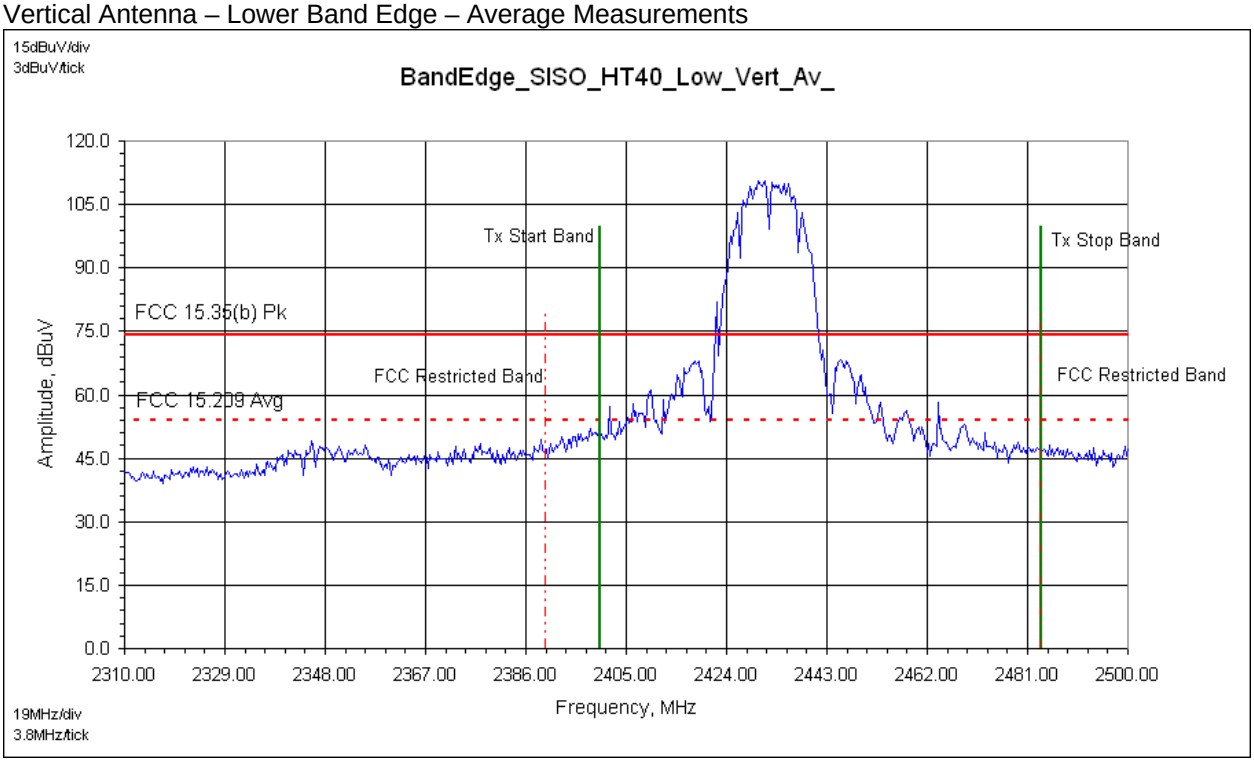



Reference only – max hold peak detector measurements referenced to average & peak limits

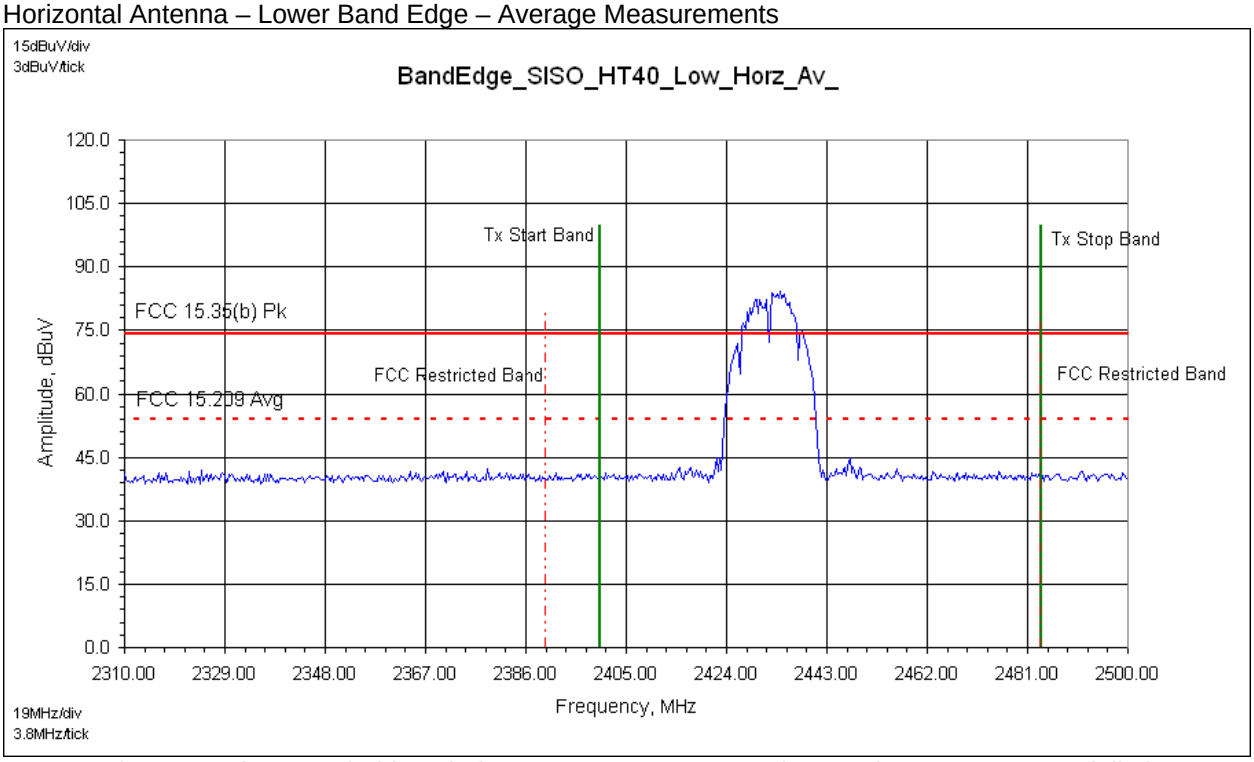
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.22 Band Edge Plots: SISO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Lower Band Edge – Average Measurements




Horizontal Antenna – Lower Band Edge – Average Measurements

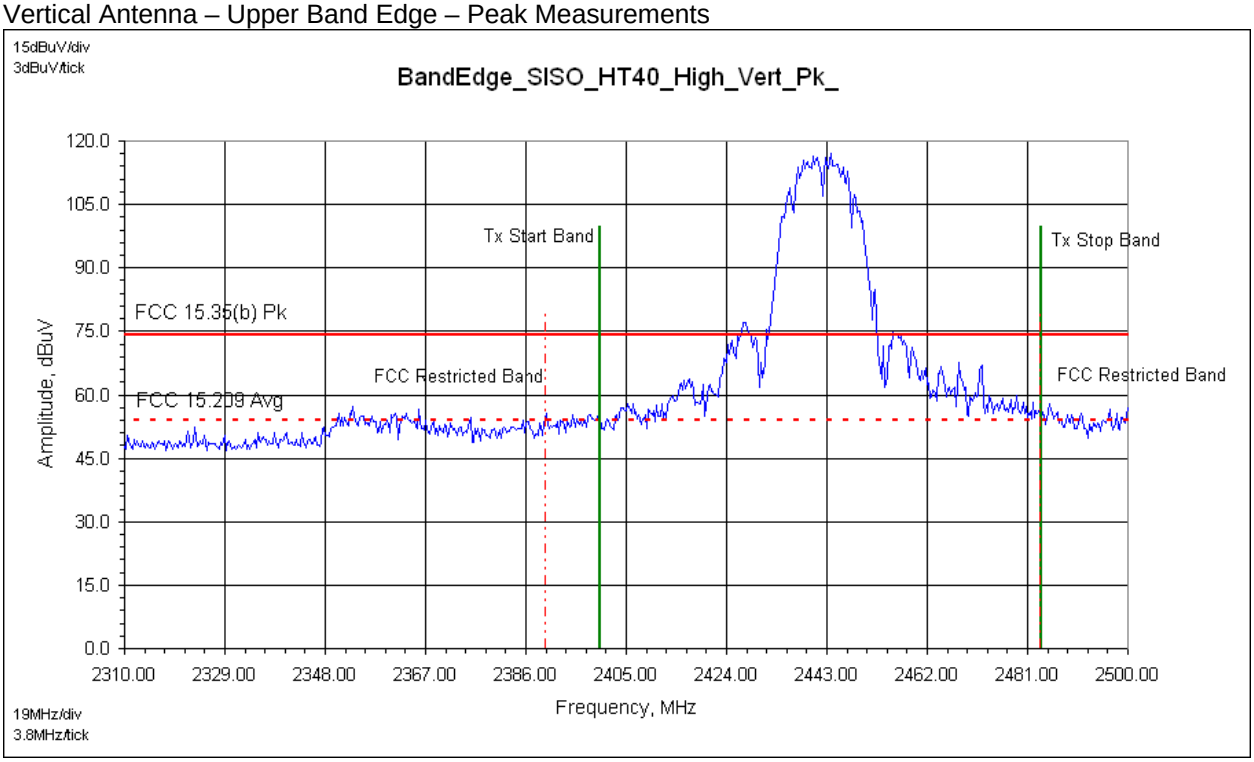



Reference only – max hold peak detector measurements referenced to average & peak limits

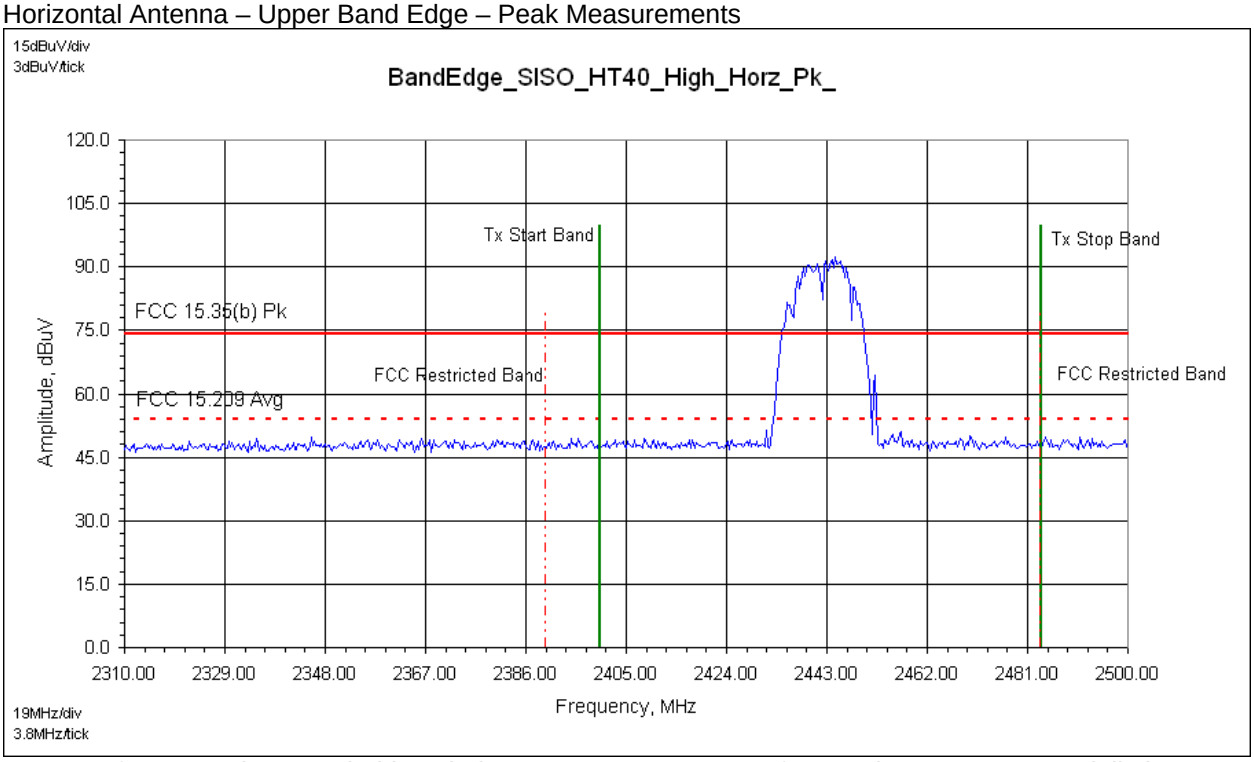
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.23 Band Edge Plots: SISO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Upper Band Edge – Peak Measurements




Horizontal Antenna – Upper Band Edge – Peak Measurements

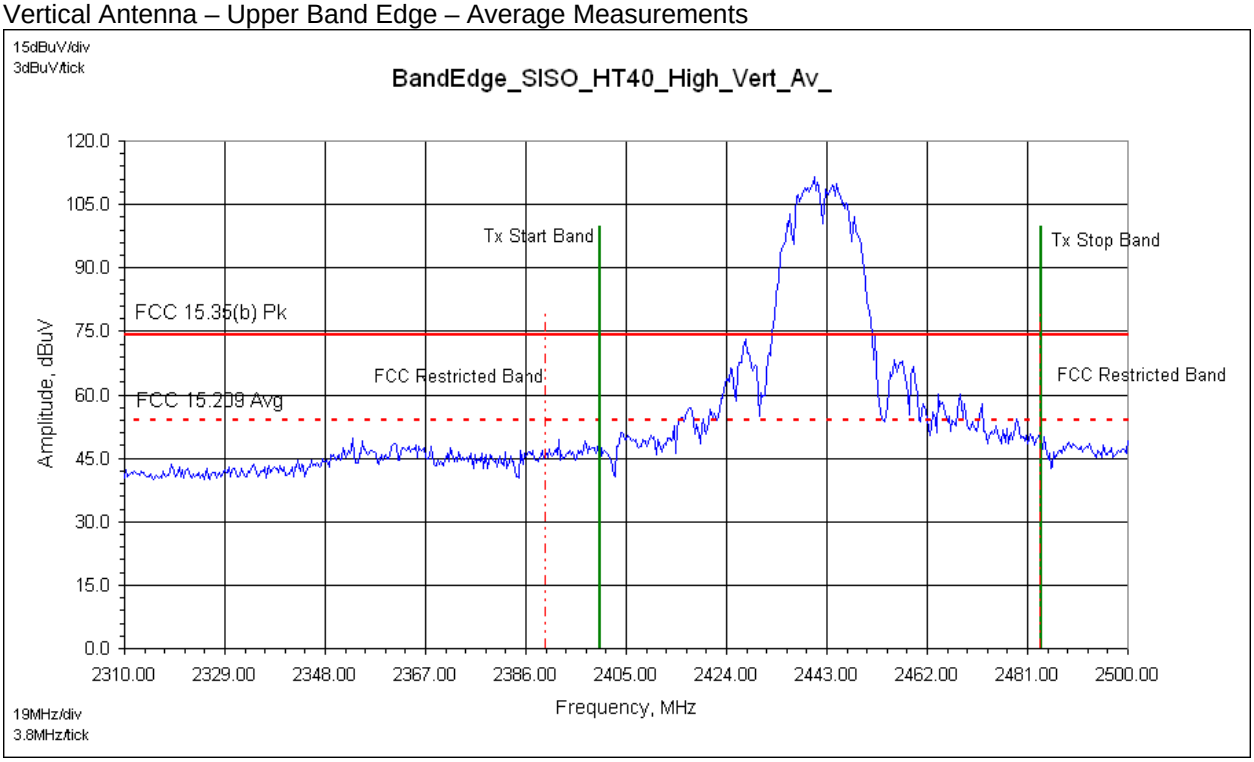



Reference only – max hold peak detector measurements referenced to average & peak limits

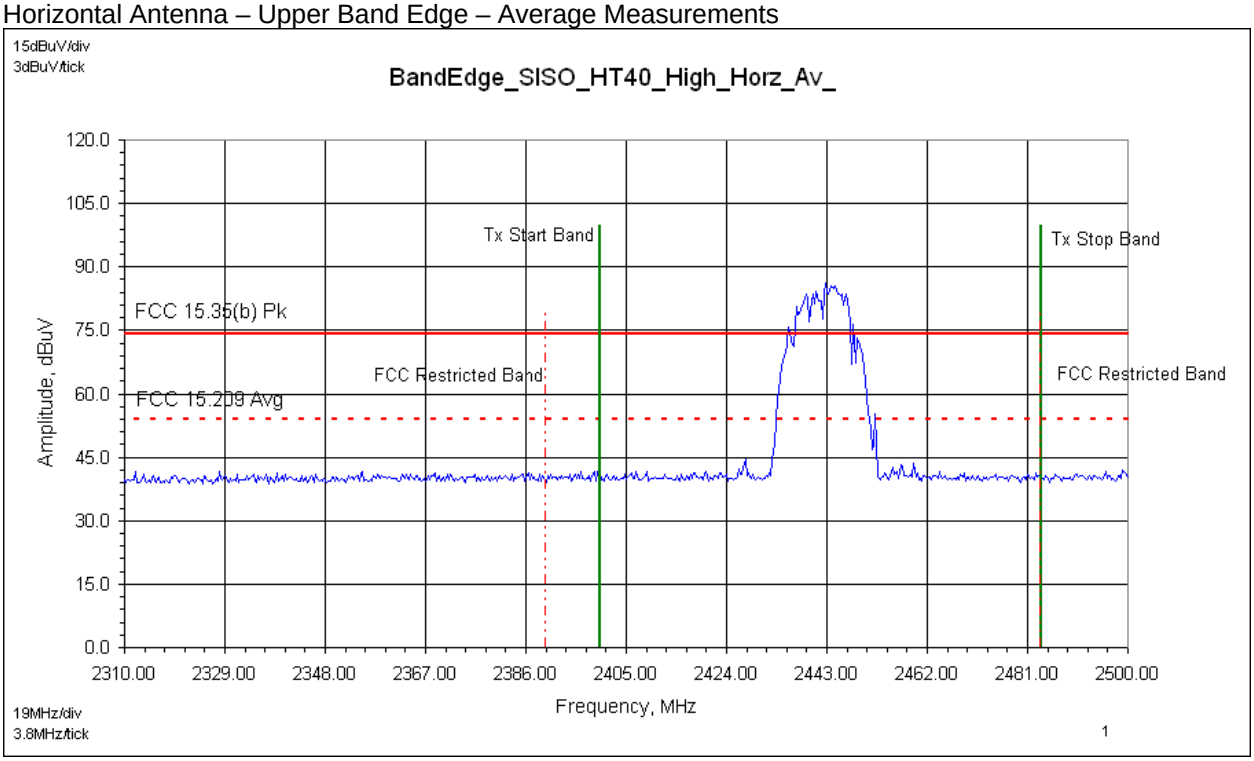
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.24 Band Edge Plots: SISO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Upper Band Edge – Average Measurements




Horizontal Antenna – Upper Band Edge – Average Measurements




Reference only – max hold peak detector measurements referenced to average & peak limits

Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.25 Test Data: SISO Band Edge – FCC Restricted Band

# Tx Spurious Radiated Emissions – Band Edge

| | | | | | |
|---|---|---|---|---|---|
| Test Report #: | **G101503629** | Test Area: | CC1 Radiated | Temperature: | 23.5 °C |
| Test Method: | FCC 15.209/ 15.205/ 15.35(b) | Test Date: | 02/05/2014<br>02/06/2014 | Relative Humidity: | 19.3 % |
| EUT Model #: | Radio Module: W2400-01<br>60°Sector Antenna:<br>SEC-25V-60-17HP | EUT Power: | 120VAC/60Hz | Air Pressure: | 83.8 kPa |
| EUT Serial #: | Radio Module: DEN1402111313<br>60°Sector Antenna: 40847, 40848 | | | | |
| Manufacturer: | FreeWave Technologies, Inc. | | | | |
| EUT Description: | Wireless router utilized in M2M industrial applications | | | | |
| Notes: | Product tested in SISO mode: single transmit chain/port – single antenna | | | | |
| | Product continuously transmitting during all testing – worst-case modulation/data | | | | |
| | SISO mode of Operation, MCS0 Data Rate, 26.17dBm power (worst-case power) | | | | |

| Level Key |
|---|
| Pk – Peak |
| Qp – Quasi Peak |
| Av - Average |

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Avg | FCC 15.35(b) Pk | (MHz) |
| **Radio System: Model W2400-01 Radio Module with 60°Sector Antenna – SISO Mode of Operation** | | | | | | | | | | | | | |
| **Measurements: HT20 Lower Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2390.0000 | 51.26 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 51.47 | V | 1.46 | 7.0 | - 2.51 | NA | 1.000 |
| 2390.0000 | 68.22 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 68.43 | V | 1.46 | 7.0 | NA | - 5.57 | 1.000 |
| | | | | | | | | | | | | | |
| 2390.0000 | 41.13 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 41.34 | H | 1.56 | 14.0 | - 12.64 | NA | 1.000 |
| 2390.0000 | 45.19 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 45.40 | H | 1.56 | 14.0 | NA | - 28.60 | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: HT20 Upper Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2483.5000 | 52.10 | **Av** | 3.58 | 28.69 | 37.67 | 5.76 | 52.46 | V | 1.51 | 11.0 | - 1.52 | NA | 1.000 |
| 2483.5000 | 63.99 | **Pk** | 3.58 | 28.69 | 37.67 | 5.76 | 64.35 | V | 1.51 | 11.0 | NA | - 9.65 | 1.000 |
| | | | | | | | | | | | | | |
| 2483.5000 | 40.91 | **Av** | 3.58 | 28.69 | 37.67 | 5.76 | 41.27 | H | 1.47 | 13.0 | - 12.71 | NA | 1.000 |
| 2483.5000 | 45.49 | **Pk** | 3.58 | 28.69 | 37.67 | 5.76 | 45.85 | H | 1.47 | 13.0 | NA | - 28.15 | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: HT40 Lower Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2390.0000 | 51.51 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 51.72 | V | 1.48 | 8.0 | - 2.26 | NA | 1.000 |
| 2390.0000 | 59.63 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 59.84 | V | 1.48 | 8.0 | NA | - 14.16 | 1.000 |
| | | | | | | | | | | | | | |
| 2390.0000 | 40.31 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 40.52 | H | 1.52 | 10.0 | - 13.46 | NA | 1.000 |
| 2390.0000 | 44.63 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 44.84 | H | 1.52 | 10.0 | NA | - 29.16 | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: HT40 Upper Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2390.0000 | 51.14 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 51.35 | V | 1.47 | 11.0 | - 2.63 | NA | 1.000 |
| 2390.0000 | 60.82 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 61.03 | V | 1.47 | 11.0 | NA | - 12.97 | 1.000 |
| | | | | | | | | | | | | | |
| 2390.0000 | 40.16 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 40.37 | H | 1.56 | 9.0 | - 13.61 | NA | 1.000 |
| 2390.0000 | 44.40 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 44.61 | H | 1.56 | 9.0 | NA | - 29.39 | 1.000 |

Example calculation:

| Measured Level | + | Cable Loss | + | Antenna Factor | - | Pre-Amp | + | Atten | = | Final Corrected Reading | Specification Limit | - | Final Corrected Reading | = | Delta Specification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (dBμV) | | (dB) | | (dB) | | (dB) | | (dB) | | (dBμV/m) | (dBμV/m) | | (dBμV/m) | | |
| **20.0** | | **3.0** | | **5.0** | | **10.0** | | **0.0** | | **18.0** | **40.0** | | **18.0** | | **- 22.0** |

Notes:

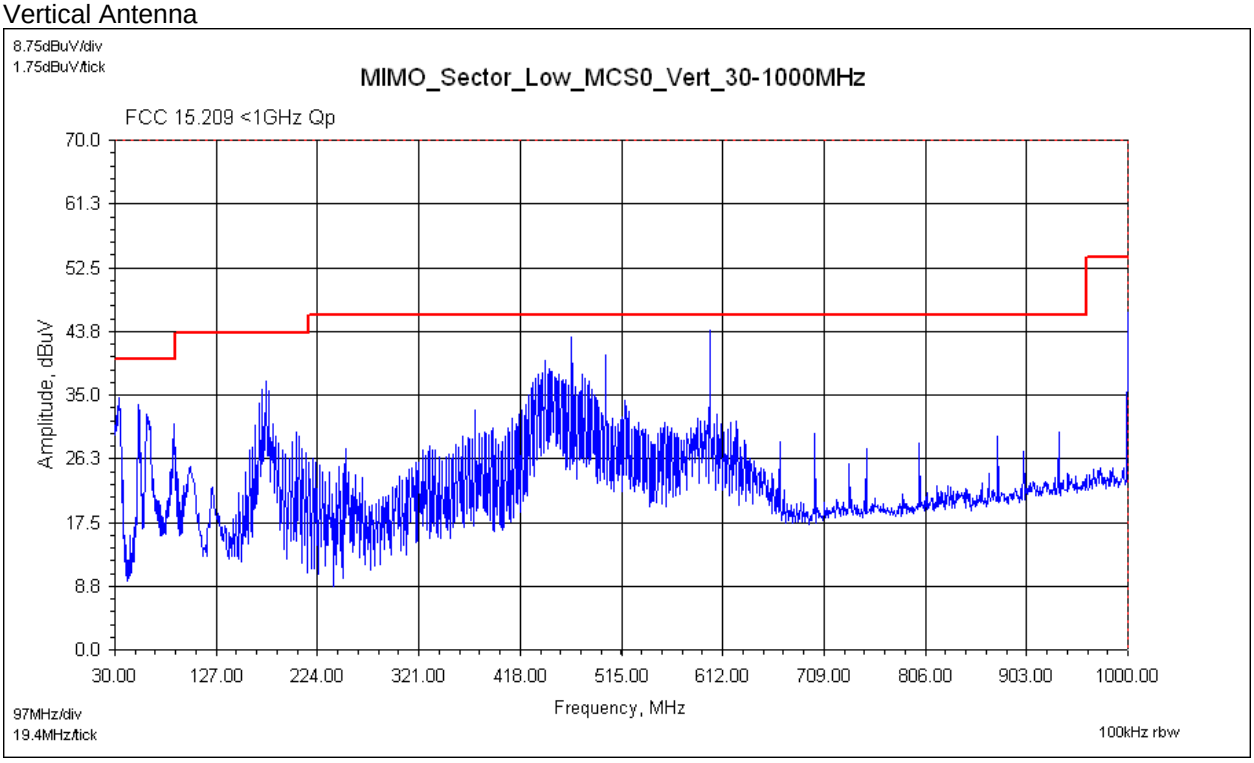
1) The highest signals – as determined from pre-scan plots – were fully-maximized and measured.
2) The notch filter was not used during band edge plots/measurements.
3) 802.11 HT20/HT40 included in measurements as well as both SISO/MIMO modes of Tx operation.

Deviations, Additions, or Exclusions: None

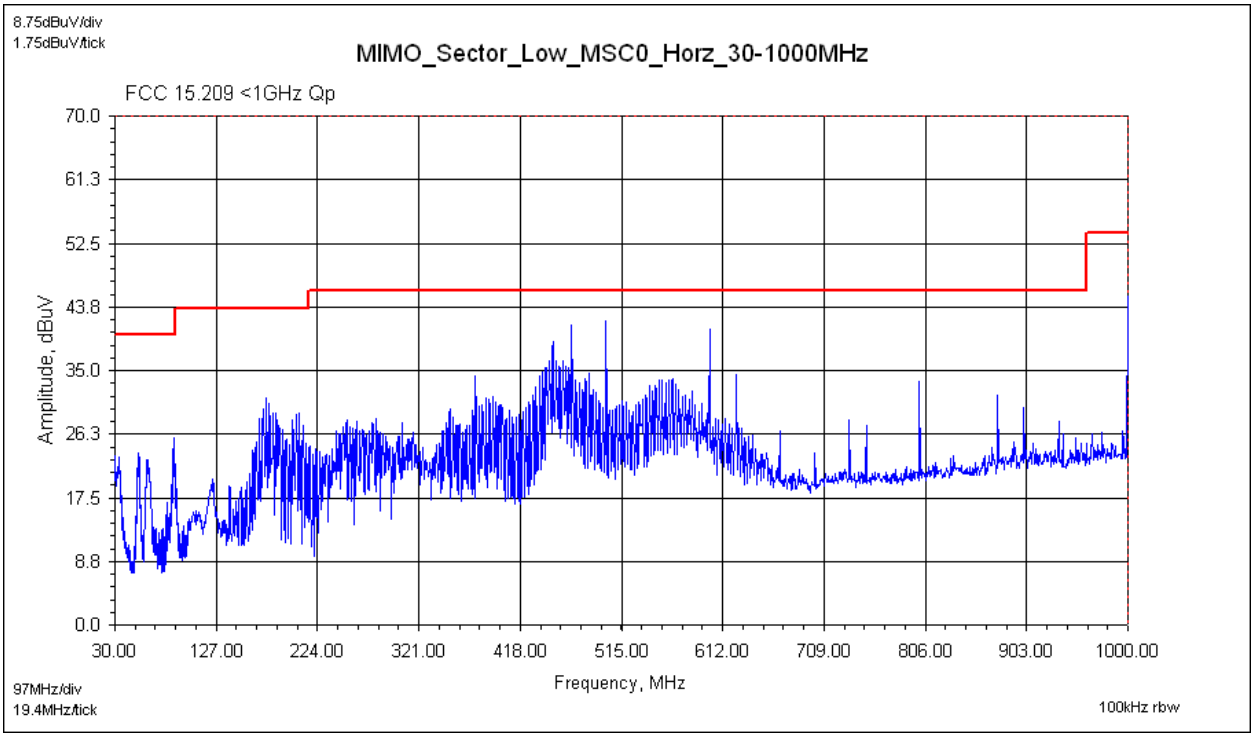
## 11.26 Plots: MIMO Mode of Operation – HT20 Low Channel: 2412MHz

30MHz to 1000MHz

Vertical Antenna




Horizontal Antenna

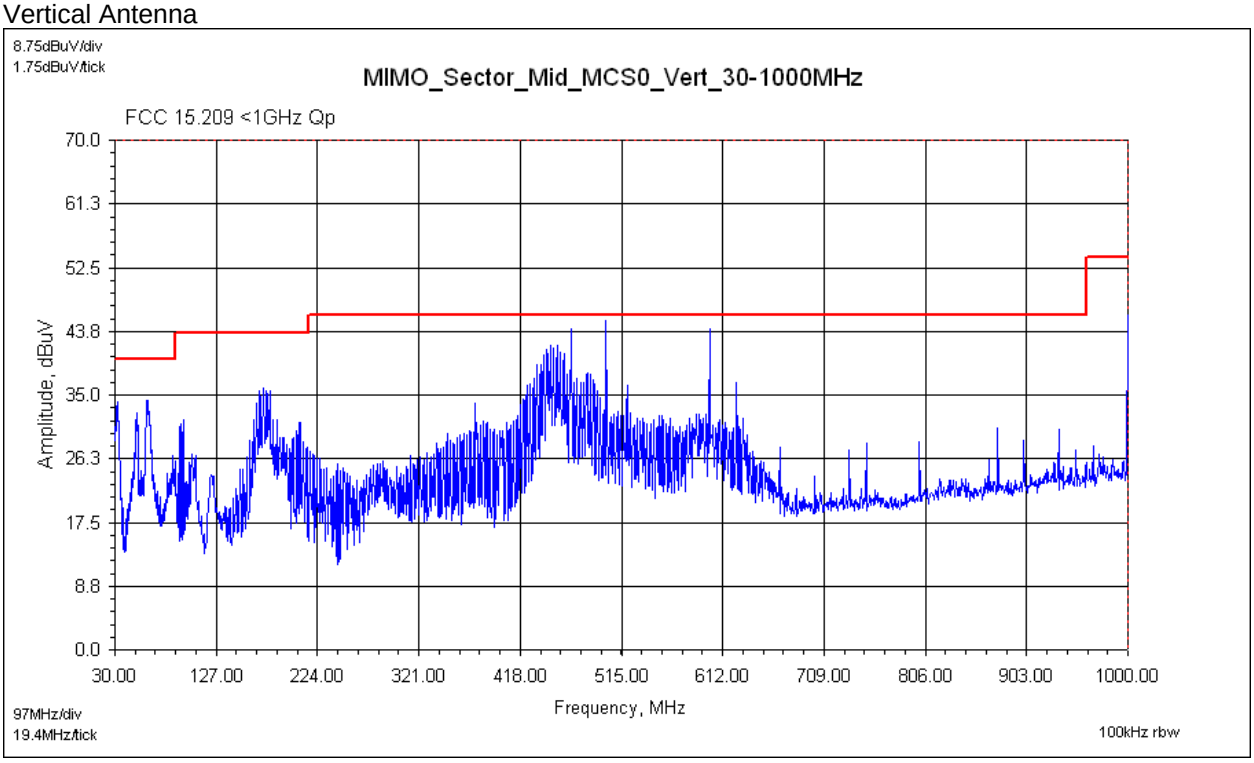



Reference only – max hold peak detector measurements referenced to quasi-peak limit

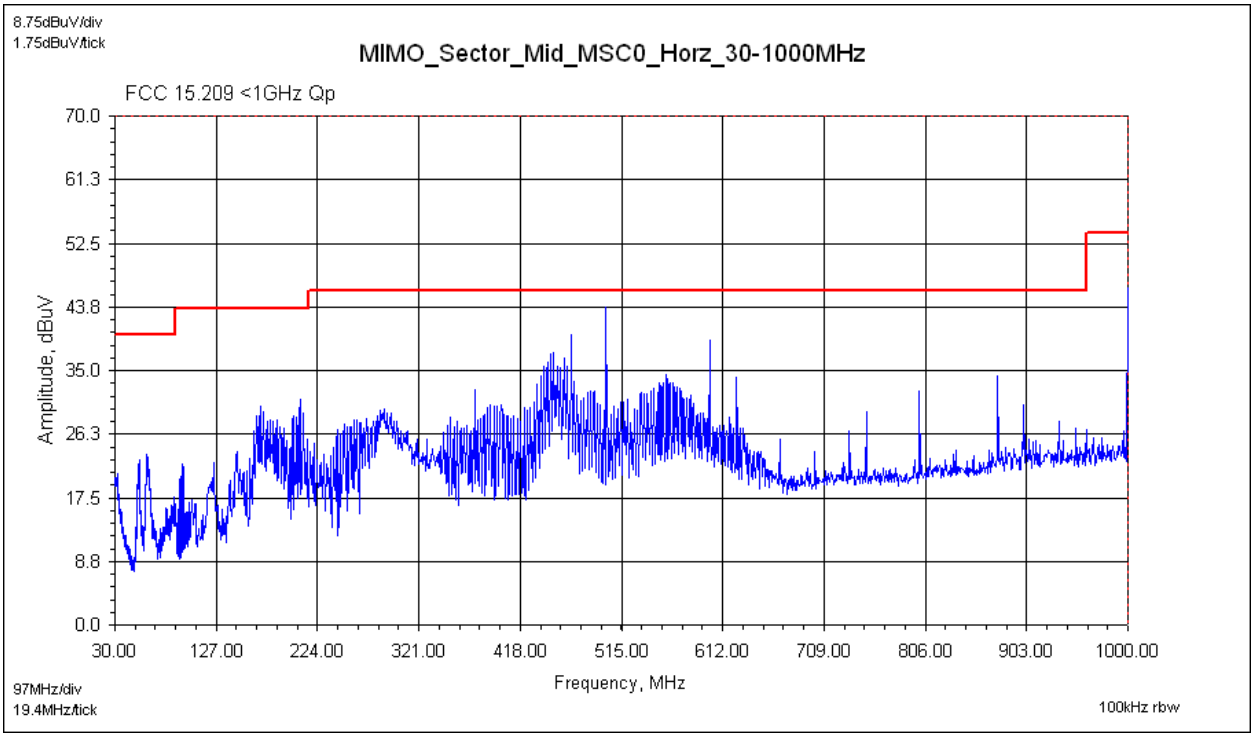
## 11.27 Plots: MIMO Mode of Operation – HT20 Mid Channel: 2437MHz

30MHz to 1000MHz

Vertical Antenna




Horizontal Antenna

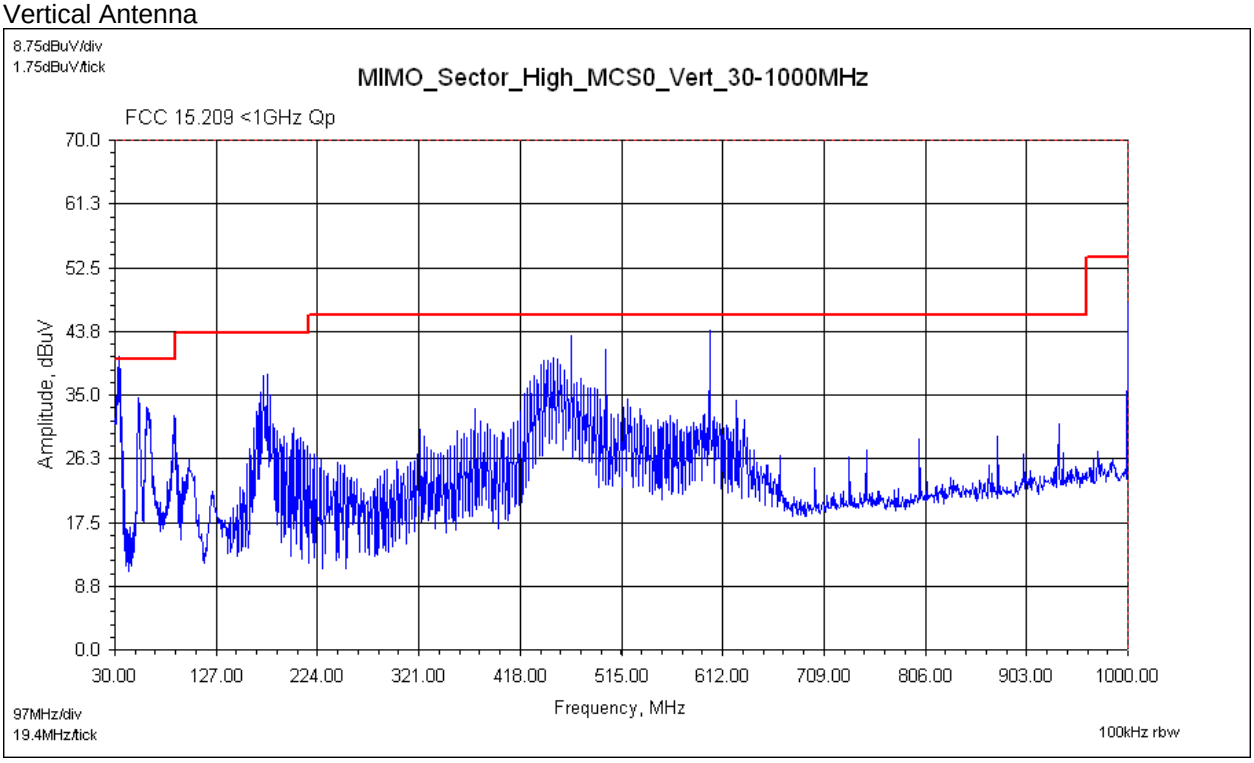



Reference only – max hold peak detector measurements referenced to quasi-peak limit

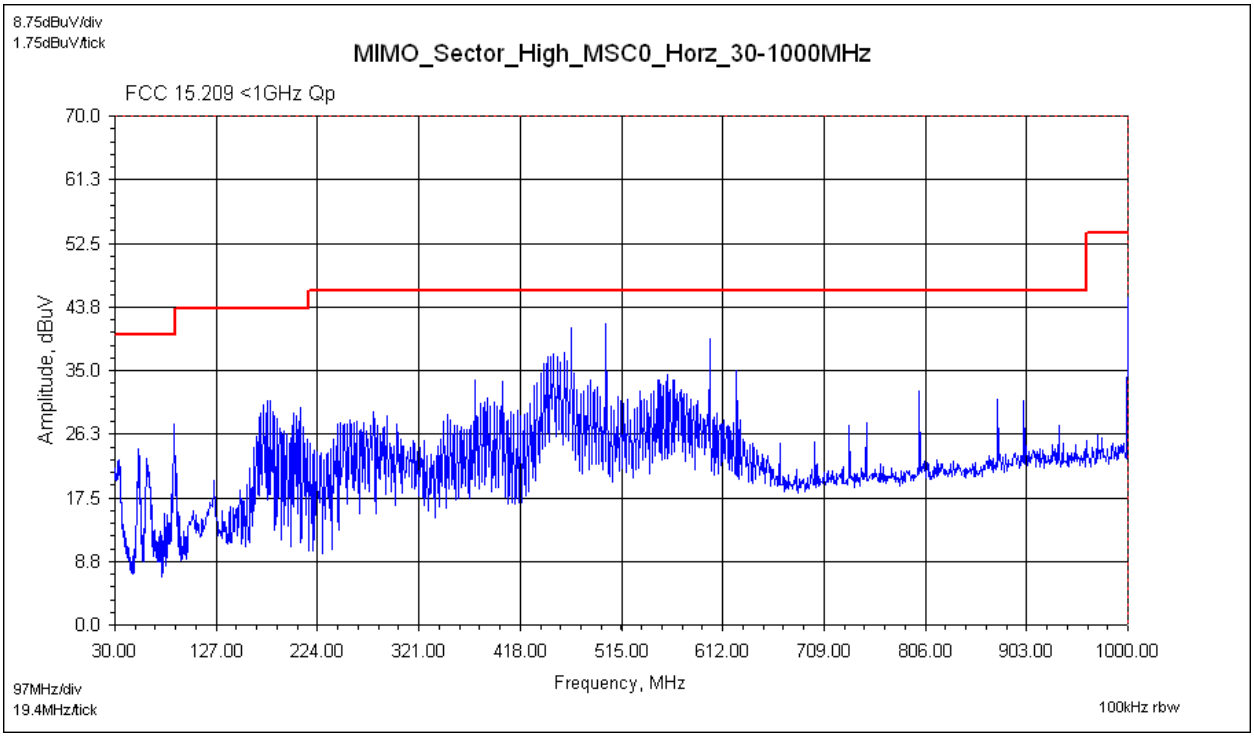
## 11.28 Plots: MIMO Mode of Operation – HT20 High Channel: 2462MHz

30MHz to 1000MHz

Vertical Antenna




Horizontal Antenna

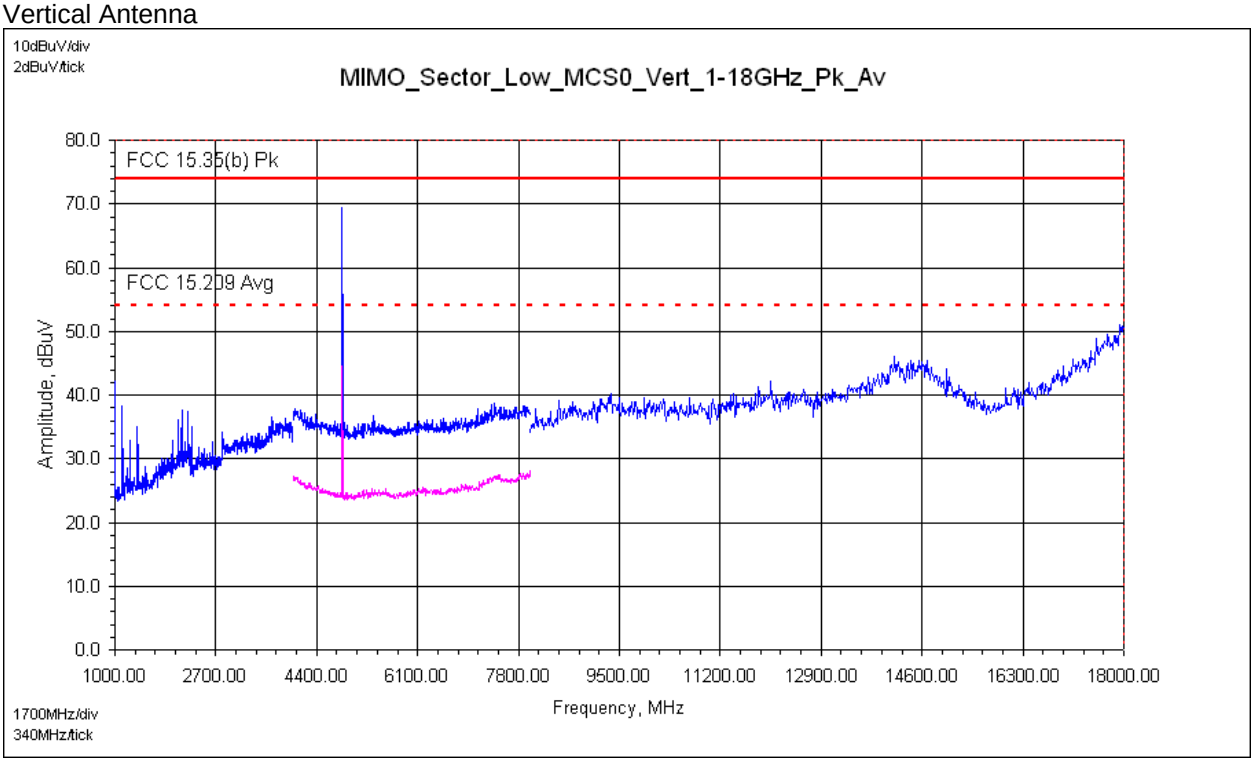



Reference only – max hold peak detector measurements referenced to quasi-peak limit

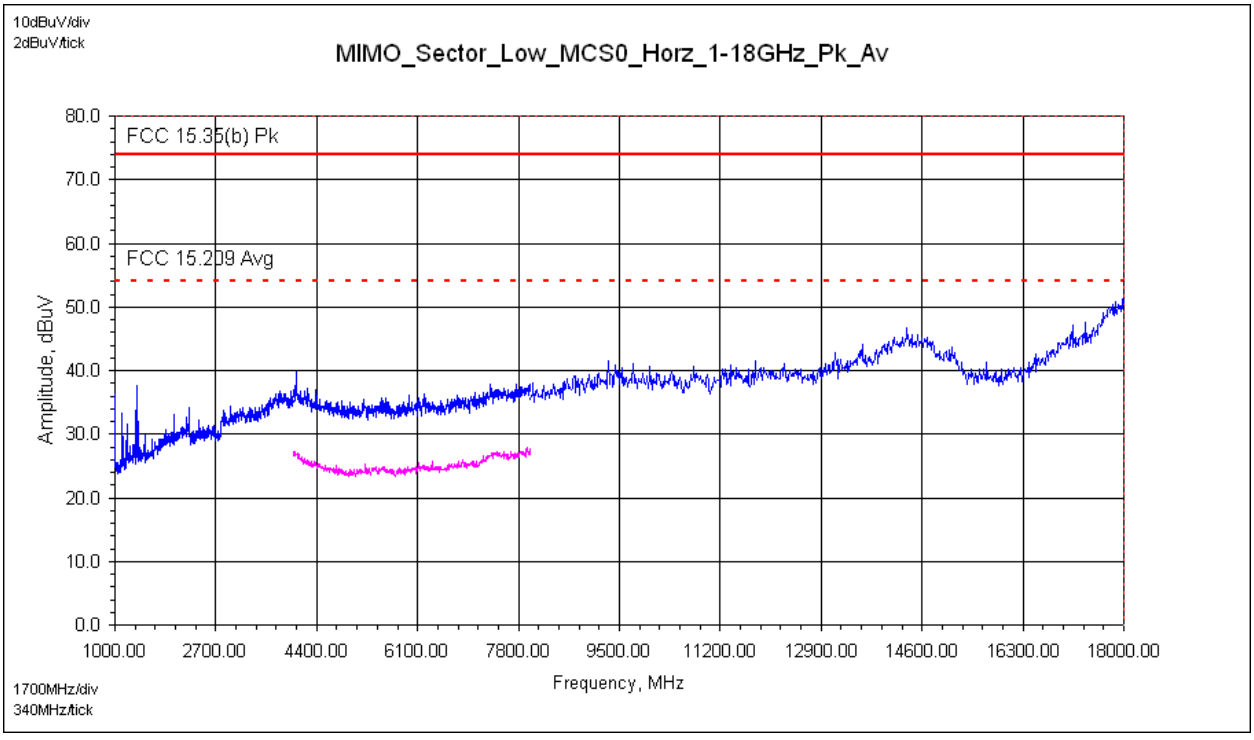
## 11.29 Plots: MIMO Mode of Operation – HT20 Low Channel: 2412 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna

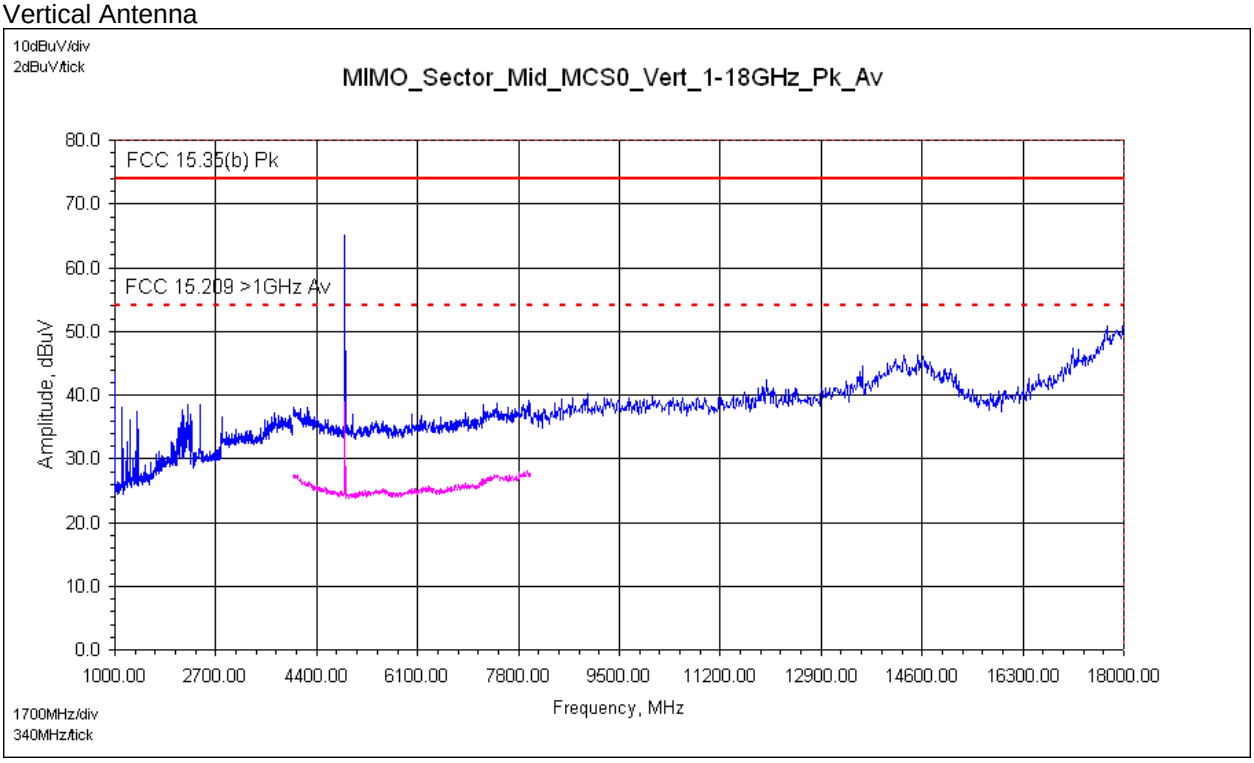



Reference only – max hold peak detector measurements referenced to average & peak limits (average trace – magenta)

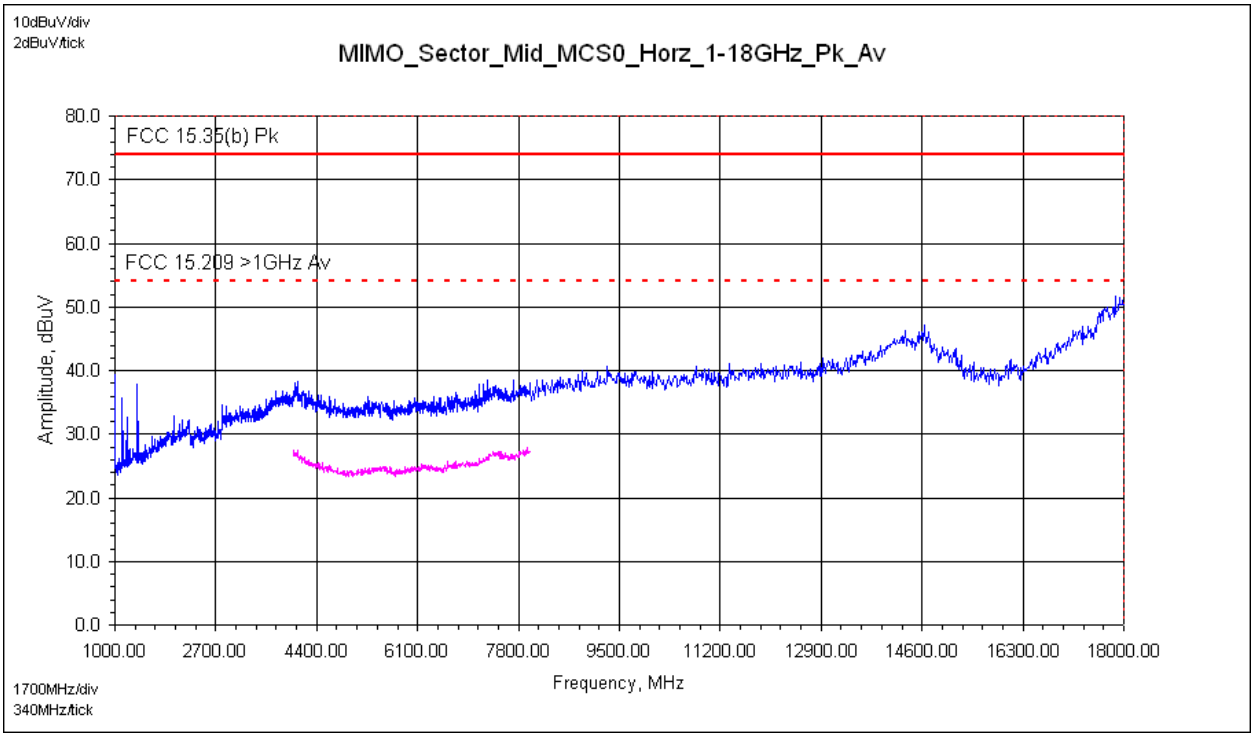
## 11.30 Plots: MIMO Mode of Operation – HT20 Mid Channel: 2437 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna

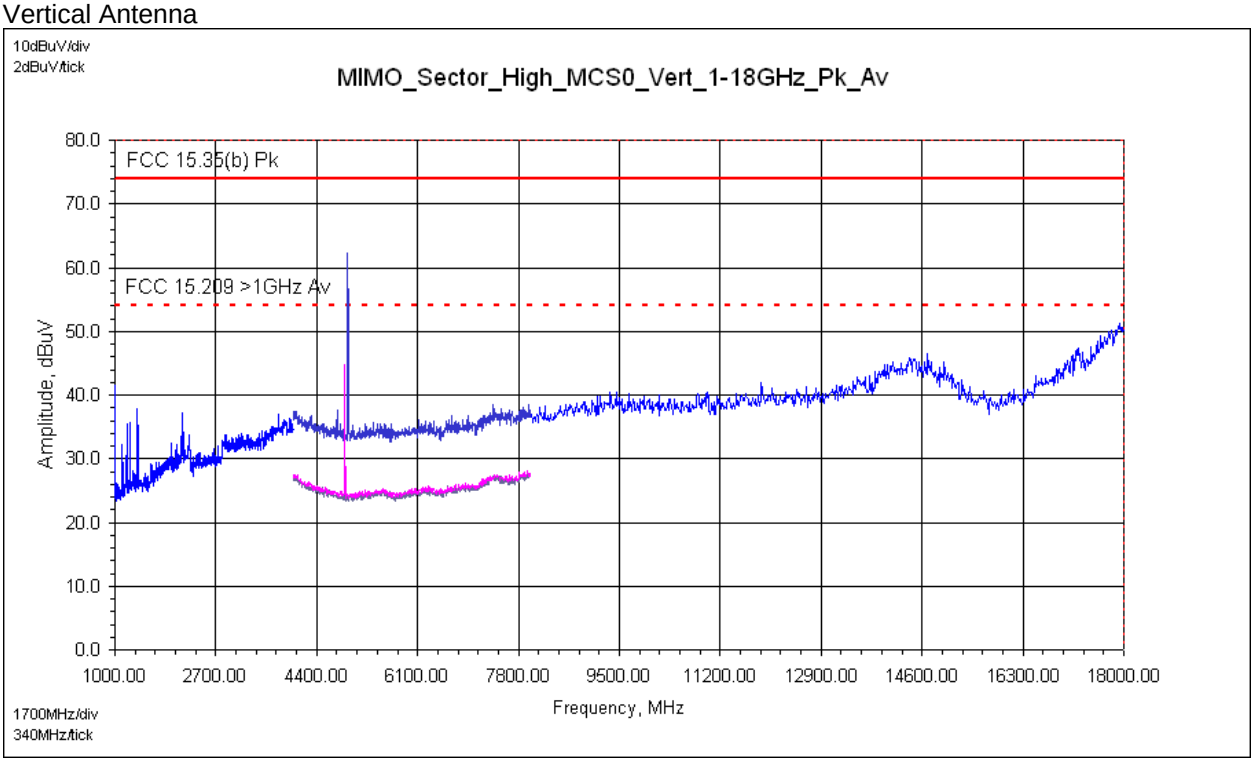



Reference only – max hold peak detector measurements referenced to average & peak limits (average trace – magenta)

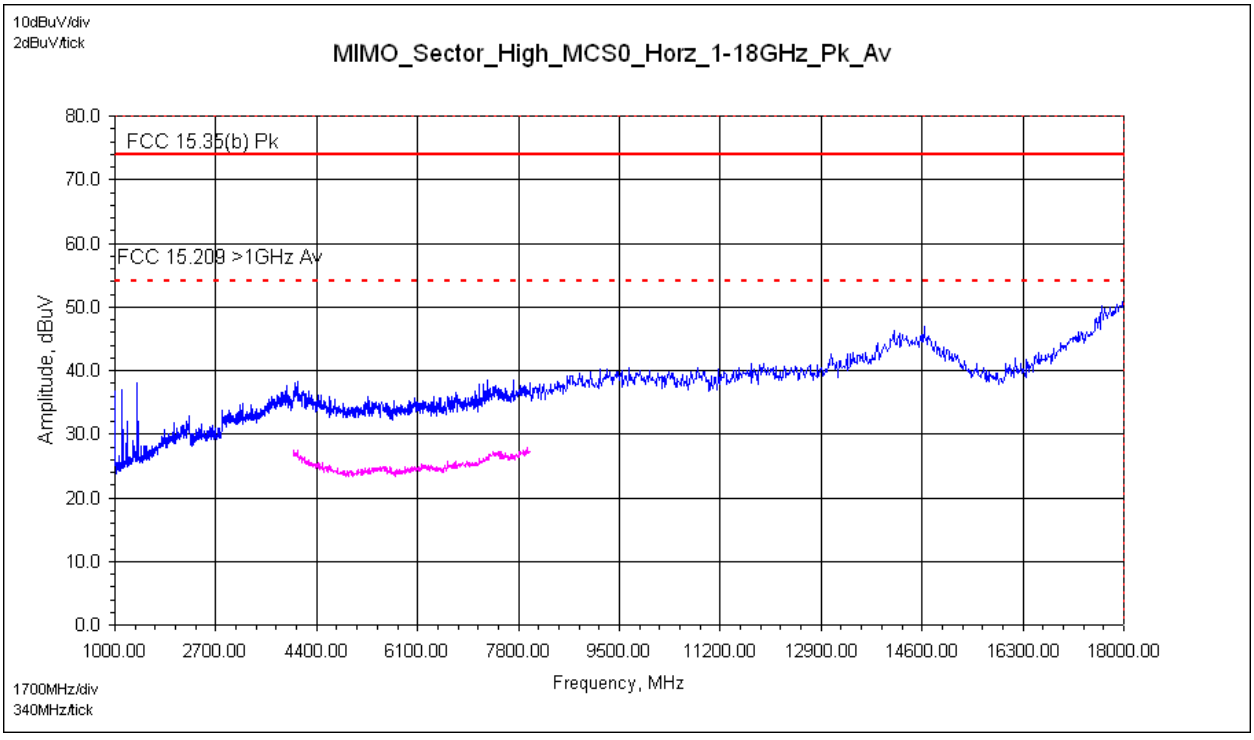
## 11.31 Plots: MIMO Mode of Operation – HT20 High Channel: 2462 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna

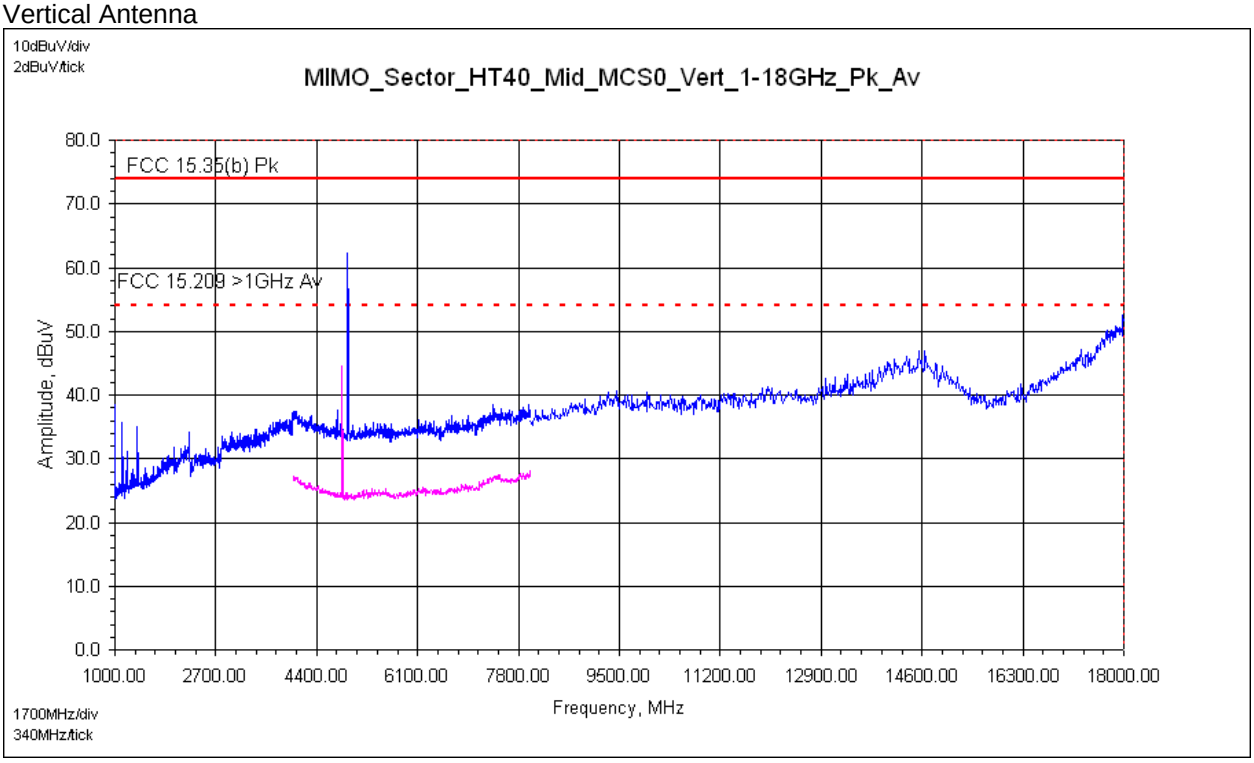



Reference only – max hold peak detector measurements referenced to average & peak limits (average trace – magenta)

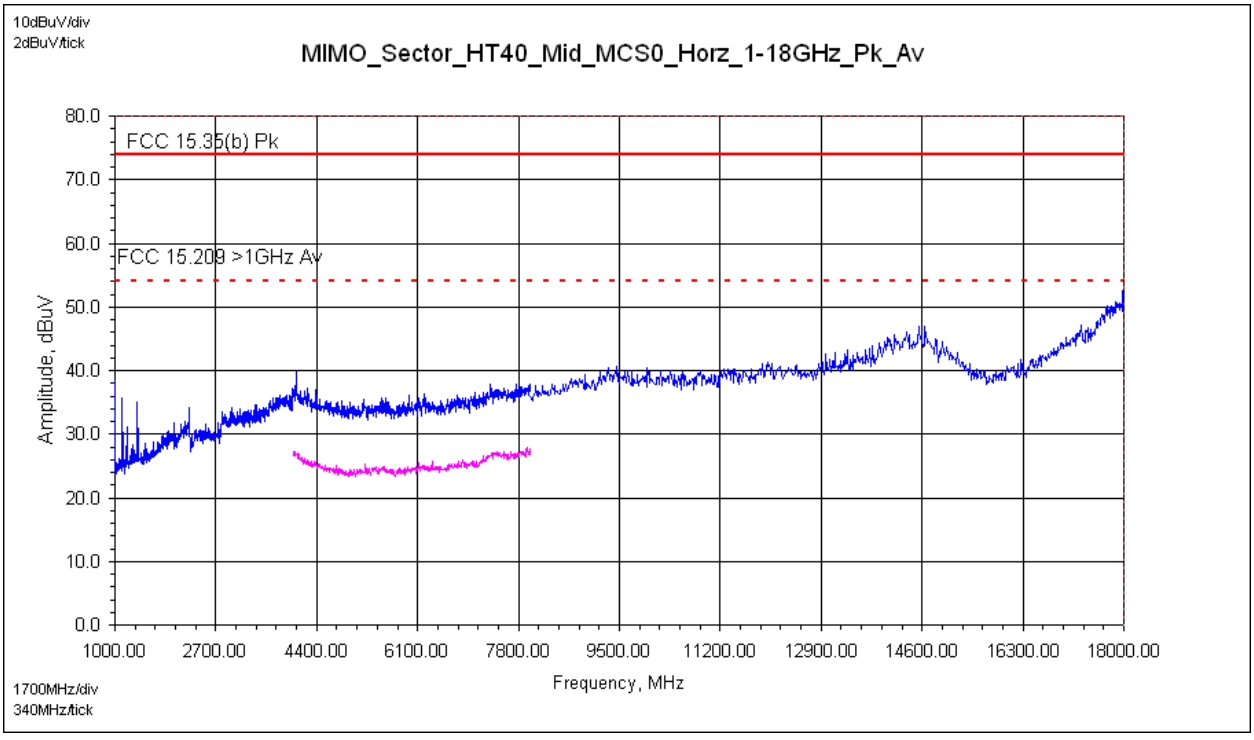
## 11.32 Plots: MIMO Mode of Operation – HT40Channel: 2437 MHz

1GHz to 18GHz

Vertical Antenna




Horizontal Antenna




Reference only – max hold peak detector measurements referenced to average & peak limits (average trace – magenta)

## 11.33 Test Data: MIMO Mode of Operation

# Tx Spurious Radiated Electromagnetic Emissions

| | | | | | |
|---|---|---|---|---|---|
| Test Report #: | **G101503629** | Test Area: | CC1 Radiated | Temperature: | 23.5 °C |
| Test Method: | FCC 15.209/ 15.205/ 15.35(b) | Test Date: | 02/05/2014<br>02/06/2014 | Relative Humidity: | 19.3 % |
| EUT Model #: | Radio Module: W2400-01<br>60°Sector Antenna:<br>SEC-25V-60-17HP | EUT Power: | 120VAC/60Hz | Air Pressure: | 83.8 kPa |

EUT Serial #: Radio Module: DEN1402111313
60°Sector Antenna: 40847, 40848

Manufacturer: FreeWave Technologies

EUT Description: Wireless router utilized in M2M industrial applications

Notes: Product tested in MIMO mode: 2 transmit chains/ports – dual antennas

Product continuously transmitting during all testing – worst-case modulation/data

MIMO mode of Operation, MCS0 Data Rate, 26.17dBm power, 23.17dBm/port (worst-case power)

| Level Key |
|---|
| Pk – Peak |
| Qp – Quasi Peak |
| Av - Average |

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Qp | N/A | (MHz) |
| **Radio System: Model W2400-01 Radio Module with 60° Sector Antennas – MIMO Mode of Operation** | | | | | | | | | | | | | |
| **Measurements: 30MHz to 1000MHz – HT20 Mid Channel 2437 MHz** | | | | | | | | | | | | | |
| 32.8045 | 42.06 | **Qp** | 0.40 | 18.76 | 28.29 | 0.00 | 32.92 | V | 1.00 | 5.8 | - 7.08 | NA | 0.120 |
| 62.0833 | 51.71 | **Qp** | 0.77 | 7.61 | 28.20 | 0.00 | 31.88 | V | 1.00 | 130.4 | - 8.12 | NA | 0.120 |
| 175.5600 | 52.97 | **Qp** | 0.89 | 11.54 | 27.69 | 0.00 | 37.71 | V | 1.00 | 324.3 | - 5.81 | NA | 0.120 |
| 456.5300 | 49.85 | **Qp** | 1.46 | 16.90 | 28.29 | 0.00 | 39.92 | V | 1.29 | 69.2 | - 6.10 | NA | 0.120 |
| 500.0004 | 52.33 | **Qp** | 1.53 | 17.70 | 28.60 | 0.00 | 42.96 | V | 1.26 | 41.9 | - 3.06 | NA | 0.120 |
| 600.0000 | 50.99 | **Qp** | 1.70 | 18.90 | 28.70 | 0.00 | 42.88 | V | 1.17 | 20.4 | - 3.14 | NA | 0.120 |
| 1000.0000 | 46.41 | **Qp** | 2.21 | 22.60 | 27.59 | 0.00 | 43.64 | V | 1.14 | 18.3 | - 10.34 | NA | 0.120 |
| | | | | | | | | | | | | | |
| 500.0004 | 52.04 | **Qp** | 1.53 | 17.70 | 28.60 | 0.00 | 42.67 | H | 1.89 | 126.9 | - 3.35 | NA | 0.120 |
| 1000.0000 | 47.82 | **Qp** | 2.21 | 22.60 | 27.59 | 0.00 | 45.05 | H | 1.45 | 33.5 | - 8.93 | NA | 0.120 |
| | | | | | | | | | | | | | |

| Freq | Level | **Det** | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | **Qp Av Pk** | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Avg | FCC 15.35(b) Pk | (MHz) |
| **Measurements: 1GHz to 18GHz – HT20 Mid Channel 2437 MHz** | | | | | | | | | | | | | |
| 1000.0100 | 61.87 | **Pk** | 2.21 | 23.82 | 37.13 | 0.34 | 51.11 | V | 1.95 | 346.0 | N/A | - 22.89 | 1.000 |
| 1000.0100 | 55.66 | **Av** | 2.21 | 23.82 | 37.13 | 0.34 | 44.90 | V | 1.95 | 346.0 | - 9.08 | NA | 1.000 |
| 1124.9800 | 50.86 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 40.97 | V | 1.94 | 346.0 | N/A | - 33.03 | 1.000 |
| 1124.9800 | 47.85 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 37.96 | V | 1.94 | 346.0 | - 16.02 | NA | 1.000 |
| 1374.9600 | 51.46 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 42.91 | V | 1.00 | 0.0 | N/A | - 31.09 | 1.000 |
| 1374.9600 | 44.85 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 36.30 | V | 1.00 | 0.0 | - 17.68 | NA | 1.000 |
| 2235.0000 | 47.79 | **Pk** | 3.38 | 27.84 | 37.42 | 2.65 | 44.24 | V | 1.30 | 105.0 | N/A | - 29.76 | 1.000 |
| 2235.0000 | 34.58 | **Av** | 3.38 | 27.84 | 37.42 | 2.65 | 31.03 | V | 1.30 | 105.0 | - 22.95 | NA | 1.000 |
| 4874.0000 | 62.96 | **Pk** | 5.20 | 32.98 | 39.08 | 0.00 | 62.06 | V | 1.90 | 9.6 | N/A | - 11.94 | 1.000 |
| 4874.0000 | 49.44 | **Av** | 5.20 | 32.98 | 39.08 | 0.00 | 48.54 | V | 1.90 | 9.6 | - 5.44 | NA | 1.000 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1124.9800 | 63.97 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 54.08 | H | 1.28 | 21.0 | N/A | - 19.92 | 1.000 |
| 1124.9800 | 47.37 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 37.48 | H | 1.28 | 21.0 | - 16.50 | NA | 1.000 |
| 1374.9800 | 53.58 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 45.03 | H | 1.52 | 90.0 | N/A | - 28.97 | 1.000 |
| 1374.9800 | 46.83 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 38.28 | H | 1.52 | 90.0 | - 15.70 | NA | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: 1GHz to 18GHz – HT40 Channel 2437 MHz** | | | | | | | | | | | | | |
| 1000.0010 | 61.10 | **Pk** | 2.21 | 23.82 | 37.13 | 0.34 | 50.34 | V | 2.10 | 345.0 | N/A | - 23.66 | 1.000 |
| 1000.0010 | 55.02 | **Av** | 2.21 | 23.82 | 37.13 | 0.34 | 44.26 | V | 2.10 | 345.0 | - 9.72 | NA | 1.000 |
| 1124.9800 | 62.02 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 52.13 | V | 2.10 | 358.0 | N/A | - 21.87 | 1.000 |
| 1124.9800 | 48.42 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 38.53 | V | 2.10 | 358.0 | - 15.45 | NA | 1.000 |
| 1374.9800 | 54.88 | **Pk** | 2.61 | 25.13 | 36.76 | 0.47 | 46.33 | V | 2.31 | 50.0 | N/A | - 27.67 | 1.000 |
| 1374.9800 | 46.33 | **Av** | 2.61 | 25.13 | 36.76 | 0.47 | 37.78 | V | 2.31 | 50.0 | - 16.20 | NA | 1.000 |
| 4874.0000 | 60.70 | **Pk** | 5.20 | 32.98 | 39.08 | 0.00 | 59.80 | V | 2.03 | 7.7 | N/A | - 14.20 | 1.000 |
| 4874.0000 | 51.47 | **Av** | 5.20 | 32.98 | 39.08 | 0.00 | 50.57 | V | 2.03 | 7.7 | - 3.41 | NA | 1.000 |
| | | | | | | | | | | | | | |
| 1000.0010 | 65.68 | **Pk** | 2.21 | 23.82 | 37.13 | 0.34 | 54.92 | H | 2.25 | 358.0 | N/A | - 19.08 | 1.000 |
| 1000.0010 | 50.05 | **Av** | 2.21 | 23.82 | 37.13 | 0.34 | 39.29 | H | 2.25 | 358.0 | - 14.69 | NA | 1.000 |
| 1124.9800 | 53.96 | **Pk** | 2.36 | 24.63 | 37.26 | 0.38 | 44.07 | H | 2.24 | 326.0 | N/A | - 29.93 | 1.000 |
| 1124.9800 | 48.88 | **Av** | 2.36 | 24.63 | 37.26 | 0.38 | 38.99 | H | 2.24 | 326.0 | - 14.99 | NA | 1.000 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

Example calculation:

| **Measured Level** | **+** | **Cable Loss** | **+** | **Antenna Factor** | **-** | **Pre-Amp** | **+** | **Atten** | **=** | **Final Corrected Reading** | **Specification Limit** | **-** | **Final Corrected Reading** | **=** | **Delta Specification** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (dBµV) | | (dB) | | (dB) | | (dB) | | (dB) | | (dBµV/m) | (dBµV/m) | | (dBµV/m) | | |
| **20.0** | | **3.0** | | **5.0** | | **10.0** | | **0.0** | | **18.0** | **40.0** | | **18.0** | | **- 22.0** |

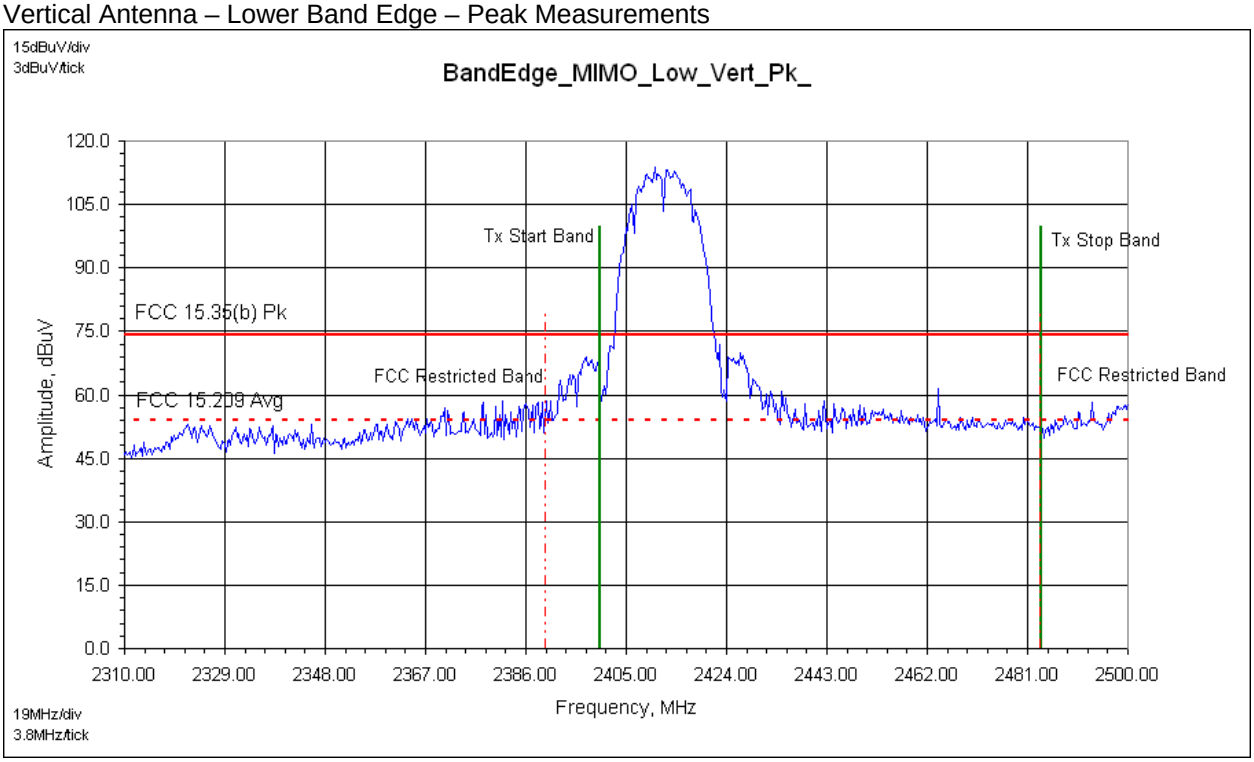
Notes:

1) The highest signals – as determined from pre-scan plots – were fully-maximized and measured.
2) For the general pre-scan plots 1-4GHz, a notch filter was utilized. Note the notch filter was <u>not used</u> during band edge plots/measurements.
3) 802.11 HT20/HT40 included in measurements as well as both SISO/MIMO modes of Tx operation.

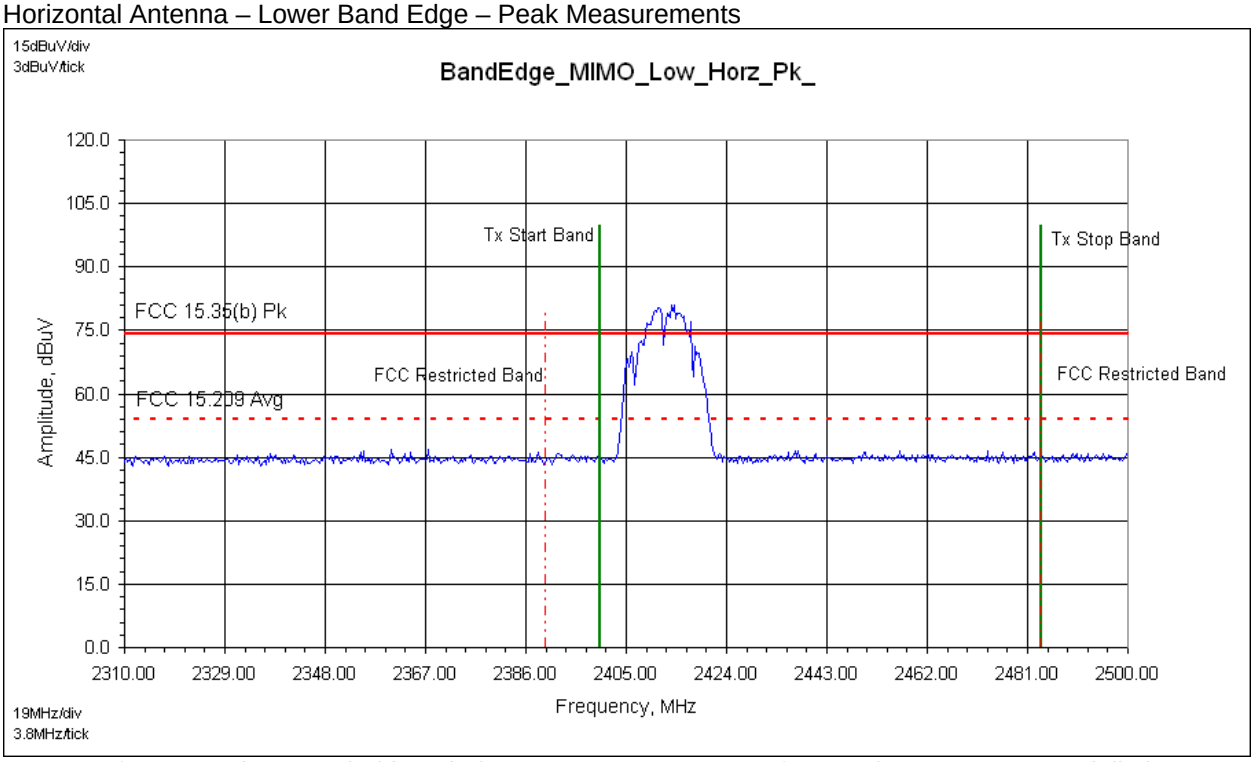
Deviations, Additions, or Exclusions: None

## 11.34 Band Edge Plots: MIMO Mode of Operation – HT20 Low Channel 2412 MHz

Vertical Antenna – Lower Band Edge – Peak Measurements




Horizontal Antenna – Lower Band Edge – Peak Measurements

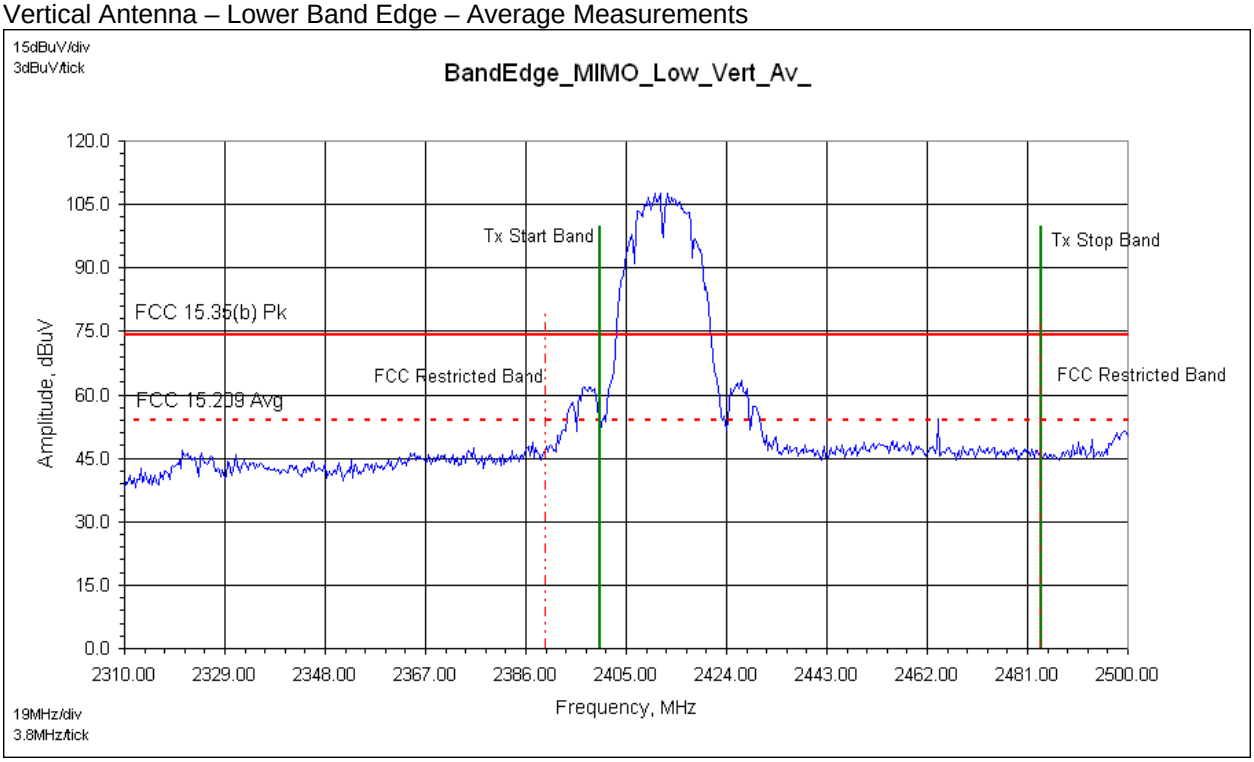



Reference only – max hold peak detector measurements referenced to average & peak limits

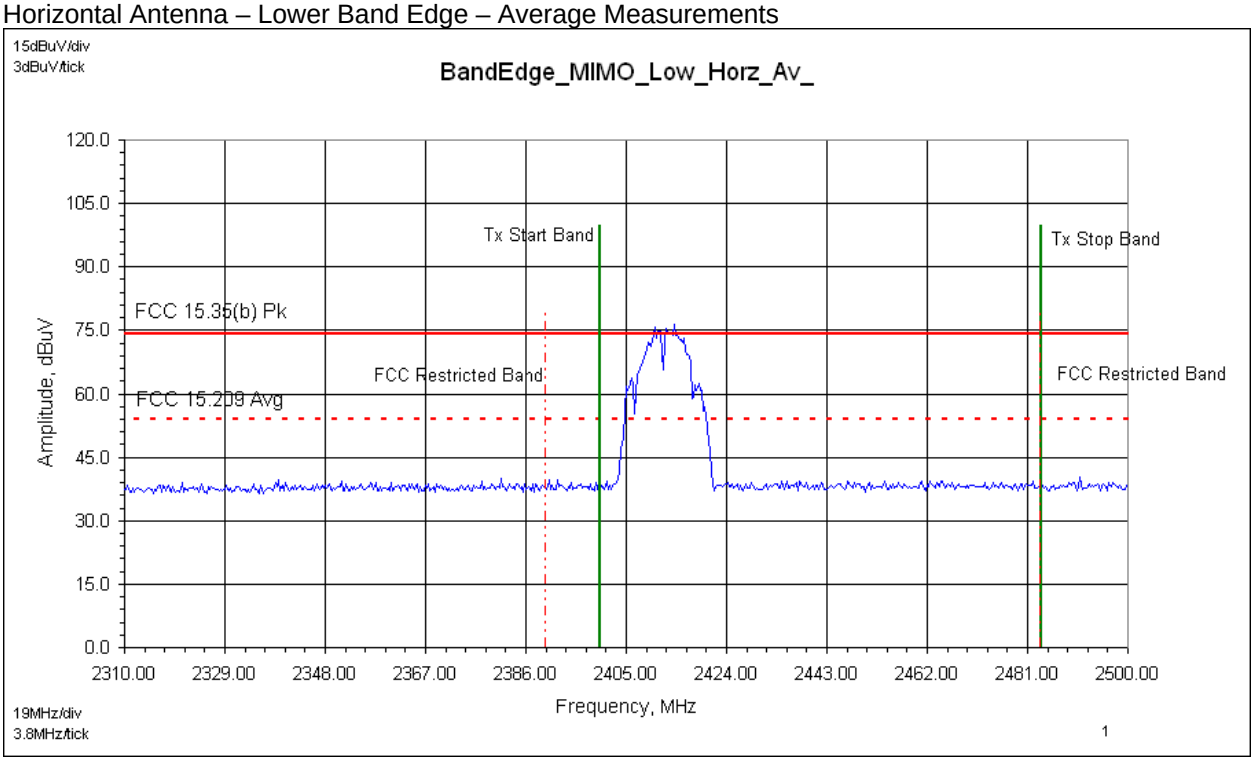
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Dashed-Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.35 Band Edge Plots: MIMO Mode of Operation – HT20 Low Channel 2412 MHz

Vertical Antenna – Lower Band Edge – Average Measurements




Horizontal Antenna – Lower Band Edge – Average Measurements

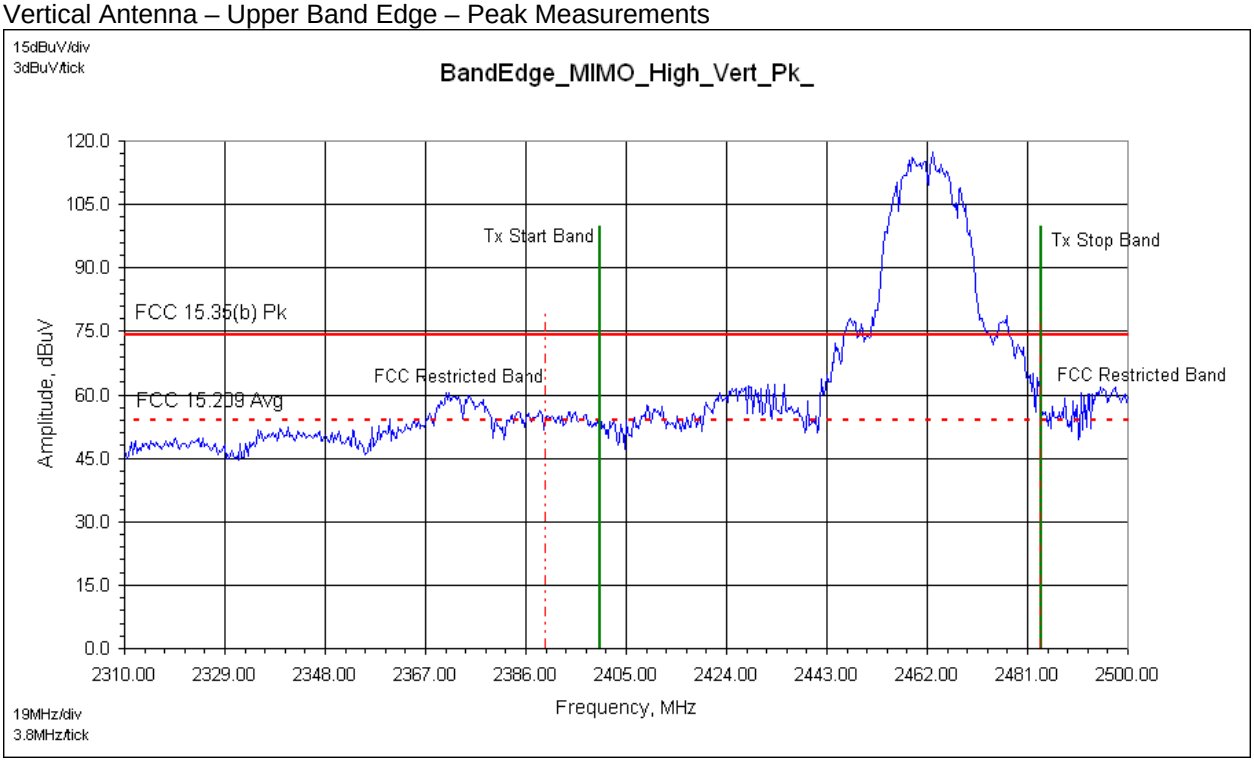



Reference only – max hold peak detector measurements referenced to average & peak limits

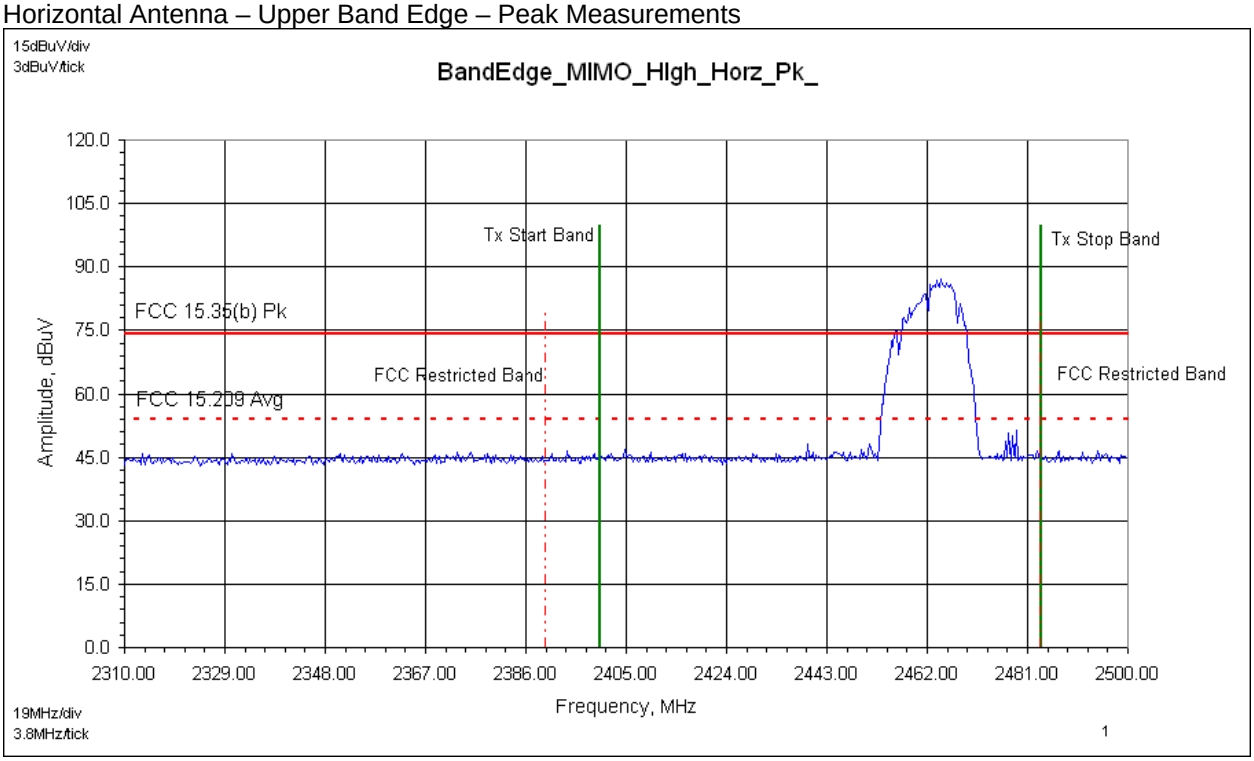
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Dashed-Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.36 Band Edge Plots: MIMO Mode of Operation – HT20 High Channel 2462 MHz

Vertical Antenna – Upper Band Edge – Peak Measurements




Horizontal Antenna – Upper Band Edge – Peak Measurements

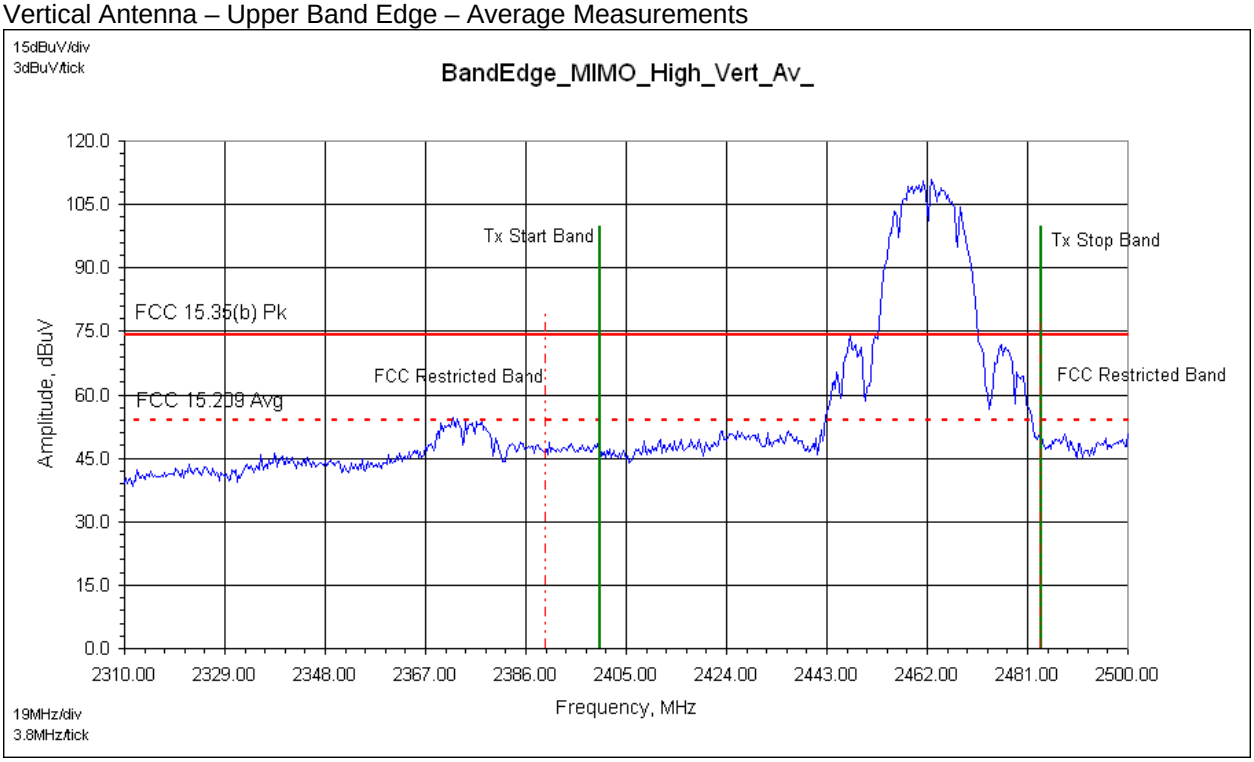



Reference only – max hold peak detector measurements referenced to average & peak limits

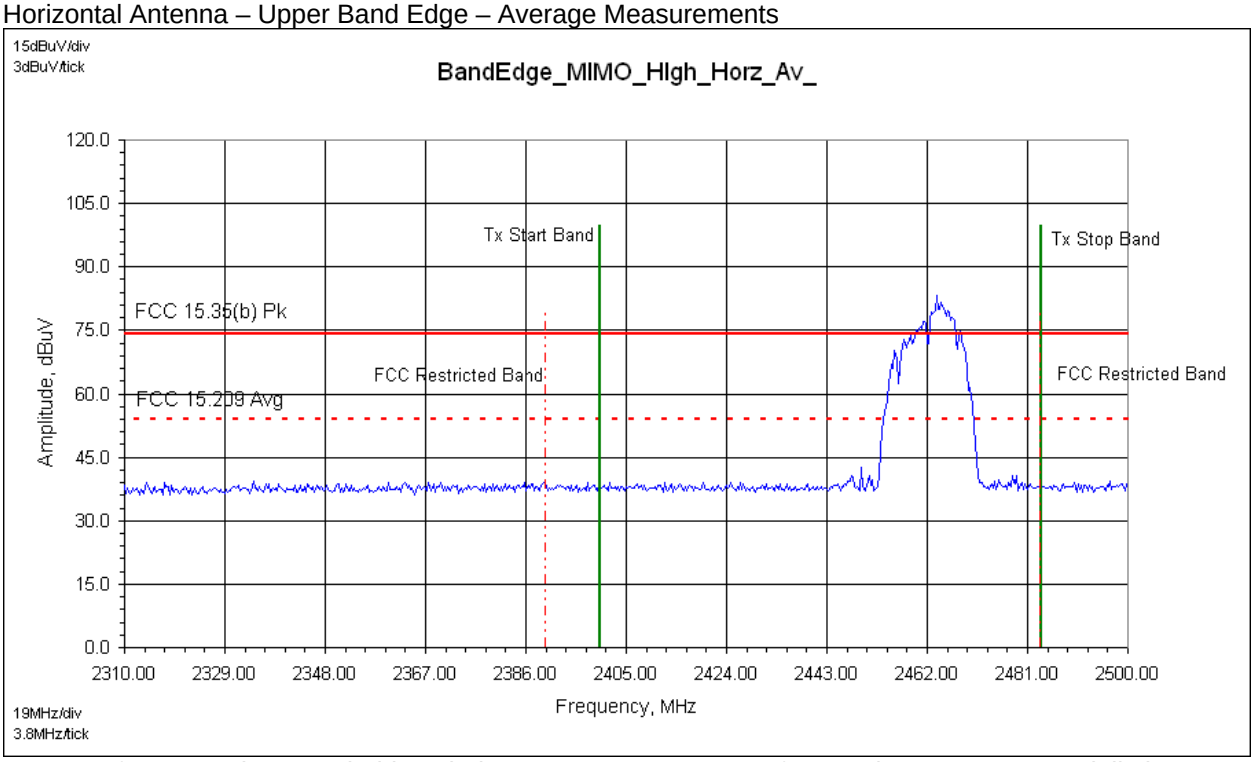
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.37 Band Edge Plots: MIMO Mode of Operation – HT20 High Channel 2462 MHz

Vertical Antenna – Upper Band Edge – Average Measurements




Horizontal Antenna – Upper Band Edge – Average Measurements

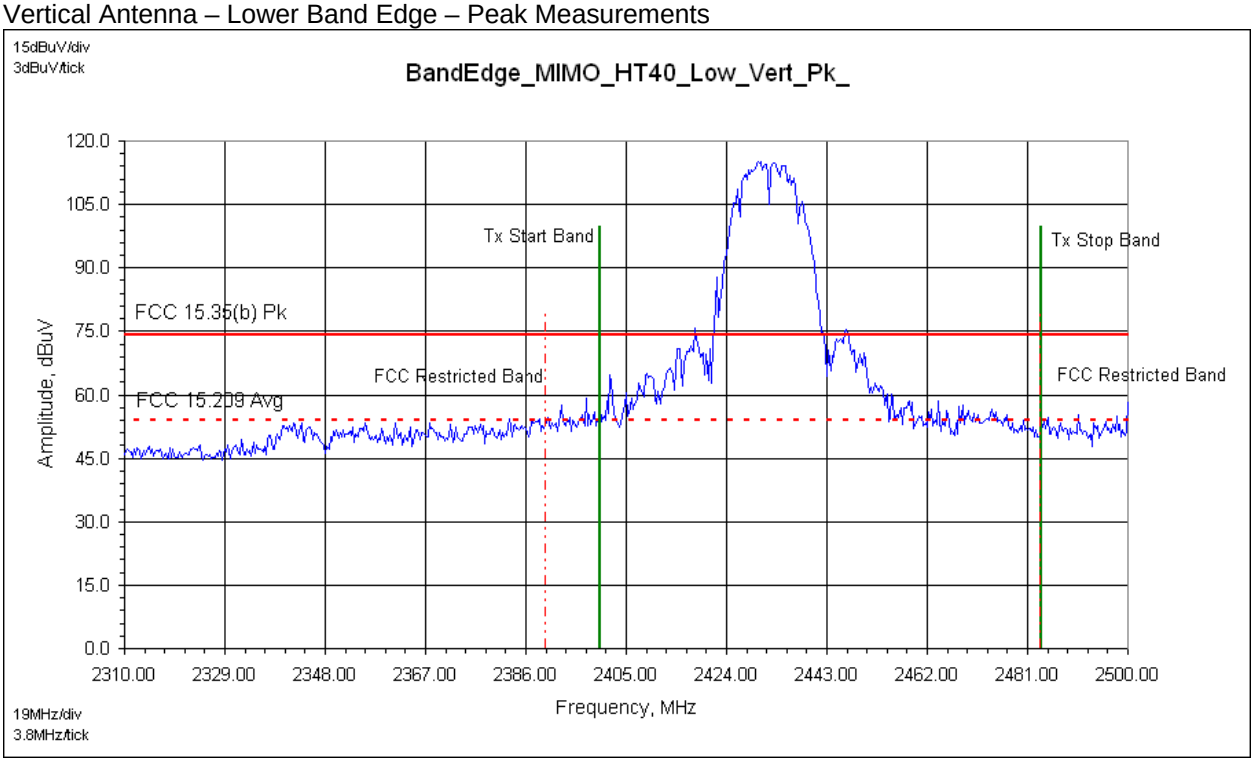



Reference only – max hold peak detector measurements referenced to average & peak limits

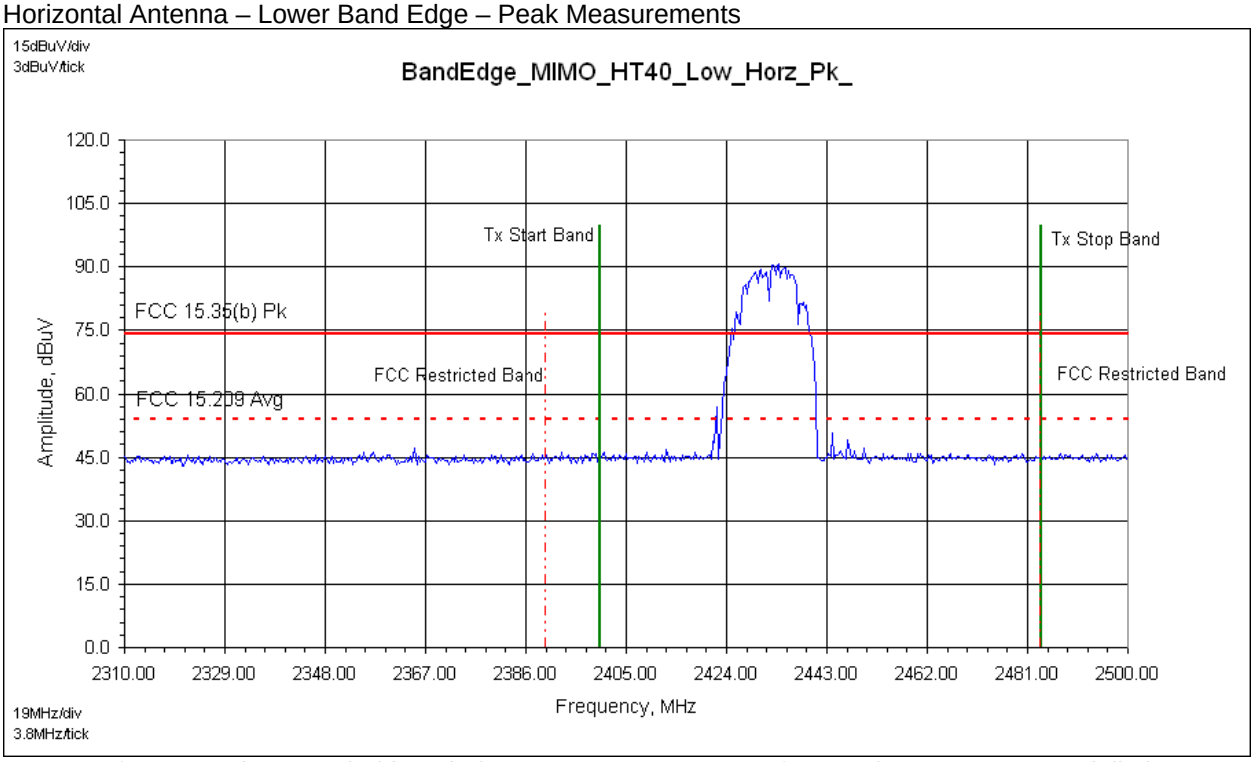
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.38 Band Edge Plots: MIMO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Lower Band Edge – Peak Measurements




Horizontal Antenna – Lower Band Edge – Peak Measurements

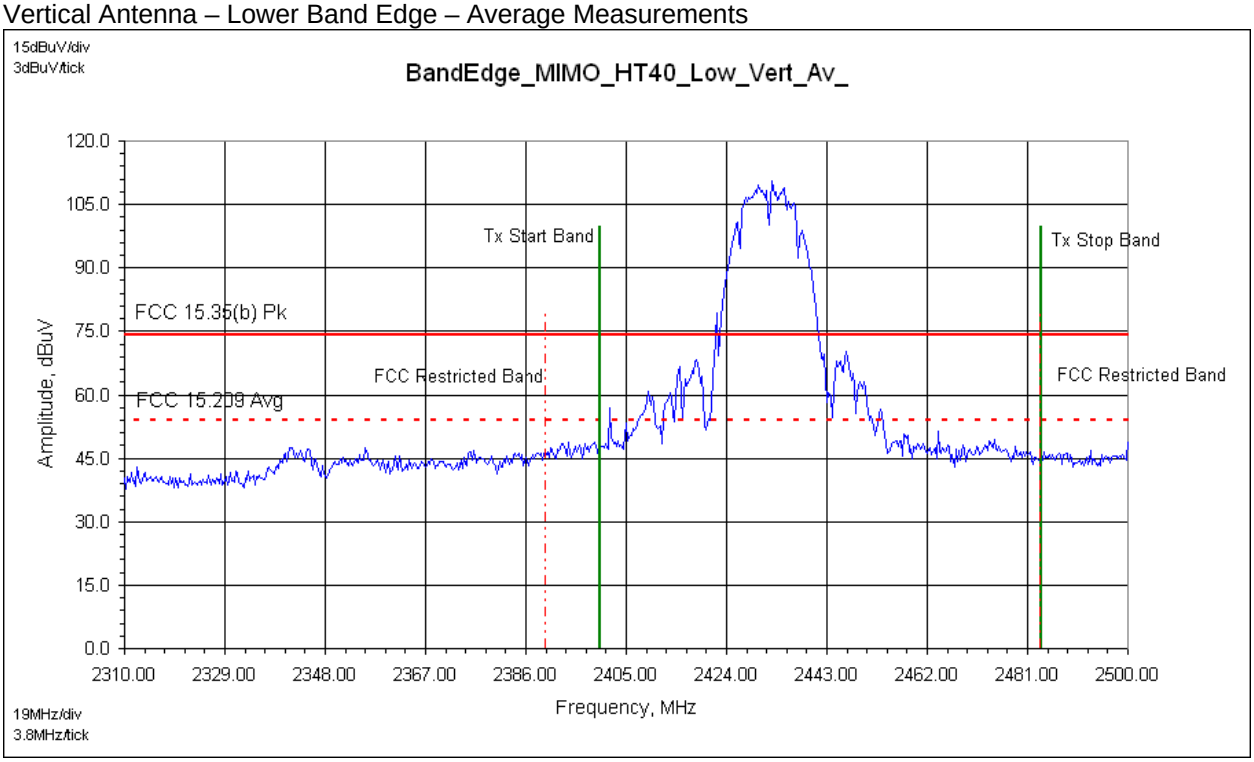



Reference only – max hold peak detector measurements referenced to average & peak limits

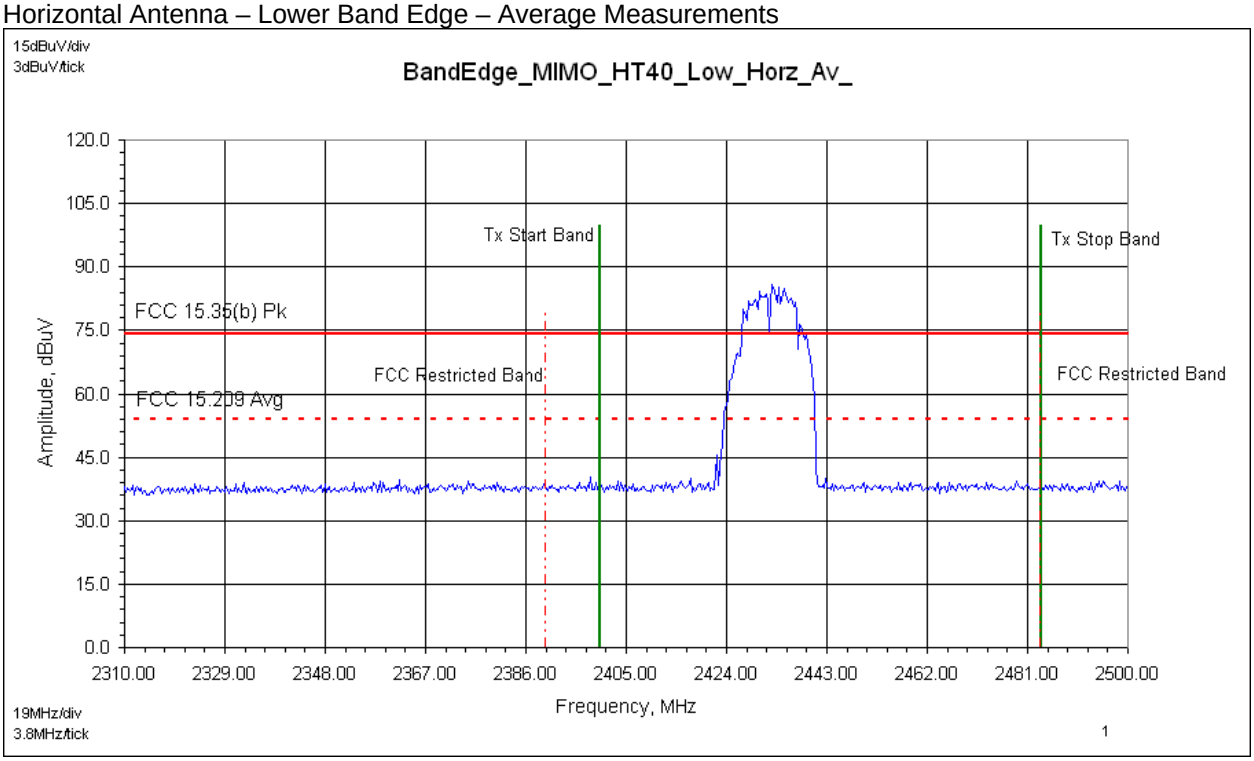
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.39 Band Edge Plots: MIMO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Lower Band Edge – Average Measurements




Horizontal Antenna – Lower Band Edge – Average Measurements

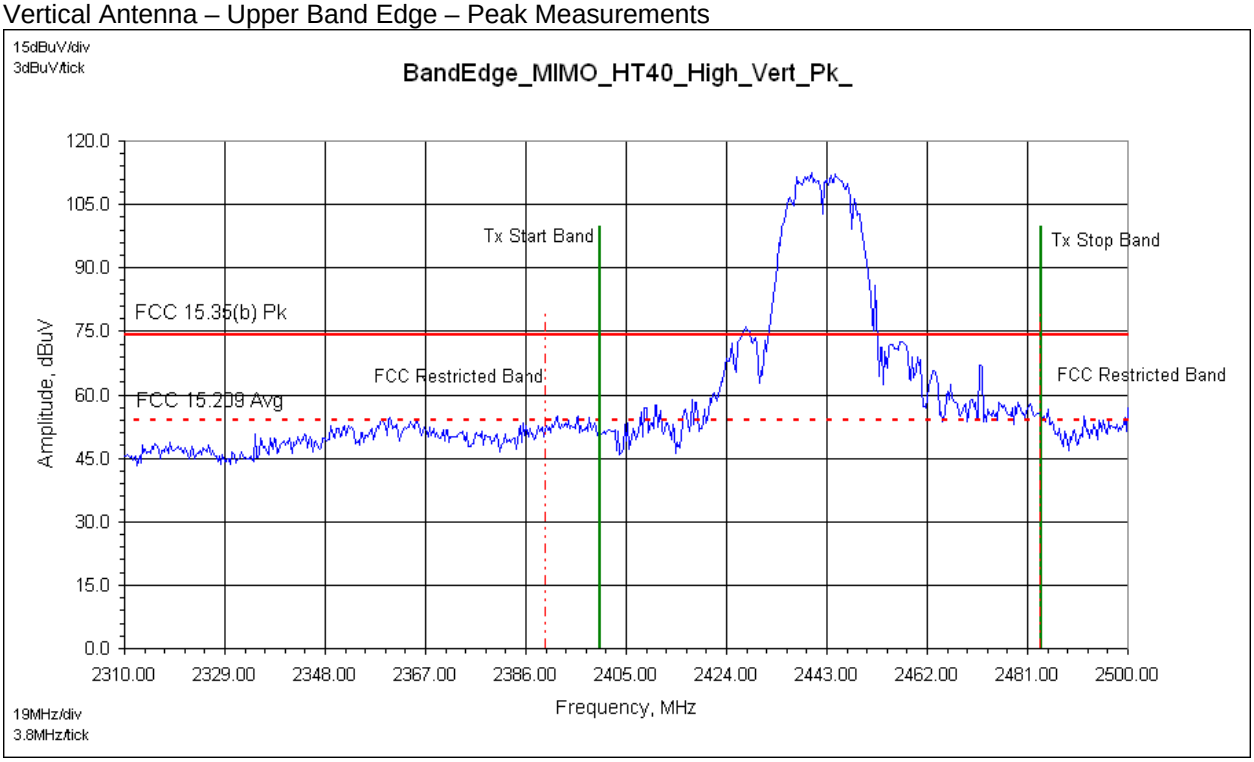



Reference only – max hold peak detector measurements referenced to average & peak limits

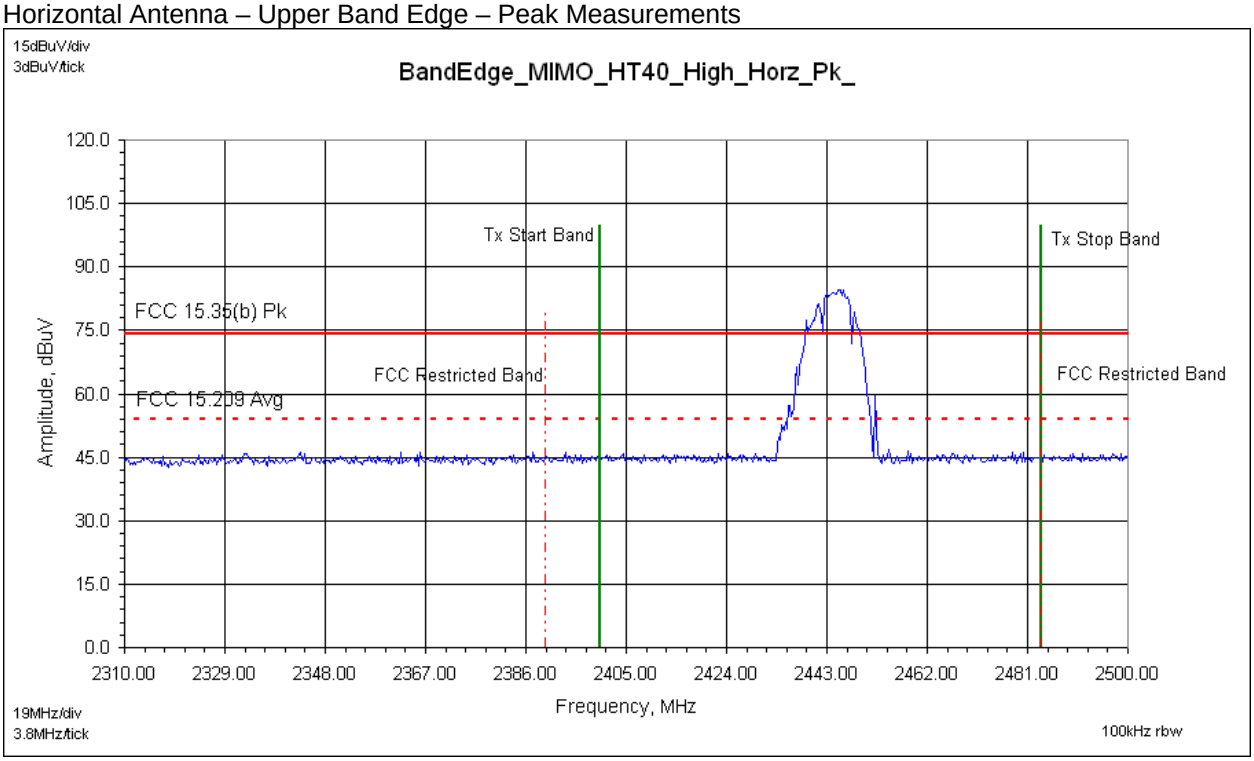
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.40 Band Edge Plots: MIMO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Upper Band Edge – Peak Measurements




Horizontal Antenna – Upper Band Edge – Peak Measurements

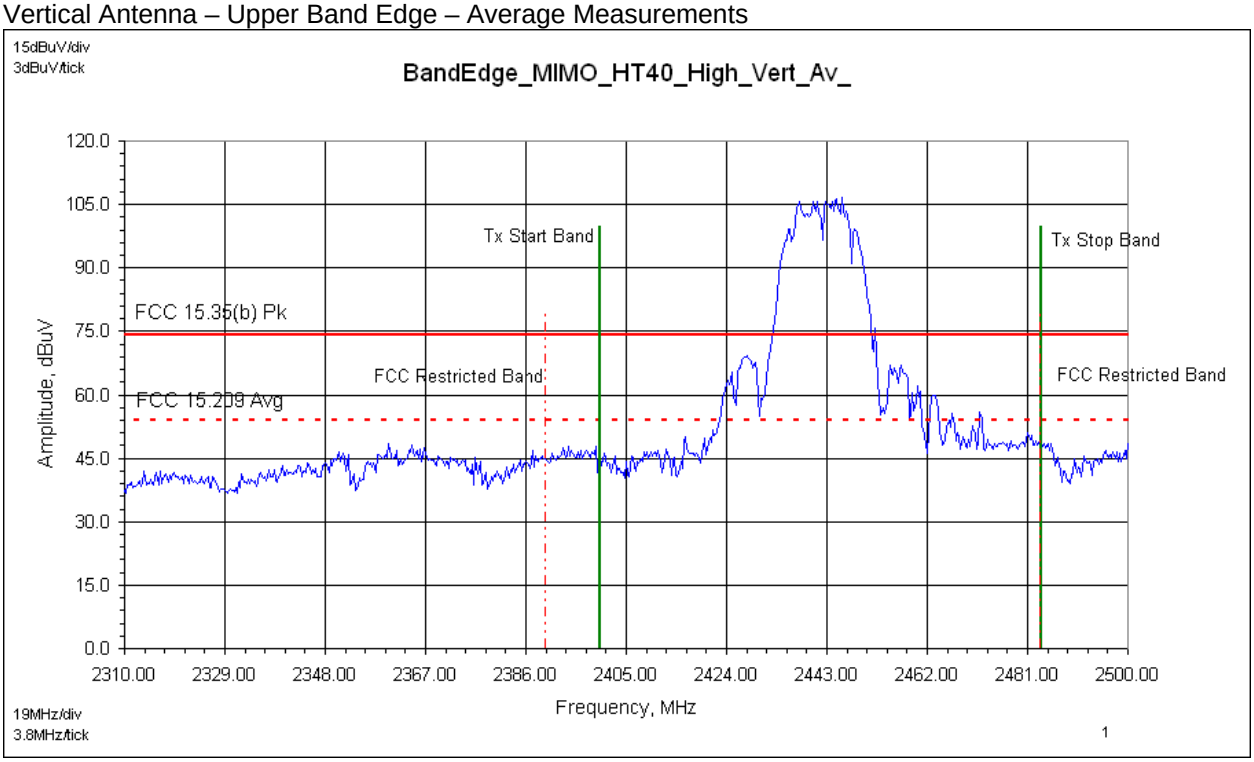



Reference only – max hold peak detector measurements referenced to average & peak limits

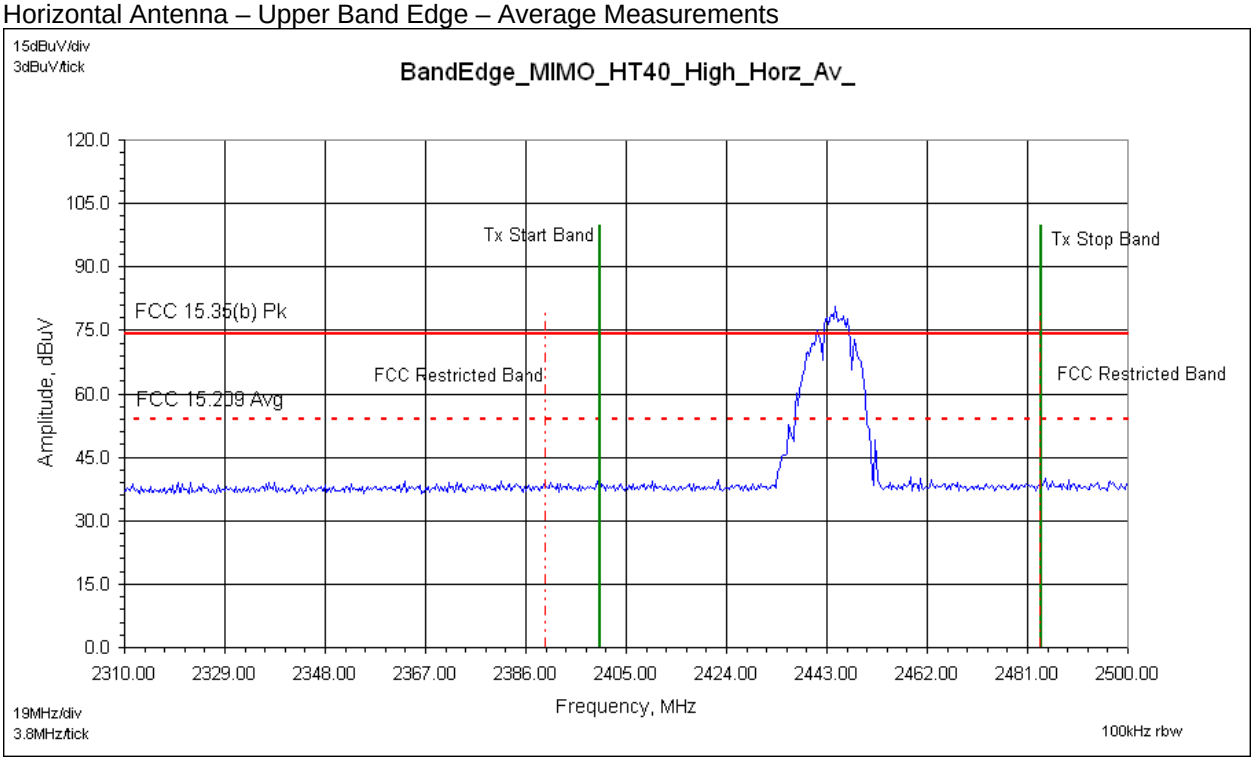
Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Peak trace line)

## 11.41 Band Edge Plots: MIMO Mode of Operation – HT40 Channel 2437 MHz

Vertical Antenna – Upper Band Edge – Average Measurements




Horizontal Antenna – Upper Band Edge – Average Measurements




Reference only – max hold peak detector measurements referenced to average & peak limits

Legend: Green Vertical Lines (Tx allowable start/stop band)
Red Vertical Lines (Restricted Band)
Blue Trace (Average trace line)

## 11.42 Test Data: MIMO Band Edge – FCC Restricted Band

# Tx Spurious Radiated Emissions – Band Edge

| | | | | | |
|---|---|---|---|---|---|
| Test Report #: | **G101503629** | Test Area: | CC1 Radiated | Temperature: | 23.5 °C |
| Test Method: | FCC 15.209/ 15.205/ 15.35(b) | Test Date: | 02/05/2014<br>02/06/2014 | Relative Humidity: | 19.3 % |
| EUT Model #: | Radio Module: W2400-01<br>60°Sector Antenna:<br>SEC-25V-60-17HP | EUT Power: | 120VAC/60Hz | Air Pressure: | 83.8 kPa |

EUT Serial #: Radio Module: DEN1402111313
60°Sector Antenna: 40847, 40848

Manufacturer: FreeWave Technologies

EUT Description: Wireless router utilized in M2M industrial applications

Notes: Product tested in MIMO mode: 2 transmit chains/ports – dual antennas

Product continuously transmitting during all testing – worst-case modulation/data

MIMO mode of Operation, MCS0 Data Rate, 26.17dBm power, 23.17dBm/port (worst-case power)

| Level Key |
|---|
| Pk – Peak |
| Qp – Quasi Peak |
| Av - Average |

| Freq | Level | Det | Cable | Ant | Preamp | Atten | Final | Pol | Hgt | Az | Delta1 | Delta2 | RBW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MHz | dBuV | Qp Av Pk | + [dB] | + [dB/m] | - [dB] | + [dB] | = [dBuV] | (V/H) | (m) | (DEG) | FCC 15.209 Avg | FCC 15.35(b) Pk | (MHz) |
| **Measurements: HT20 Lower Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2390.0000 | 51.26 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 51.47 | V | 1.46 | 7.0 | - 2.51 | NA | 1.000 |
| 2390.0000 | 68.22 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 68.43 | V | 1.46 | 7.0 | NA | - 5.57 | 1.000 |
| | | | | | | | | | | | | | |
| 2390.0000 | 41.13 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 41.34 | H | 1.56 | 14.0 | - 12.64 | NA | 1.000 |
| 2390.0000 | 45.19 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 45.40 | H | 1.56 | 14.0 | NA | - 28.60 | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: HT20 Upper Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2483.5000 | 52.10 | **Av** | 3.58 | 28.69 | 37.67 | 5.76 | 52.46 | V | 1.51 | 11.0 | - 1.52 | NA | 1.000 |
| 2483.5000 | 63.99 | **Pk** | 3.58 | 28.69 | 37.67 | 5.76 | 64.35 | V | 1.51 | 11.0 | NA | - 9.65 | 1.000 |
| | | | | | | | | | | | | | |
| 2483.5000 | 40.91 | **Av** | 3.58 | 28.69 | 37.67 | 5.76 | 41.27 | H | 1.47 | 13.0 | - 12.71 | NA | 1.000 |
| 2483.5000 | 45.49 | **Pk** | 3.58 | 28.69 | 37.67 | 5.76 | 45.85 | H | 1.47 | 13.0 | NA | - 28.15 | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: HT40 Lower Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2390.0000 | 51.51 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 51.72 | V | 1.48 | 8.0 | - 2.26 | NA | 1.000 |
| 2390.0000 | 59.63 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 59.84 | V | 1.48 | 8.0 | NA | - 14.16 | 1.000 |
| | | | | | | | | | | | | | |
| 2390.0000 | 40.31 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 40.52 | H | 1.52 | 10.0 | - 13.46 | NA | 1.000 |
| 2390.0000 | 44.63 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 44.84 | H | 1.52 | 10.0 | NA | - 29.16 | 1.000 |
| | | | | | | | | | | | | | |
| **Measurements: HT40 Upper Band Edge – FCC Restricted Band** | | | | | | | | | | | | | |
| 2390.0000 | 51.14 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 51.35 | V | 1.47 | 11.0 | - 2.63 | NA | 1.000 |
| 2390.0000 | 60.82 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 61.03 | V | 1.47 | 11.0 | NA | - 12.97 | 1.000 |
| | | | | | | | | | | | | | |
| 2390.0000 | 40.16 | **Av** | 3.50 | 28.51 | 37.57 | 5.76 | 40.37 | H | 1.56 | 9.0 | - 13.61 | NA | 1.000 |
| 2390.0000 | 44.40 | **Pk** | 3.50 | 28.51 | 37.57 | 5.76 | 44.61 | H | 1.56 | 9.0 | NA | - 29.39 | 1.000 |
| | | | | | | | | | | | | | |

Example calculation:

| Measured Level | + | Cable Loss | + | Antenna Factor | - | Pre-Amp | + | Atten | = | Final Corrected Reading | Specification Limit | - | Final Corrected Reading | = | Delta Specification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (dBμV) | | (dB) | | (dB) | | (dB) | | (dB) | | (dBμV/m) | (dBμV/m) | | (dBμV/m) | | |
| **20.0** | | **3.0** | | **5.0** | | **10.0** | | **0.0** | | **18.0** | **40.0** | | **18.0** | | **- 22.0** |

Notes:

1) The highest signals – as determined from pre-scan plots – were fully-maximized and measured.
2) The notch filter was not used during band edge plots/measurements.
3) 802.11 HT20/HT40 included in measurements as well as both SISO/MIMO modes of Tx operation.

Deviations, Additions, or Exclusions: None

## 12 Power Spectral Density – PSD

### 12.1 Method

### 12.2 Test Results:

Test not required for Class II Permissive Change.

## 13 Radiated Emissions (Digital Part of Receiver)

### 13.1 Test Results:

Test not required for Class II Permissive Change.

## 14 AC Mains Conducted Emissions - Transmitter

### 14.1 Test Results:

Test not required for Class II Permissive Change.

## 15 RF Exposure Requirement

### 15.1 Test Results:

To be supplied by the customer.

## 16 Duty Cycle/ Duty Cycle Correction Factor

### 16.1 Results:

Test not required for Class II Permissive Change.

## 17 Appendix A: Antenna Specifications

RadioWaves SEC-25V-60-17HP (60º Sector Antenna)

RADIOWAVES

# 60° 2.40 - 2.70 GHz MMDS/ISM Sector Antennas

### Features

- **Antenna dimensions:**
  - SEC-25V-60-14 25.5 x 8.5 x 7.5" (65 x 21.6 x 19 cm)
  - SEC-25H-60-14 25.5 x 8.5 x 7.5" (65 x 21.6 x 19 cm)
  - SEC-25D-60-14 41.5 x 8.5 x 7.5" (105 x 21.6 x 19 cm)
  - SEC-25V-60-17 41.5 x 8.5 x 7.5" (105 x 21.6 x 19 cm)
  - SEC-25H-60-17 41.5 x 8.5 x 7.5" (105 x 21.6 x 19 cm)
- **Flat panel design**
- **Lightweight and rugged design**
- **Low windload**
- **Easily installed**
- **RF Connector Interface:** Type "N" female
- **Polarization**
  - Plane Polarized (horizontal or vertical)
  - Dual Polarized, 14.5 dBi Model (horizontal and vertical)
- **Standard antenna mount accommodates a 2.5" to 4.5" diameter pipe**
- **Optional 15° mechanical downtilt**
- **Optional mount kit available for a 1.25" to 2.5" pipe**

### Electrical Specifications (typical performance)*

| Model Number | Frequency, GHz | Polarization | Gain dBi (nominal) | Beamwidth -3dB Az° | Beamwidth -3dB El.° | X-Pol. Rejection, dB | F/B Ratio dB | VSWR, Max (R.L., dB) |
|---|---|---|---|---|---|---|---|---|
| SEC-25V-60-14 | 2.40 - 2.70 | Vertical | 14.5 | 60 | 16 | 25 | >25 | 1.5:1 (14.0) |
| SEC-25H-60-14 | 2.40 - 2.70 | Horizontal | 14.5 | 60 | 16 | 25 | >25 | 1.5:1 (14.0) |
| SEC-25D-60-14 | 2.40 - 2.70 | Dual | 14.5 | 60 | 16 | 25 | >25 | 1.5:1 (14.0) |
| SEC-25V-60-17 | 2.40 - 2.70 | Vertical | 17.5 | 60 | 8 | 25 | >25 | 1.5:1 (14.0) |
| SEC-25H-60-17 | 2.40 - 2.70 | Horizontal | 17.5 | 60 | 8 | 25 | >25 | 1.5:1 (14.0) |
| SEC-25V-60-17HP | 2.40 - 2.70 | Vertical | 17.5 | 60 | 8 | 25 | 35 | 1.5:1 (14.0) |
| SEC-25H-60-17HP | 2.40 - 2.70 | Horizontal | 17.5 | 60 | 8 | 25 | 35 | 1.5:1 (14.0) |

* *For 2.15 - 2.70 GHz models, contact the factory.*
* *All specifications subject to change without notice.*

**Radio Waves, Inc.**
http://www.radiowavesinc.com

## 18 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

| Parameter | Uncertainty ± | Notes |
|---|---|---|
| Radiated emissions, 10kHz to 30 MHz | 3.4 dB | |
| Radiated emissions, 30 to 200 MHz HP | 2.2 dB | |
| Radiated emissions, 30 to 200 MHz VP | 3.8 dB | |
| Radiated emissions, 200 to 1000 MHz HP | 2.8 dB | |
| Radiated emissions, 200 to 1000 MHz VP | 2.7 dB | |
| Radiated emissions, 1 to 18 GHz | 5.2 dB | |
| Conducted port emissions 10kHz to 1000 MHz | 1.0 dB | |
| Conducted port emissions 1 – 26.5 GHz | 1.6 dB | |
| AC mains Conducted emissions, 9kHz to 30 MHz | 3.14 dB | |

## 19 Revision History

| Revision Level | Date | Report Number | Notes |
|---|---|---|---|
| 0 | 2/24/2014 | 101503629DEN-001C | Original Issue |
| | | | |
| | | | |
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