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W66 N220 Commerce Court ● Cedarburg, WI 53012 USA ● Phone: 262.375.4400 ● Fax: 262.375.4248 ● www.lsr.com

# ENGINEERING TEST REPORT # TR 314413 A
## LSR Job #: C-2114

Compliance Testing of:
TiWi-C-W

Test Date(s):
December 2, 4 2014, January 6, 20, 21, 30, February 3, 4, 16, 17, and March 16-25 2015

Prepared For:
LSR
Attn: Josh Bablitch
W66N220 Commerce Ct
Cedarburg, WI 53012

**This Test Report is issued under the Authority of:** Adam Alger, EMC Engineer

Signature: Date: 4-22-15

| **Test Report Reviewed by:** | **Report by:** |
|---|---|
| Michael Hintzke EMC Engineer | Adam Alger, EMC Engineer |
| Signature: Date: 2/21/15 | Signature: Date: 2-18-15 |

## Table of Contents

## LS Research, LLC in Review

*As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:*


*A2LA – American Association for Laboratory Accreditation*

*Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation*
*A2LA Certificate Number: 1255.01*

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*Federal Communications Commission (FCC) – USA*

*Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948*
*FCC Registration Number: 90756*

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Industrie Canada Industry Canada

Canada

*Industry Canada*

*On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1*
*File Number: IC 3088-A*
*On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1*
*File Number: IC 3088*

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*U. S. Conformity Assessment Body (CAB) Validation*

*Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility –Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).*
*Date of Validation: January 16, 2001*

*Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.*
*Date of Validation: November 20, 2002*
*Notified Body Identification Number: 1243*

## 1.0 Summary of Test Report

In December 2014 to March 2015 the EUT, TiWi-C-W, as provided by LSR was tested and MEETS the following requirements:

| FCC and IC Paragraph | Test Requirements | Compliance (Yes/No) |
|---|---|---|
| FCC:15.247 (a)(2)<br>IC: RSS 210 A8.2 (a) | 6 dB Bandwidth of a Digital Modulation System | Yes |
| FCC : 15.247(b) & 1.1310<br>IC : RSS 210 A8.4 | Maximum Output Power | Yes |
| FCC:15.247 (d)<br>IC: RSS 210 A8.2 (b) | Power Spectral Density of a Digital Modulation System | Yes |
| FCC :15.247(d)<br>IC : RSS 210 A8.5 | RF Conducted Spurious Emissions at the Transmitter Antenna Terminal | Yes |
| FCC : 15.247(c), 15.209 & 15.205<br>IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7 | Transmitter Radiated Emissions | Yes |
| FCC : 15.109<br>IC : RSS GEN | Receive Mode (Digital Device) Radiated Emissions | Yes |
| FCC : 2.1055 (d) | Frequency Stability | Yes |
| FCC : 15.207<br>IC : RSS GEN sect. 7.2.2 | Power Line Conducted Emissions Measurements | Yes |

## 2.0 Test Facilities

All testing was performed at:

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.
LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

## 3.0 Client Information

| | |
|---|---|
| **Manufacturer Name:** | LSR |
| **Address:** | W66N220 Commerce Ct Cedarburg, WI 53012 |
| **Contact Person:** | Josh Bablitch |

## 3.1 Equipment Under Test (EUT) Information

*The following information has been supplied by the applicant.*

| | |
|---|---|
| **Product Name:** | TiWi-C-W |
| **Model Number:** | TiWi-C-W |
| **Serial Number:** | **4-layer**<br>Chip Antenna (20E1F0018); U.FL (20E2D0037)<br><br>**2-layer**<br>Chip Antenna (20E2D0073); U.FL (20E280006) |
| **FCC ID** | TFB-1001 |
| **IC Number** | 5969A-1001 |

## 3.2 Product Information

The TiWi-C-W Module is a radio module that implements an 802.11 b/g/n WLAN (Wireless Local Area Network) transceiver in the 2.4 GHz band and multiple antenna options.

Chip Antenna:

Johanson Part # 2450AT18A100 (Peak Gain 0.5 dBi)

U.FL Antenna port utilizes the following antenna options:

LSR 2.4 GHz Dipole Antenna (Gain +2 dBi)
LSR 2.4 GHz FlexPIFA 2 dBi Antenna w/U.FL Cable

## 3.3 Modifications Incorporated In the EUT for Compliance Purposes

None noted at time of test

## 3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

## 3.5 Additional Information

1. Programmed for continuous transmit or receive on low (2412 MHz), middle (2437 MHz), and high channel (2462 MHz) using programming board (DLP-TXRX-0 V2.3) and USB cable connected to laptop with TiWi-C-W RF Eval Tool Version 1.2.0.0
Continuous transmit modulated mode at all WLAN modes / data rates is available via test tool as well as selecting antenna 1 or antenna 2.

2. Worst case modes determined and reported; 1 Mbps (802.11b), 6 Mbps (802.11g), and MCS0 (802.11n).

3. FCC KDB 558074 Section 12 conducted and radiated with impedance matching utilized for emissions in restricted bands for U.FL Antenna port option.

## 4.0 Conditions of Test

Environmental:

| | |
|---|---|
| Temperature: | 20-25º C |
| Relative Humidity: | 30-60% |
| Atmospheric Pressure: | 86-106 kPa |

Mains Voltage: 120VAC 60Hz
DC Supply to EUT: 3.3 VDC (nominal) 3.13-3.46 VDC range

## 5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

| Frequency Range | Resolution Bandwidth |
|---|---|
| 9 kHz – 150 kHz | 200 Hz |
| 150 kHz – 30 MHz | 9 kHz |
| 30 MHz – 1000 MHz | 120 kHz |
| Above 1000 MHz | 1 MHz |

## 6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, 15.109, Industry Canada RSS-210, Issue 8 (2010), Annex 8, RSS-GEN Issue 4 (2014).

If some emissions are seen to be within 3 dB of their respective limits:
As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

# Appendix A – Test Equipment

LS RESEARCH LLC
Wireless Product Development
**Equipment Calibration**

Date : 12-Dec-2014 Type Test : Emissions Job # : C-2114

Prepared By: Adam Alger Customer : LSR Quote #: 314413

| No. | Asset # | Description | Manufacturer | Model # | Serial # | Cal Date | Cal Due Date | Equipment Status |
|---|---|---|---|---|---|---|---|---|
| 1 | EE 960085 | N9038A MXE 26.5GHz Receiver | Agilent | N9038A | MY51210148 | 8/9/2014 | 8/9/2015 | Active Calibration |
| 2 | EE 960087 | 44GHz EXA Spectrum Analyzer | Agilent | N9010A | MY53400296 | 12/11/2014 | 12/11/2015 | Active Calibration |
| 3 | EE 960088 | 8GHz MXE Spectrum Analyzer | Agilent | N9038A | MY51210138 | 1/9/2015 | 1/9/2016 | Active Calibration |
| 4 | EE 960073 | Spectrum Analyzer | Agilent | E4446A | US45300564 | 10/19/2014 | 10/19/2015 | Active Calibration |
| 5 | AA 960158 | Double Ridge Horn Antenna | ETS Lindgren | 3117 | 109300 | 6/20/2014 | 6/20/2015 | Active Calibration |
| 6 | EE 960159 | 0.8 - 21GHz LNA | Mini-Circuits | ZVA-213X-S+ | 740411007 | 6/20/2014 | 6/20/2015 | Active Calibration |
| 7 | AA 960153 | 2.4GHz High Pass Filter | KWM | HPF-L-14186 | 7272-04 | 4/7/2014 | 4/7/2015 | Active Calibration |
| 8 | AA 960007 | Double Ridge Horn Antenna | EMCO | 3115 | 9311-4138 | 7/28/2014 | 7/28/2015 | Active Calibration |
| 9 | AA 960005 | Biconical Antenna | EMCO | 93110B | 9601-2280 | 8/7/2014 | 8/7/2015 | Active Calibration |
| 10 | AA 960004 | Log Periodic Antenna | EMCO | 93146 | 9512-4276 | 8/22/2014 | 8/22/2015 | Active Calibration |
| 11 | EE 960146 | Std. Gain Horn Ant. w/preamp | Adv. Micro / EMC | WLA622-4 / 3160-09 | 123001 | 8/20/2014 | 8/20/2015 | Active Calibration |
| 12 | EE 960084 | LISN - 15A | COM-POWER | LI-215A | 191920 | 5/2/2014 | 5/2/2015 | Active Calibration |

Project Engineer: Quality Assurance:

## Appendix B – Test Data
### B.1 – RF Conducted Emissions

| | |
|---|---|
| Manufacturer | LSR |
| Test Location | LS Research, LLC |
| Rule Part | FCC Part 15.247 / RSS-210 Annex 8 |
| General Measurement Procedure | FCC KDB 558074 D01 DTS Meas Guidance v03r02<br>ANSI C63.10-2009 Section 6.7 |
| General Description of Measurement | A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. |

## B.1.1 – RF Conducted – Fundamental Bandwidth

| | |
|---|---|
| Manufacturer | LSR |
| Date | 2-16, 2-17, 3-16, 3-19, 3-20 2015 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | FCC Part 15.247 / RSS-210 A8 |
| Specific Measurement Procedure | FCC KDB 558074 Section 8.0 DTS bandwidth<br>ANSI C63.10-2009 Section 6.9<br>RSS-GEN Section 6.6 |
| Additional Description of Measurement | Peak detector used |
| Additional Notes | 1. Continuous transmit modulated used for this test.<br>2. 4-layer DTS BW. 4-layer and 2-layer 99% BW/OBW (need for power measurements) |

**TABLE**

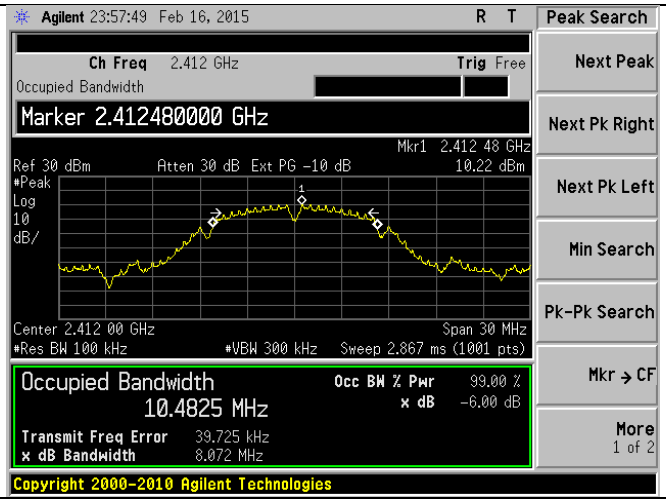
**4-layer board – Antenna 1**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) |
|---|---|---|---|---|---|
| b | 1 | 2412 | 8.072 | 10.696 | 12.856 |
| | | 2437 | 7.603 | 10.884 | 13.109 |
| | | 2462 | 8.085 | 10.740 | 12.861 |
| g | 6 | 2412 | 16.360 | 17.076 | 20.284 |
| | | 2437 | 16.366 | 17.079 | 20.473 |
| | | 2462 | 16.383 | 17.144 | 20.446 |
| n | MCS 0 | 2412 | 17.618 | 18.112 | 20.935 |
| | | 2437 | 17.625 | 18.025 | 20.693 |
| | | 2462 | 17.619 | 18.118 | 20.638 |

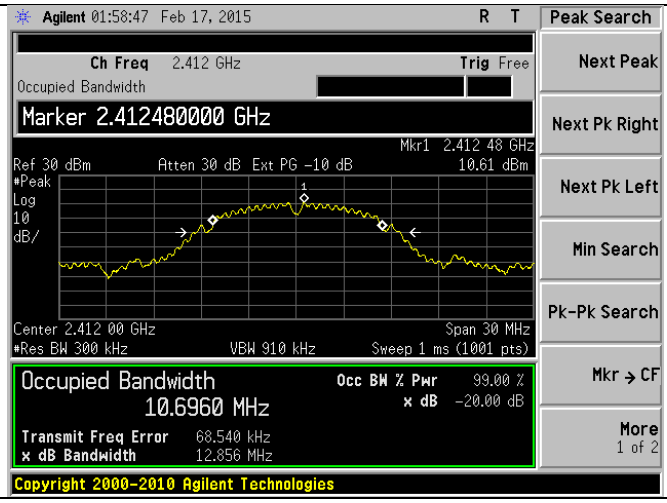
**4-layer board – Antenna 2**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) |
|---|---|---|---|---|---|
| b | 1 | 2412 | 8.047 | 10.719 | 12.865 |
| | | 2437 | 8.050 | 10.948 | 13.142 |
| | | 2462 | 8.081 | 10.766 | 12.902 |
| g | 6 | 2412 | 16.411 | 17.199 | 20.526 |
| | | 2437 | 16.391 | 17.171 | 20.541 |
| | | 2462 | 16.381 | 17.183 | 20.533 |
| n | MCS 0 | 2412 | 17.624 | 18.193 | 20.984 |
| | | 2437 | 17.615 | 18.157 | 20.927 |
| | | 2462 | 17.625 | 18.133 | 21.014 |

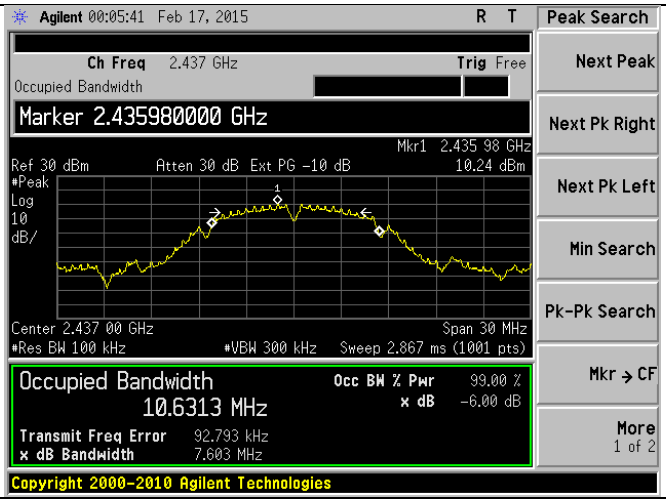
**PLOTS (4-layer board – Antenna 1)**
**802.11b**



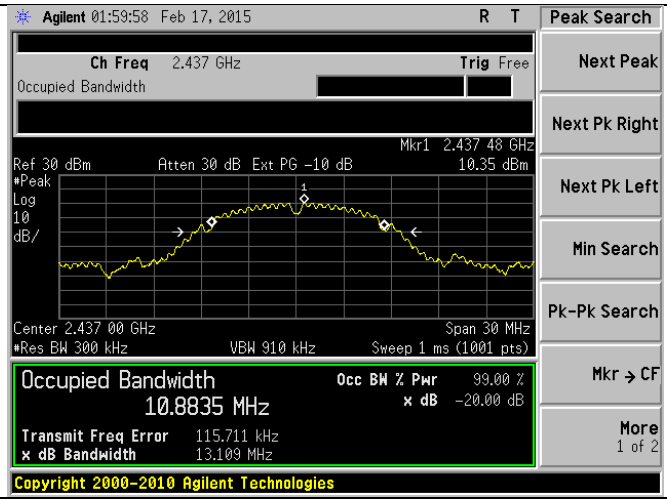

Low Channel - 6 dB DTS BW



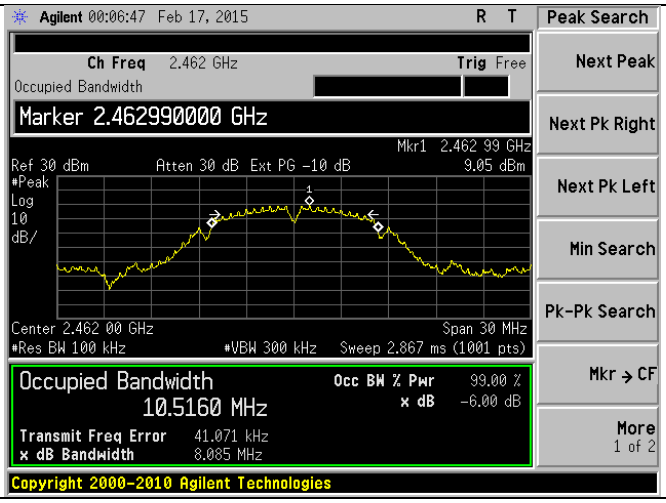

Low Channel - OBW / 99 %



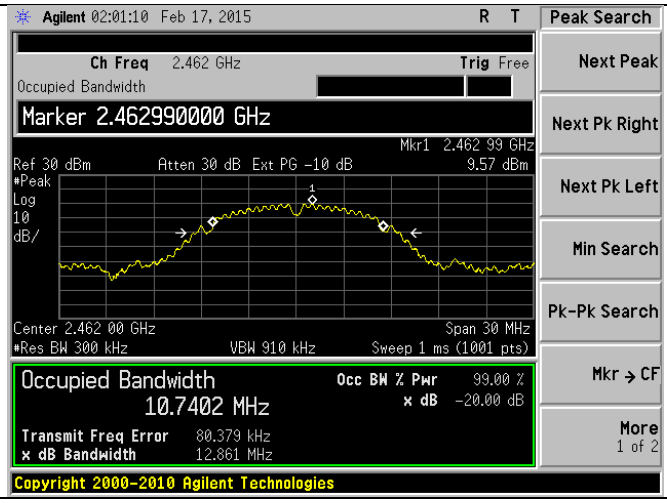

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

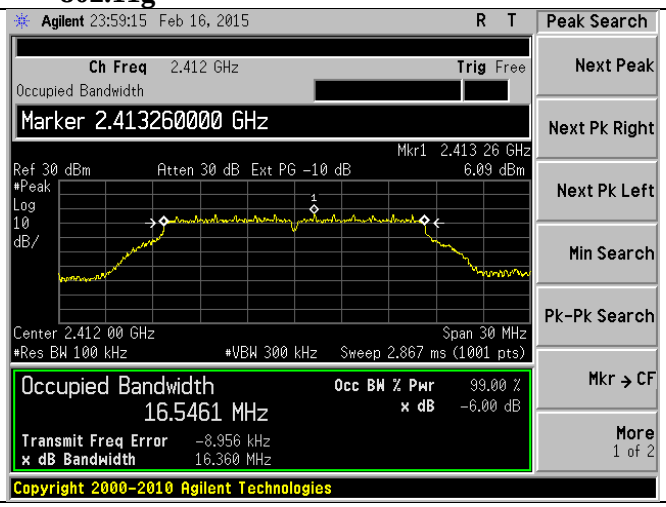



High Channel - 6 dB DTS BW

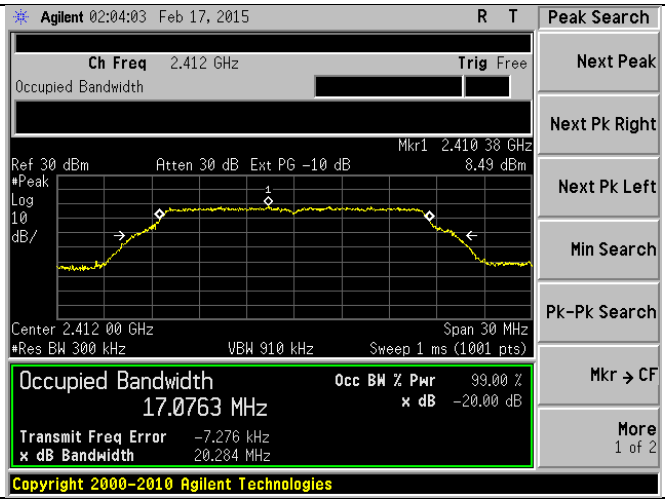



High Channel - OBW / 99 %

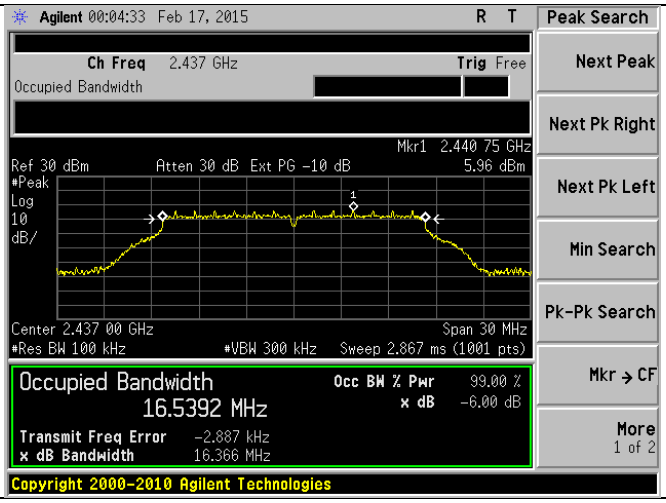
**802.11g**



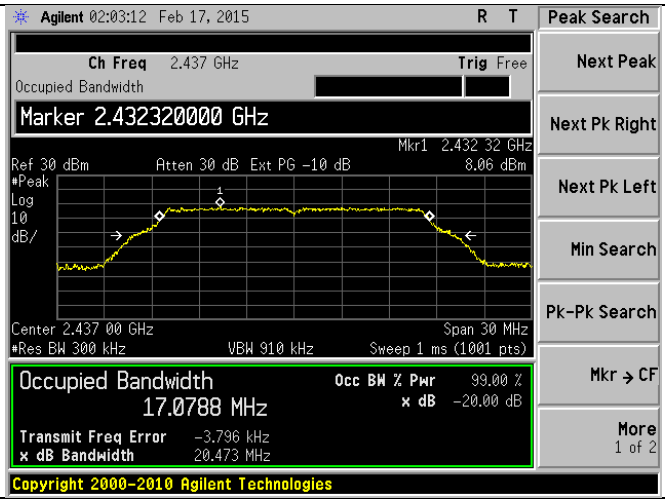

Low Channel - 6 dB DTS BW



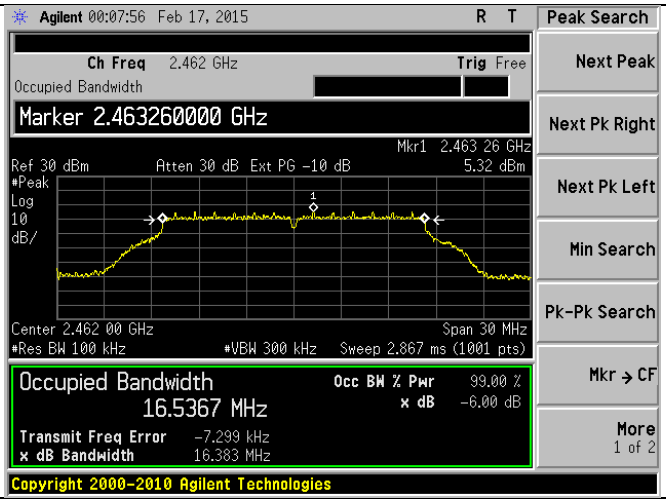

Low Channel - OBW / 99 %



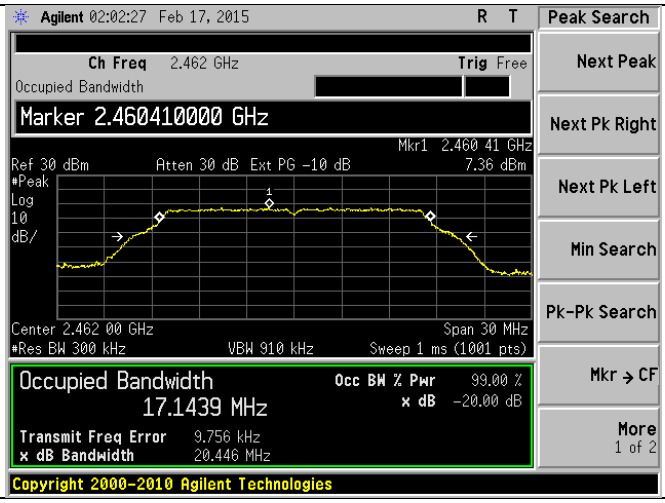

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

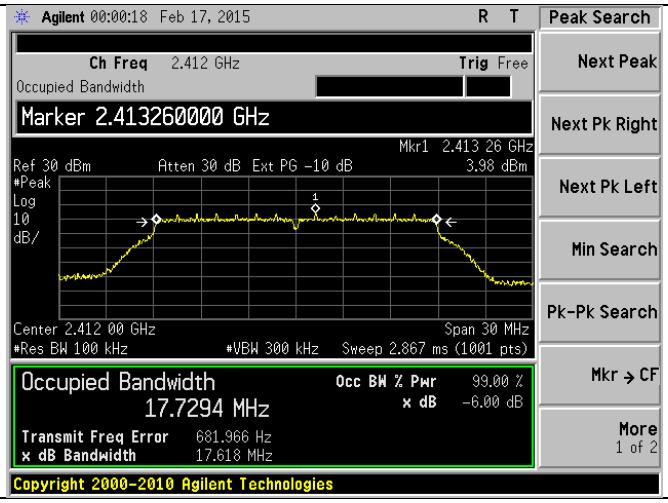



High Channel - 6 dB DTS BW

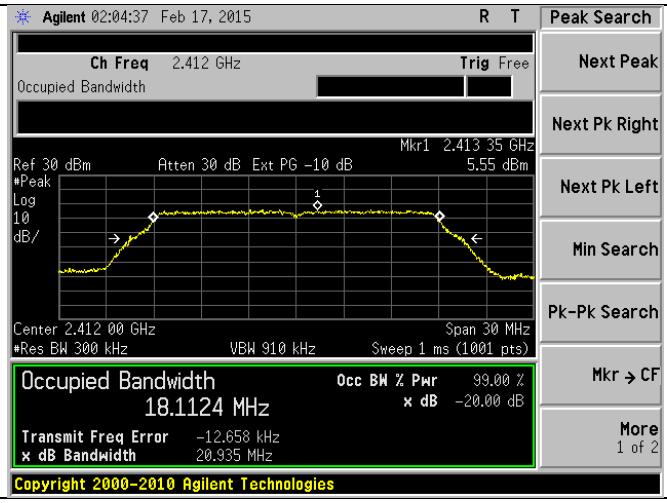



High Channel - OBW / 99 %

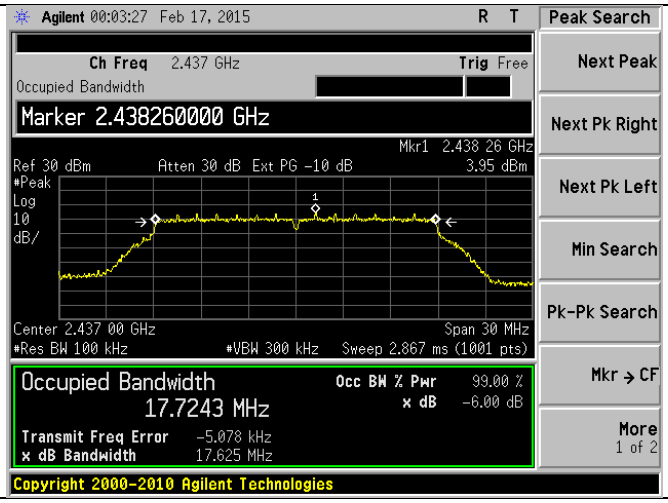
**802.11n**



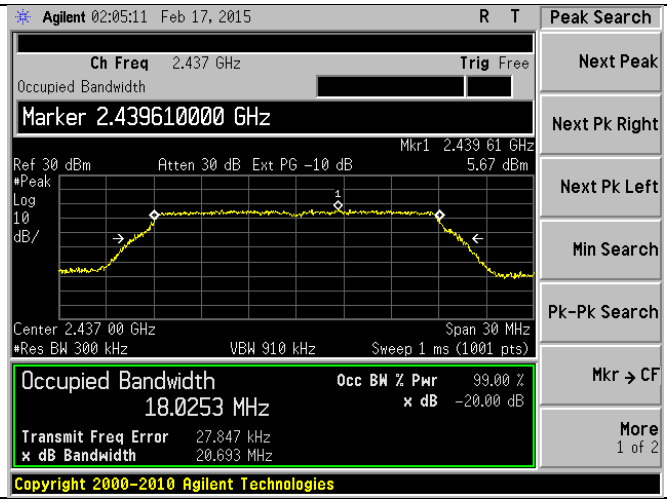

Low Channel - 6 dB DTS BW



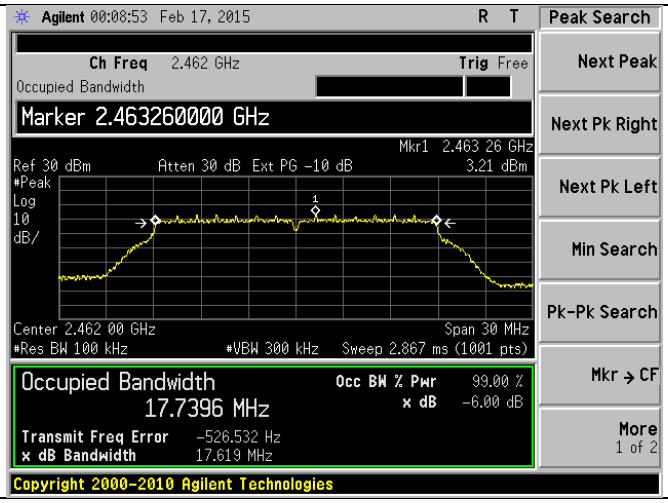

Low Channel - OBW / 99 %



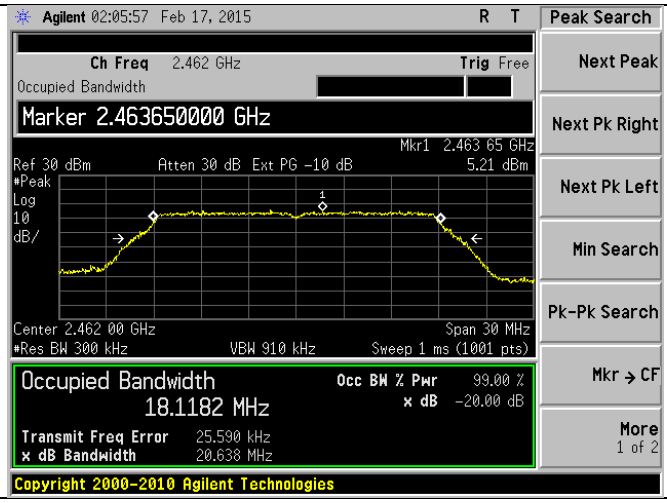

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

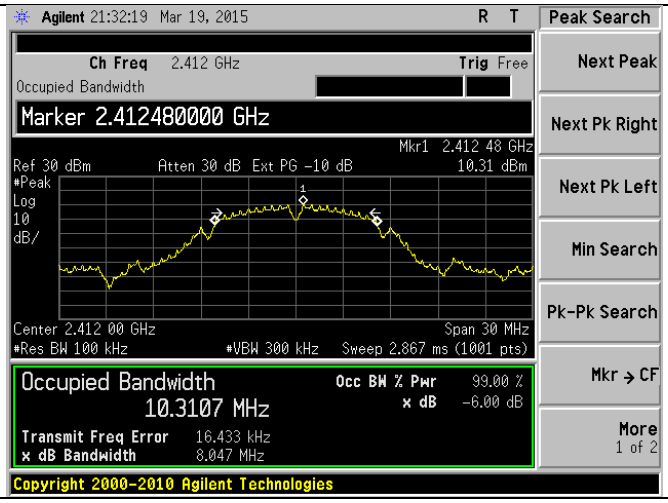



High Channel - 6 dB DTS BW

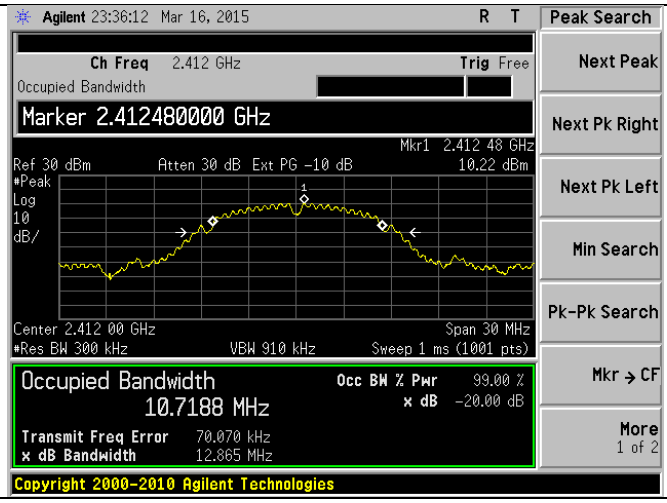



High Channel - OBW / 99 %

**PLOTS (4-layer board – Antenna 2)**
**802.11b**




Low Channel - 6 dB DTS BW

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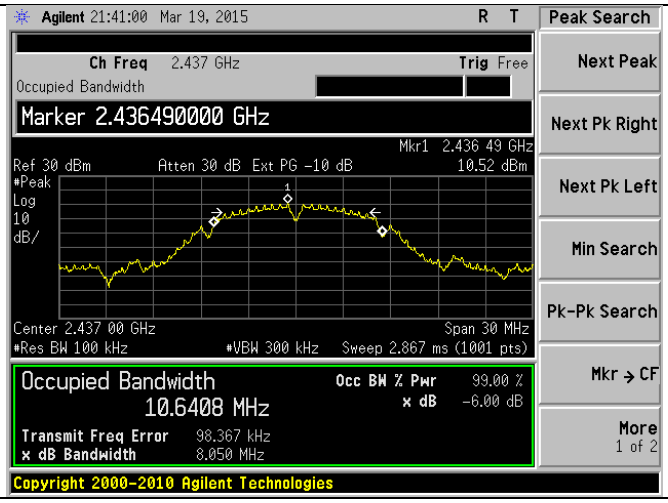


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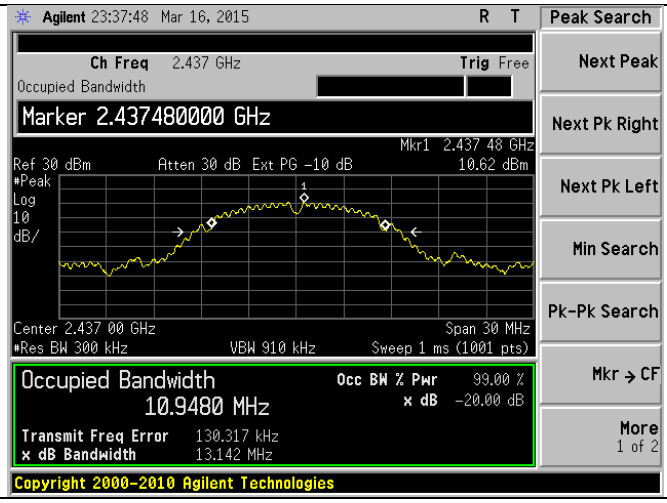


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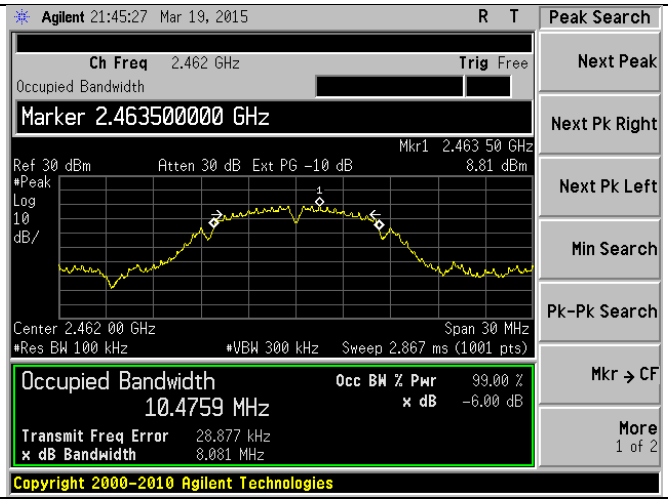


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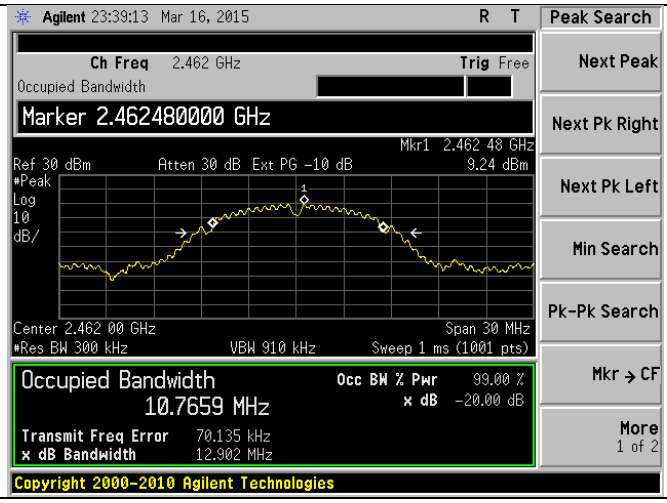
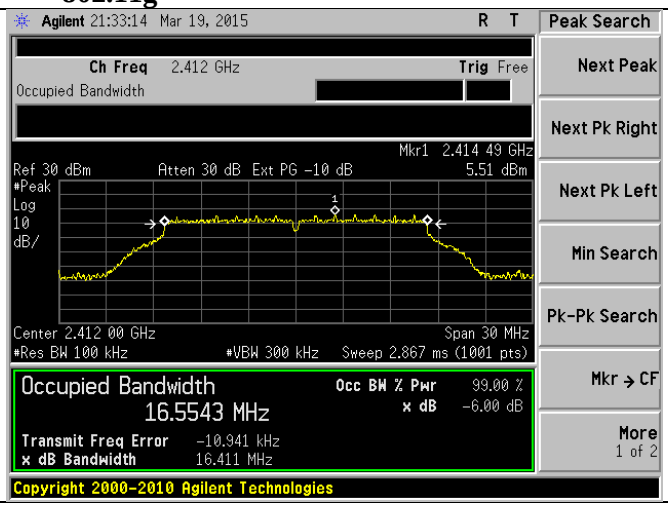



High Channel - OBW / 99 %

**802.11g**

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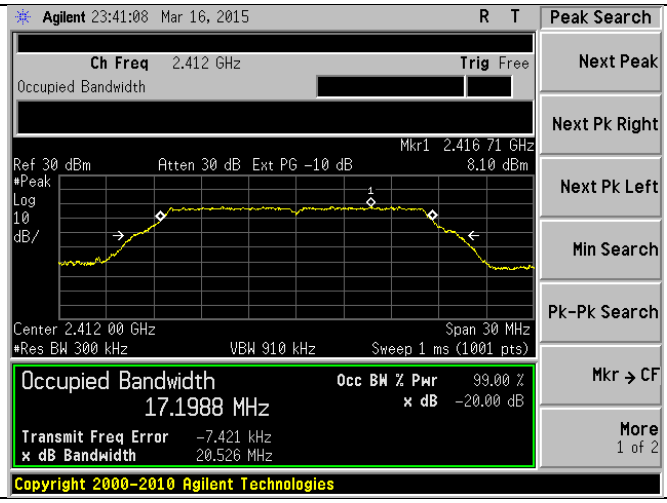
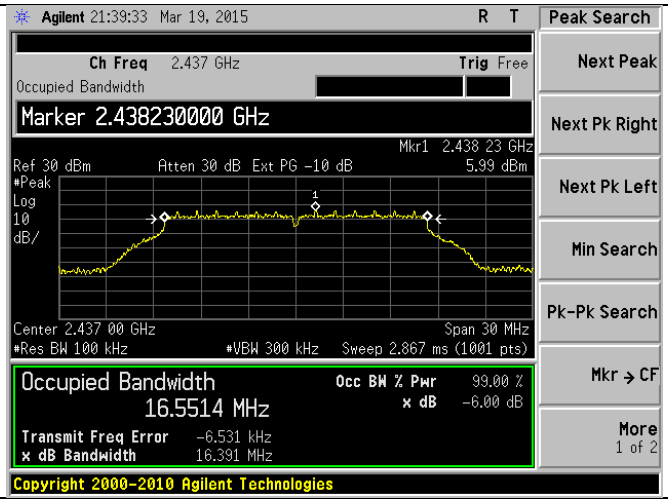



Low Channel - OBW / 99 %

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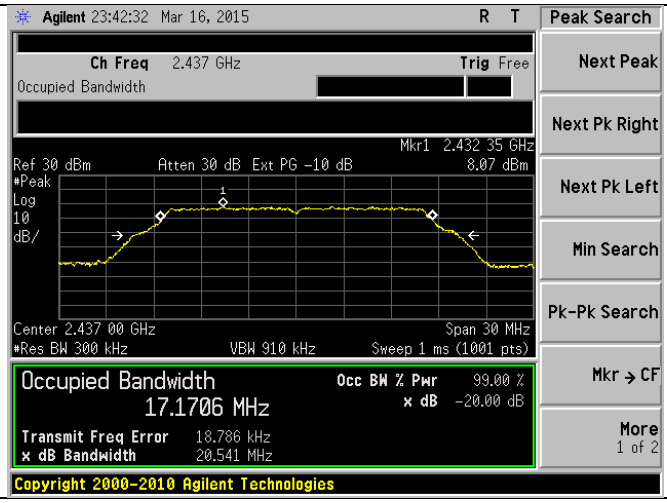
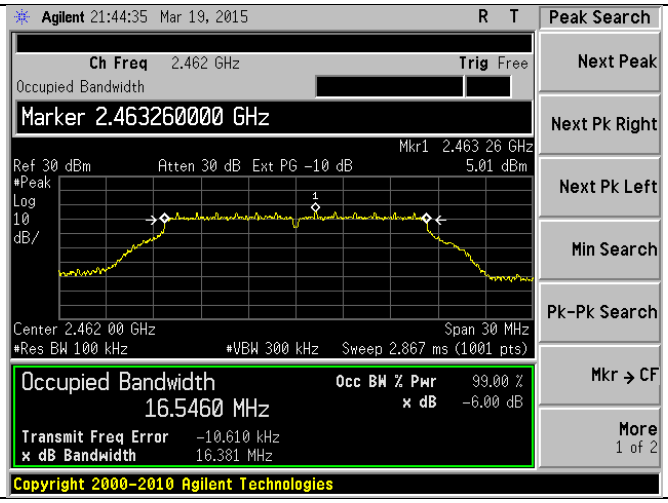
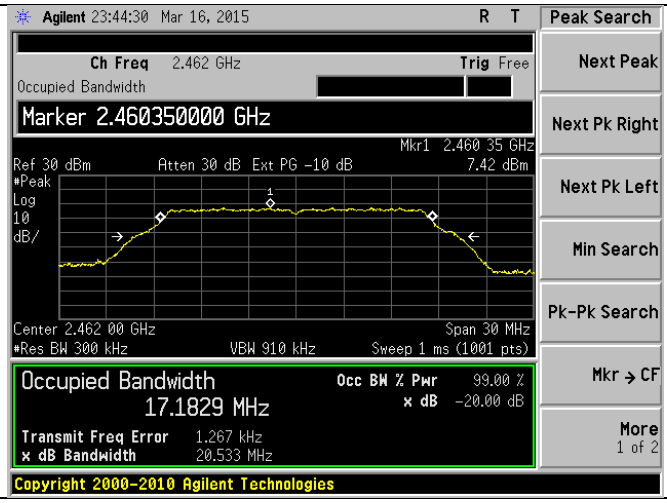



Mid Channel - OBW / 99 %

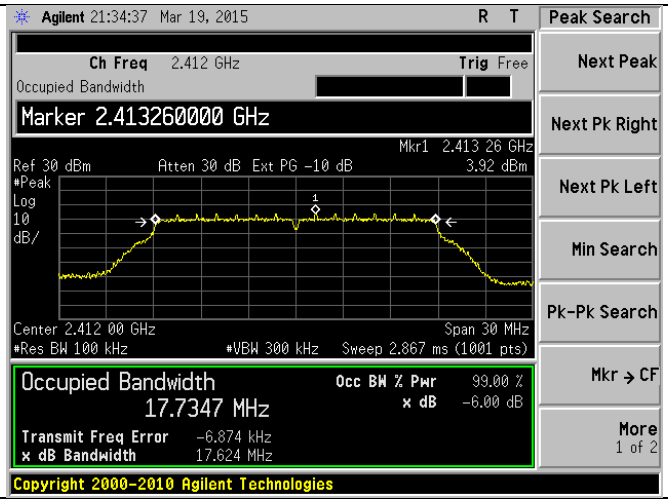



High Channel - 6 dB DTS BW

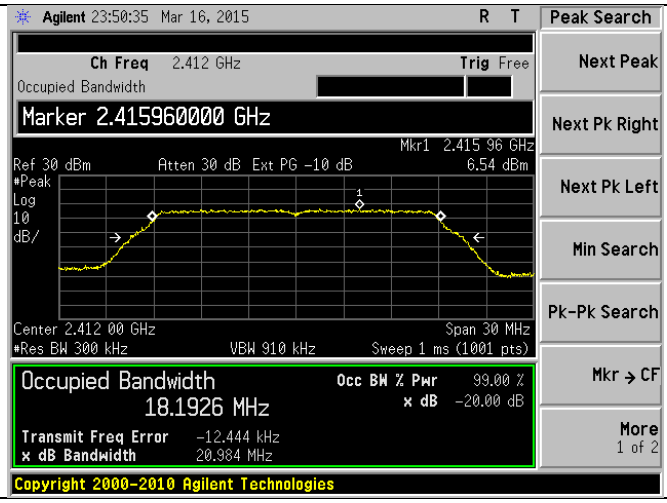



High Channel - OBW / 99 %

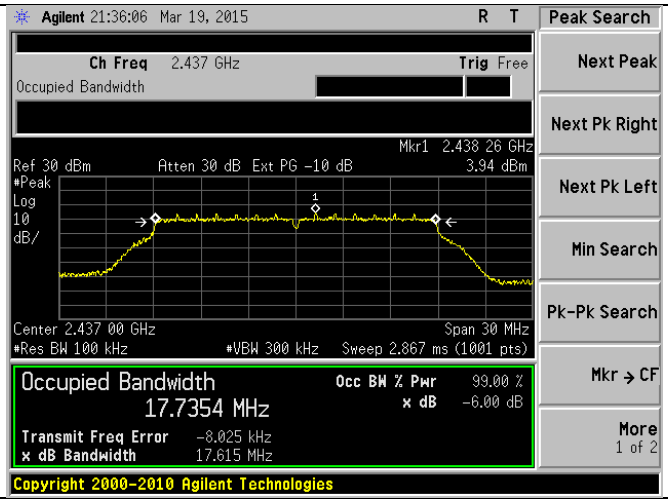
**802.11n**



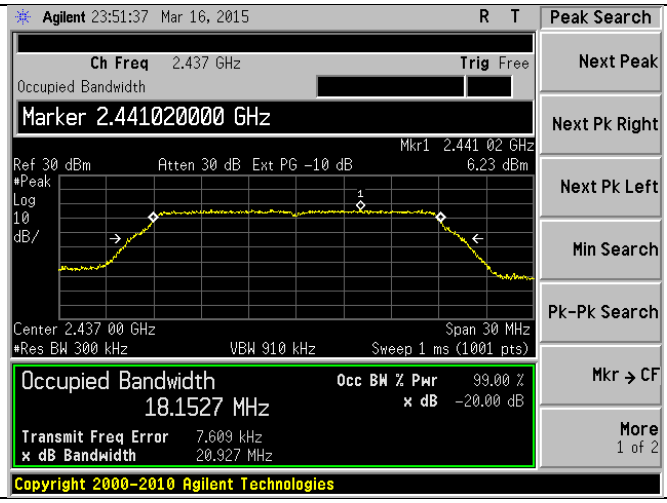

Low Channel - 6 dB DTS BW



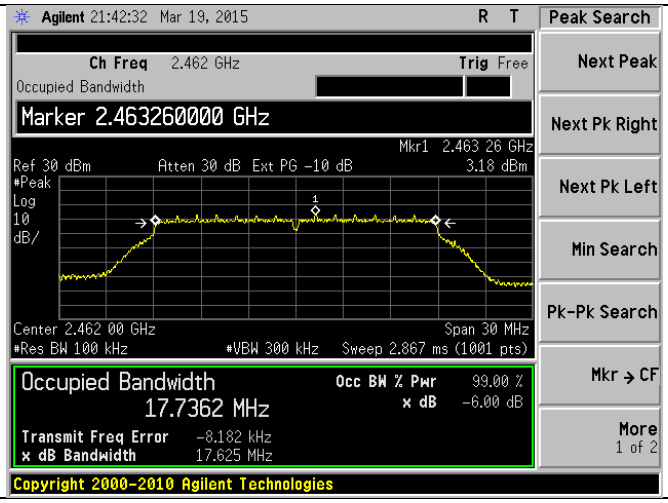

Low Channel - OBW / 99 %



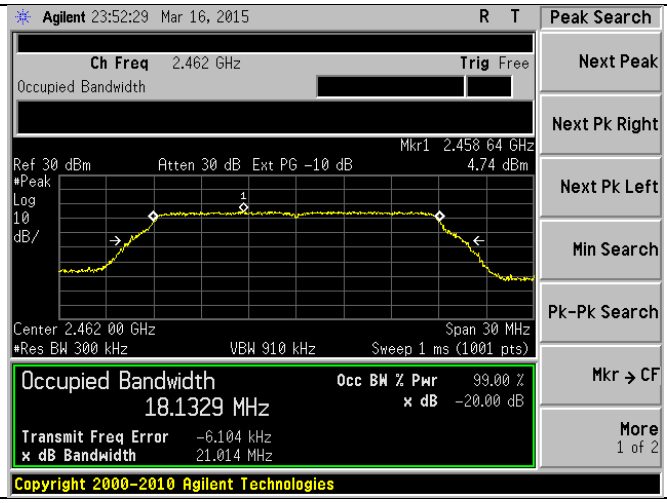

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %




High Channel - 6 dB DTS BW




High Channel - OBW / 99 %

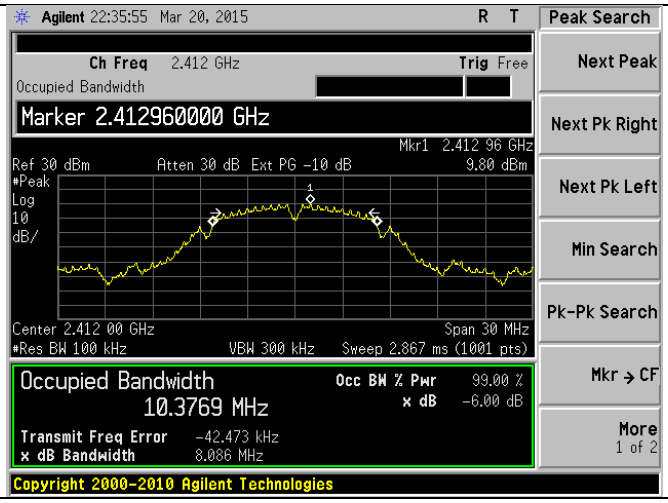
**Table**
**2-layer board – Antenna 1**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) |
|---|---|---|---|---|---|
| b | 1 | 2412 | 8.086 | 10.491 | 12.544 |
| | | 2437 | 8.089 | 10.629 | 12.848 |
| | | 2462 | 8.082 | 10.670 | 13.057 |
| g | 6 | 2412 | 16.391 | 17.043 | 20.244 |
| | | 2437 | 16.397 | 17.147 | 20.474 |
| | | 2462 | 16.396 | 17.116 | 20.066 |
| n | MCS 0 | 2412 | 17.631 | 18.090 | 20.608 |
| | | 2437 | 17.636 | 18.107 | 20.886 |
| | | 2462 | 17.615 | 18.146 | 20.902 |

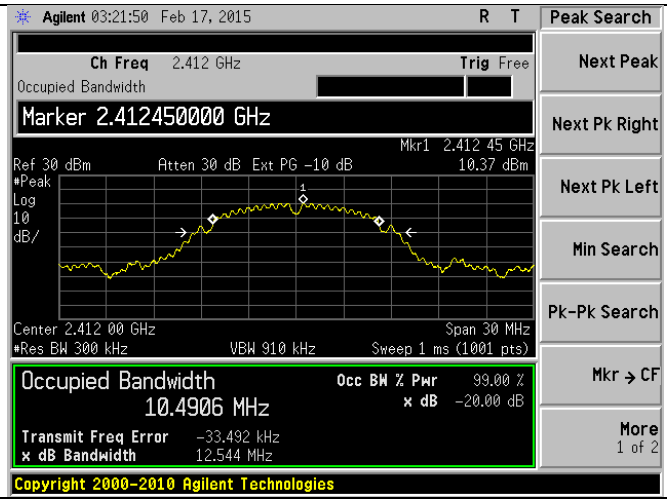
**2-layer board – Antenna 2**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) |
|---|---|---|---|---|---|
| b | 1 | 2412 | 8.078 | 10.658 | 12.857 |
| | | 2437 | 8.083 | 10.684 | 12.873 |
| | | 2462 | 8.091 | 10.677 | 12.877 |
| g | 6 | 2412 | 16.397 | 17.120 | 20.460 |
| | | 2437 | 16.374 | 17.166 | 20.329 |
| | | 2462 | 16.400 | 17.172 | 20.434 |
| n | MCS 0 | 2412 | 17.621 | 18.138 | 20.952 |
| | | 2437 | 17.631 | 18.148 | 20.825 |
| | | 2462 | 17.627 | 18.161 | 20.969 |

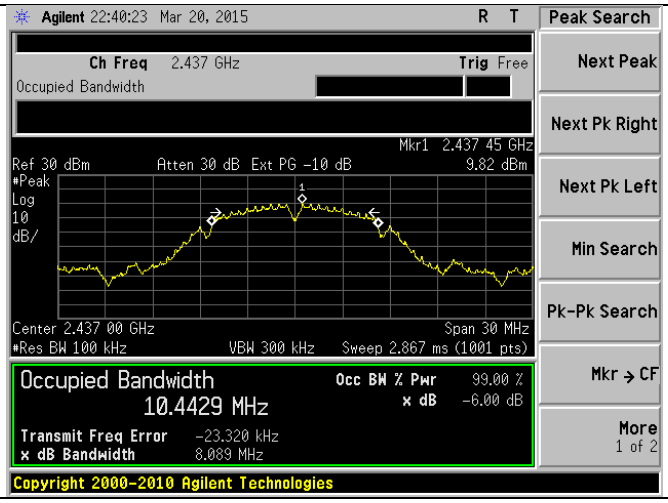
**PLOTS (2-layer board – Antenna 1)**
**802.11b**



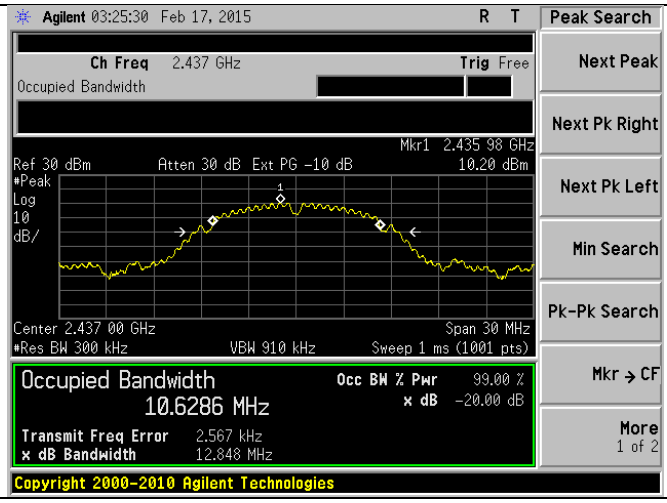

Low Channel - 6 dB DTS BW



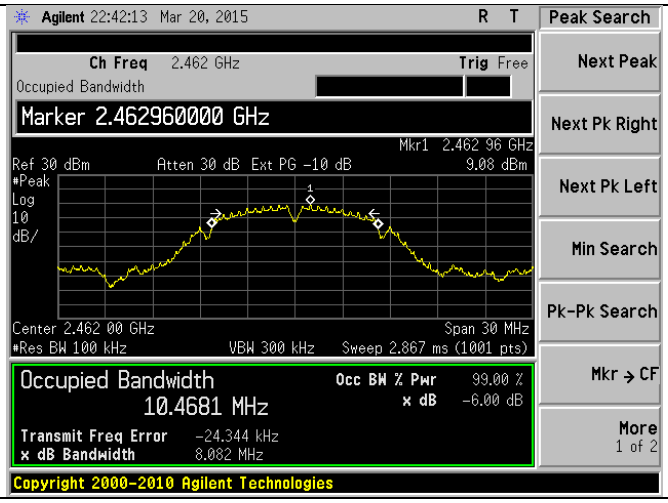

Low Channel - OBW / 99 %



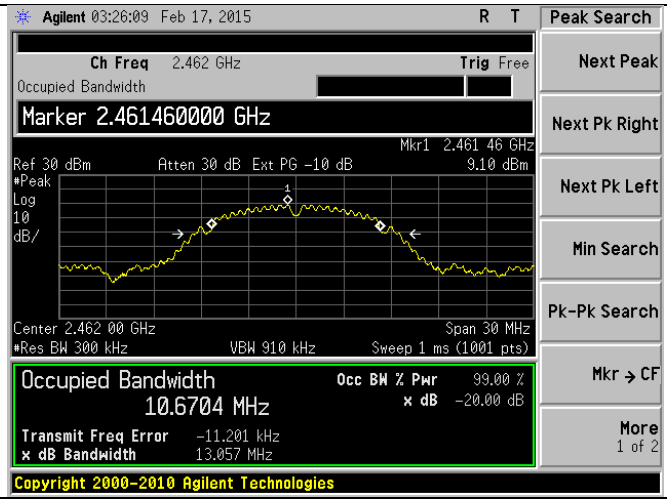

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

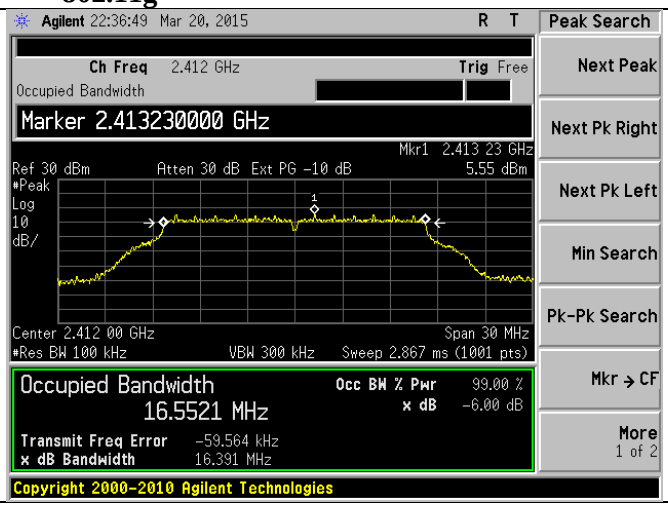



High Channel - 6 dB DTS BW

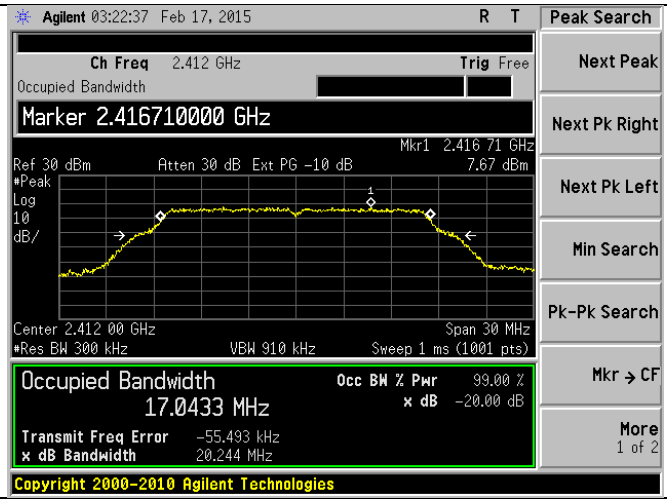



High Channel - OBW / 99 %

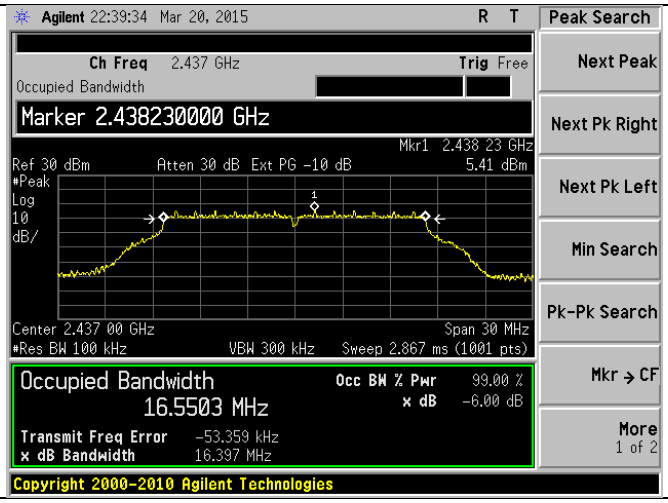
**802.11g**



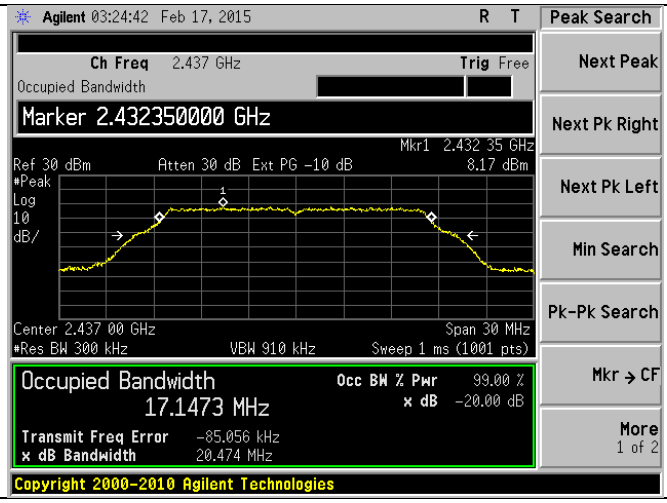

Low Channel - 6 dB DTS BW



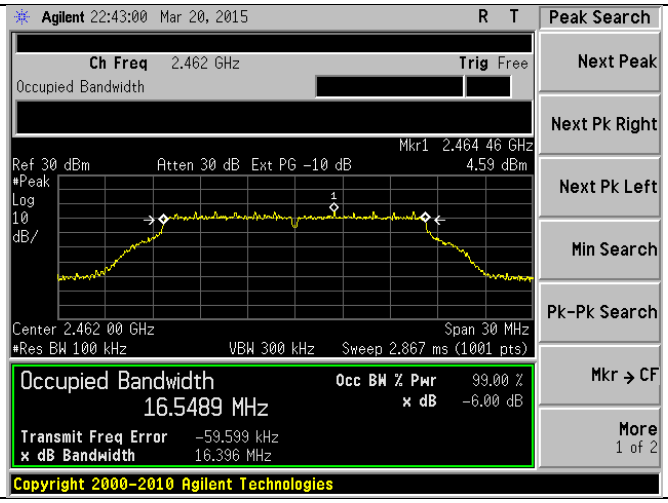

Low Channel - OBW / 99 %



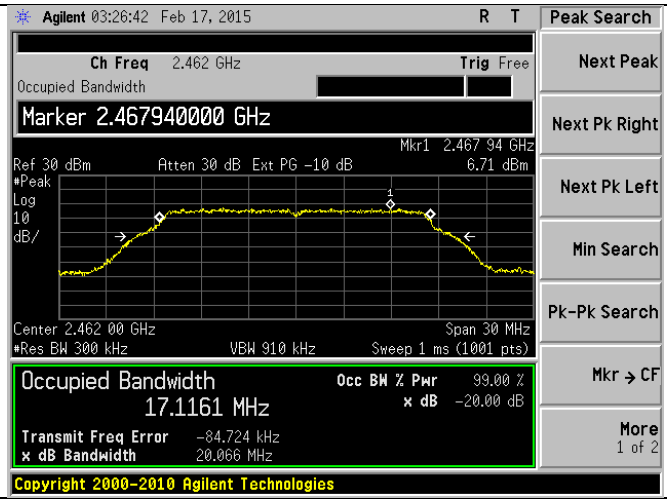

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

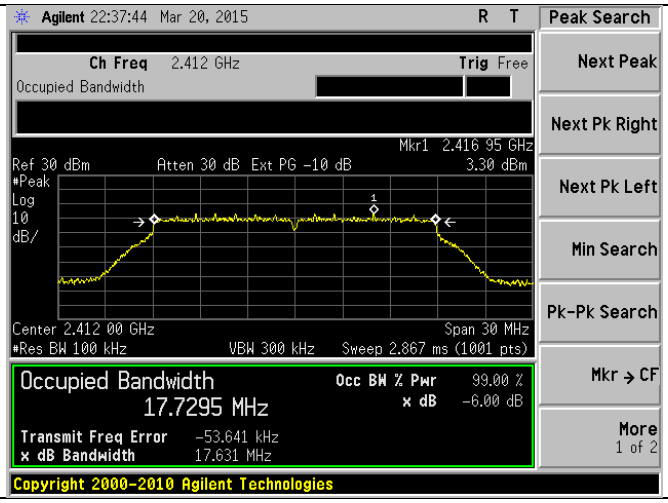



High Channel - 6 dB DTS BW

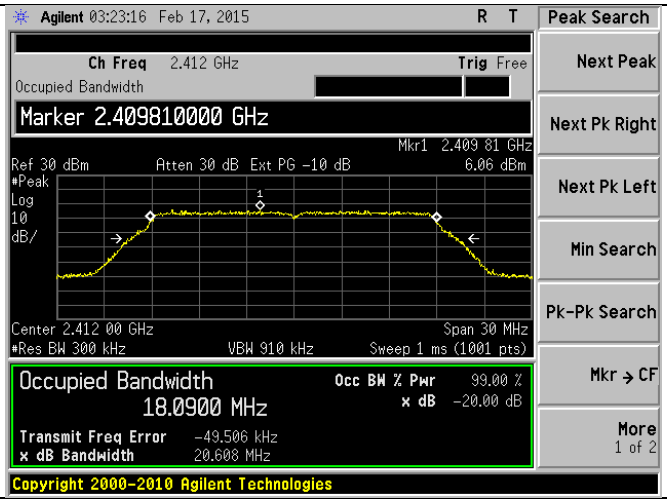



High Channel - OBW / 99 %

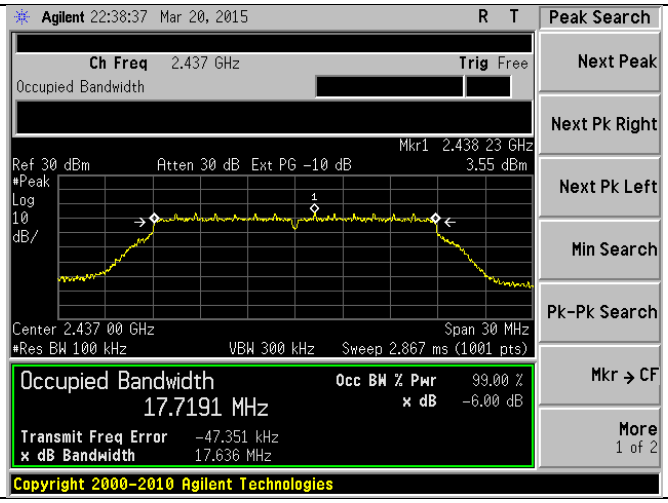
**802.11n**



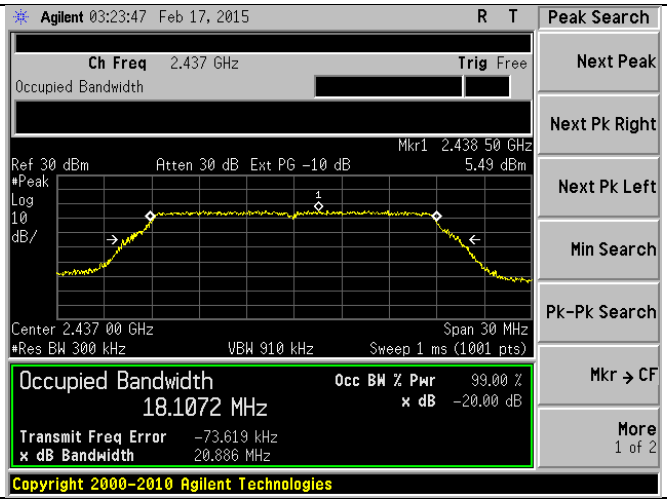

Low Channel - 6 dB DTS BW



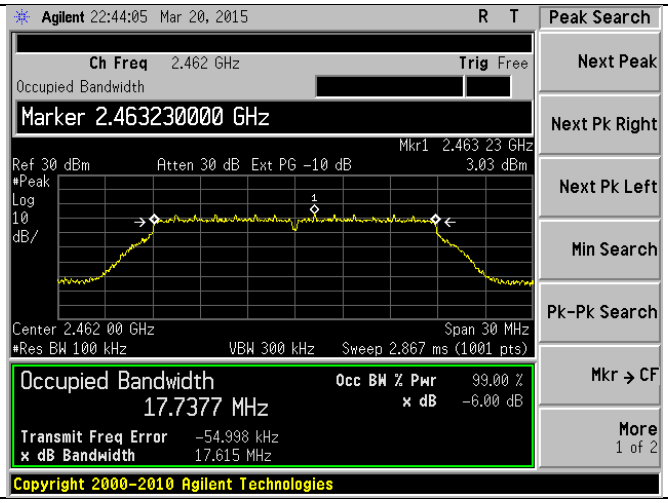

Low Channel - OBW / 99 %



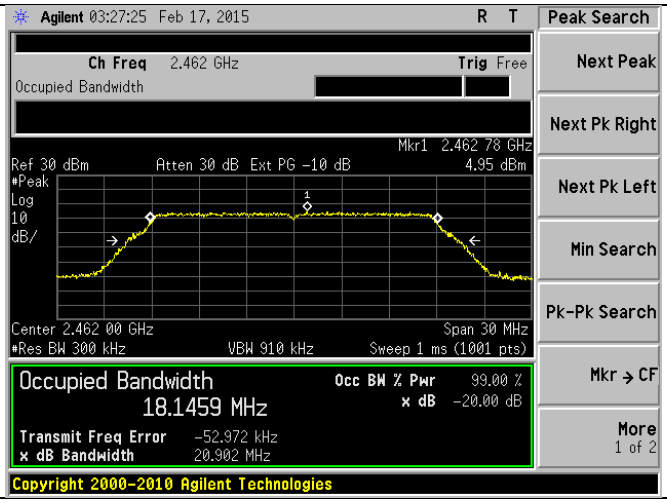

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

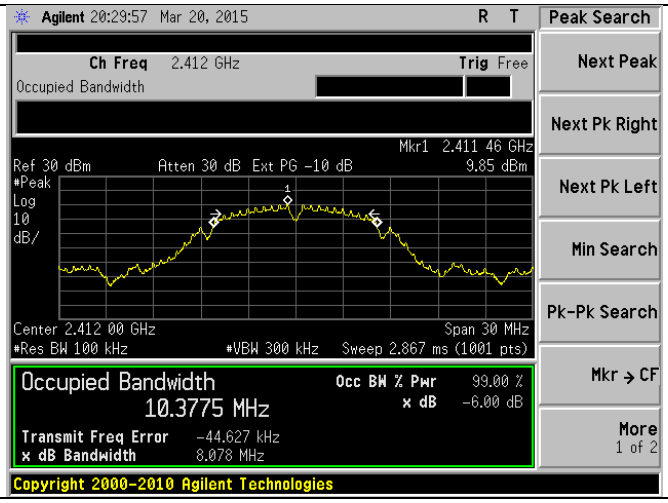



High Channel - 6 dB DTS BW

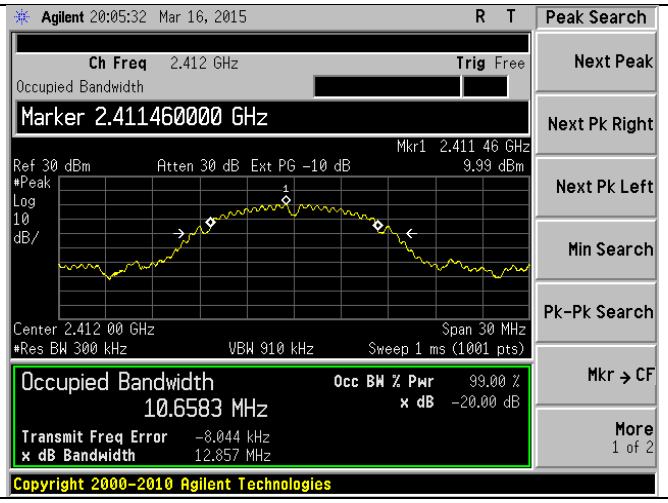



High Channel - OBW / 99 %

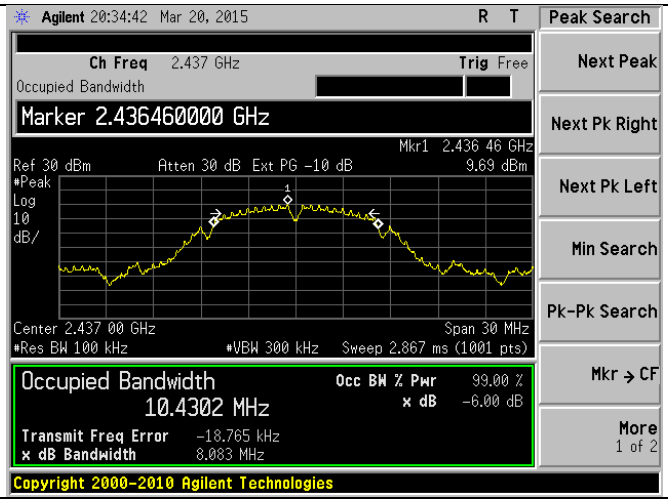
**PLOTS (2-layer board – Antenna 2)**
**802.11b**



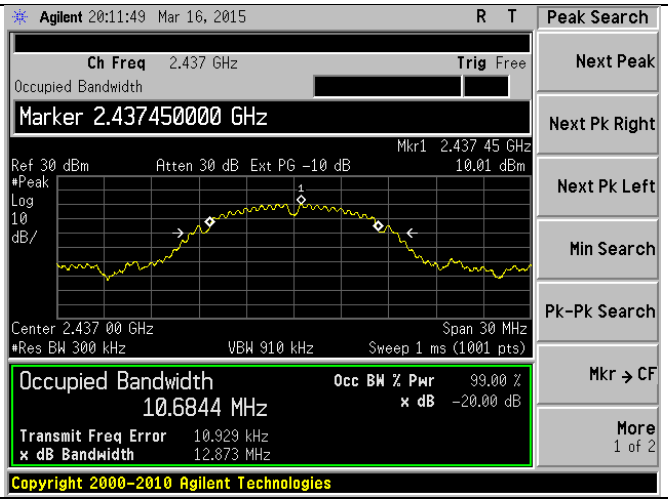

Low Channel - 6 dB DTS BW



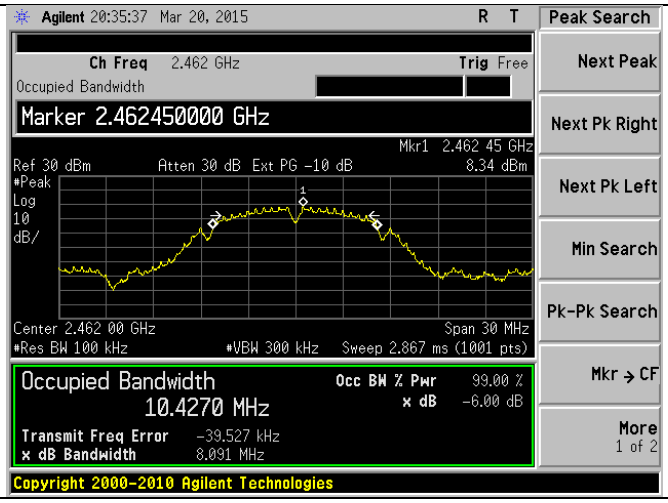

Low Channel - OBW / 99 %



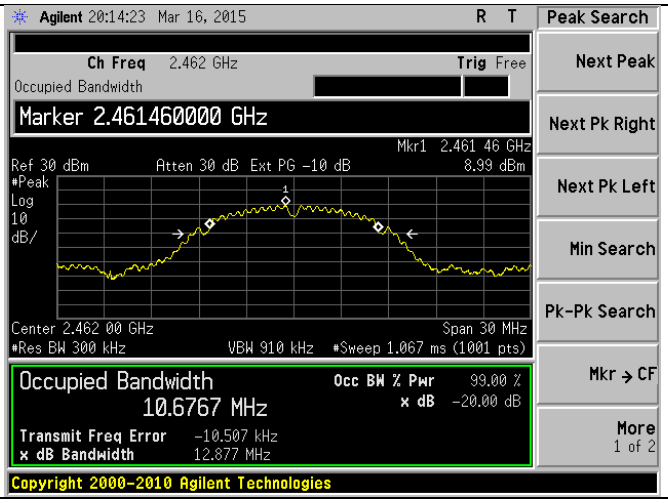

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

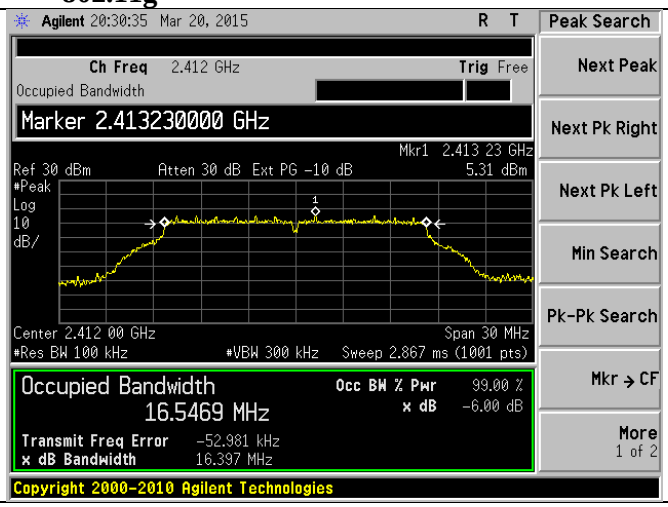



High Channel - 6 dB DTS BW

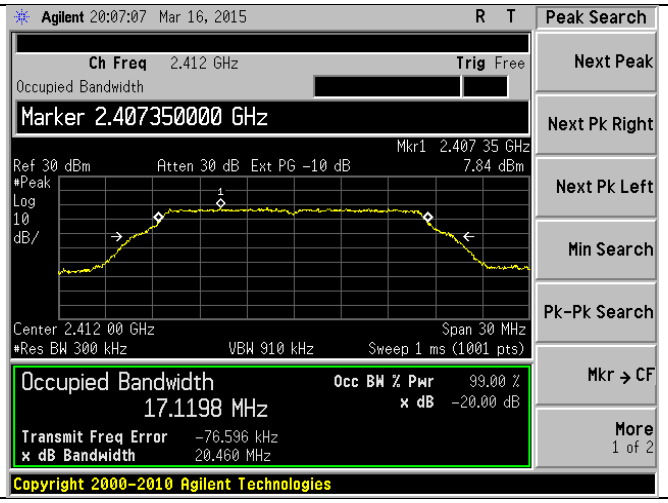



High Channel - OBW / 99 %

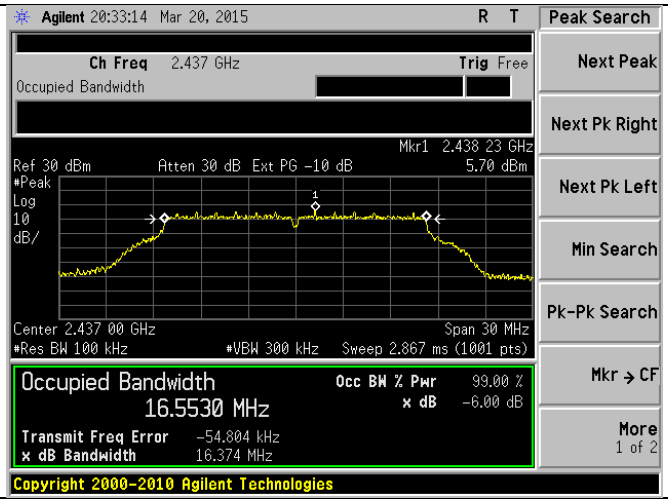
**802.11g**



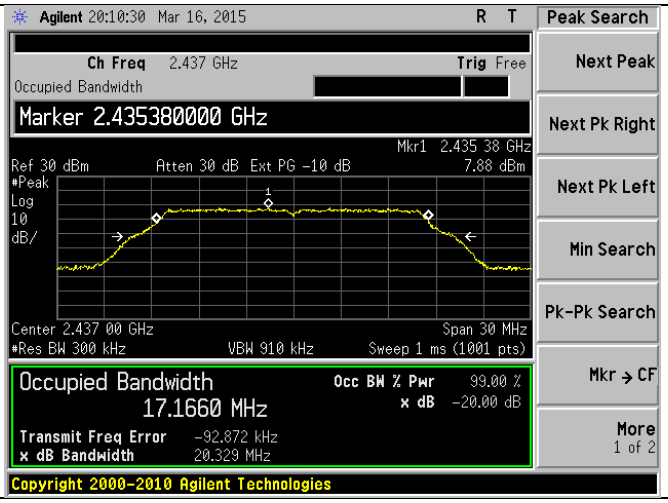

Low Channel - 6 dB DTS BW



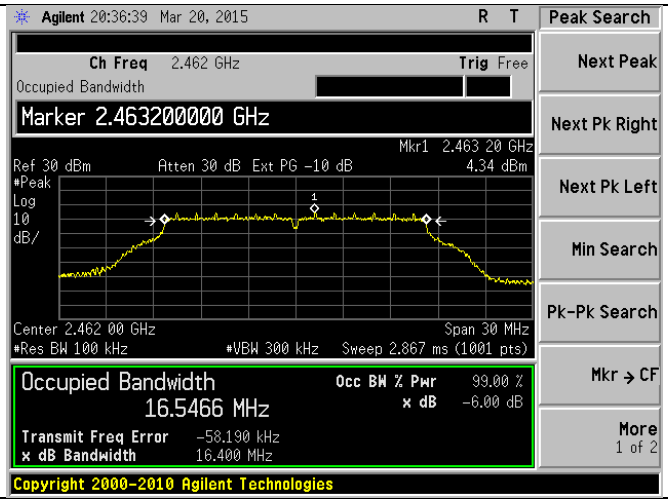

Low Channel - OBW / 99 %



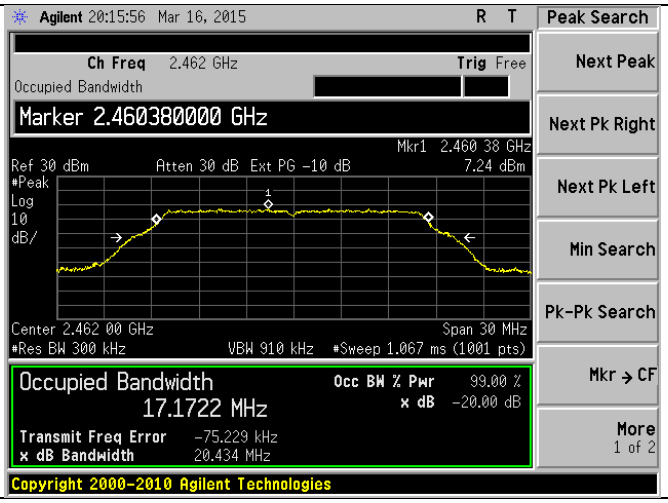

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %

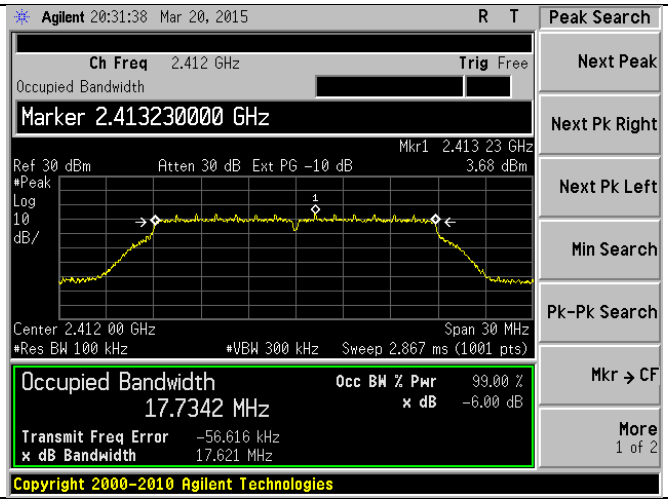



High Channel - 6 dB DTS BW

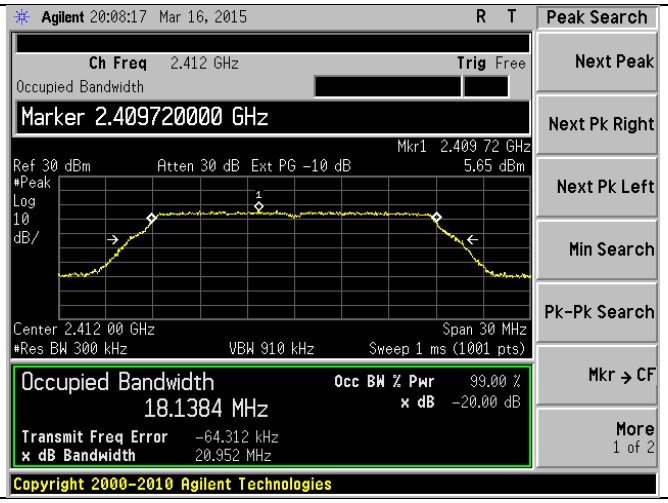



High Channel - OBW / 99 %

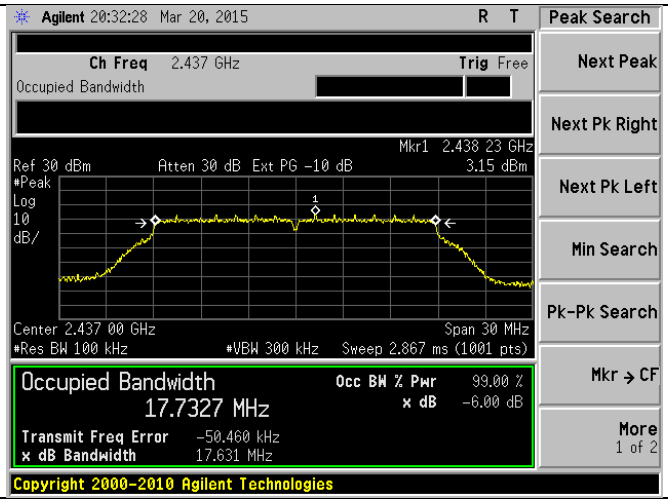
**802.11n**



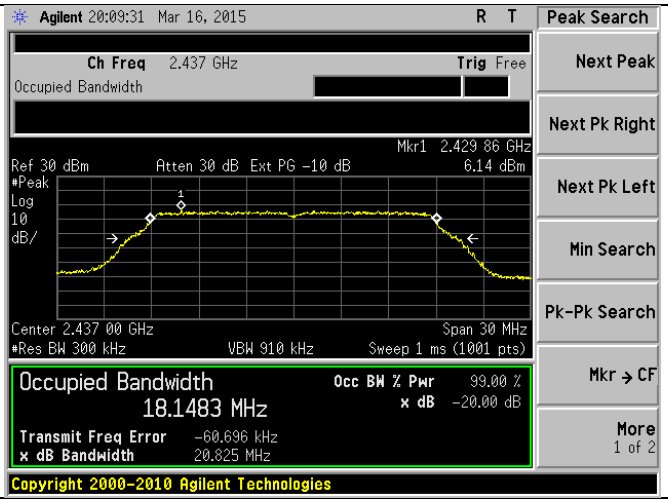

Low Channel - 6 dB DTS BW



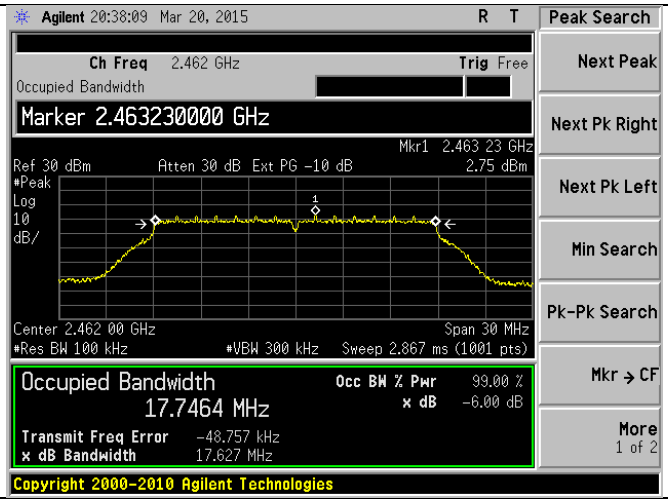

Low Channel - OBW / 99 %



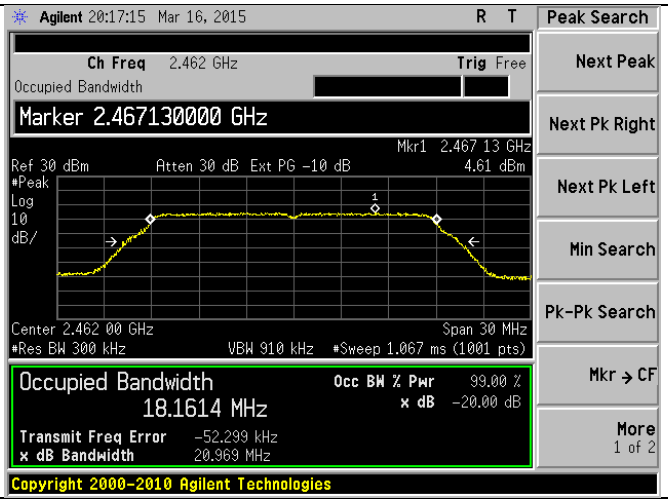

Mid Channel - 6 dB DTS BW




Mid Channel - OBW / 99 %




High Channel - 6 dB DTS BW




High Channel - OBW / 99 %

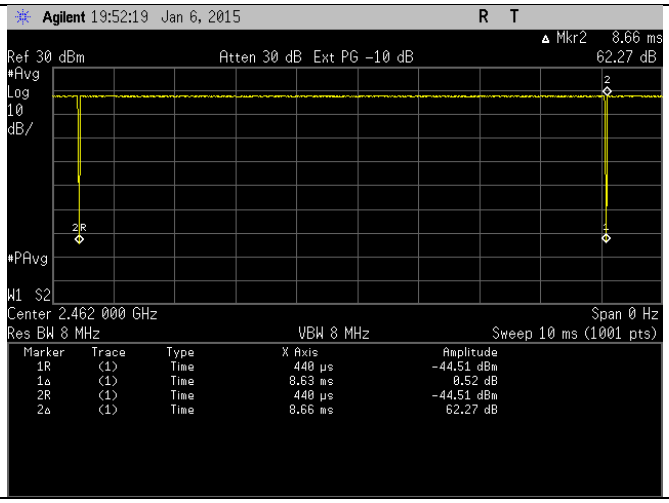
## B.1.2 – RF Conducted – Duty Cycle

| | |
|---|---|
| Manufacturer | LSR |
| Date | 1-6-15 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | 15.247 / RSS-210 A8 |
| Specific Measurement Procedure | FCC KDB 558074 Section 6 |
| Additional Description of Measurement | Peak Detector with Maximum RBW available |
| Additional Notes | 1. Continuous transmit modulated used for this test<br>2. 4-layer data representative of both designs |

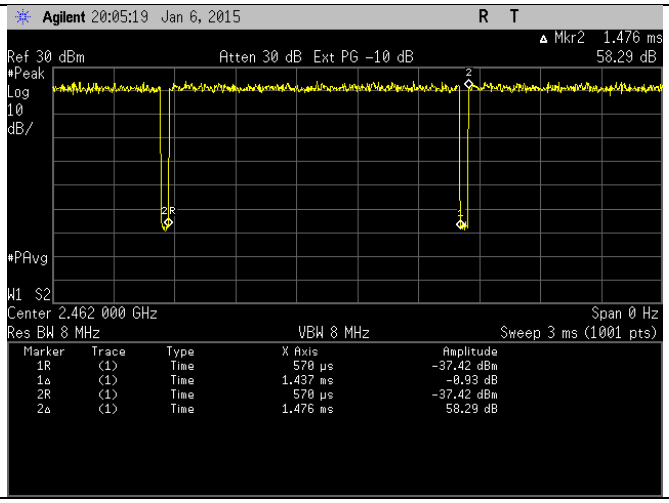
**Table**

| Mode (802.11) | Mode (Mbps) | On-time (ms) | Total Time (ms) | Duty | Duty Cycle correction (dB) |
|---|---|---|---|---|---|
| b | 1 | 8.630 | 8.660 | 1.00 | 0.02 |
| g | 6 | 1.437 | 1.476 | 0.97 | 0.12 |
| n | MCS0 | 1.342 | 1.382 | 0.97 | 0.13 |

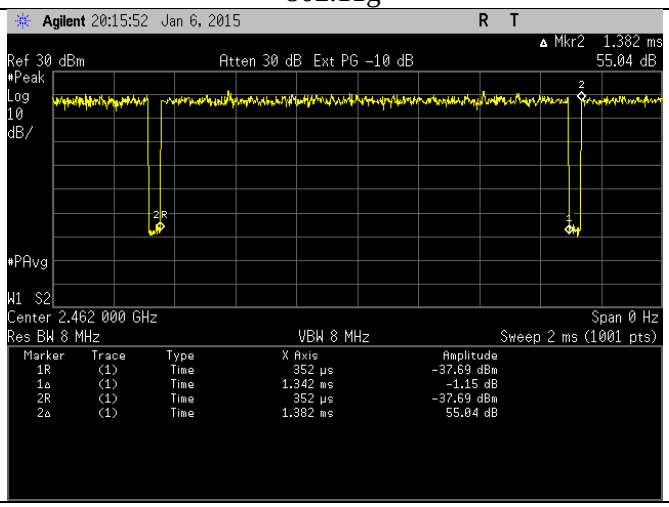
**Plots**




802.11b




802.11g




802.11n

## B.1.3 – RF Conducted – Fundamental Power and Spectral Density

| | |
|---|---|
| Manufacturer | LSR |
| Date | 2-16, 3-16, 3,-17, 3-19, 3-20, 3-21, 2015 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | 15.247 / RSS-210 A8 |
| Specific Measurement Procedure | FCC KDB 558074 Section 9.2.2.4 (Power) / 10.5 (PSD)<br>FCC KDB 558074 Section 10.3 |
| Additional Description of Measurement | Average Output Power and Average PSD methods utilized for measurement<br>100 kHz resolution bandwidth used for Power Spectral Density measurement |
| Additional Notes | 1. Continuous transmit modulated used for this test.<br>2. 4-layer and 2-layer tested. Antenna 1 and antenna 2 tested.<br>Sample Calculation:<br>Margin (dB) = Limit – Measured Level |

**Table**

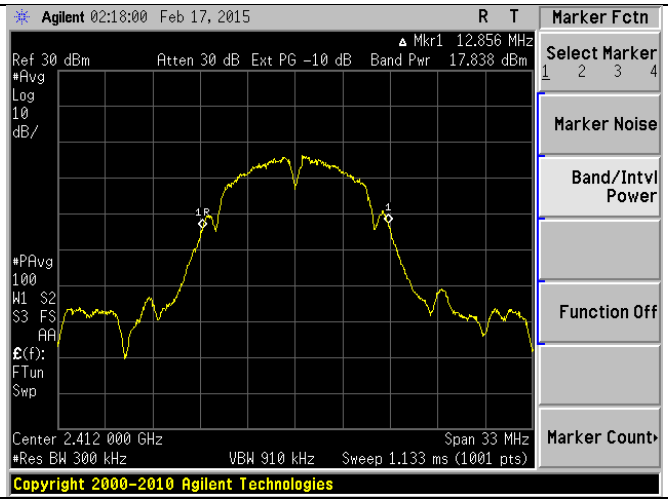
**4-layer board – Antenna 1**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) | Meas Power (dBm) | Duty (dB) | Max Avg. Power (dBm) | Max Avg. Power Limit (dBm) | Max Avg. Power Margin (dB) | Meas PSD 100 kHz (dBm) | Duty (dB) | Max Avg. PSD 100 kHz (dBm) | Max Avg. PSD Limit (dBm / 3 kHz) | Max Avg. PSD Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2412 | 8.072 | 10.696 | 12.856 | 17.838 | 0.015 | 17.853 | 30 | 12.15 | 1.967 | 0.015 | 1.982 | 8 | 6.02 |
| | | 2437 | 7.603 | 10.884 | 13.109 | 17.973 | 0.015 | 17.988 | | 12.01 | 1.723 | 0.015 | 1.738 | | 6.26 |
| | | 2462 | 8.085 | 10.740 | 12.861 | 16.945 | 0.015 | 16.960 | | 13.04 | 0.736 | 0.015 | 0.751 | | 7.25 |
| g | 6 | 2412 | 16.360 | 17.076 | 20.284 | 16.803 | 0.116 | 16.919 | | 13.08 | -3.164 | 0.116 | -3.048 | | 11.05 |
| | | 2437 | 16.366 | 17.079 | 20.473 | 16.850 | 0.116 | 16.966 | | 13.03 | -3.006 | 0.116 | -2.890 | | 10.89 |
| | | 2462 | 16.383 | 17.144 | 20.446 | 15.987 | 0.116 | 16.103 | | 13.90 | -4.078 | 0.116 | -3.962 | | 11.96 |
| n | MCS 0 | 2412 | 17.618 | 18.112 | 20.935 | 14.814 | 0.128 | 14.942 | | 15.06 | -5.495 | 0.128 | -5.367 | | 13.37 |
| | | 2437 | 17.625 | 18.025 | 20.693 | 14.934 | 0.128 | 15.062 | | 14.94 | -5.349 | 0.128 | -5.221 | | 13.22 |
| | | 2462 | 17.619 | 18.118 | 20.638 | 14.111 | 0.128 | 14.239 | | 15.76 | -6.167 | 0.128 | -6.039 | | 14.04 |

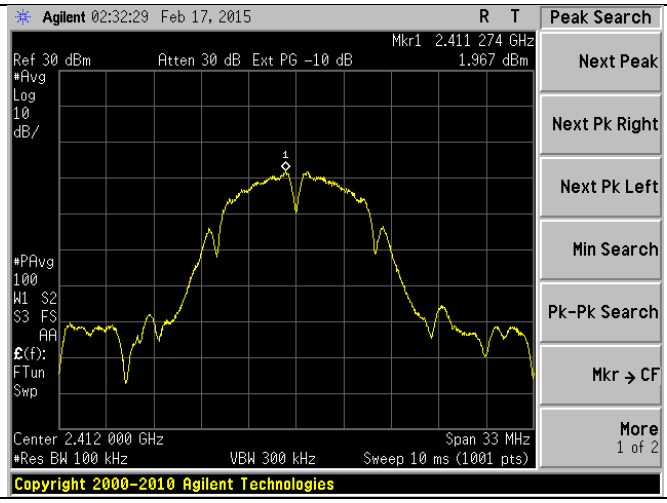
**4-layer board – Antenna 2**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) | Meas Power (dBm) | Duty (dB) | Max Avg. Power (dBm) | Max Avg. Power Limit (dBm) | Max Avg. Power Margin (dB) | Meas PSD 100 kHz (dBm) | Duty (dB) | Max Avg. PSD 100 kHz (dBm) | Max Avg. PSD Limit (dBm / 3 kHz) | Max Avg. PSD Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2412 | 8.047 | 10.719 | 12.865 | 17.785 | 0.015 | 17.800 | 30 | 12.20 | 1.524 | 0.015 | 1.539 | 8 | 6.46 |
| | | 2437 | 8.050 | 10.948 | 13.142 | 17.939 | 0.015 | 17.954 | | 12.05 | 1.369 | 0.015 | 1.384 | | 6.62 |
| | | 2462 | 8.081 | 10.766 | 12.902 | 16.871 | 0.015 | 16.886 | | 13.11 | 0.271 | 0.015 | 0.286 | | 7.71 |
| g | 6 | 2412 | 16.411 | 17.199 | 20.526 | 16.689 | 0.116 | 16.805 | | 13.19 | -3.105 | 0.116 | -2.989 | | 10.99 |
| | | 2437 | 16.391 | 17.171 | 20.541 | 16.782 | 0.116 | 16.898 | | 13.10 | -3.136 | 0.116 | -3.020 | | 11.02 |
| | | 2462 | 16.381 | 17.183 | 20.533 | 15.897 | 0.116 | 16.013 | | 13.99 | -4.194 | 0.116 | -4.078 | | 12.08 |
| n | MCS 0 | 2412 | 17.624 | 18.193 | 20.984 | 14.794 | 0.128 | 14.922 | | 15.08 | -5.551 | 0.128 | -5.423 | | 13.42 |
| | | 2437 | 17.615 | 18.157 | 20.927 | 14.803 | 0.128 | 14.931 | | 15.07 | -5.211 | 0.128 | -5.083 | | 13.08 |
| | | 2462 | 17.625 | 18.133 | 21.014 | 14.033 | 0.128 | 14.161 | | 15.84 | -6.209 | 0.128 | -6.081 | | 14.08 |

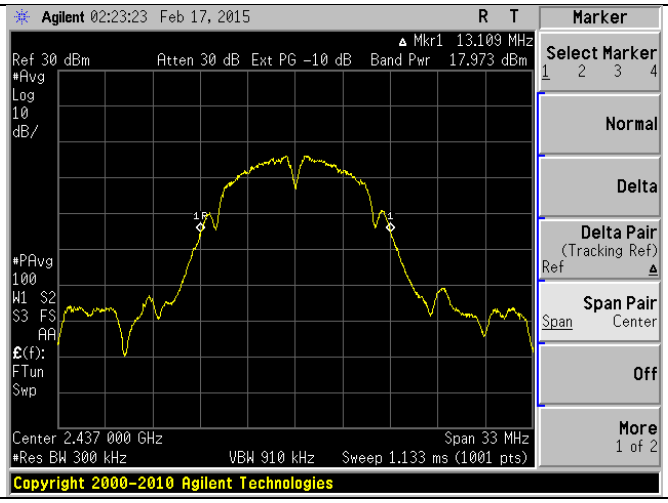
**PLOTS (4-layer board – Antenna 1)**
**802.11b**



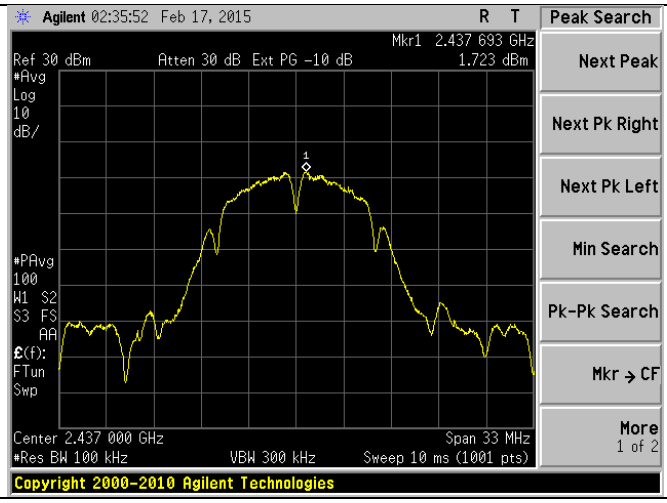

Low Channel - Power



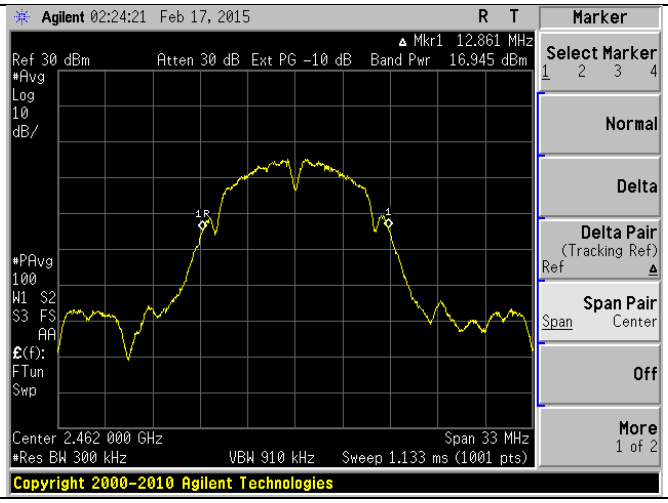

Low Channel - PSD



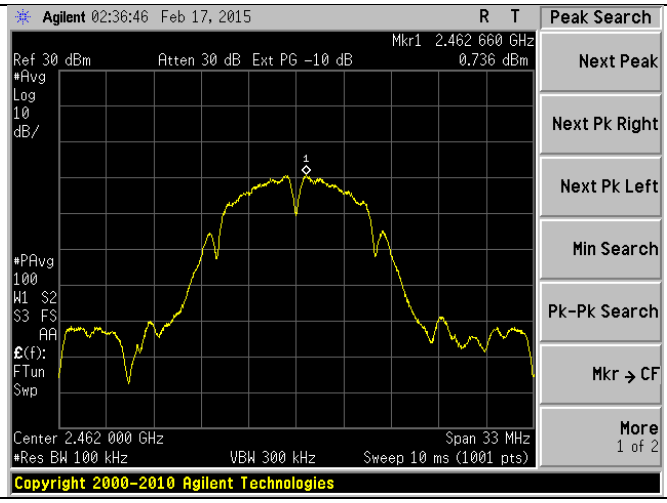

Mid Channel - Power




Mid Channel - PSD

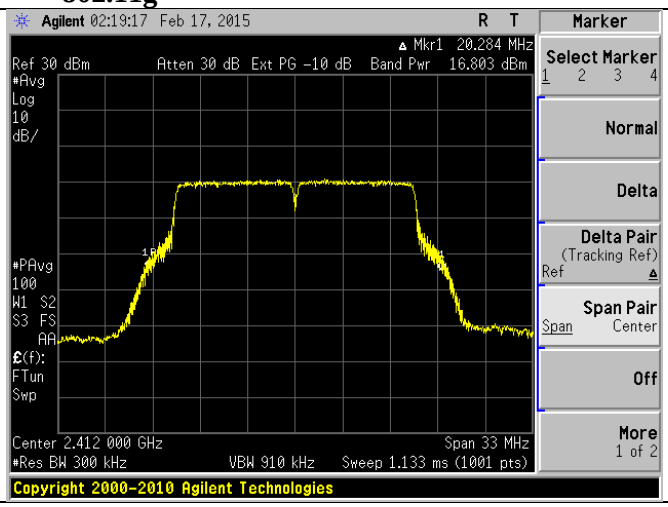



High Channel - Power

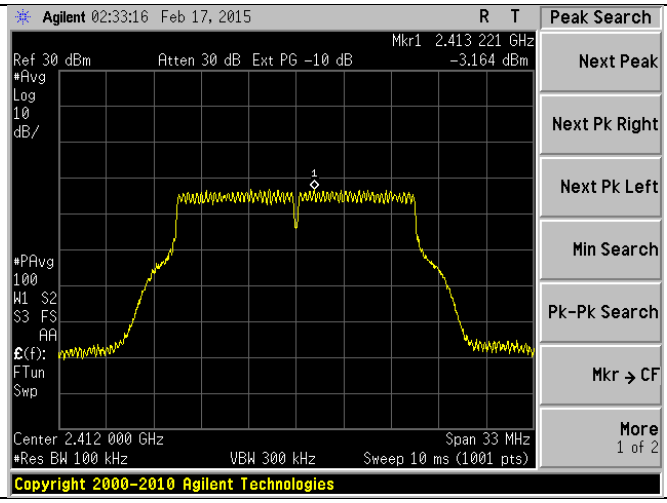



High Channel - PSD

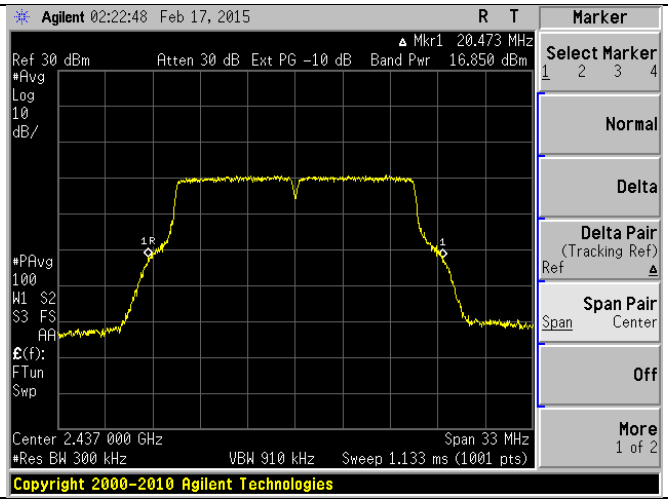
**802.11g**



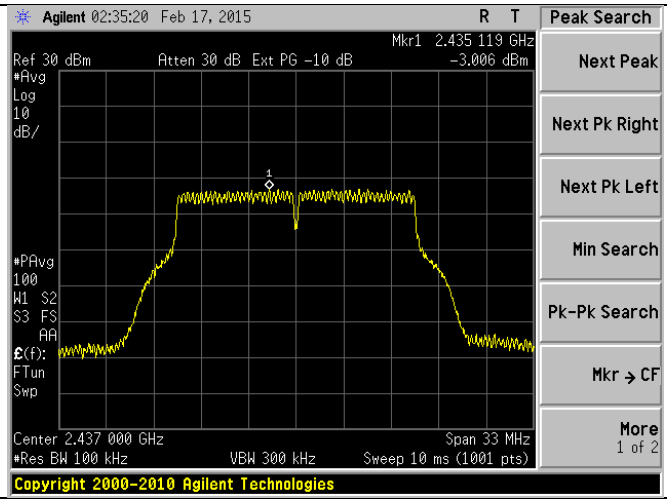

Low Channel - Power



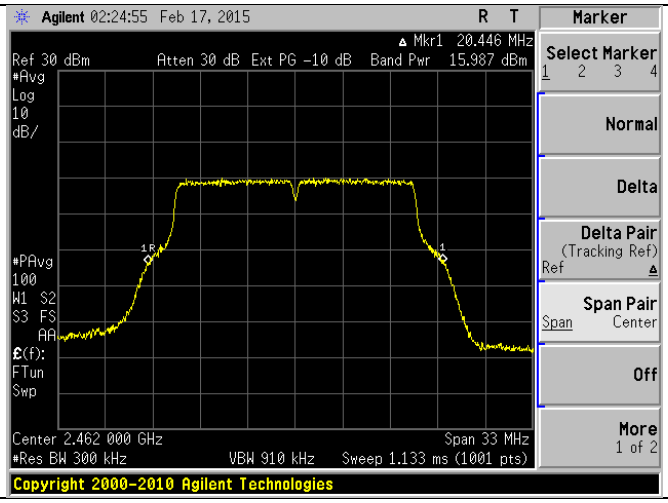

Low Channel - PSD



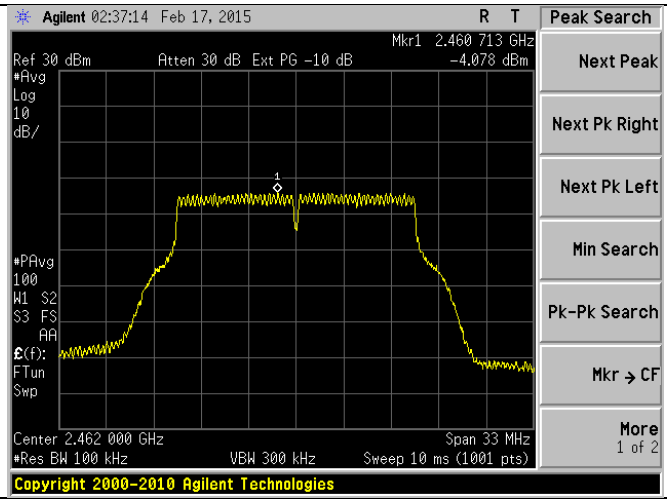

Mid Channel - Power




Mid Channel - PSD

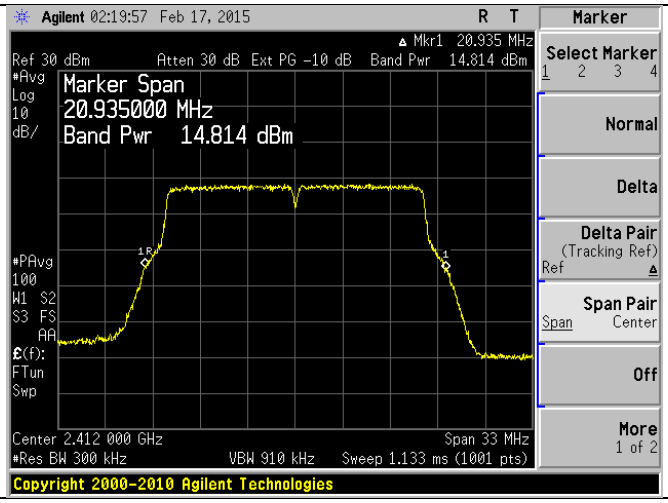



High Channel - Power

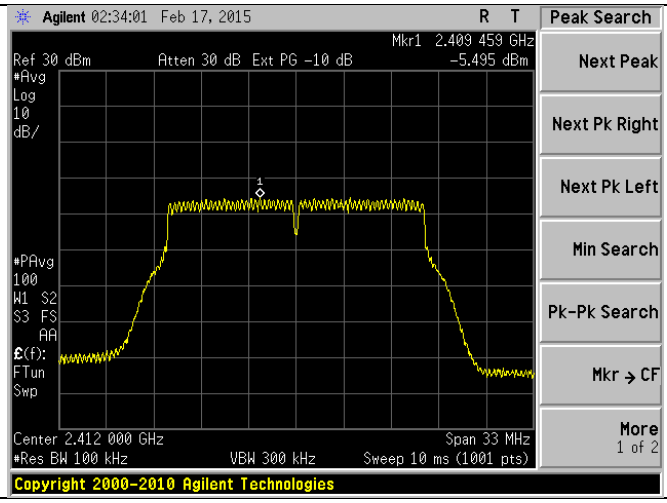



High Channel - PSD

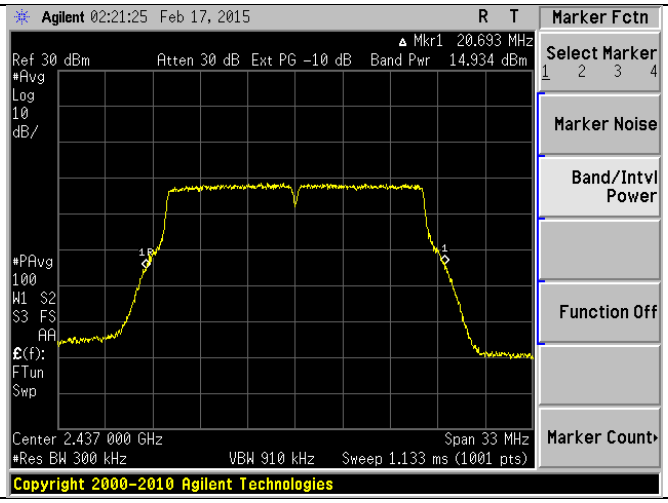
**802.11n**



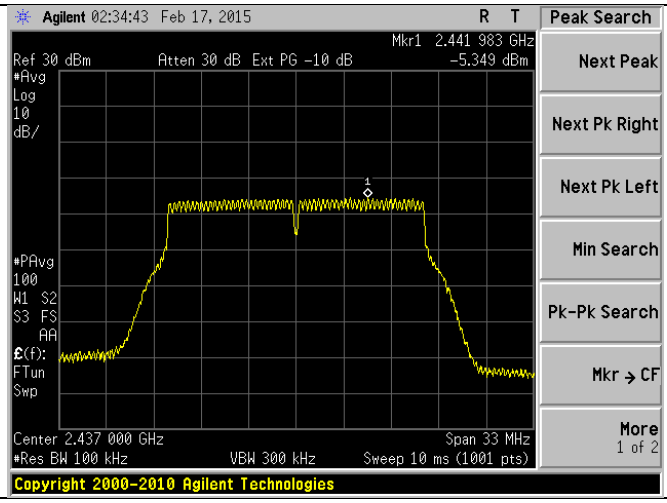

Low Channel - Power



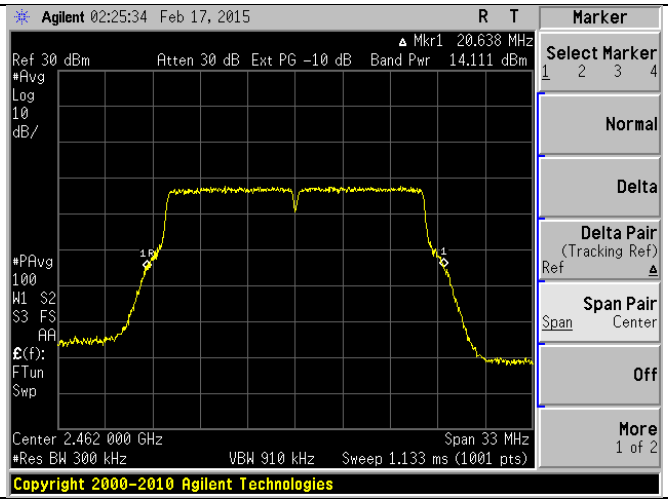

Low Channel - PSD



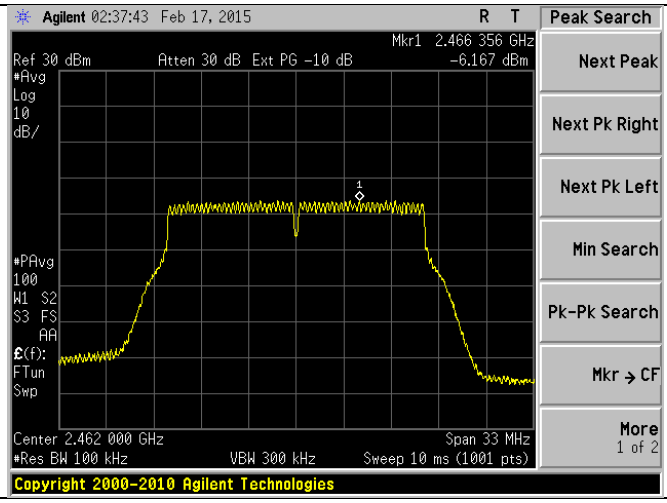

Mid Channel - Power




Mid Channel - PSD

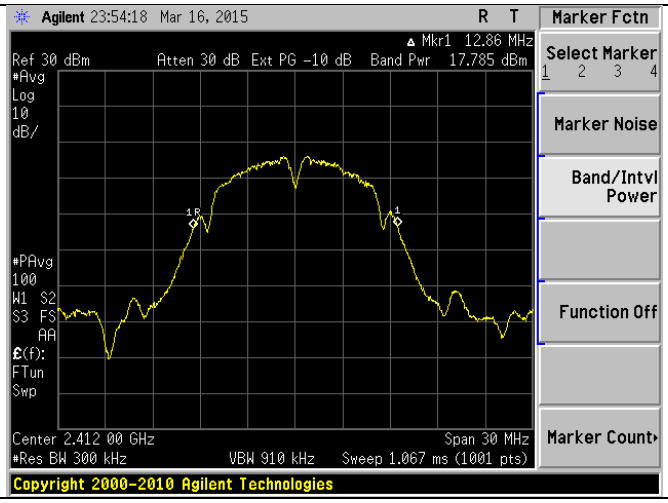



High Channel - Power

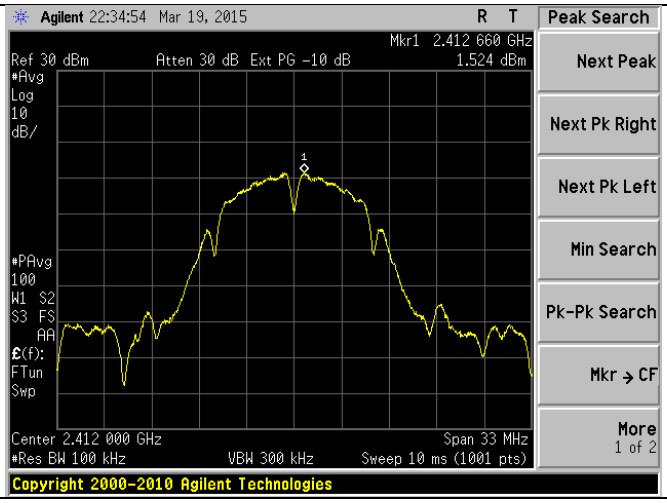



High Channel - PSD

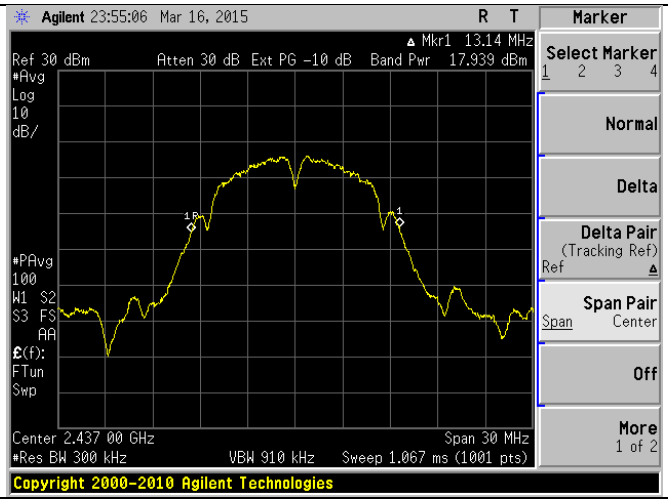
**PLOTS (4-layer board – Antenna 2)**
**802.11b**



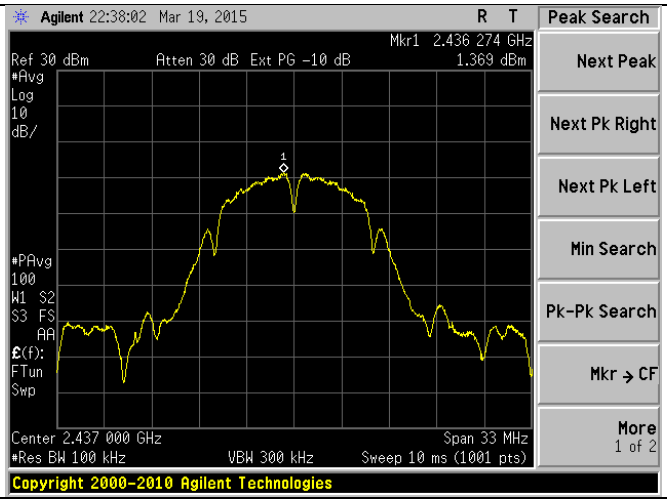

Low Channel - Power



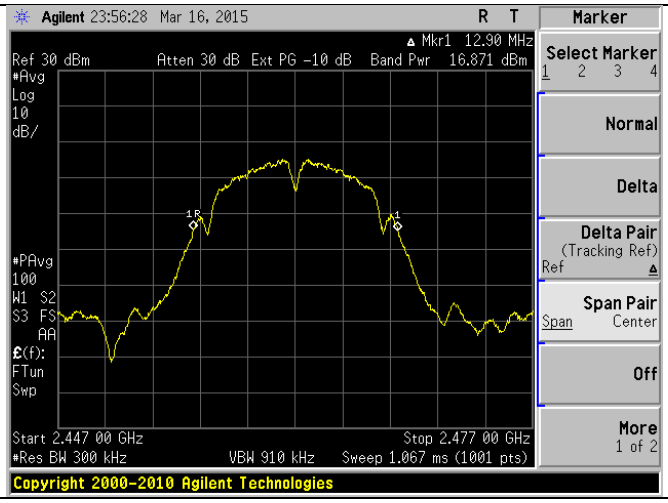

Low Channel - PSD



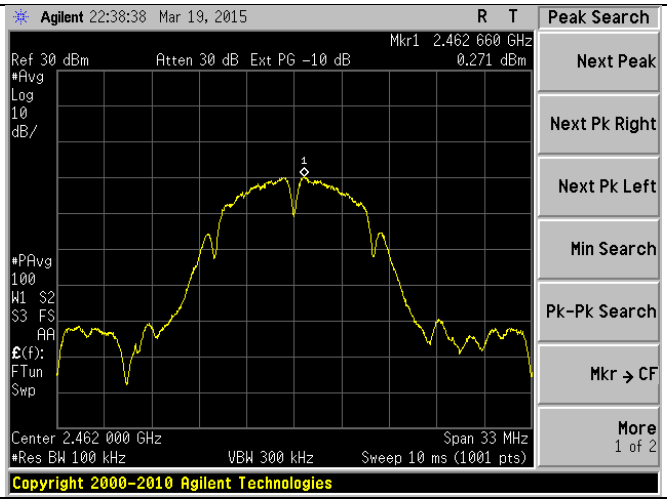

Mid Channel - Power




Mid Channel - PSD

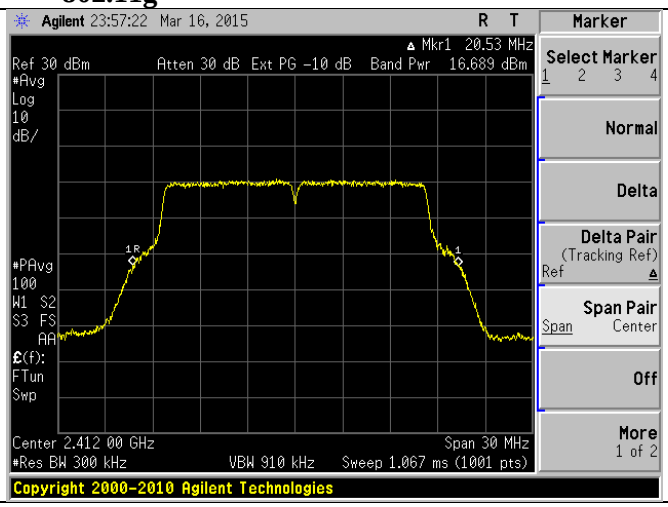



High Channel - Power

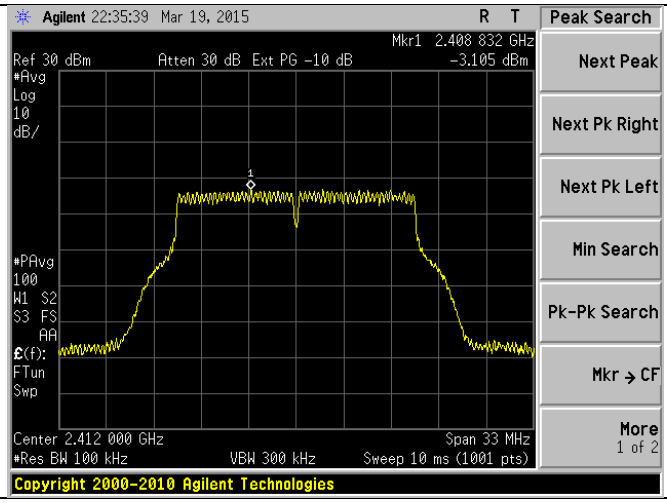



High Channel - PSD

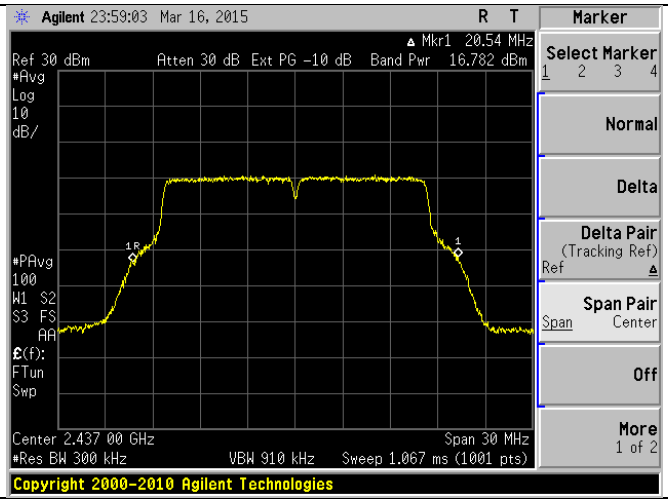
**802.11g**



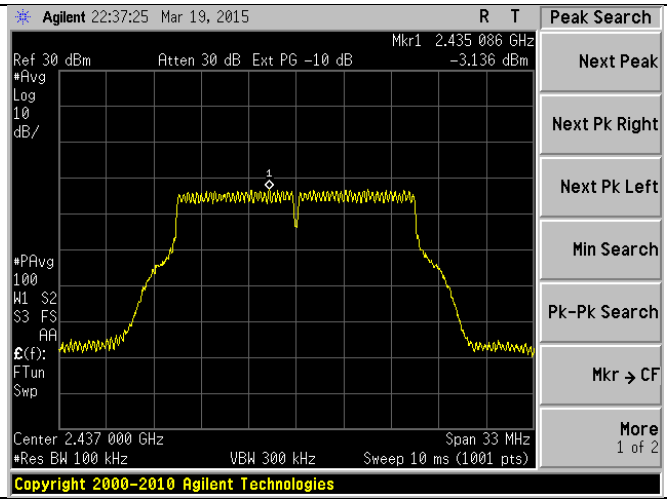

Low Channel - Power



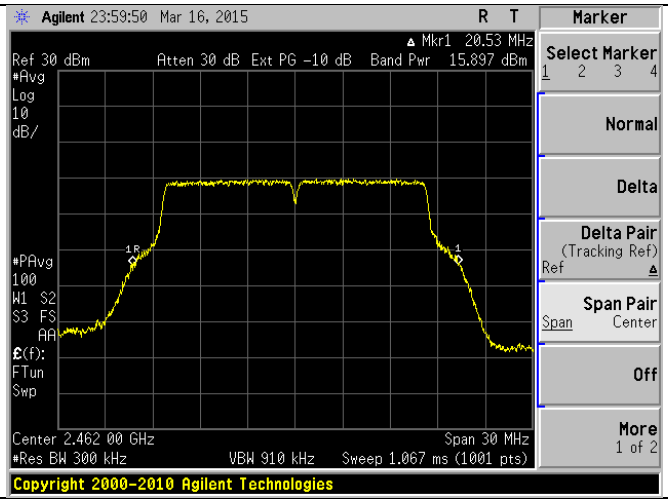

Low Channel - PSD



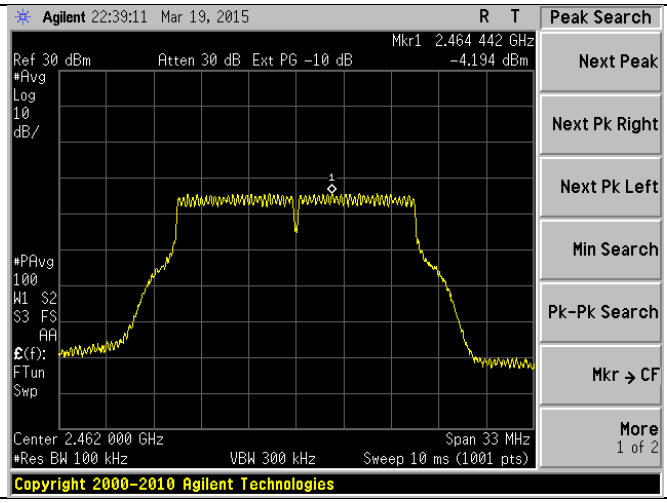

Mid Channel - Power




Mid Channel - PSD

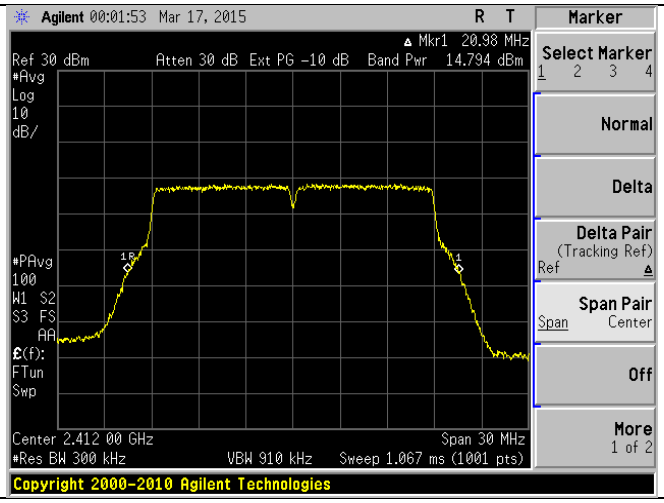



High Channel - Power

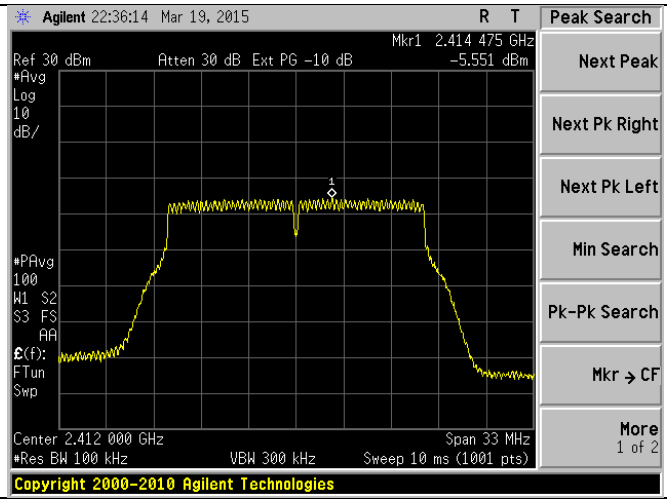



High Channel - PSD

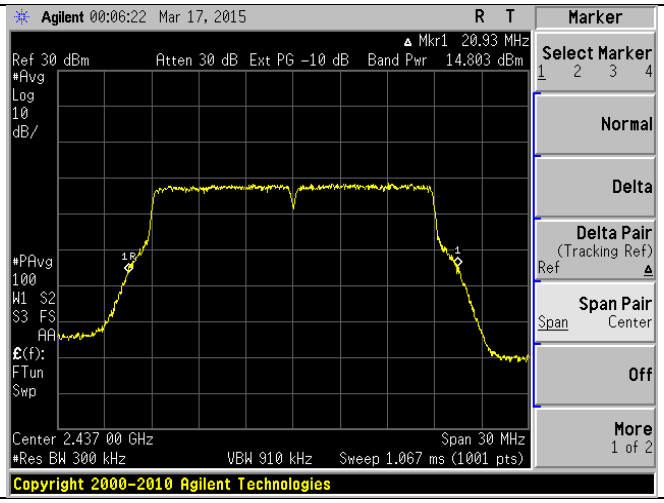
**802.11n**



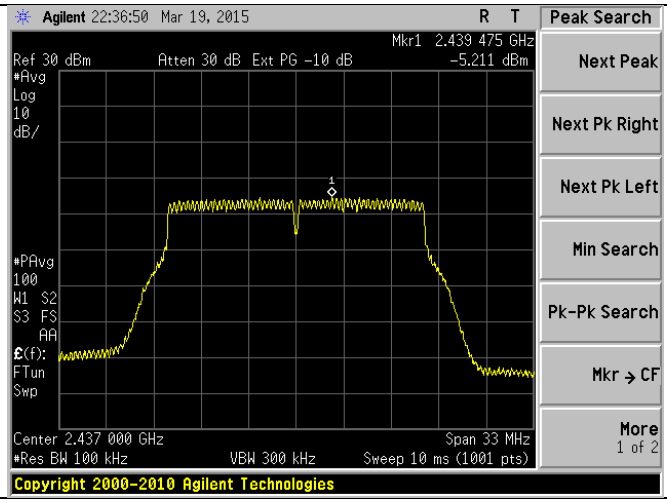

Low Channel - Power



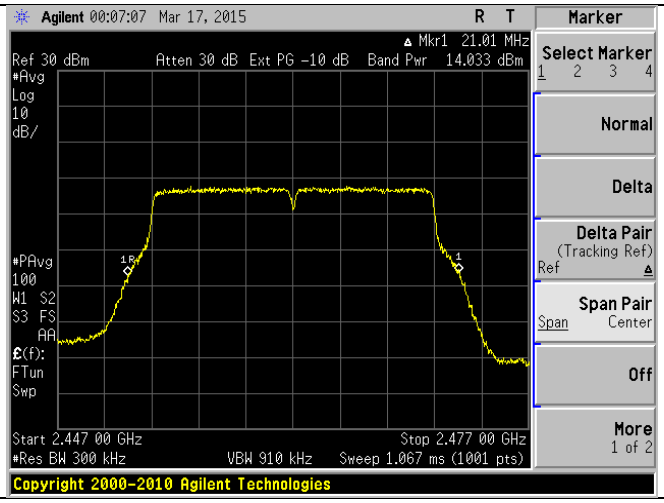

Low Channel - PSD



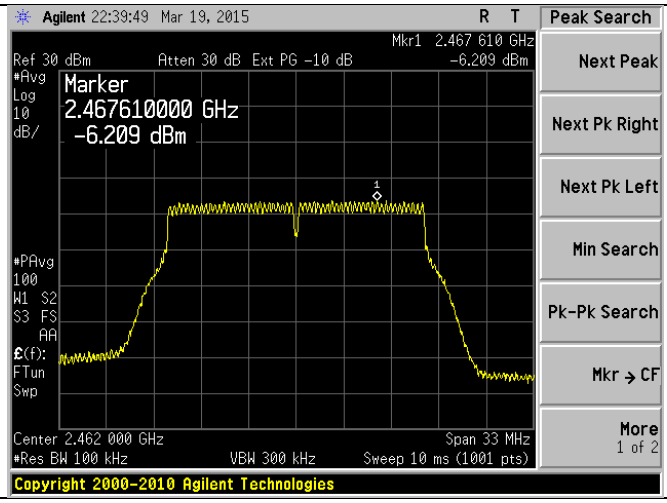

Mid Channel - Power




Mid Channel - PSD




High Channel - Power




High Channel - PSD

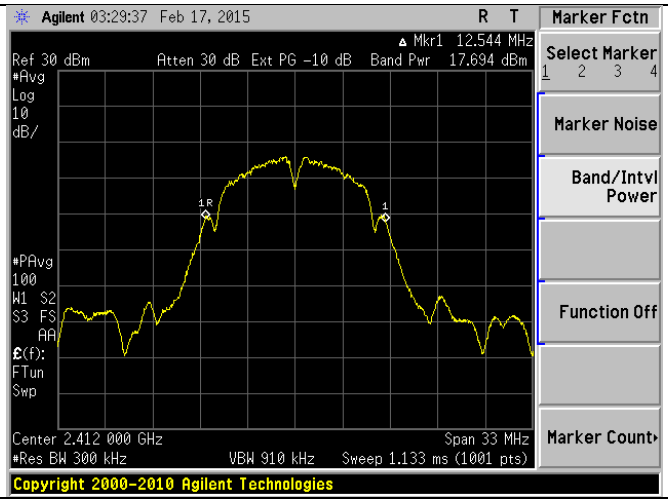
## Table
## 2-layer board – Antenna 1

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) | Meas Power (dBm) | Duty (dB) | Max Avg. Power (dBm) | Max Avg. Power Limit (dBm) | Max Avg. Power Margin (dB) | Meas PSD 100 kHz (dBm) | Duty (dB) | Max Avg. PSD 100 kHz (dBm) | Max Avg. PSD Limit (dBm / 3 kHz) | Max Avg. PSD Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2412 | 8.086 | 10.491 | 12.544 | 17.694 | 0.015 | 17.709 | 30 | 12.29 | 1.318 | 0.015 | 1.333 | 8 | 6.67 |
| | | 2437 | 8.089 | 10.629 | 12.848 | 17.719 | 0.015 | 17.734 | | 12.27 | 1.622 | 0.015 | 1.637 | | 6.36 |
| | | 2462 | 8.082 | 10.670 | 13.057 | 16.576 | 0.015 | 16.591 | | 13.41 | 0.289 | 0.015 | 0.304 | | 7.70 |
| g | 6 | 2412 | 16.391 | 17.043 | 20.244 | 16.457 | 0.116 | 16.573 | | 13.43 | -3.486 | 0.116 | -3.370 | | 11.37 |
| | | 2437 | 16.397 | 17.147 | 20.474 | 16.481 | 0.116 | 16.597 | | 13.40 | -3.163 | 0.116 | -3.047 | | 11.05 |
| | | 2462 | 16.396 | 17.116 | 20.066 | 15.583 | 0.116 | 15.699 | | 14.30 | -3.794 | 0.116 | -3.678 | | 11.68 |
| n | MCS 0 | 2412 | 17.631 | 18.090 | 20.608 | 14.490 | 0.128 | 14.618 | | 15.38 | -5.825 | 0.128 | -5.697 | | 13.70 |
| | | 2437 | 17.636 | 18.107 | 20.886 | 14.532 | 0.128 | 14.660 | | 15.34 | -5.584 | 0.128 | -5.456 | | 13.46 |
| | | 2462 | 17.615 | 18.146 | 20.902 | 13.738 | 0.128 | 13.866 | | 16.13 | -6.694 | 0.128 | -6.566 | | 14.57 |

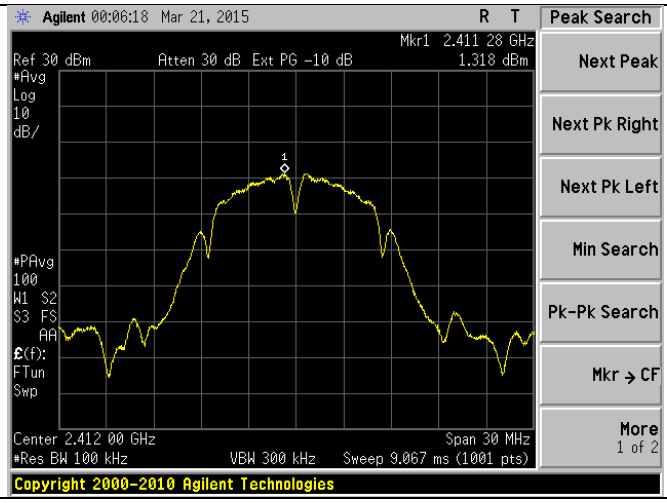
## 2-layer board – Antenna 2

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 99 % BW (MHz) | 20 dB OBW (MHz) | Meas Power (dBm) | Duty (dB) | Max Avg. Power (dBm) | Max Avg. Power Limit (dBm) | Max Avg. Power Margin (dB) | Meas PSD 100 kHz (dBm) | Duty (dB) | Max Avg. PSD 100 kHz (dBm) | Max Avg. PSD Limit (dBm / 3 kHz) | Max Avg. PSD Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2412 | 8.078 | 10.658 | 12.857 | 17.454 | 0.015 | 17.469 | 30 | 12.53 | 1.226 | 0.015 | 1.241 | 8 | 6.76 |
| | | 2437 | 8.083 | 10.684 | 12.873 | 17.580 | 0.015 | 17.595 | | 12.40 | 1.471 | 0.015 | 1.486 | | 6.51 |
| | | 2462 | 8.091 | 10.677 | 12.877 | 16.399 | 0.015 | 16.414 | | 13.59 | 0.140 | 0.015 | 0.155 | | 7.84 |
| g | 6 | 2412 | 16.397 | 17.120 | 20.460 | 16.264 | 0.116 | 16.380 | | 13.62 | -2.841 | 0.116 | -2.725 | | 10.72 |
| | | 2437 | 16.374 | 17.166 | 20.329 | 16.248 | 0.116 | 16.364 | | 13.64 | -3.415 | 0.116 | -3.299 | | 11.30 |
| | | 2462 | 16.400 | 17.172 | 20.434 | 15.381 | 0.116 | 15.497 | | 14.50 | -4.533 | 0.116 | -4.417 | | 12.42 |
| n | MCS 0 | 2412 | 17.621 | 18.138 | 20.952 | 14.316 | 0.128 | 14.444 | | 15.56 | -5.753 | 0.128 | -5.625 | | 13.63 |
| | | 2437 | 17.631 | 18.148 | 20.825 | 14.368 | 0.128 | 14.496 | | 15.50 | -5.984 | 0.128 | -5.856 | | 13.86 |
| | | 2462 | 17.627 | 18.161 | 20.969 | 13.602 | 0.128 | 13.730 | | 16.27 | -6.854 | 0.128 | -6.726 | | 14.73 |

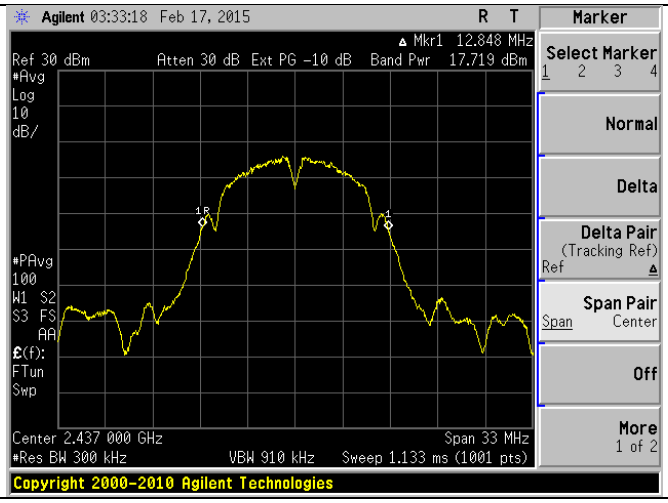
**PLOTS (2-layer board – Antenna 1)**
**802.11b**



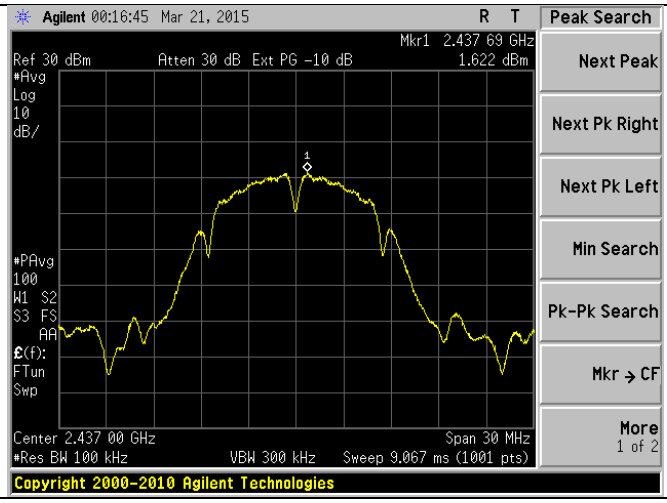

Low Channel - Power



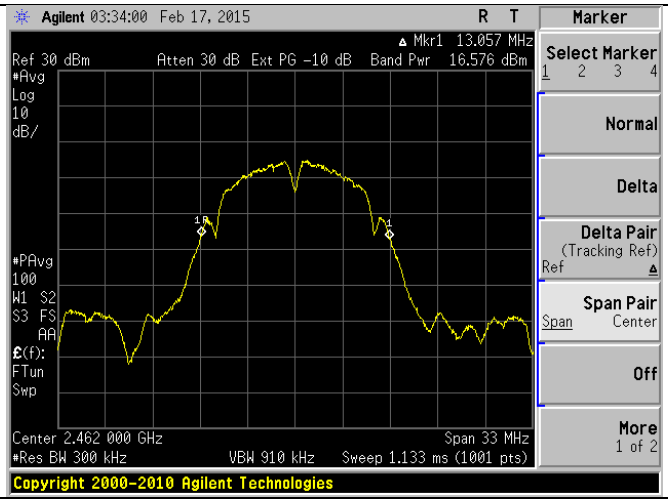

Low Channel - PSD



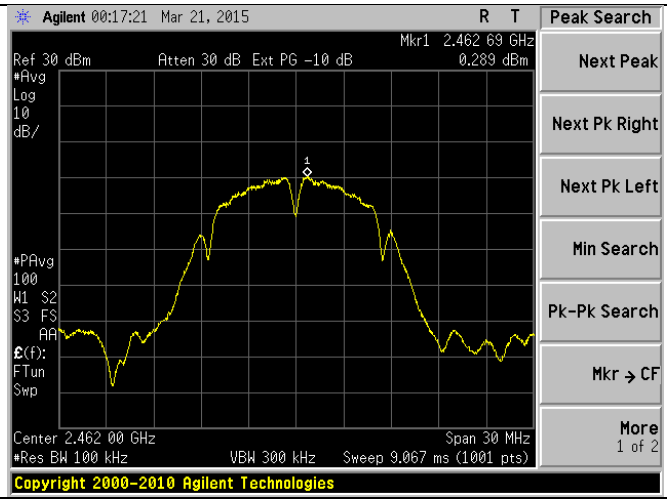

Mid Channel - Power




Mid Channel - PSD

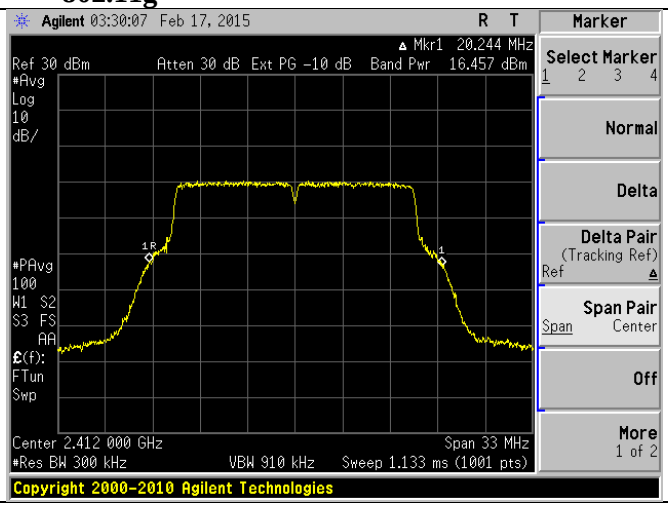



High Channel - Power

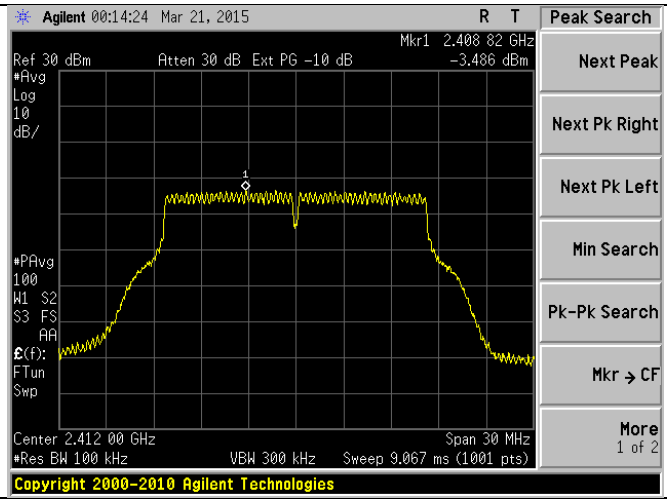



High Channel - PSD

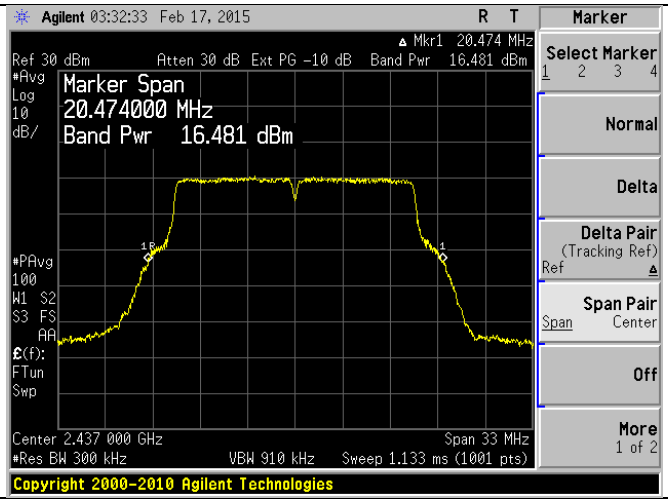
**802.11g**



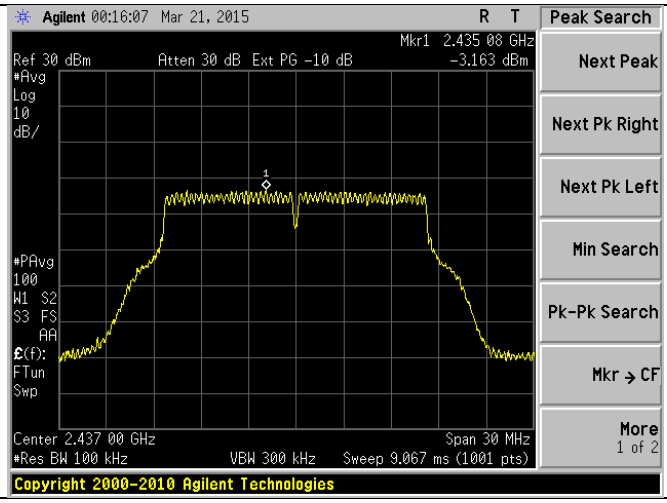

Low Channel - Power



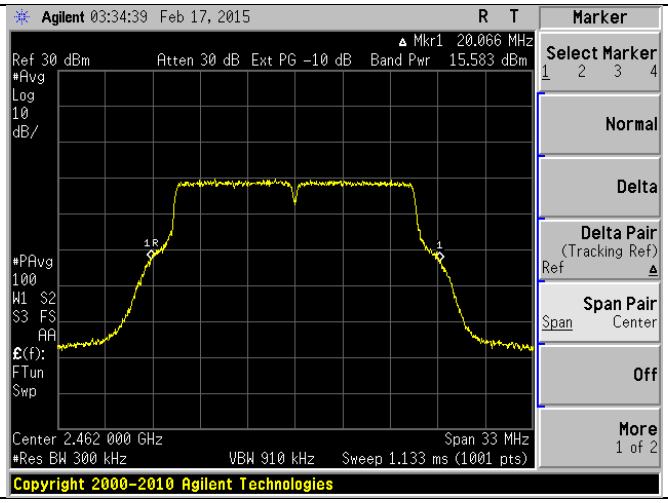

Low Channel - PSD



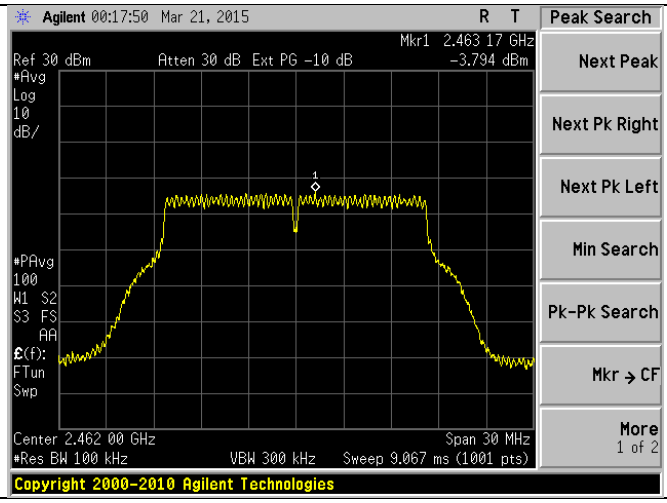

Mid Channel - Power




Mid Channel - PSD

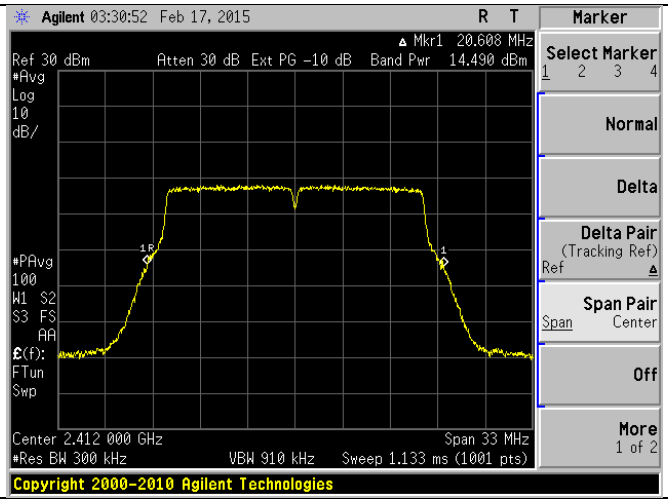



High Channel - Power

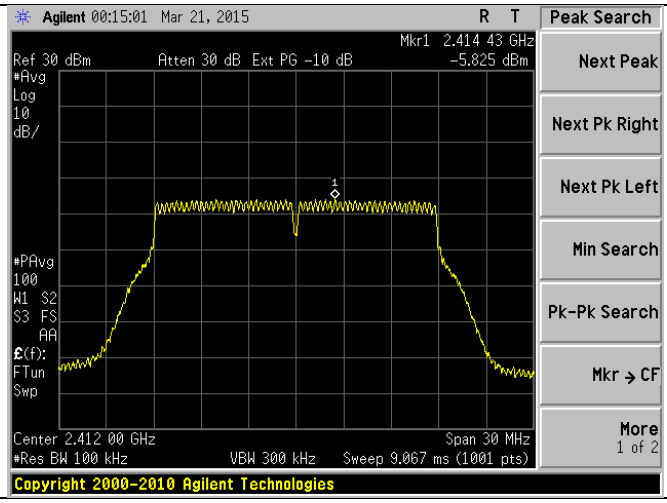



High Channel - PSD

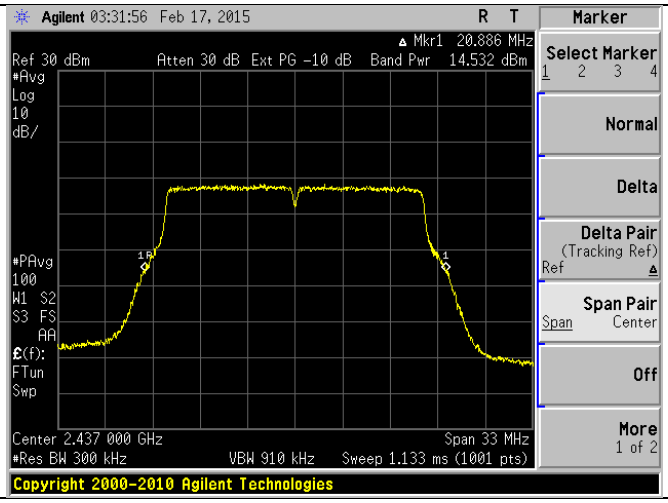
**802.11n**



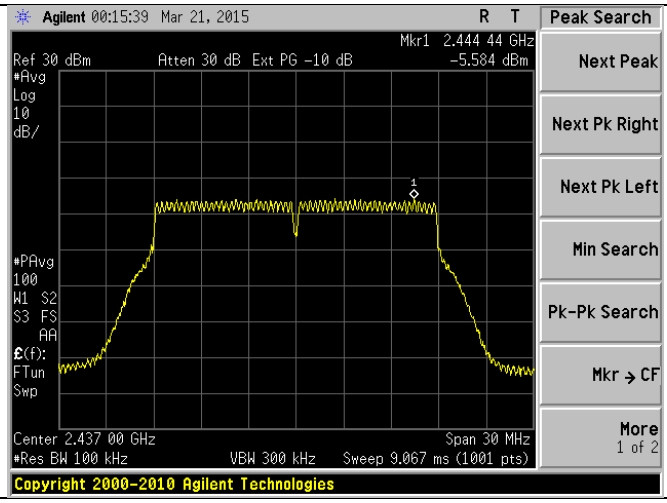

Low Channel - Power



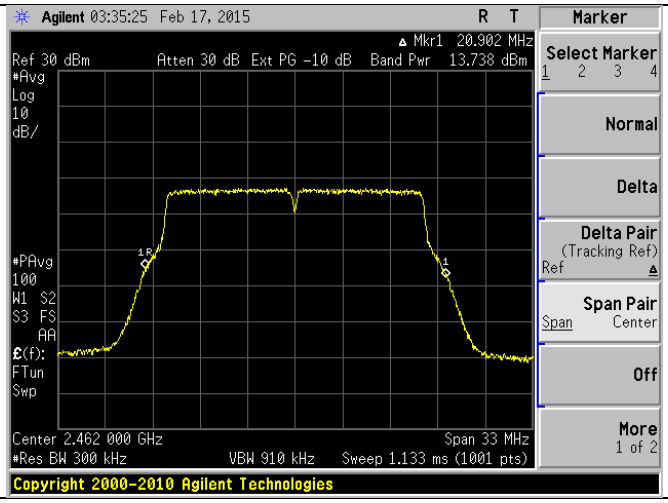

Low Channel - PSD



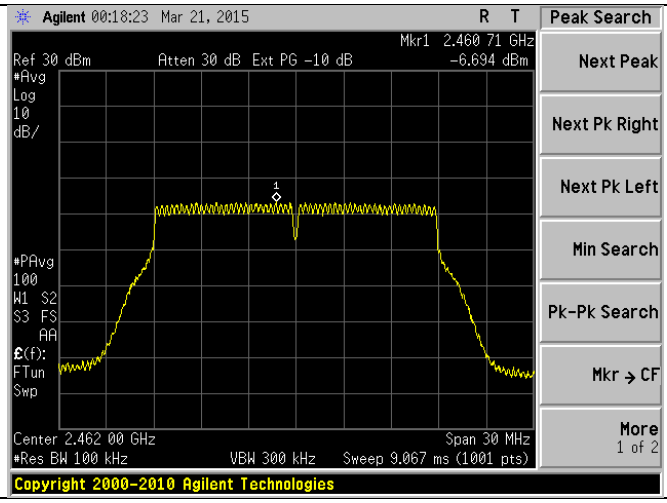

Mid Channel - Power




Mid Channel - PSD

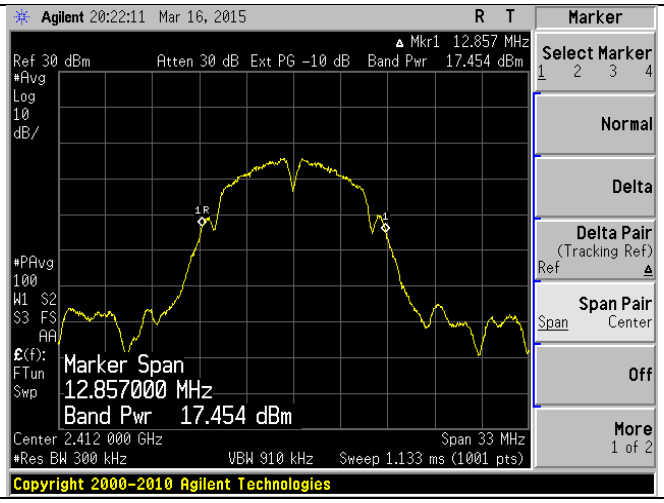



High Channel - Power

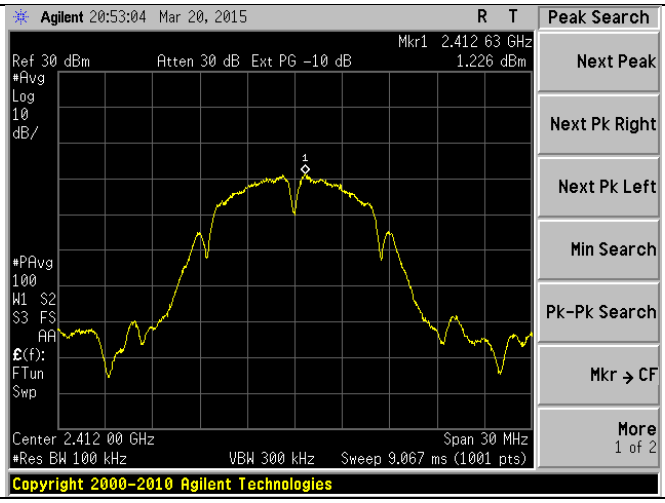



High Channel - PSD

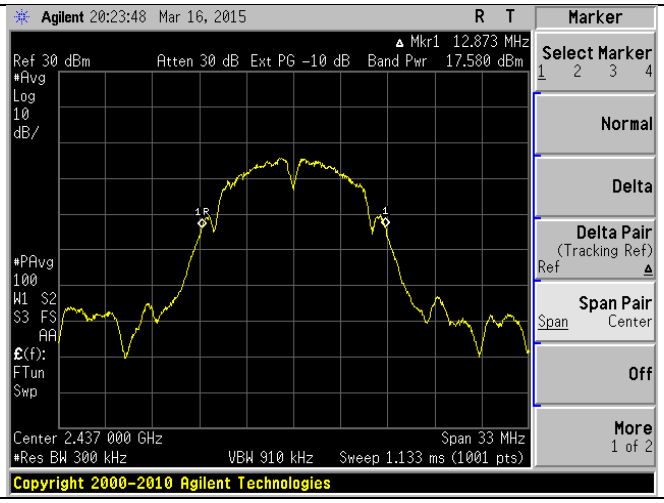
**PLOTS (2-layer board – Antenna 2)**
**802.11b**



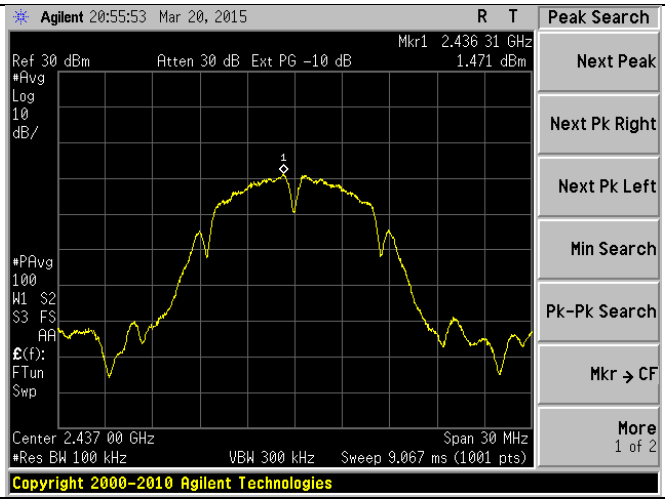

Low Channel - Power



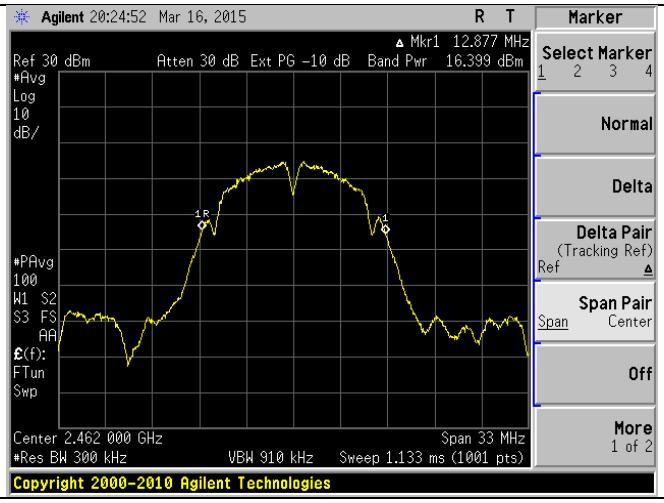

Low Channel - PSD



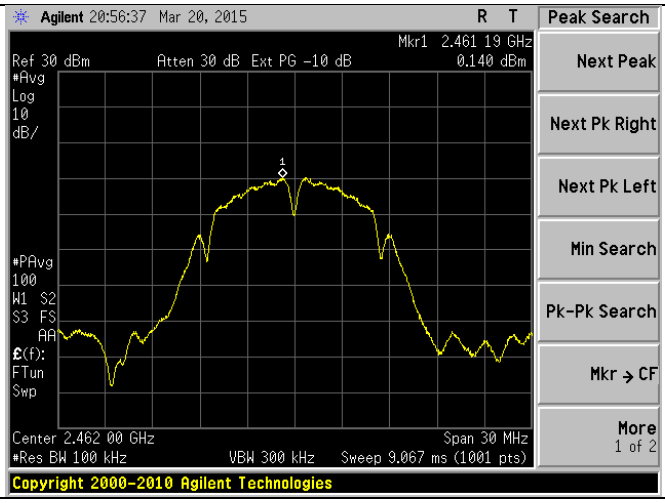

Mid Channel - Power




Mid Channel - PSD

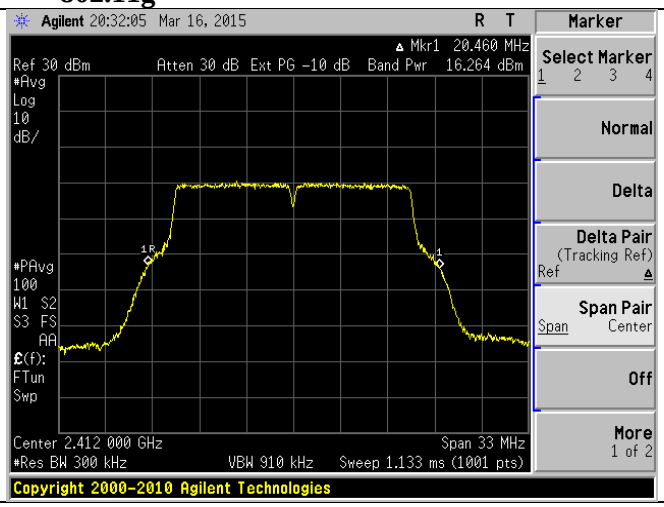



High Channel - Power

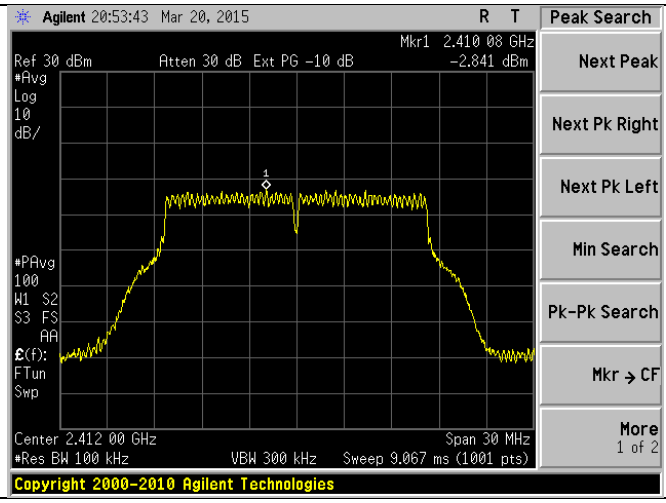



High Channel - PSD

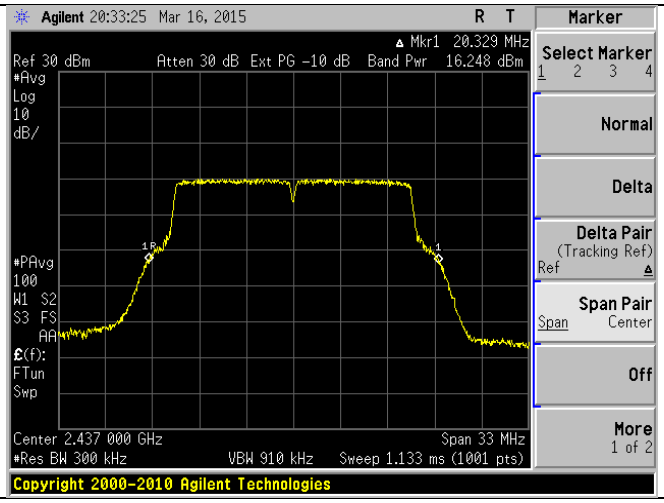
**802.11g**



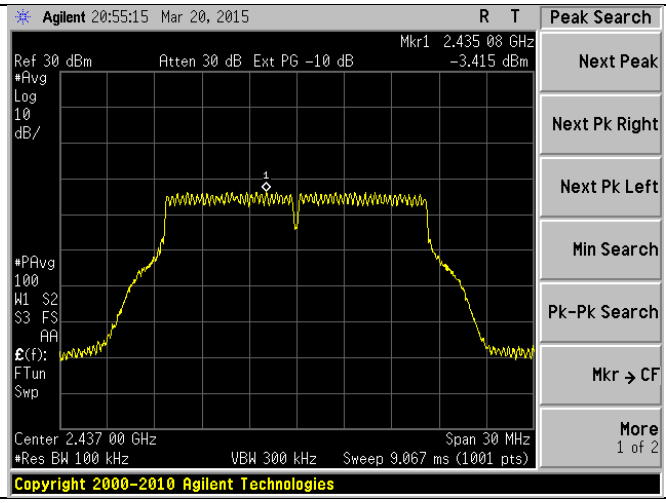

Low Channel - Power



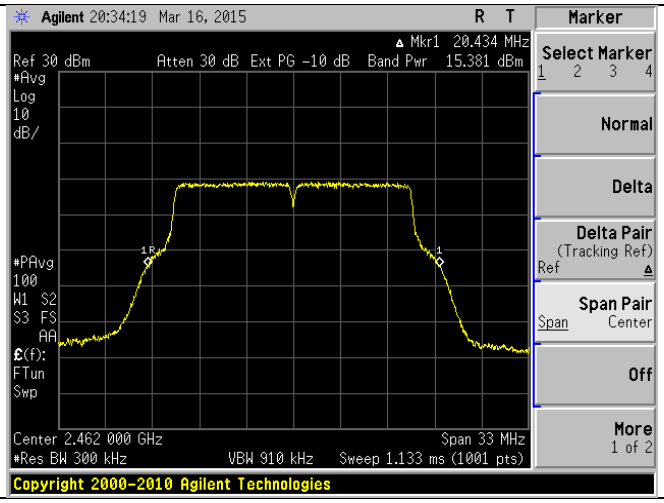

Low Channel - PSD



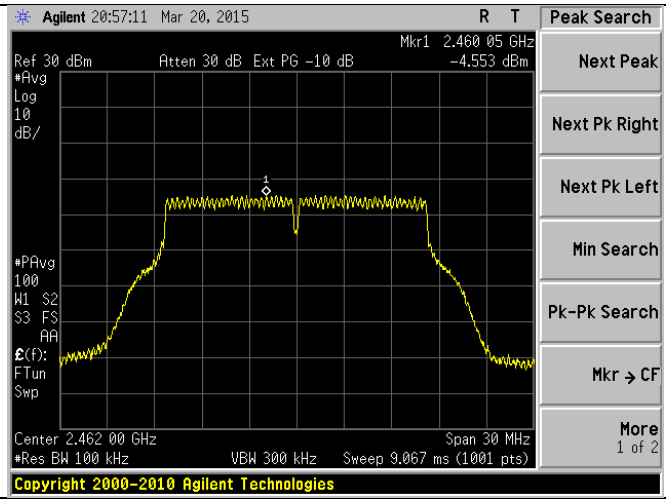

Mid Channel - Power




Mid Channel - PSD

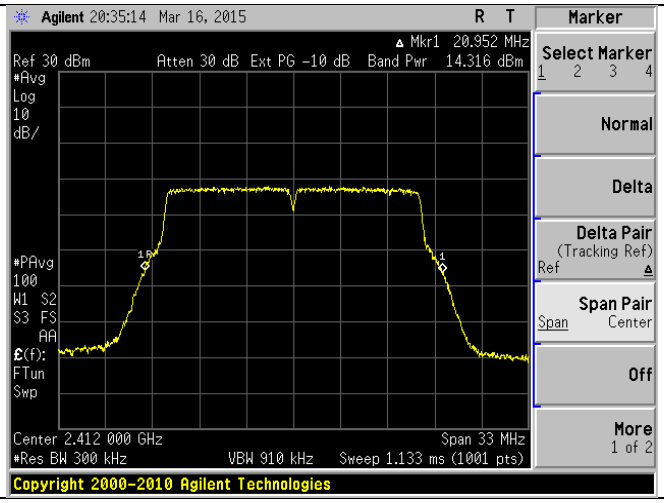



High Channel - Power

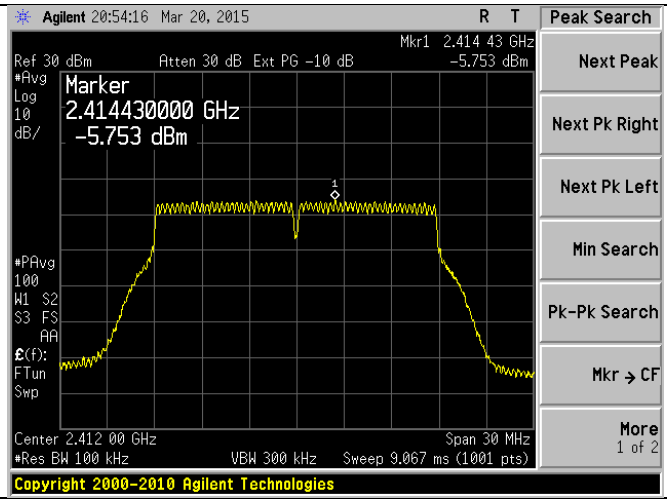



High Channel - PSD

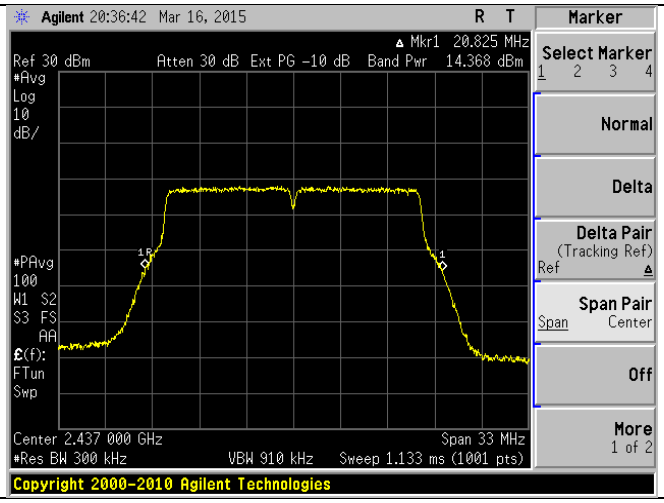
**802.11n**



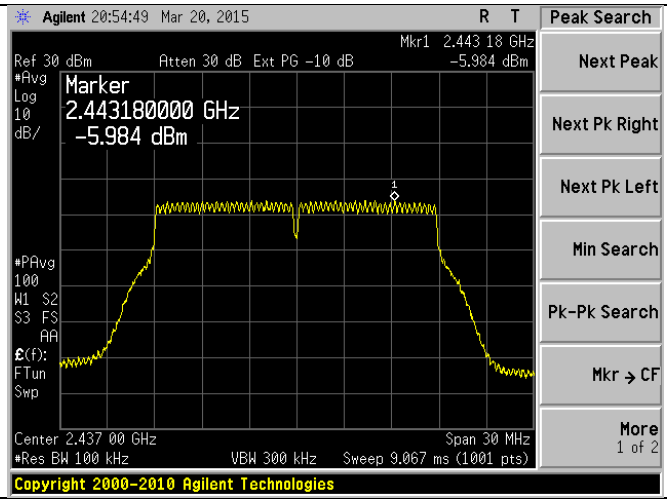

Low Channel - Power



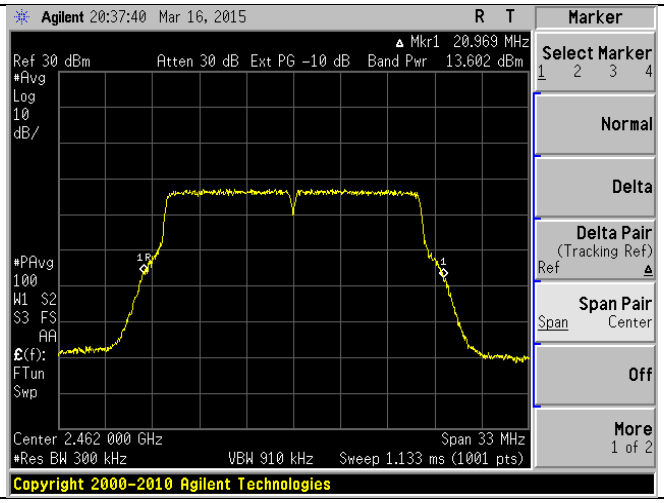

Low Channel - PSD



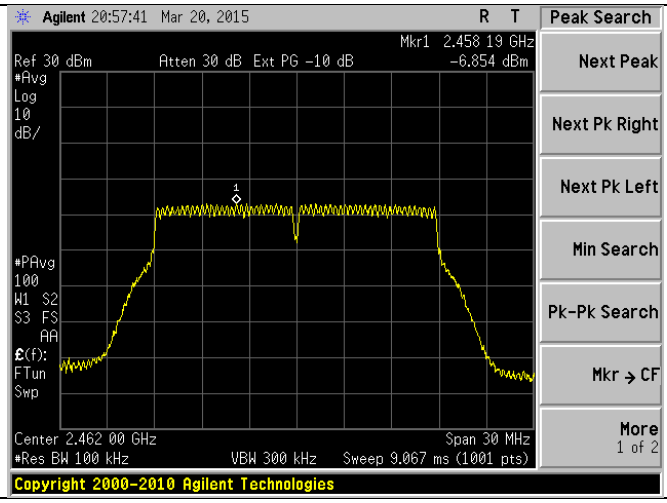

Mid Channel - Power




Mid Channel - PSD




High Channel - Power




High Channel - PSD

### B.1.4 – RF Conducted – Emissions in non-restricted frequency bands

| | |
|---|---|
| Manufacturer | LSR |
| Date | 2-16, 2-17, 3-16, 3-19, 3-20 2015 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | 15.247 / RSS-210 A8 |
| Specific Measurement Procedure | FCC KDB 558074 Section 11.0 – Emissions in non-restricted frequency bands |
| Additional Description of Measurement | Average output power measurements therefore emissions attenuated 30 dBc. |
| Additional Notes | 1. Continuous transmit modulated used for this test.<br>2. See DTS BW plots for 100 kHz reference |

**Table**

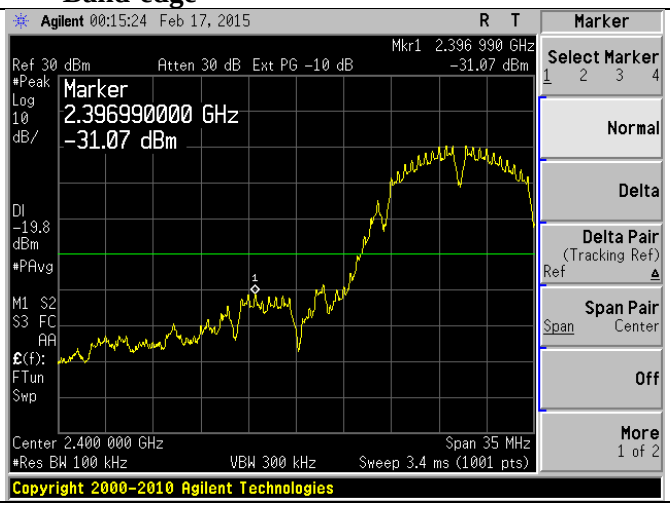
**4-layer board – Antenna 1**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 100 kHz Reference (dBm) |
|---|---|---|---|---|
| b | 1 | 2412 | 8.072 | 10.22 |
| | | 2437 | 7.603 | 10.24 |
| | | 2462 | 8.085 | 9.05 |
| g | 6 | 2412 | 16.360 | 6.09 |
| | | 2437 | 16.366 | 5.96 |
| | | 2462 | 16.383 | 5.32 |
| n | MCS 0 | 2412 | 17.618 | 3.98 |
| | | 2437 | 17.625 | 3.95 |
| | | 2462 | 17.619 | 3.21 |

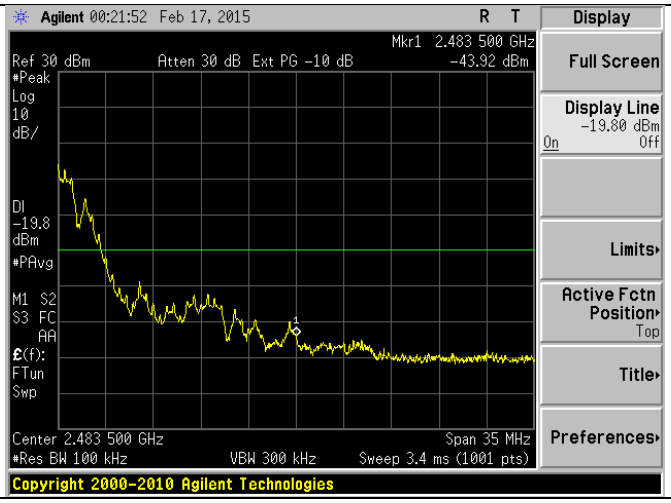
**4-layer board – Antenna 2**

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | 6 dB DTS BW (MHz) | 100 kHz Reference (dBm) |
|---|---|---|---|---|
| b | 1 | 2412 | 8.047 | 10.31 |
| | | 2437 | 8.050 | 10.52 |
| | | 2462 | 8.081 | 8.81 |
| g | 6 | 2412 | 16.411 | 5.51 |
| | | 2437 | 16.391 | 5.99 |
| | | 2462 | 16.381 | 5.01 |
| n | MCS 0 | 2412 | 17.624 | 3.92 |
| | | 2437 | 17.615 | 3.94 |
| | | 2462 | 17.625 | 3.18 |

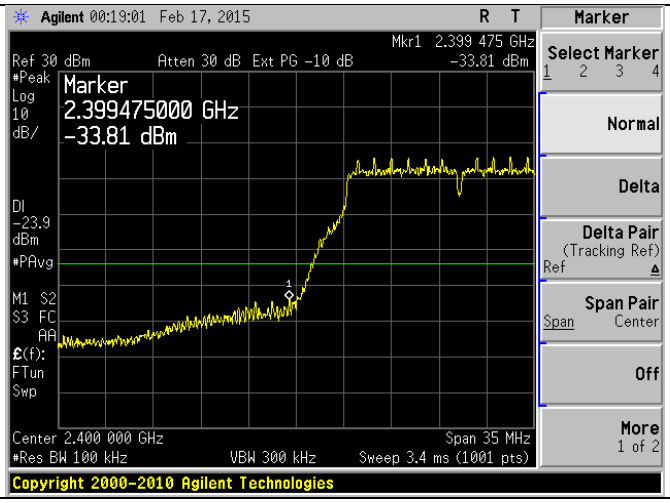
**Plots (4-layer board – Antenna 1)**
**Band-edge**



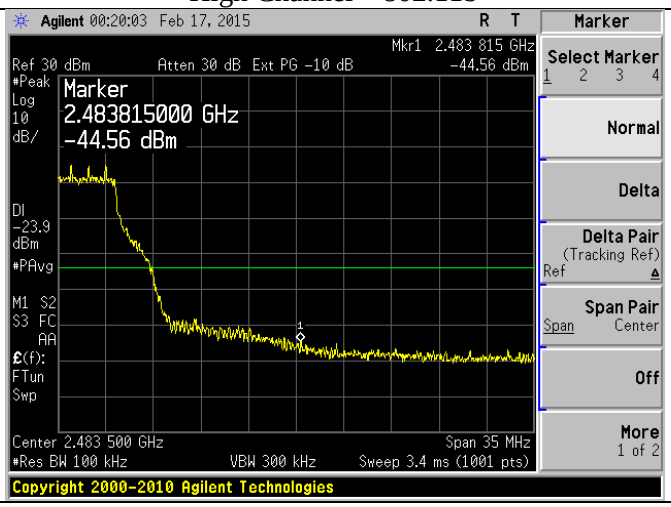

Low Channel – 802.11b



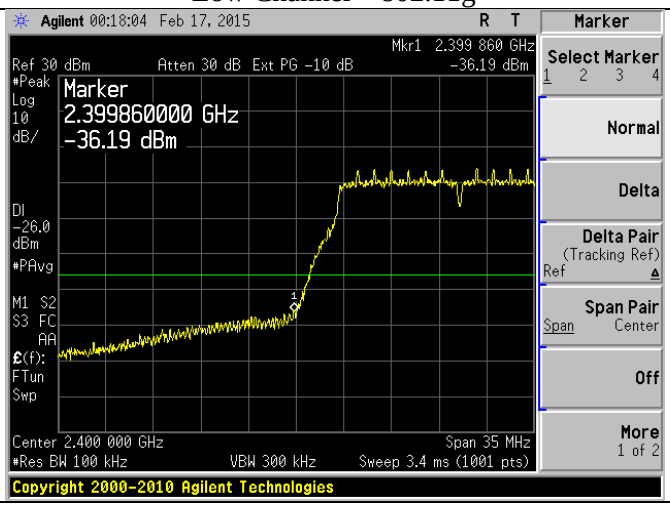

High Channel – 802.11b



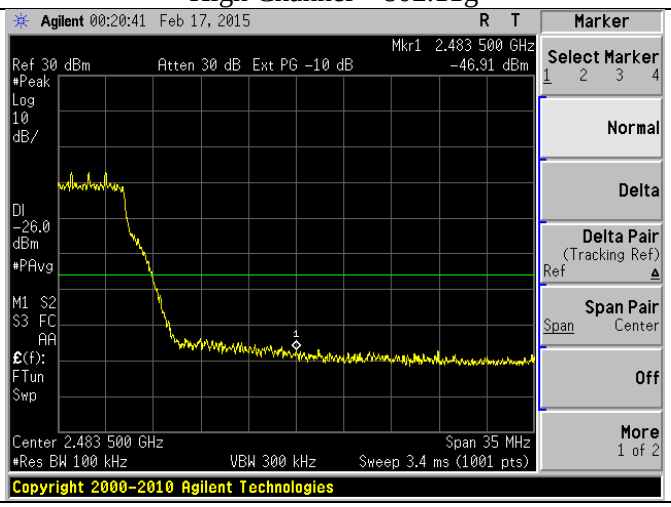

Low Channel – 802.11g




High Channel – 802.11g

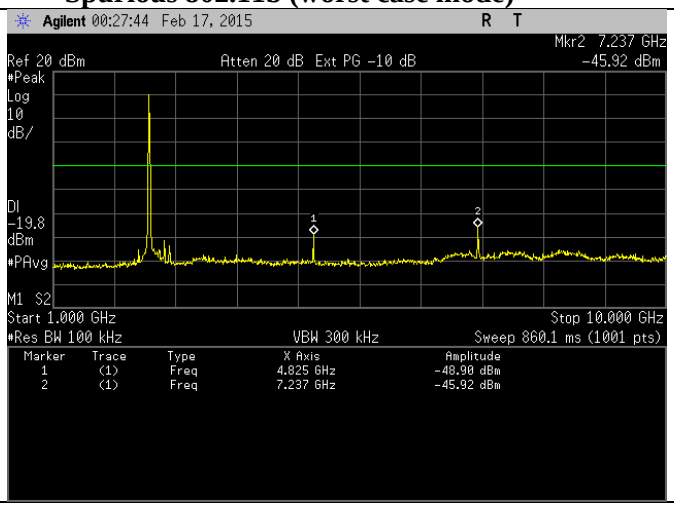



Low Channel – 802.11n

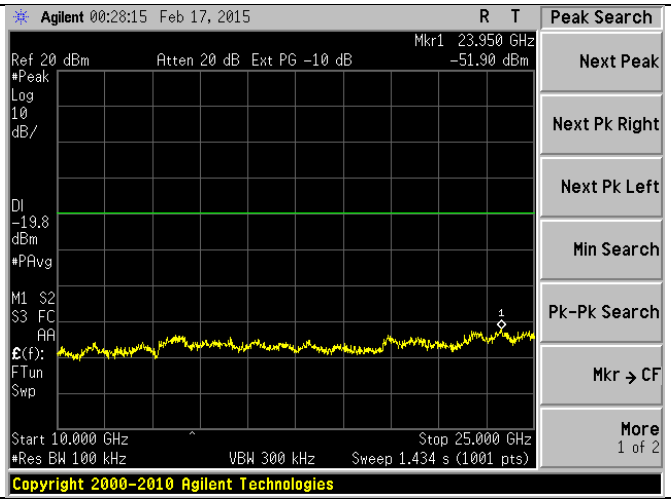



High Channel – 802.11n

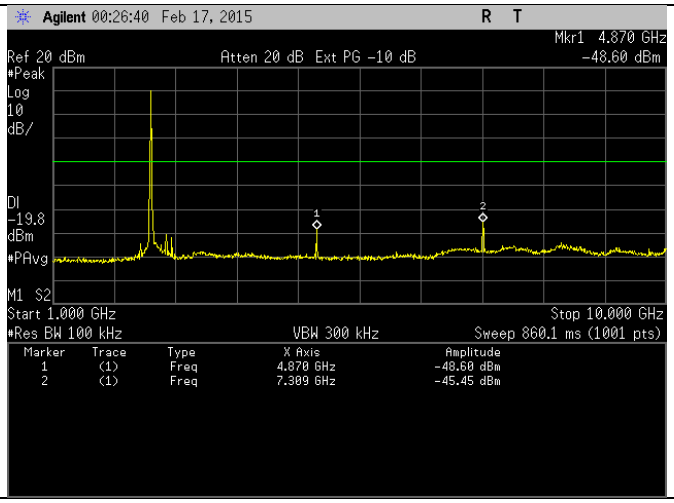
**Spurious 802.11b (worst case mode)**



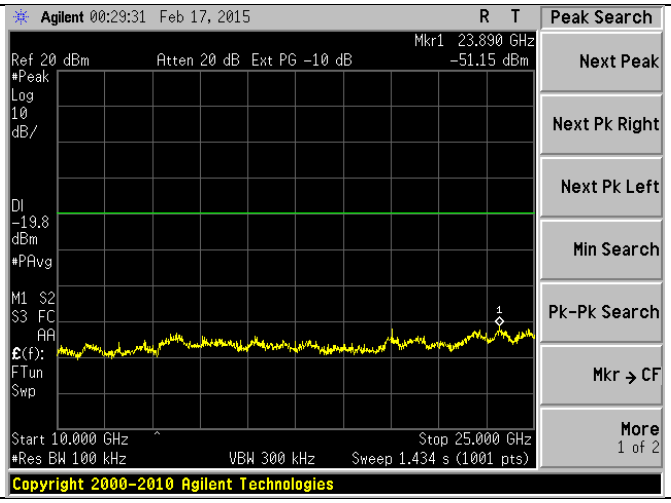

Low Channel 1-10 GHz



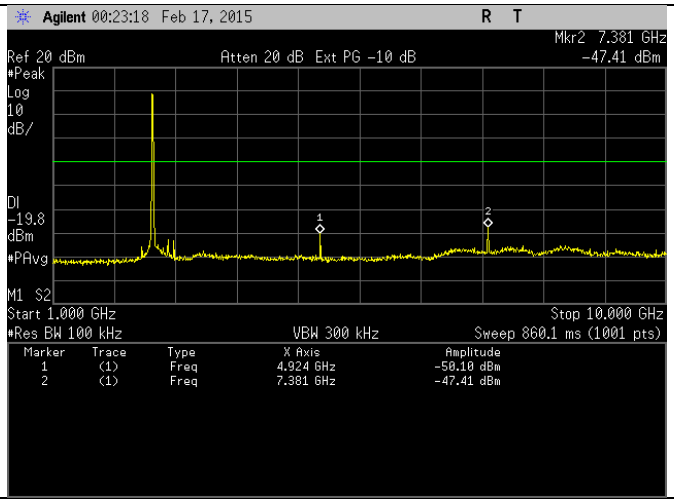

Low Channel 10-25 GHz



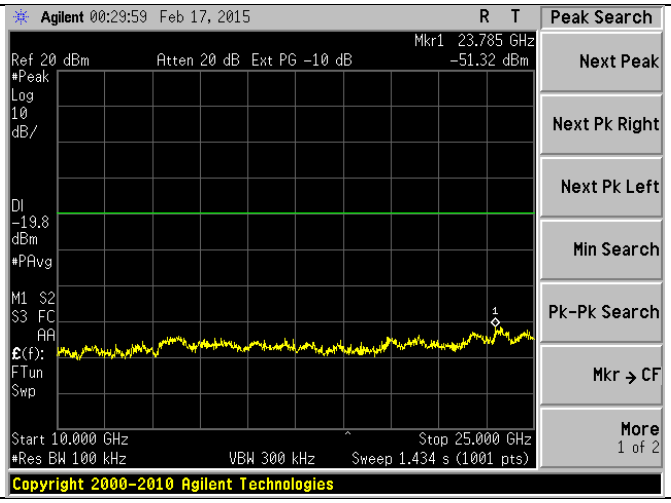

Mid Channel 1-10 GHz




Mid Channel 10-25 GHz

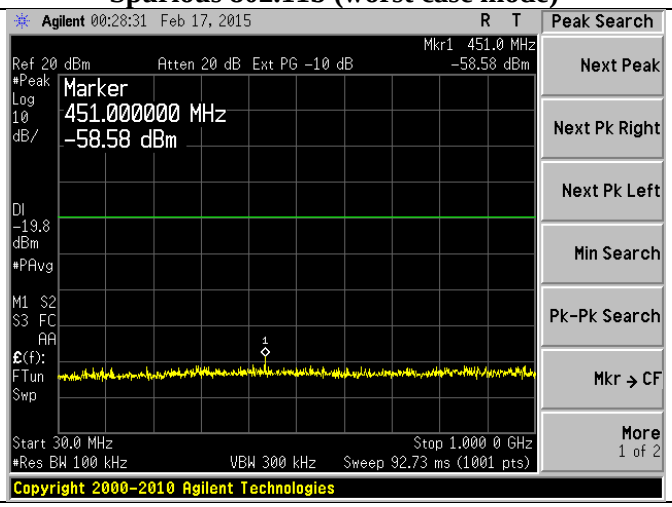



High Channel 1-10 GHz

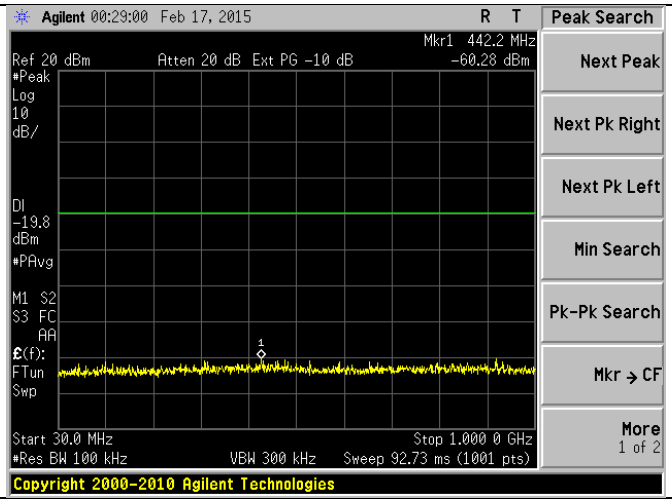



High Channel 10-25 GHz

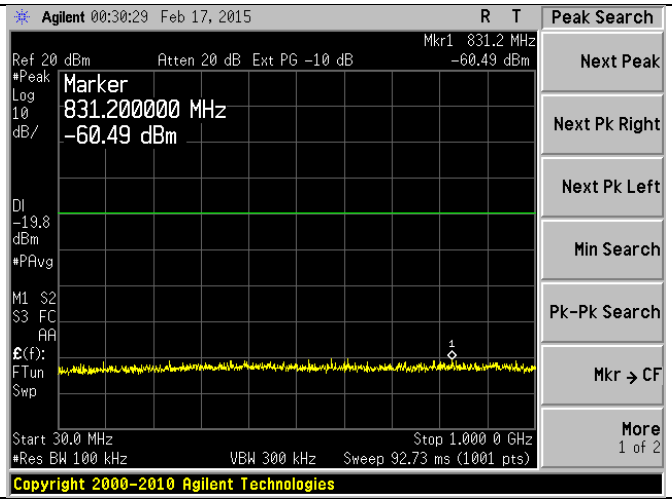
**Spurious 802.11b (worst case mode)**




Low Channel 30-1000 MHz



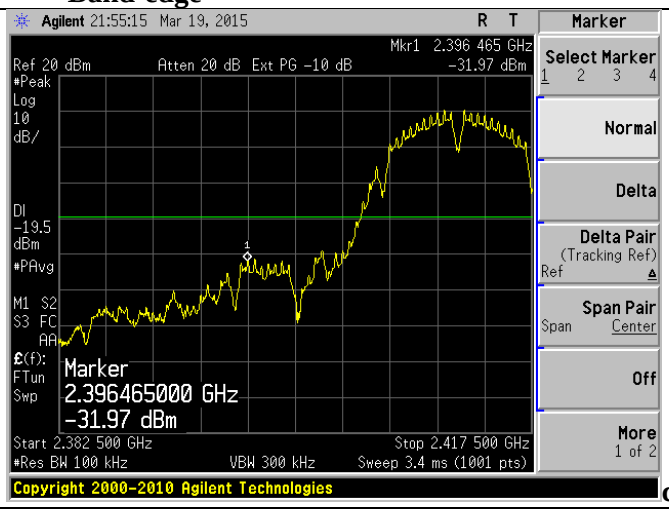

Mid Channel 30-1000 MHz



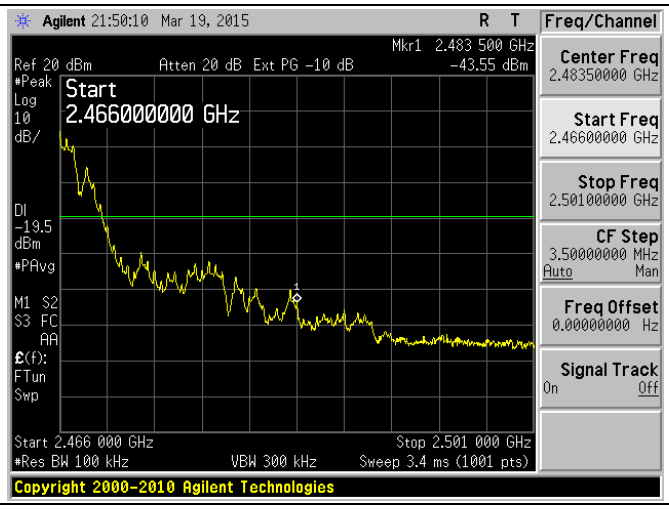

High Channel 30-1000 MHz

**Plots (4-layer board – Antenna 2)**

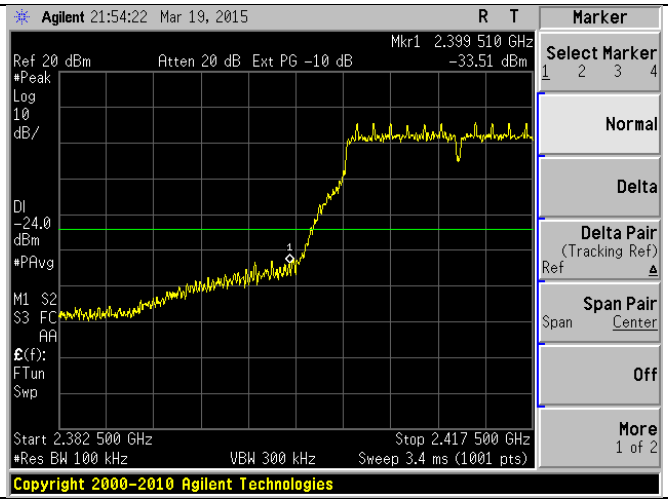
**Band-edge**



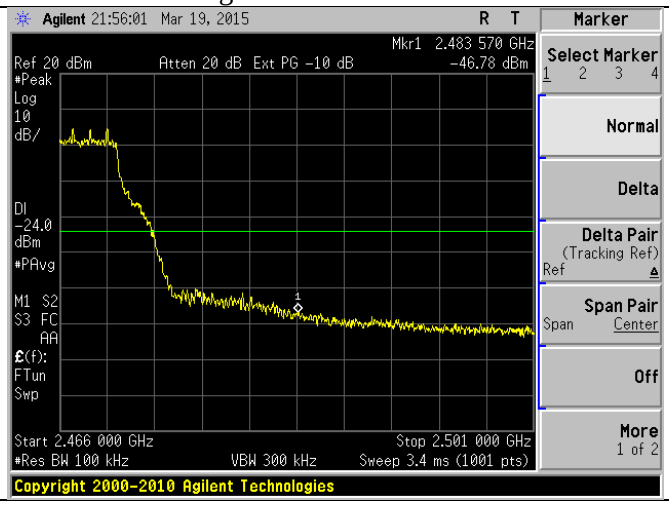

Low Channel – 802.11b



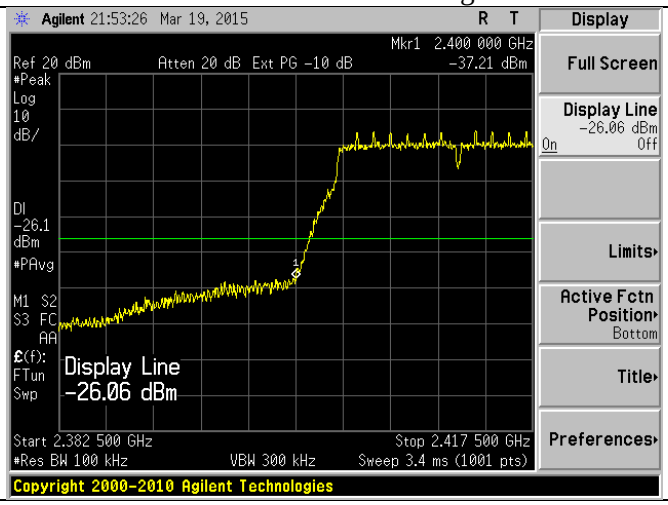

High Channel – 802.11b



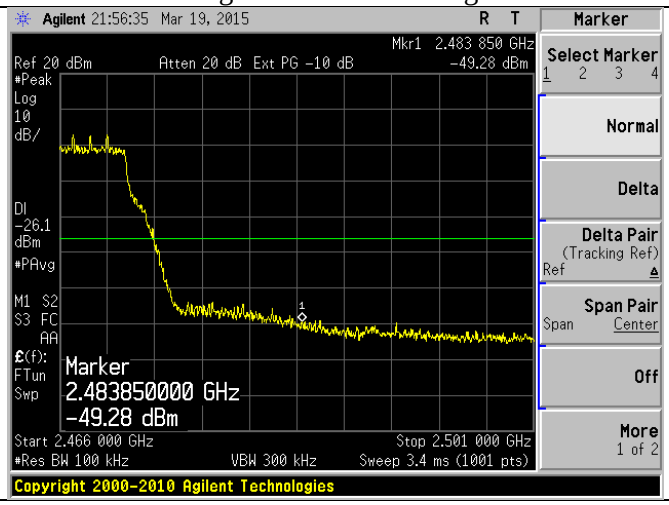

Low Channel – 802.11g




High Channel – 802.11g

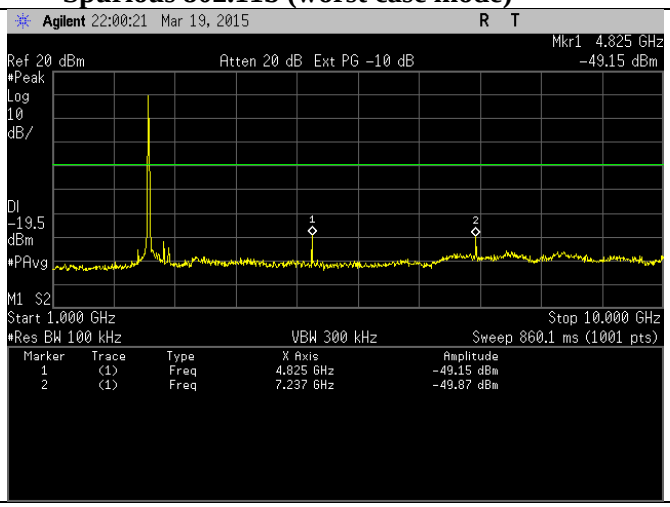



Low Channel – 802.11n

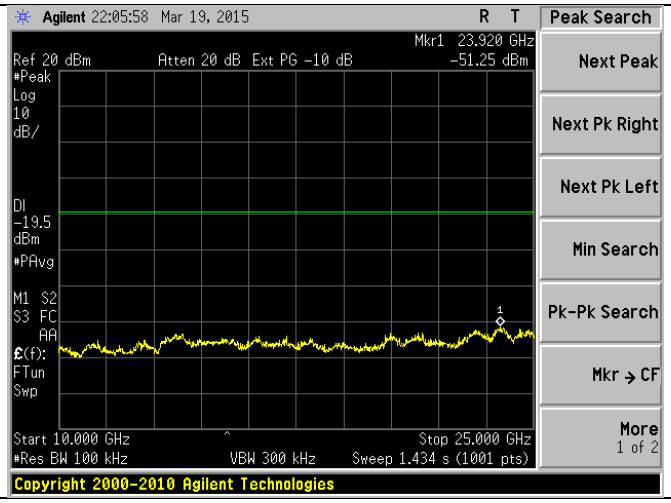



High Channel – 802.11n

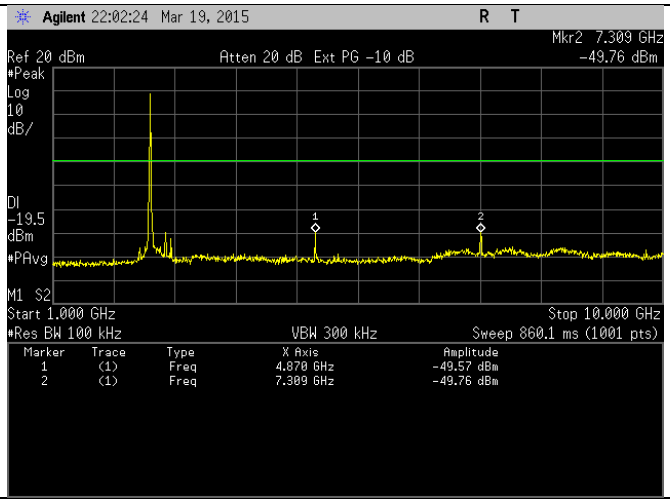
**Spurious 802.11b (worst case mode)**



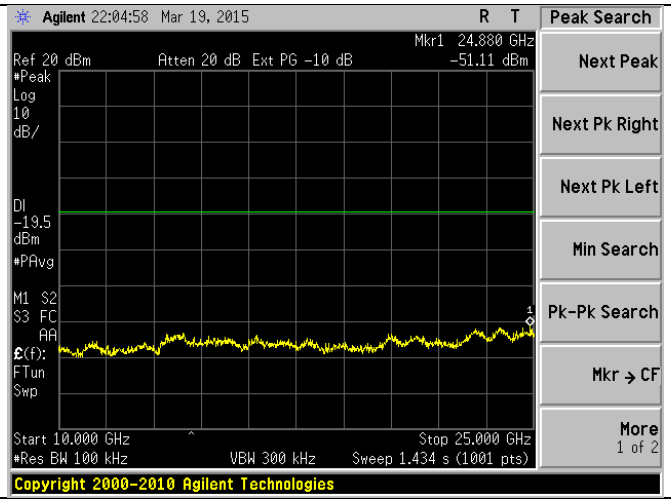

Low Channel 1-10 GHz



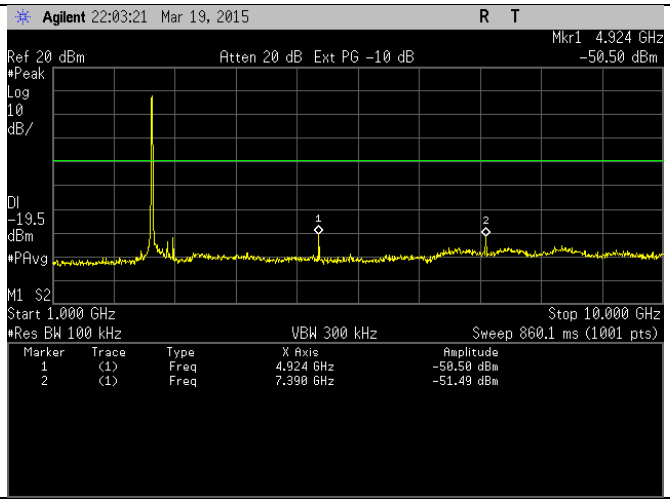

Low Channel 10-25 GHz



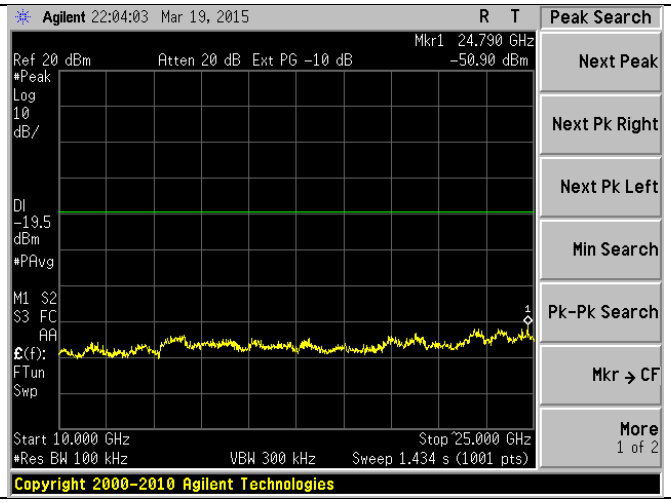

Mid Channel 1-10 GHz




Mid Channel 10-25 GHz

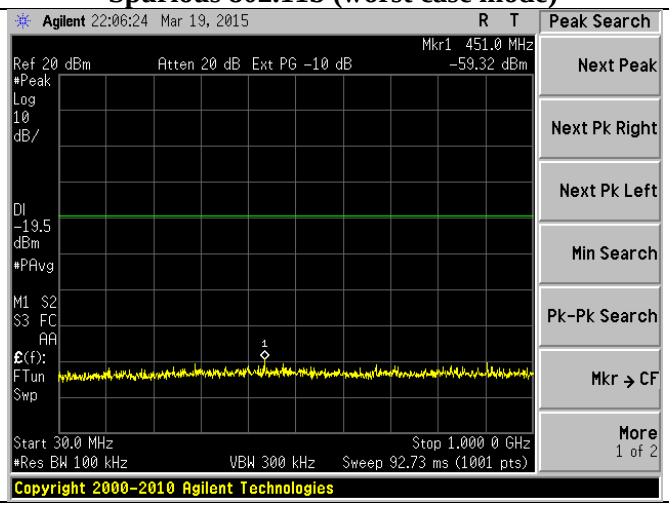



High Channel 1-10 GHz

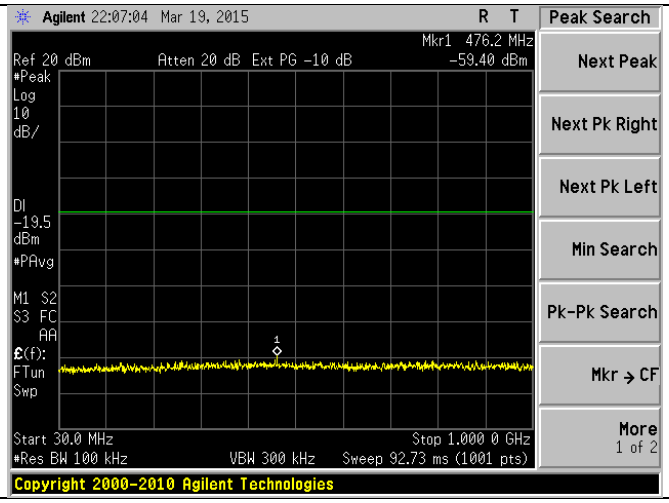



High Channel 10-25 GHz

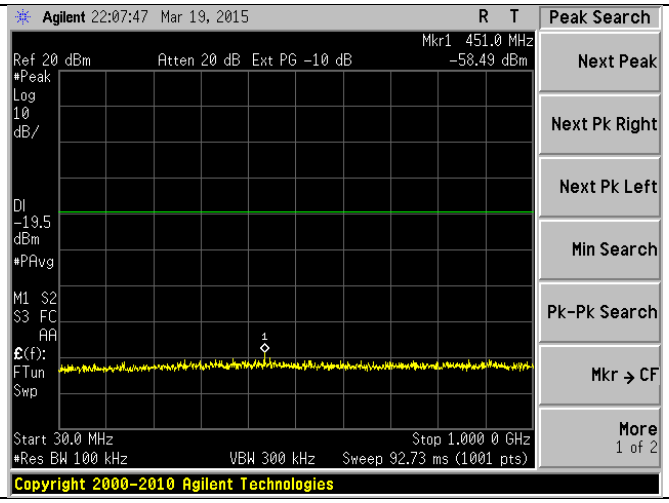
**Spurious 802.11b (worst case mode)**




Low Channel 30-1000 MHz



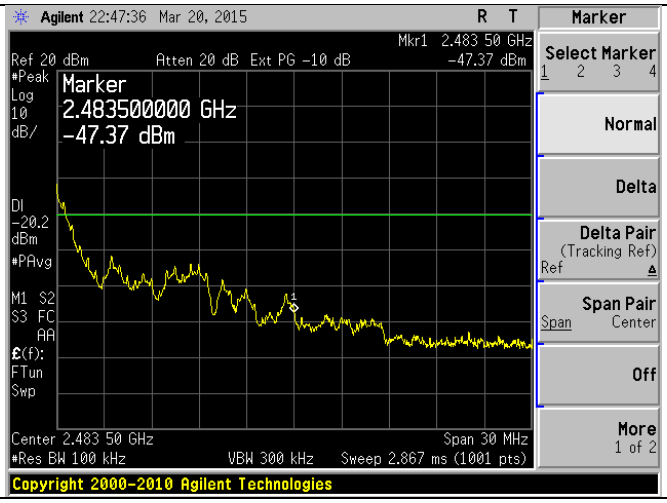

Mid Channel 30-1000 MHz



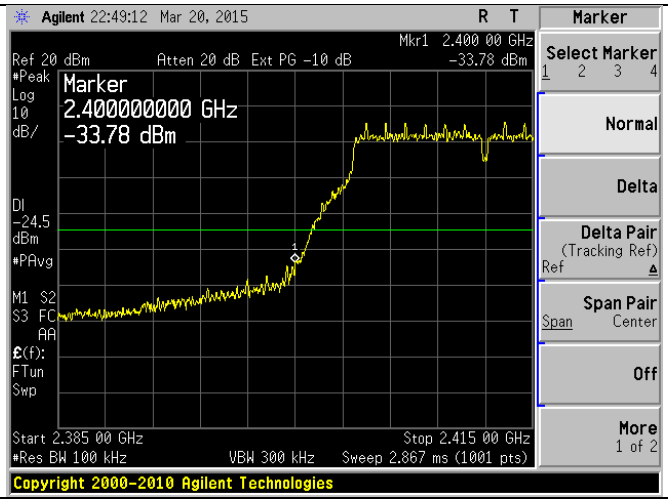

High Channel 30-1000 MHz

**Plots (2-layer board – Antenna 1)**
**Band-edge**

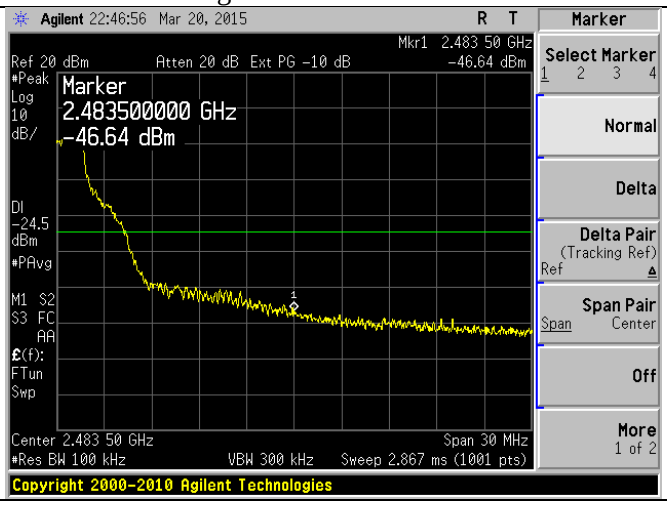

Low Channel – 802.11b



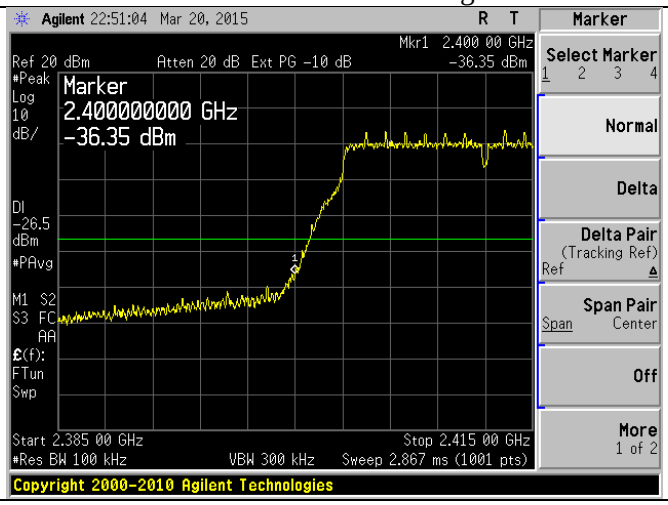

High Channel – 802.11b



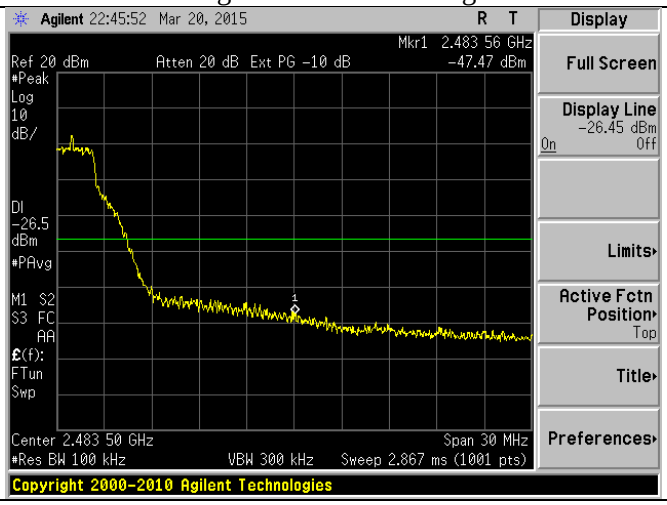

Low Channel – 802.11g




High Channel – 802.11g

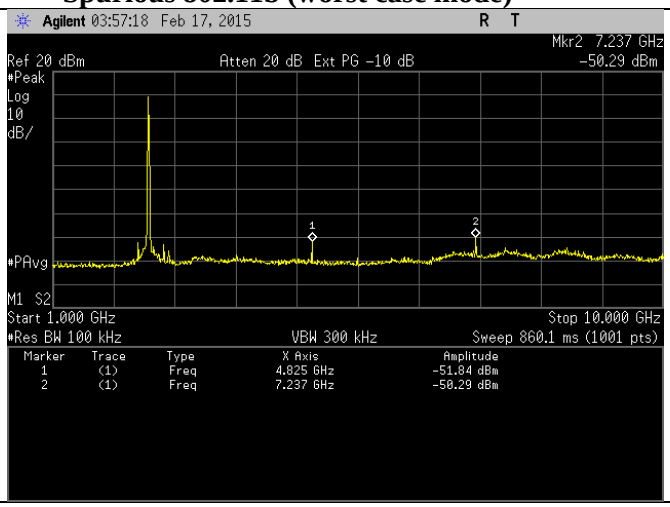



Low Channel – 802.11n

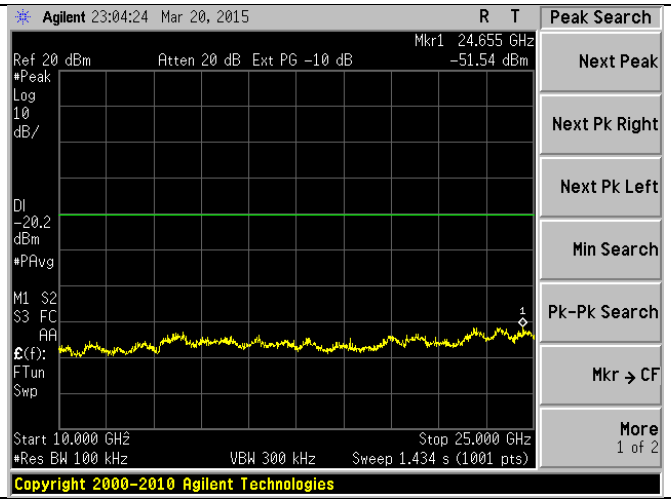



High Channel – 802.11n

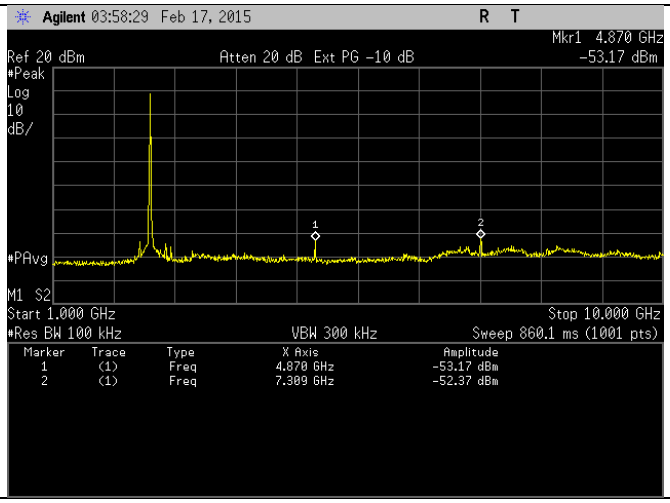
**Spurious 802.11b (worst case mode)**



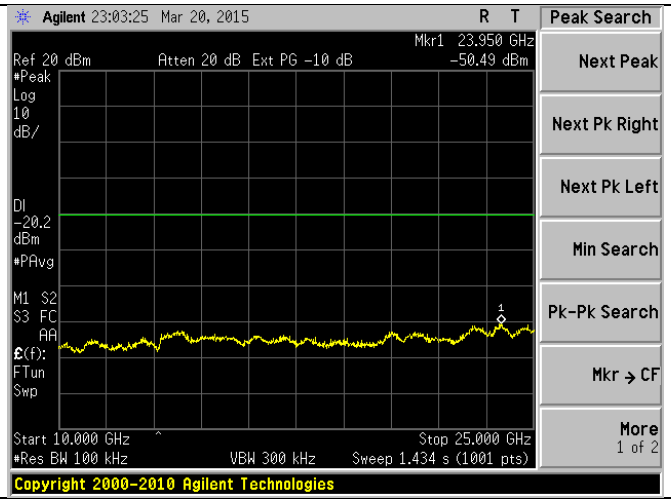

Low Channel 1-10 GHz



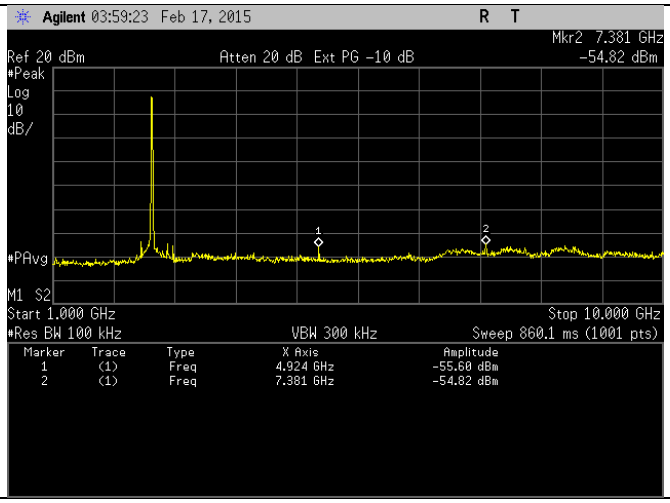

Low Channel 10-25 GHz



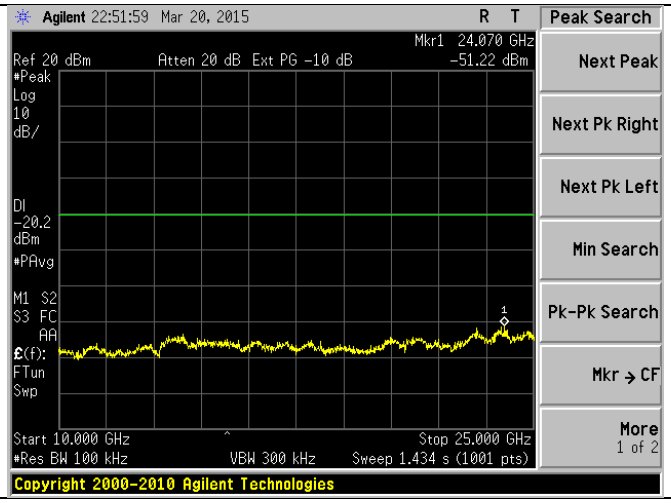

Mid Channel 1-10 GHz




Mid Channel 10-25 GHz

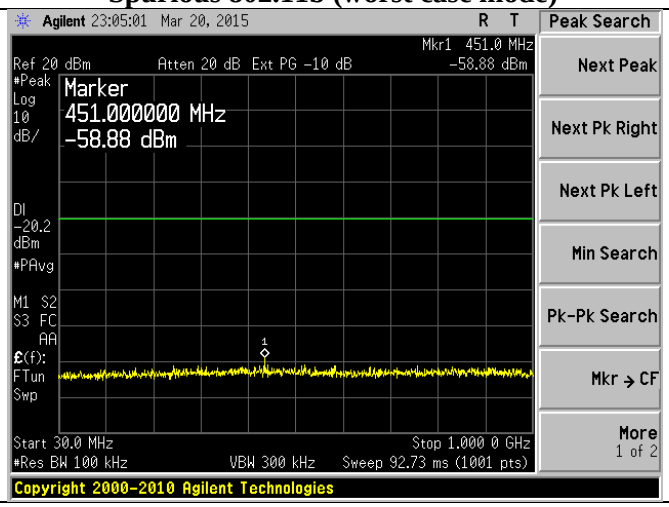



High Channel 1-10 GHz

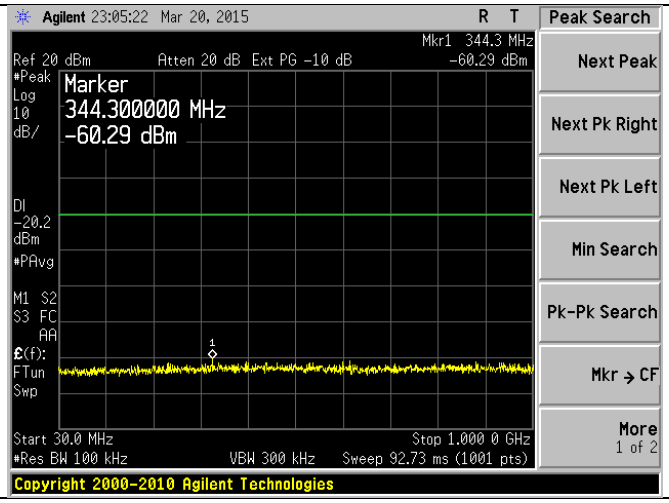



High Channel 10-25 GHz

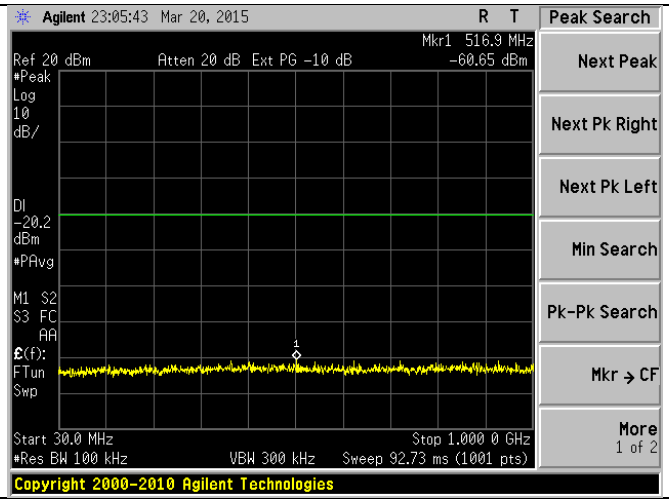
**Spurious 802.11b (worst case mode)**




Low Channel 30-1000 MHz

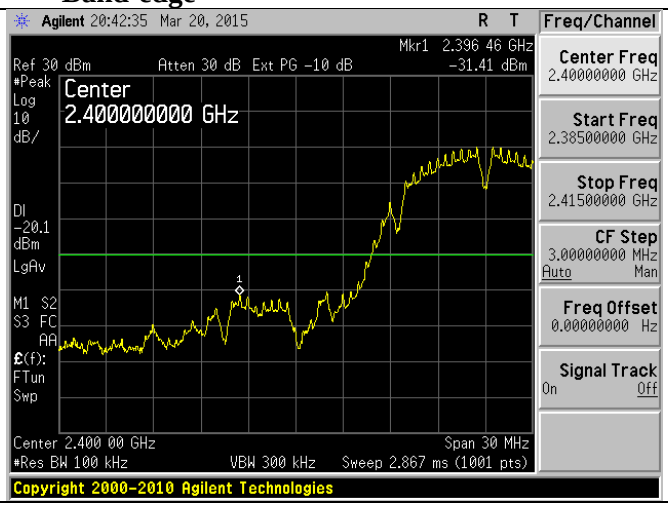



Mid Channel 30-1000 MHz

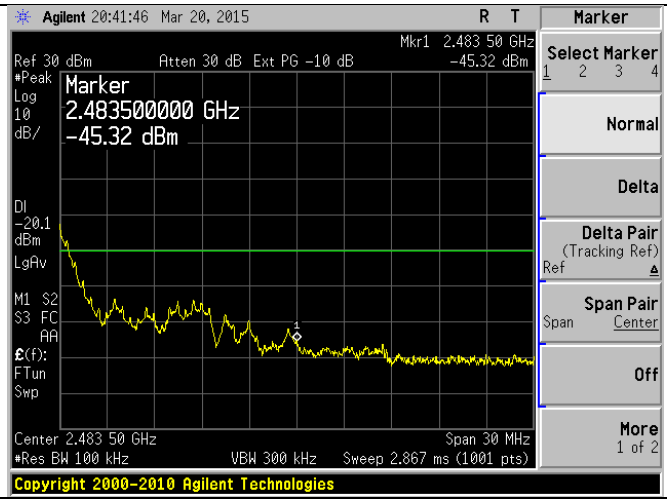



High Channel 30-1000 MHz

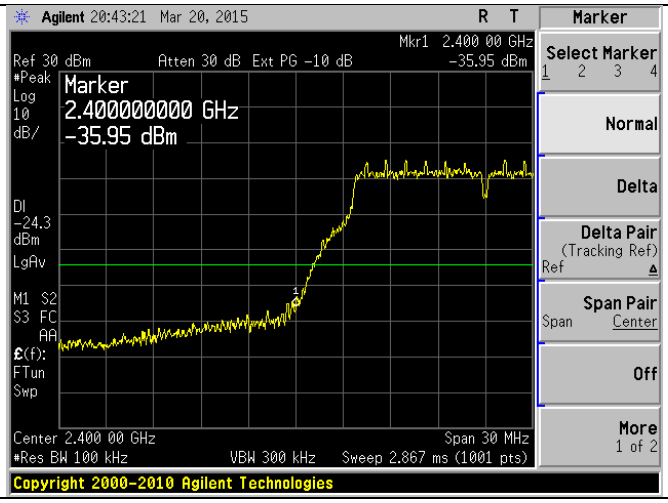
**Plots (2-layer board – Antenna 2)**
**Band-edge**



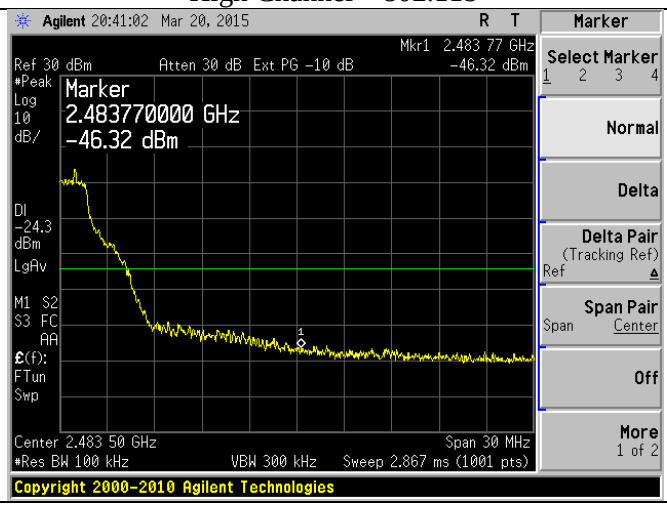

Low Channel – 802.11b



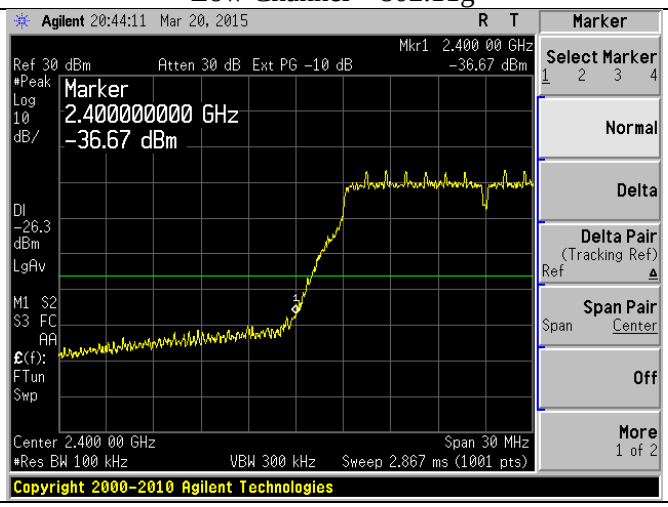

High Channel – 802.11b



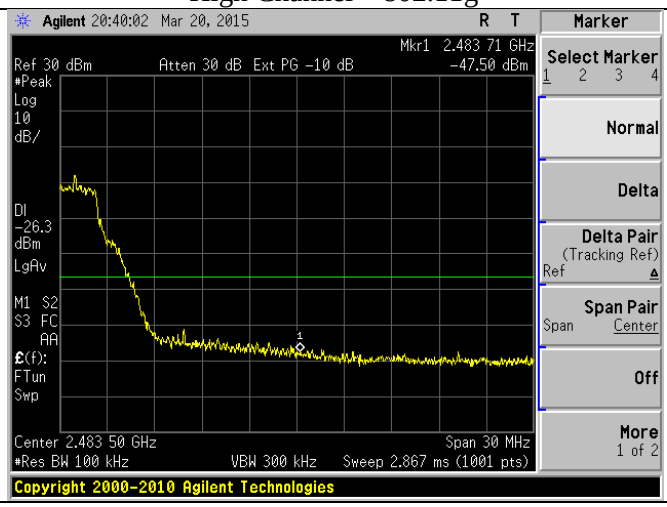

Low Channel – 802.11g




High Channel – 802.11g

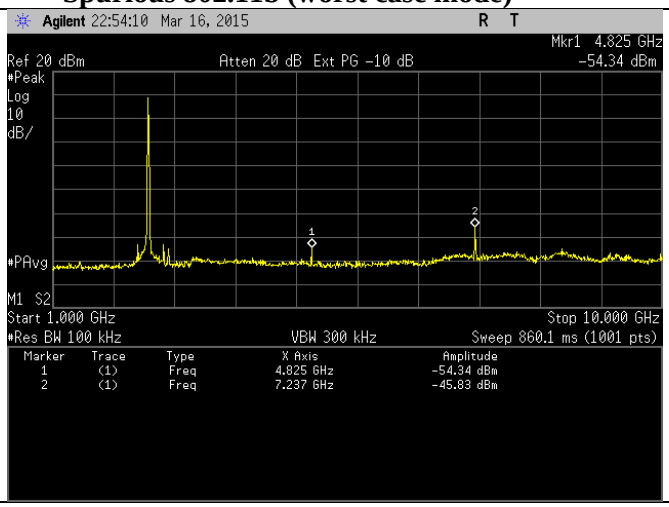



Low Channel – 802.11n

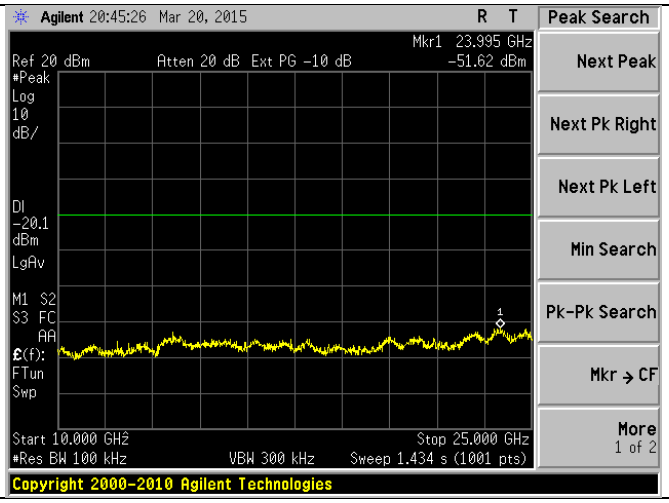



High Channel – 802.11n

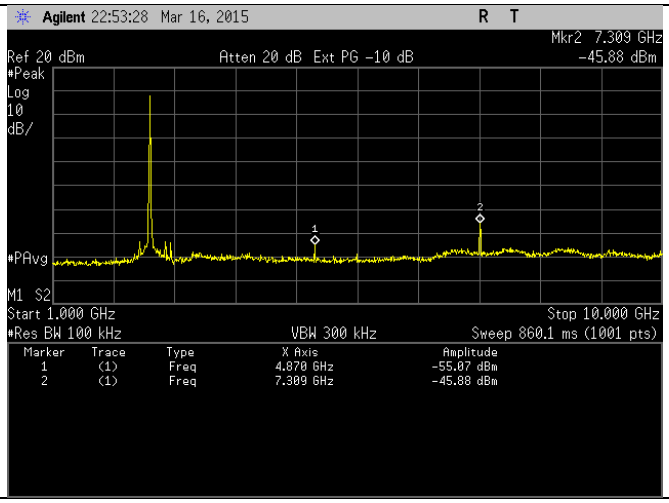
**Spurious 802.11b (worst case mode)**



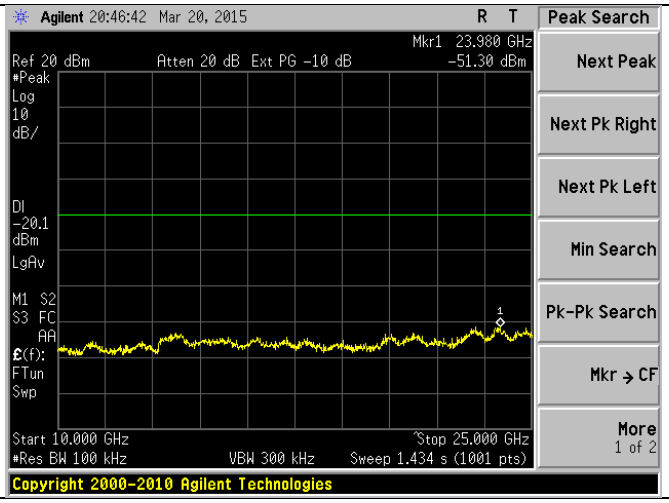

Low Channel 1-10 GHz



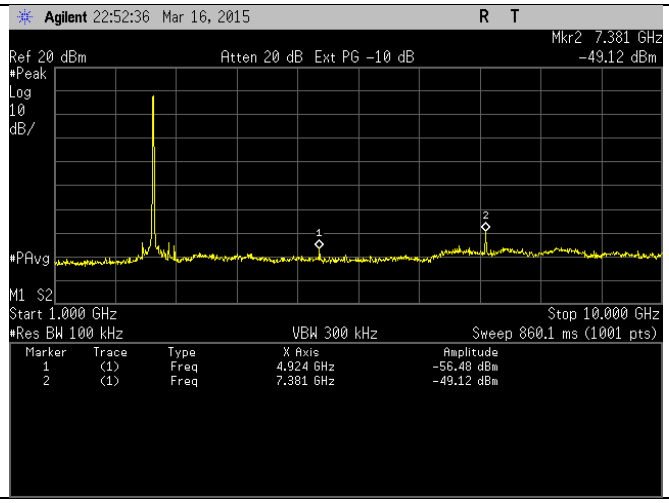

Low Channel 10-25 GHz



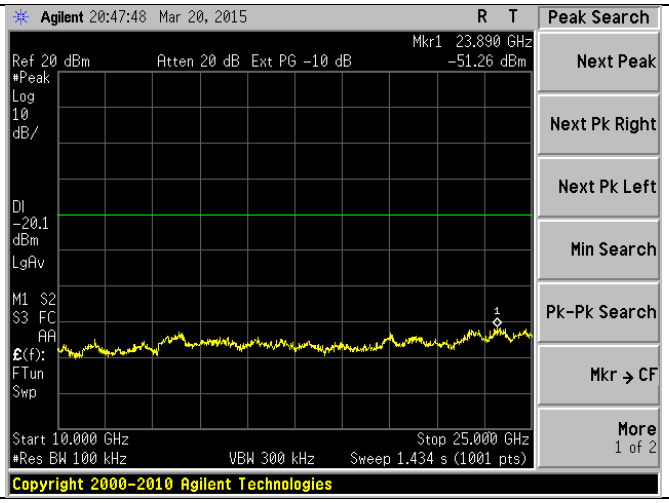

Mid Channel 1-10 GHz




Mid Channel 10-25 GHz

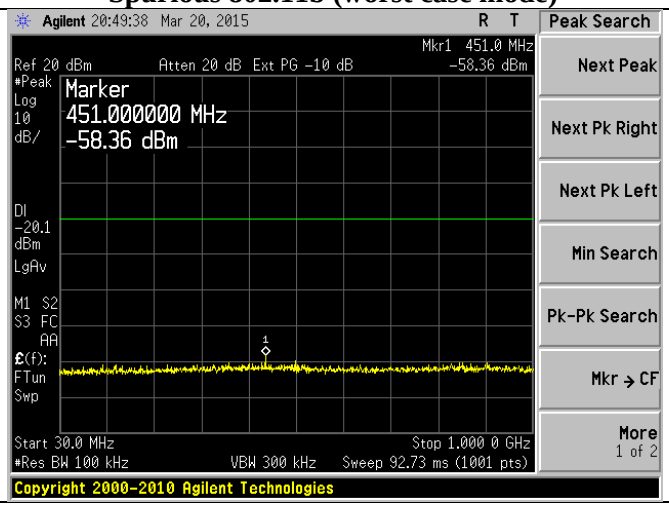



High Channel 1-10 GHz

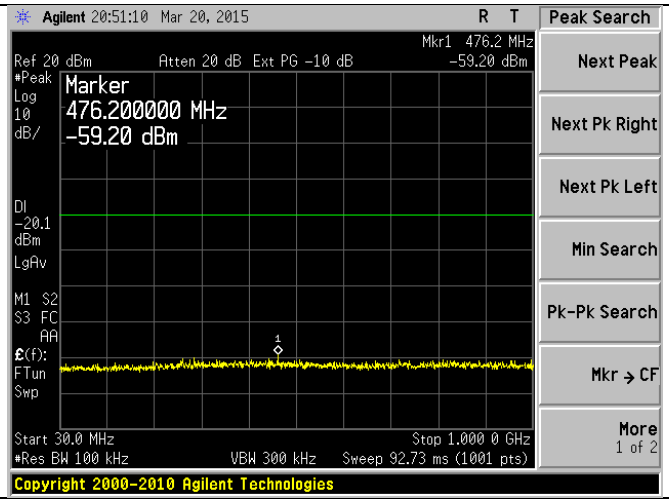



High Channel 10-25 GHz

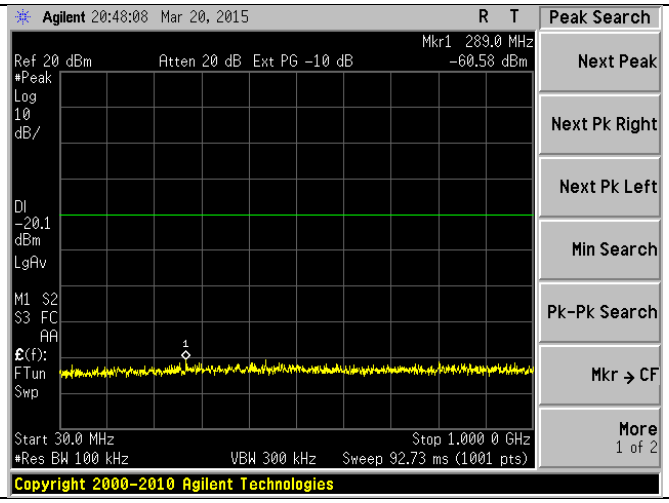
**Spurious 802.11b (worst case mode)**




Low Channel 30-1000 MHz




Mid Channel 30-1000 MHz




High Channel 30-1000 MHz

### B.1.5 – RF Conducted – Emissions in restricted frequency bands

| | |
|---|---|
| Manufacturer | LSR |
| Date | 2-16, 2-17, 3-16, 3-17, 3-19, 3-20 2015 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | 15.247 / RSS-210 A8 |
| Specific Measurement Procedure | FCC KDB 558074 Section 12.0 Emissions in restricted frequency bands<br>Section 12.2.5.2 (Average Measurements) |
| Additional Description of Measurement | RF Conducted Measurement<br>Maximum antenna gain 2.0 dBi |
| Additional Notes | 1. Continuous transmit modulated used for this test. |

### Lower Band-Edge (4-layer board – Antenna 1)

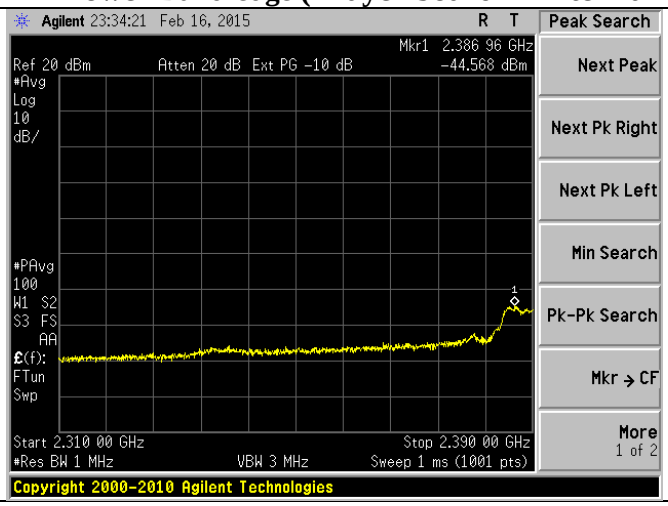
Average

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38996 | -44.568 | 2.00 | 0.02 | 95.26 | 52.70 | 54 | 1.3 |
| g | 6 | 2.38984 | -43.934 | | 0.12 | | 53.44 | | 0.6 |
| n | MCS 0 | 2.38984 | -44.294 | | 0.13 | | 53.09 | | 0.9 |

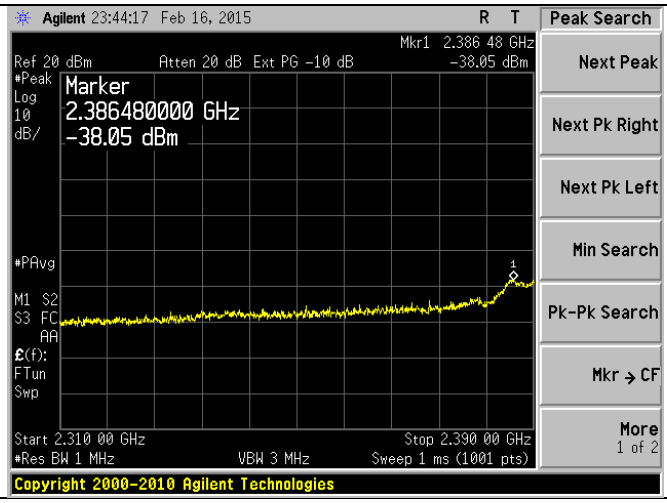
Peak

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38648 | -38.05 | 2.00 | 95.26 | 59.21 | 74 | 14.8 |
| g | 6 | 2.39000 | -33.40 | | | 63.86 | | 10.1 |
| n | MCS0 | 2.38984 | -28.88 | | | 68.38 | | 5.6 |

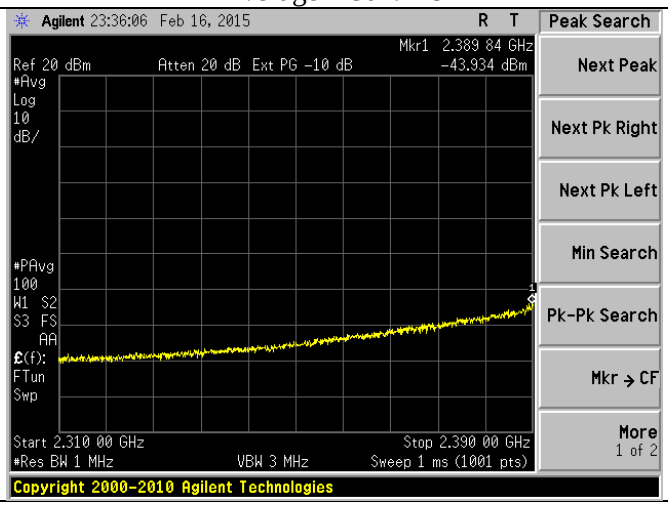
## Lower Band-edge (4-layer board – Antenna 1)



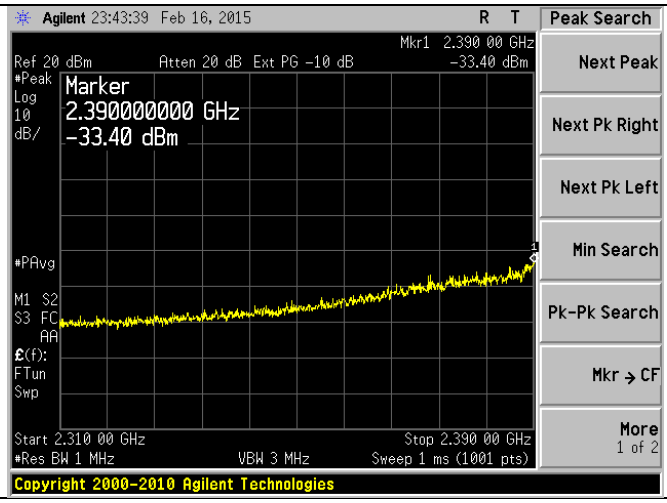

Average – 802.11b



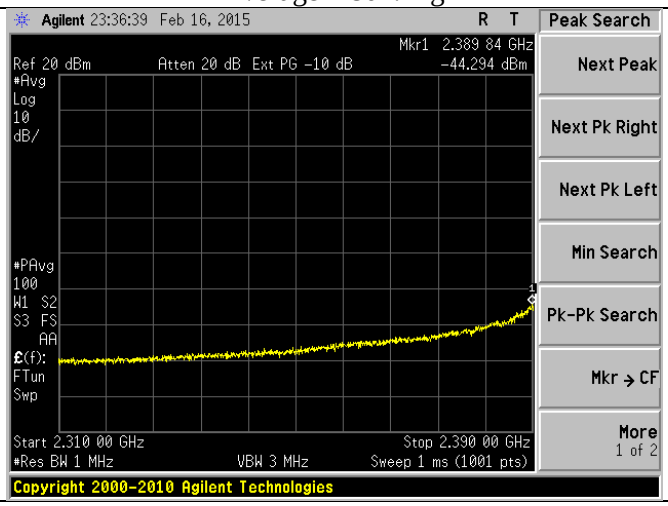

Peak – 802.11b



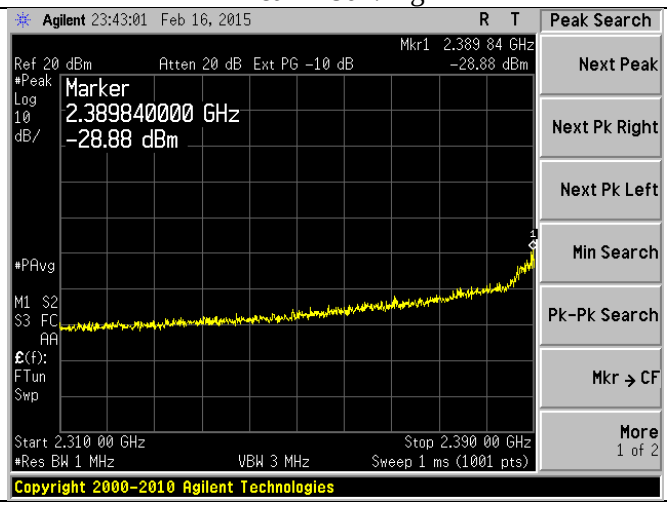

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

**Upper Band-Edge (4-layer board – Antenna 1)**

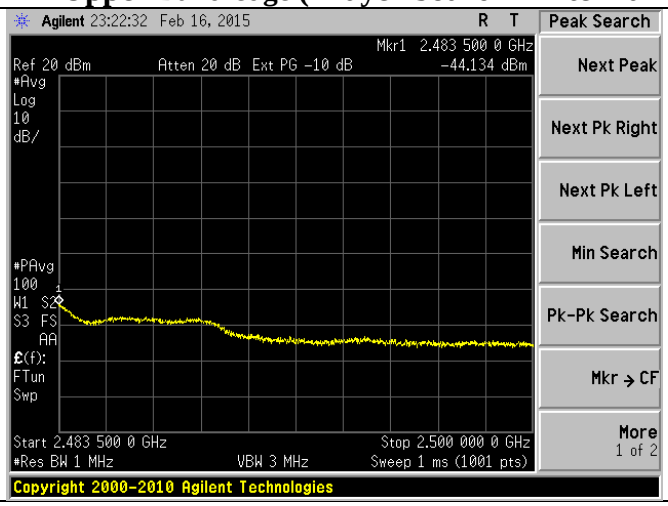
Average

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4835 | -44.134 | 2.00 | 0.02 | 95.26 | 53.14 | 54 | 0.9 |
| g | 6 | 2.4836 | -45.905 | | 0.12 | | 51.47 | | 2.5 |
| n | MCS 0 | 2.4837 | -49.595 | | 0.13 | | 47.79 | | 6.2 |

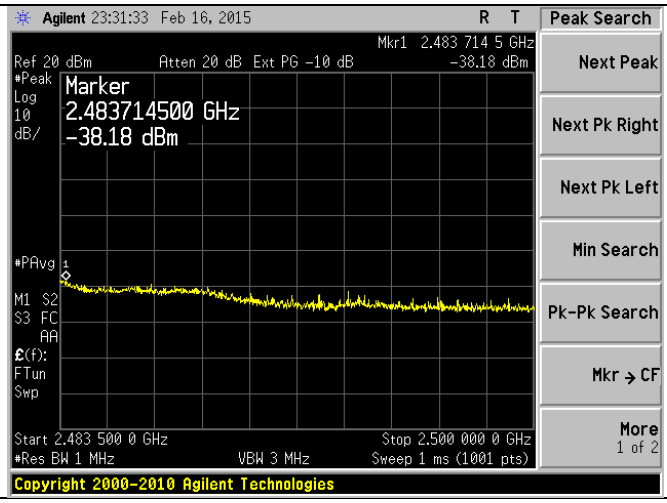
Peak

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4837 | -38.18 | 2.00 | 95.26 | 59.08 | 74 | 14.9 |
| g | 6 | 2.4840 | -32.33 | | | 64.93 | | 9.1 |
| n | MCS0 | 2.4837 | -37.03 | | | 60.23 | | 13.8 |

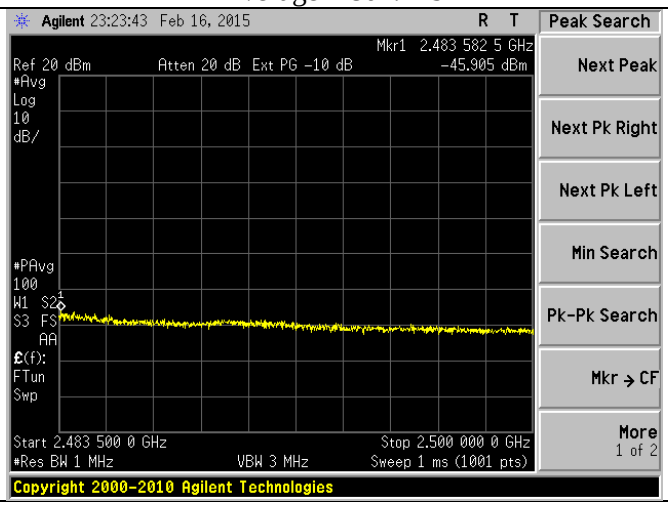
## Upper Band-edge (4-layer board – Antenna 1)



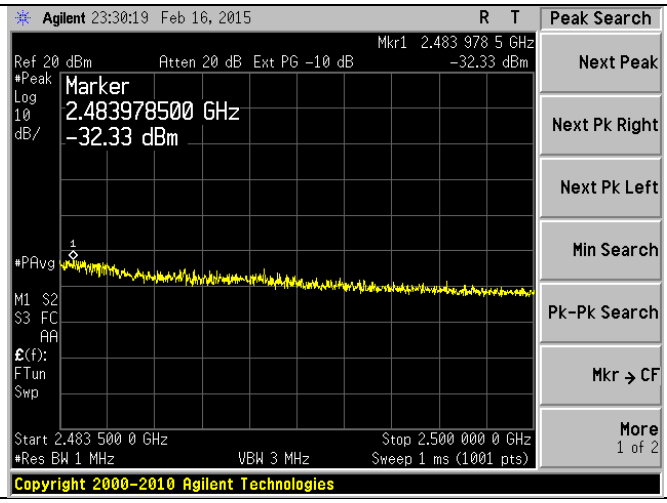

Average – 802.11b



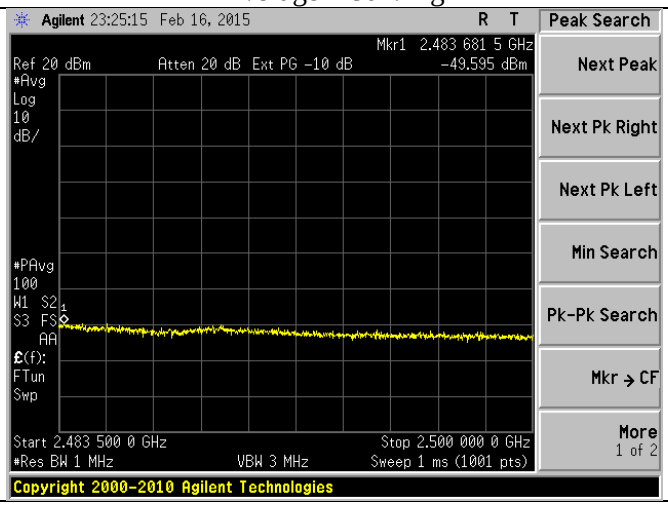

Peak – 802.11b



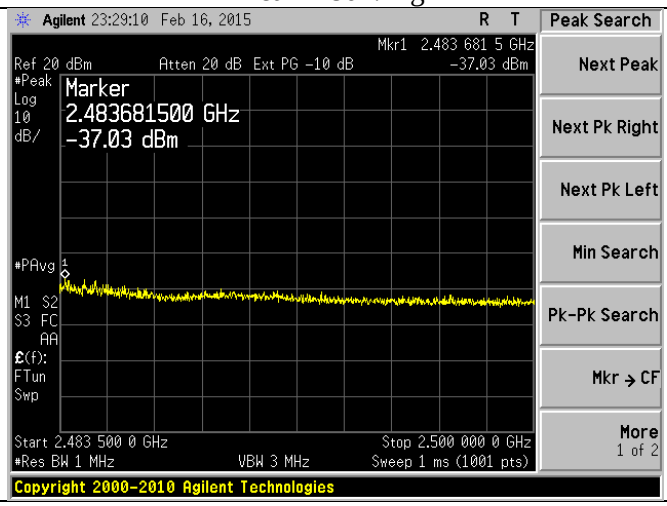

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

**Harmonics**
**4-layer board – Antenna 1**
**802.11b (worst case mode)**

**2nd Harmonic**
Average

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 4824.18 | -49.534 | 2.00 | 0.02 | 95.26 | 47.74 | 54 | 6.3 |
| | | 4873.90 | -49.494 | | 0.12 | | 47.88 | | 6.1 |
| | | 4924.10 | -51.220 | | 0.13 | | 46.17 | | 7.8 |

Peak

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 4824.19 | -44.36 | 2.00 | 95.26 | 52.90 | 74 | 21.1 |
| | | 4873.82 | -44.69 | | | 52.57 | | 21.4 |
| | | 4924.00 | -45.21 | | | 52.05 | | 22.0 |

**3rd Harmonic**
Average

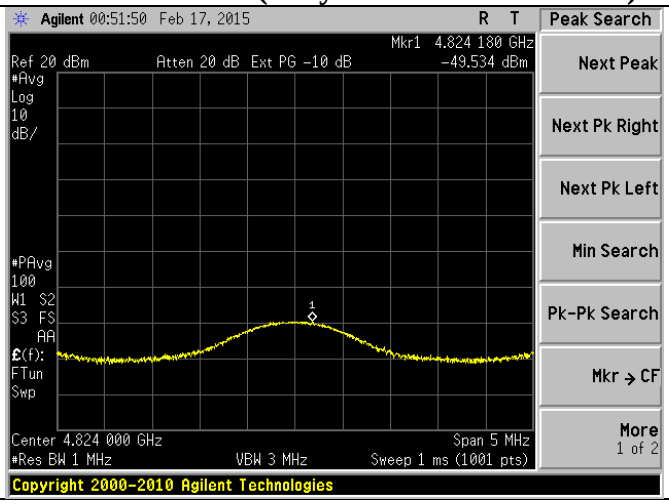
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 0.02 | 95.26 | - | 54 | - |
| | | 7309.85 | -45.071 | | 0.12 | | 52.30 | | 1.7 |
| | | 7385.21 | -47.167 | | 0.13 | | 50.22 | | 3.8 |

Peak

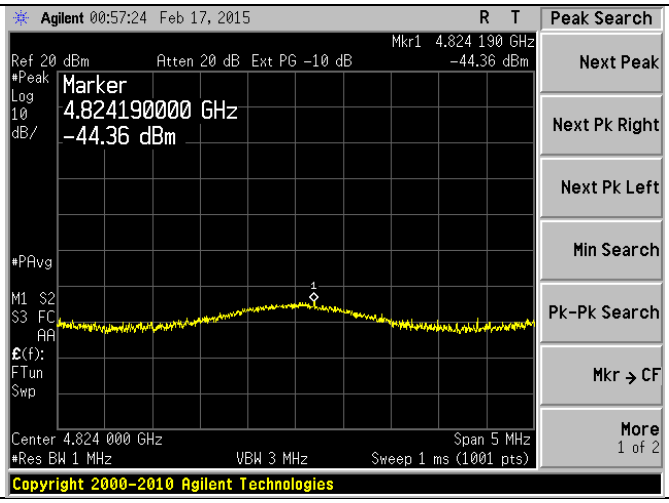
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 95.26 | - | 74 | - |
| | | 7309.64 | -39.52 | | | 57.74 | | 16.3 |
| | | 7384.97 | -41.02 | | | 56.24 | | 17.8 |

**Note:** Low Channel 3rd harmonic not in restricted band.

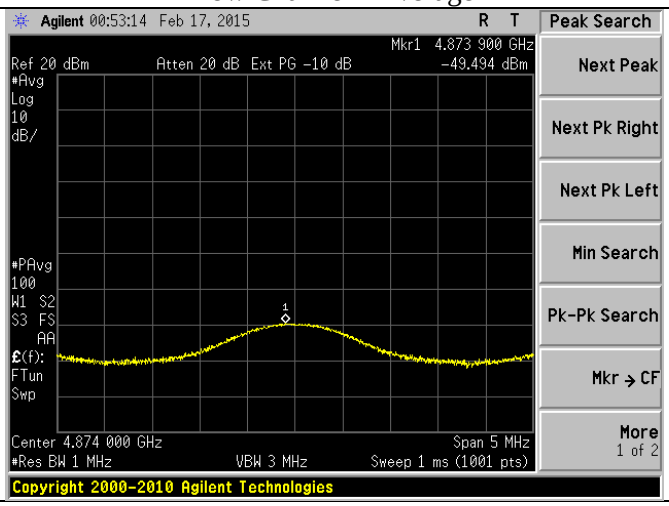
## 2nd Harmonic (4-layer board – Antenna 1)



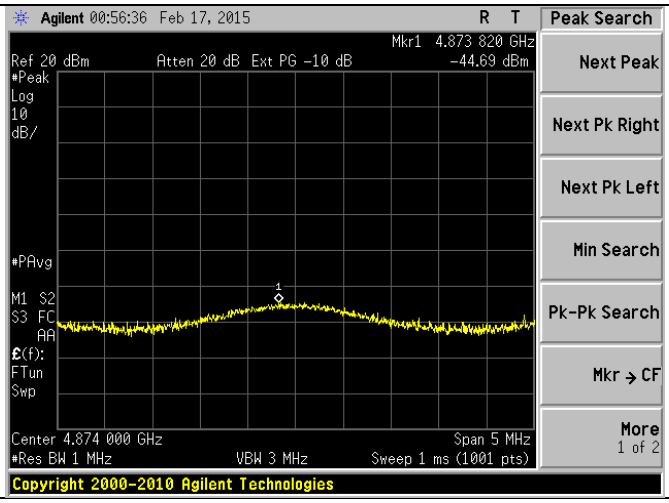

Low Channel - Average



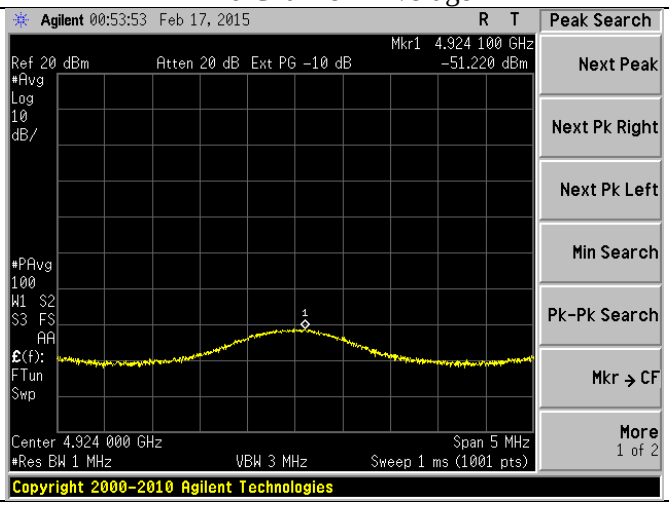

Low Channel - Peak



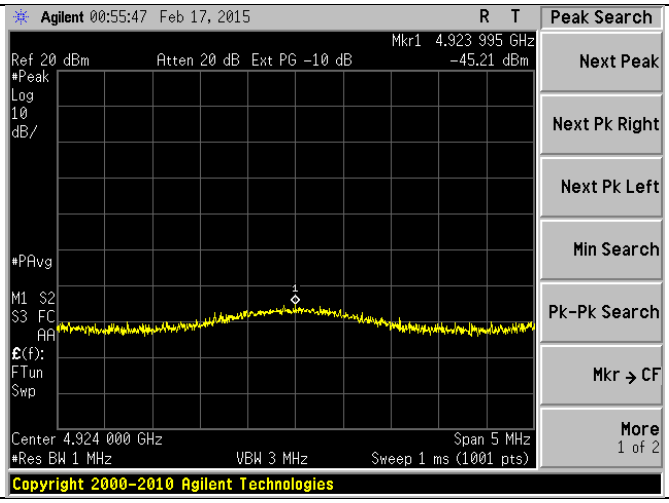

Mid Channel - Average




Mid Channel - Peak

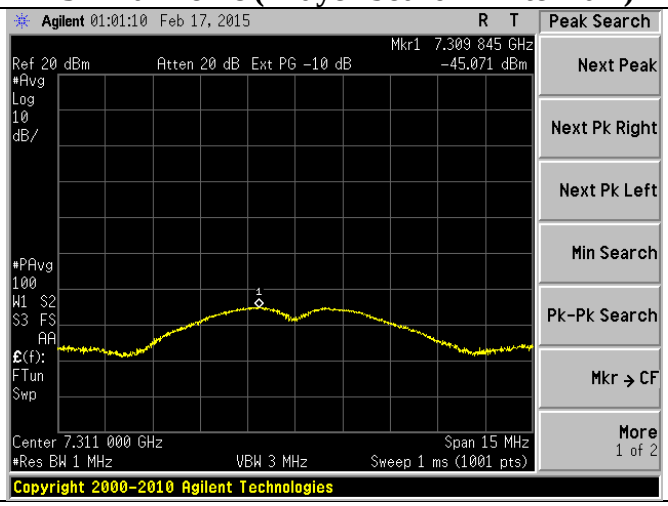



High Channel - Average

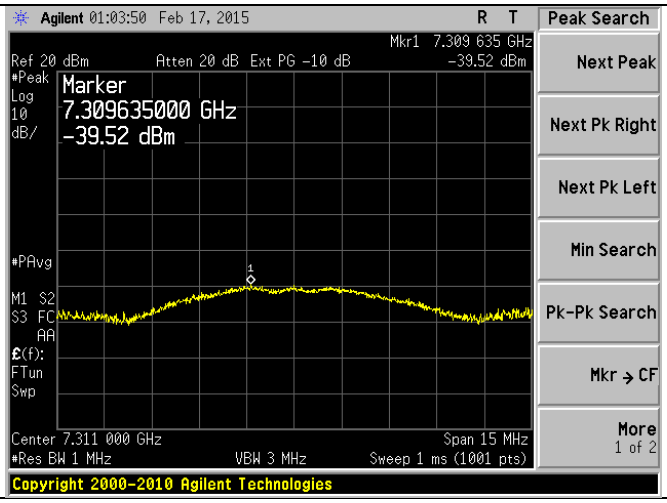



High Channel - Peak

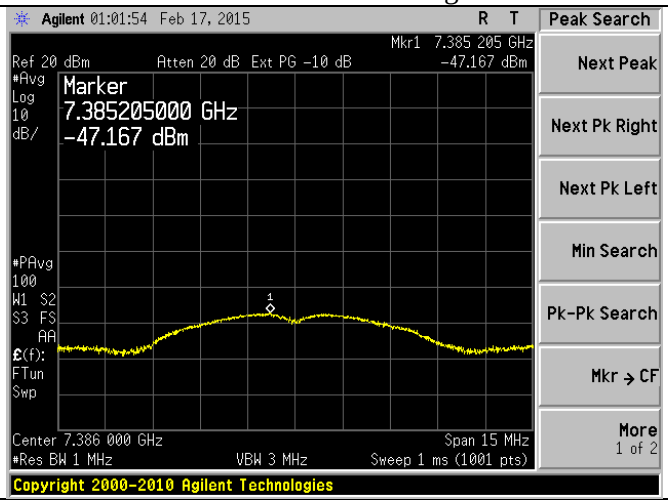
## 3rd Harmonic (4-layer board – Antenna 1)



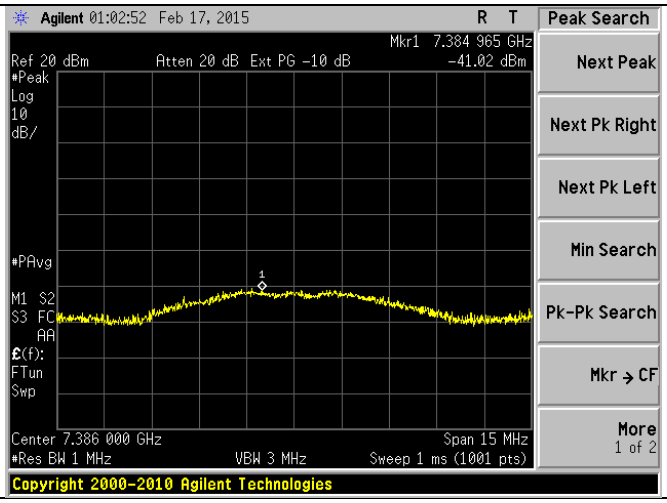

Mid Channel - Average




Mid Channel - Peak




High Channel - Average




High Channel - Peak

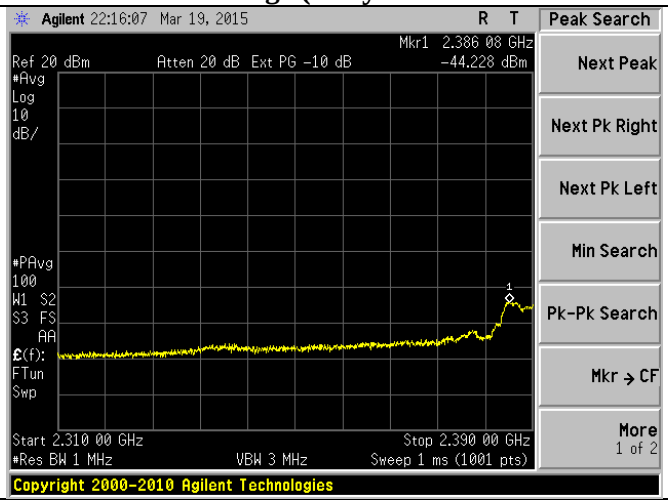
**4-layer board – Antenna 2**
**Lower band edge restricted band**
**Average**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38608 | -44.228 | 2.00 | 0.02 | 95.26 | 53.04 | 54 | 1.0 |
| g | 6 | 2.38992 | -43.953 | | 0.12 | | 53.42 | | 0.6 |
| n | MCS 0 | 2.38976 | -44.414 | | 0.13 | | 52.97 | | 1.0 |

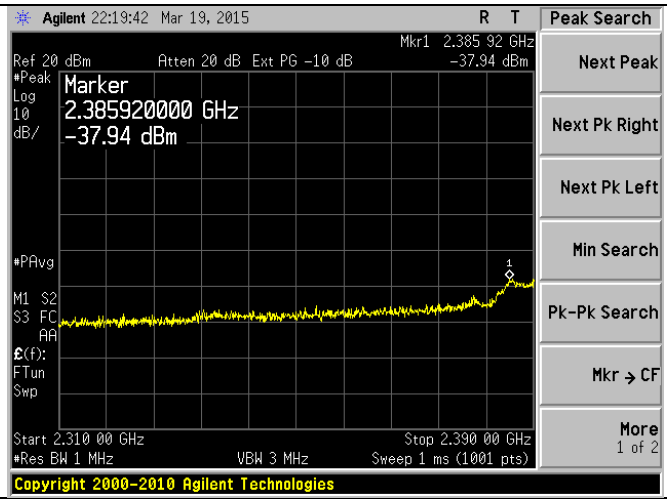
**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38592 | -37.94 | 2.00 | 95.26 | 59.32 | 74 | 14.7 |
| g | 6 | 2.38992 | -31.90 | | | 65.36 | | 8.6 |
| n | MCS0 | 2.38952 | -31.66 | | | 65.60 | | 8.4 |

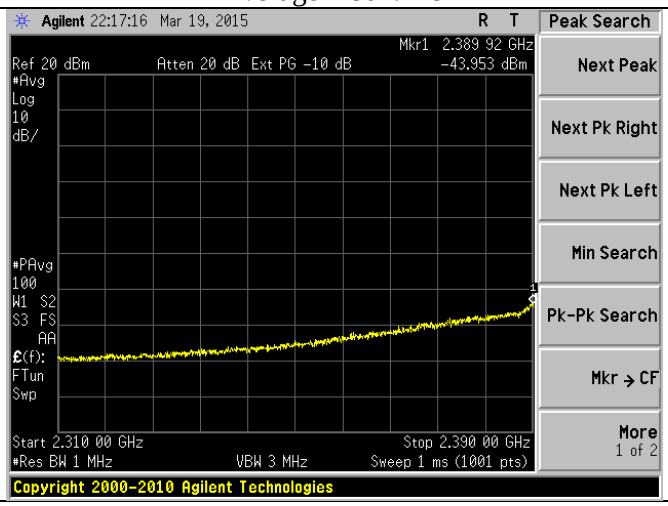
## Lower Band-edge (4-layer board – Antenna 2)



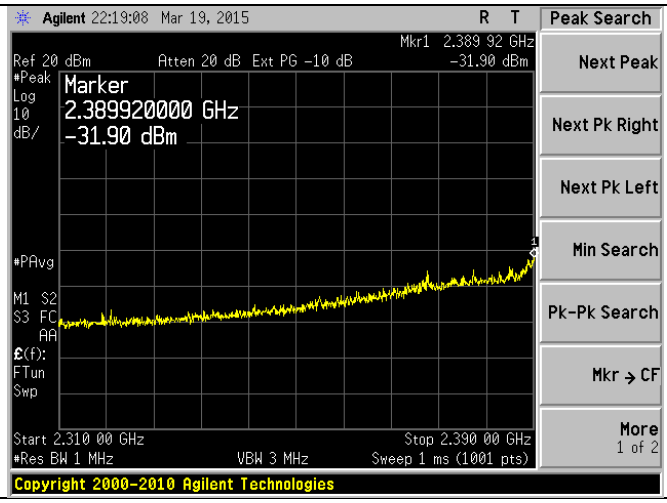

Average – 802.11b



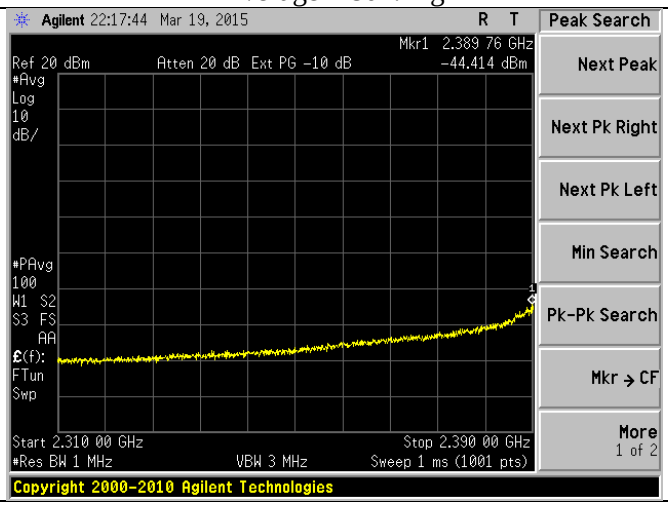

Peak – 802.11b



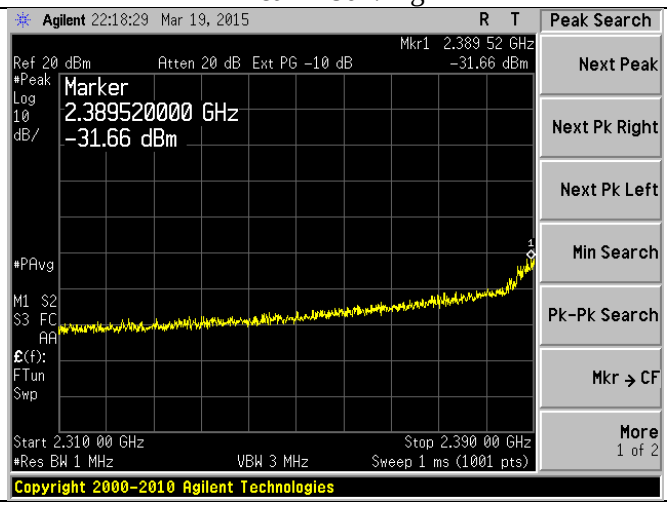

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

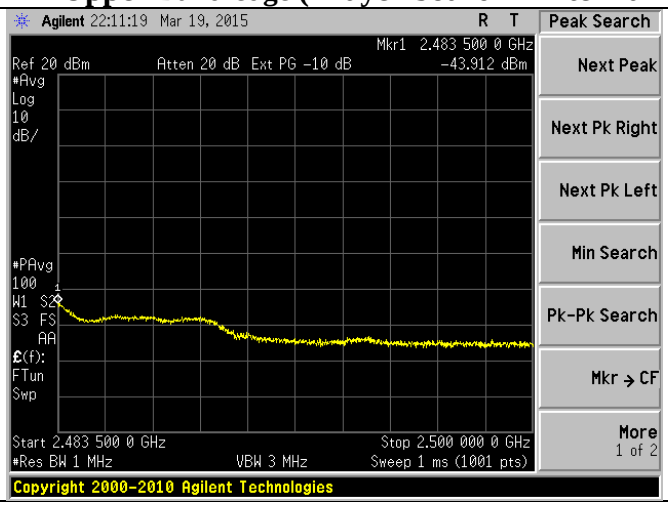
**4-layer board – Antenna 2**
**Upper band edge restricted band**
**Average**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4835 | -43.912 | 2.00 | 0.02 | 95.26 | 53.36 | 54 | 0.6 |
| g | 6 | 2.4840 | -46.519 | | 0.12 | | 50.85 | | 3.1 |
| n | MCS 0 | 2.4844 | -49.688 | | 0.13 | | 47.70 | | 6.3 |

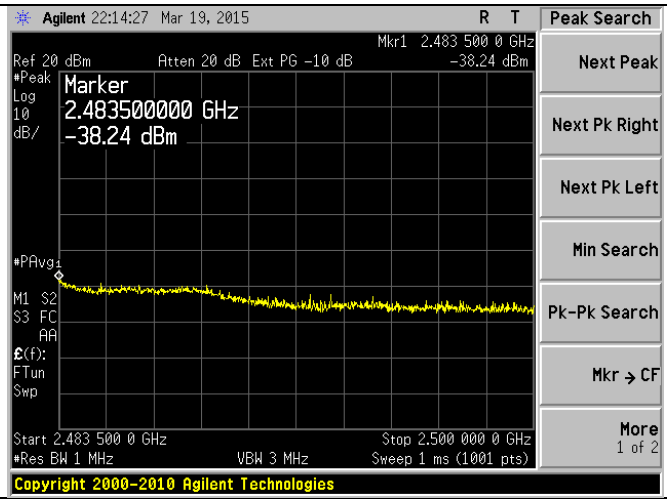
**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4835 | -38.24 | 2.00 | 95.26 | 59.02 | 74 | 15.0 |
| g | 6 | 2.4844 | -33.76 | | | 63.50 | | 10.5 |
| n | MCS0 | 2.4845 | -38.02 | | | 59.24 | | 14.8 |

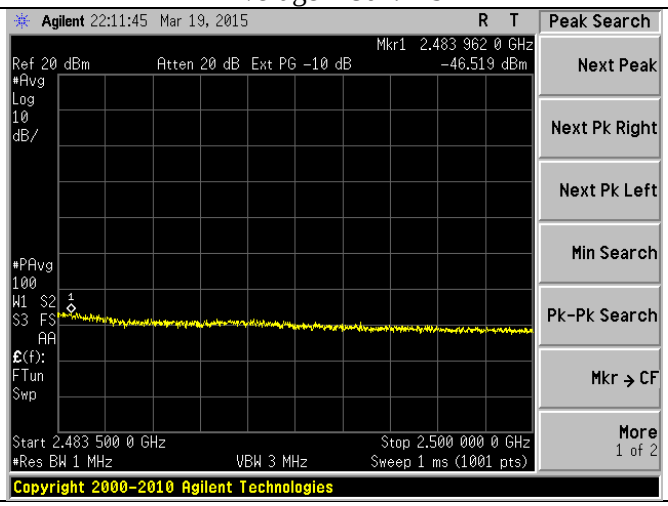
## Upper Band-edge (4-layer board – Antenna 2)



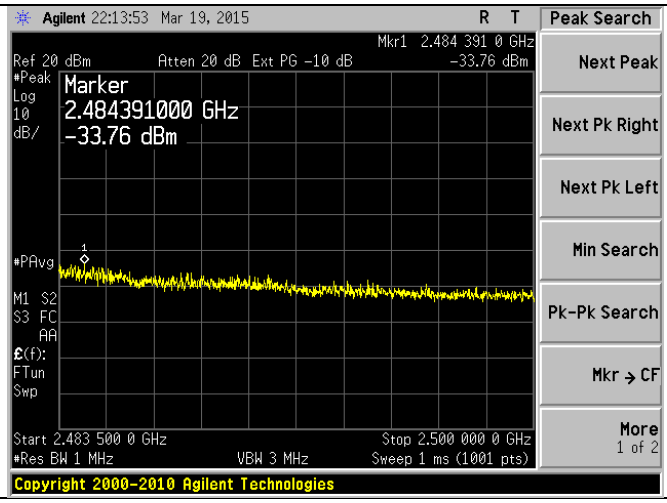

Average – 802.11b



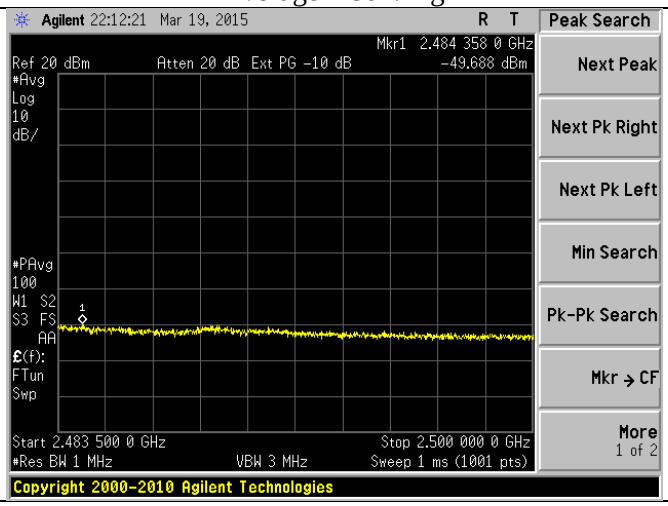

Peak – 802.11b



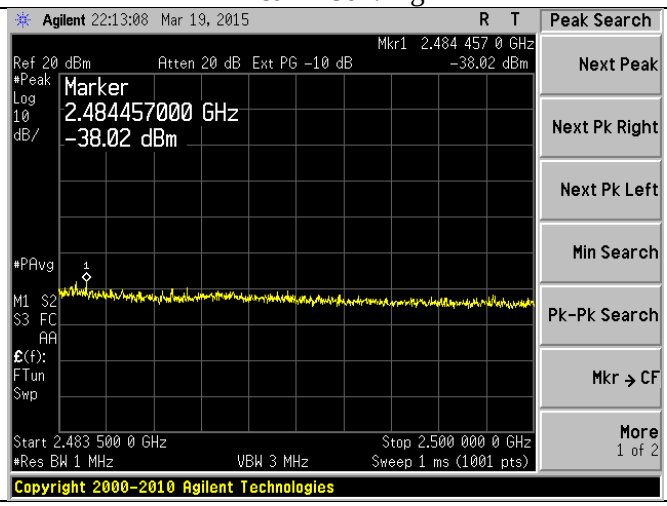

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

**Harmonics**
**4-layer board – Antenna 2**
**802.11b (worst case mode)**

**2nd Harmonic**
Average

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 4823.94 | -49.595 | 2.00 | 0.02 | 95.26 | 47.68 | 54 | 6.3 |
| | | 4874.00 | -49.822 | | 0.12 | | 47.55 | | 6.4 |
| | | 4923.94 | -51.662 | | 0.13 | | 45.72 | | 8.3 |

Peak

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 4823.94 | -44.90 | 2.00 | 95.26 | 52.36 | 74 | 21.6 |
| | | 4874.08 | -45.65 | | | 51.61 | | 22.4 |
| | | 4923.79 | -45.89 | | | 51.37 | | 22.6 |

**3rd Harmonic**
Average

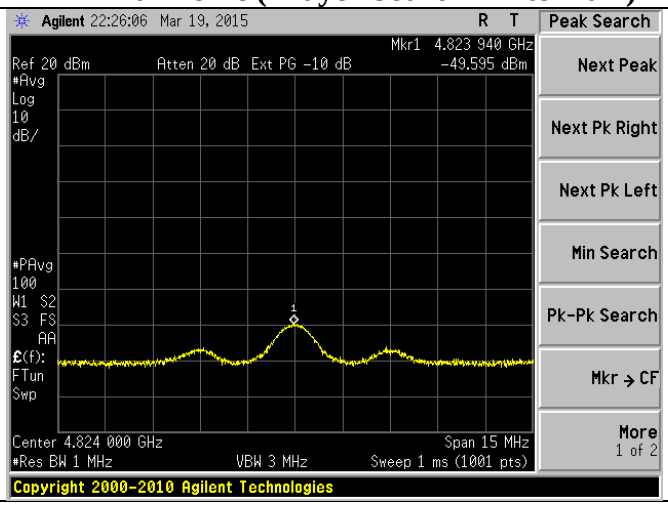
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 0.02 | 95.26 | - | 54 | - |
| | | 7309.92 | -48.166 | | 0.12 | | 49.21 | | 4.8 |
| | | 7384.58 | -49.559 | | 0.13 | | 47.83 | | 6.2 |

Peak

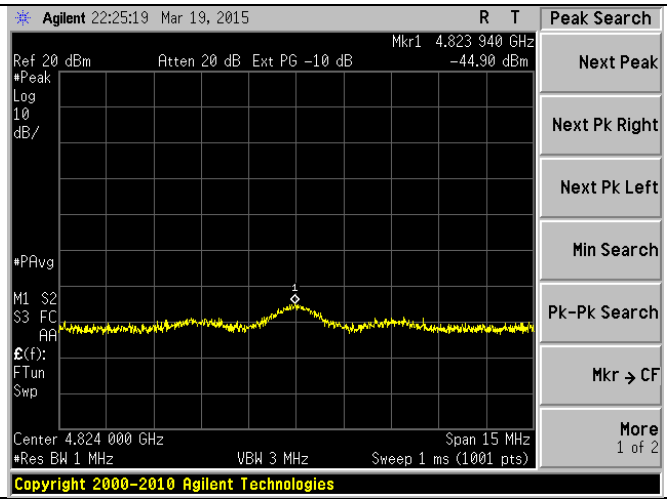
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 95.26 | - | 74 | - |
| | | 7309.62 | -41.81 | | | 55.45 | | 18.6 |
| | | 7384.58 | -42.68 | | | 54.58 | | 19.4 |

**Note:** Low Channel 3rd harmonic not in restricted band.

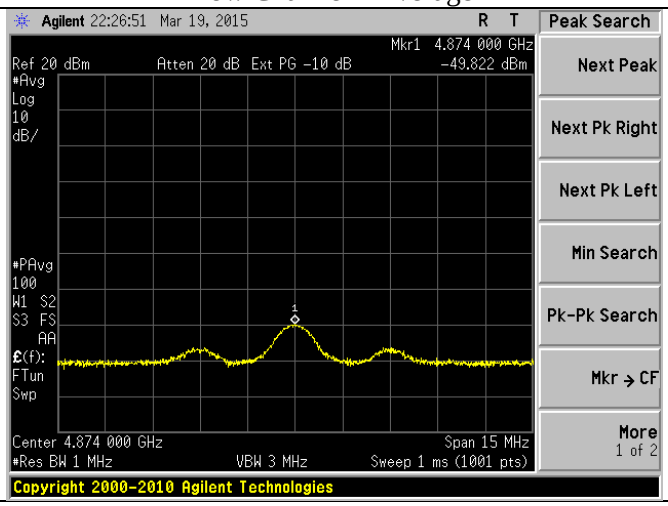
## 2nd Harmonic (4-layer board – Antenna 2)



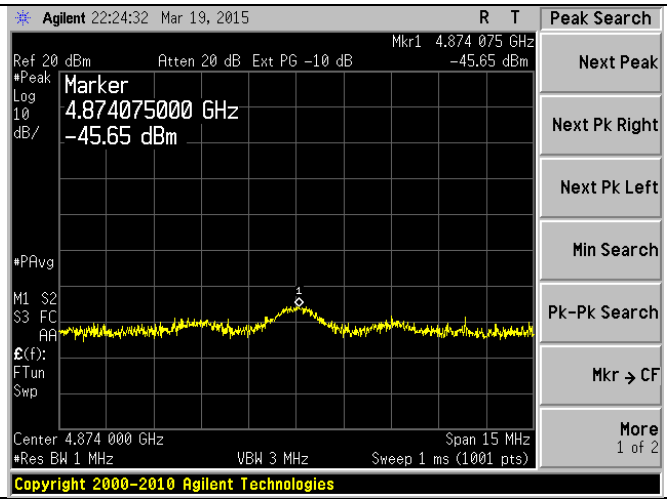

Low Channel - Average



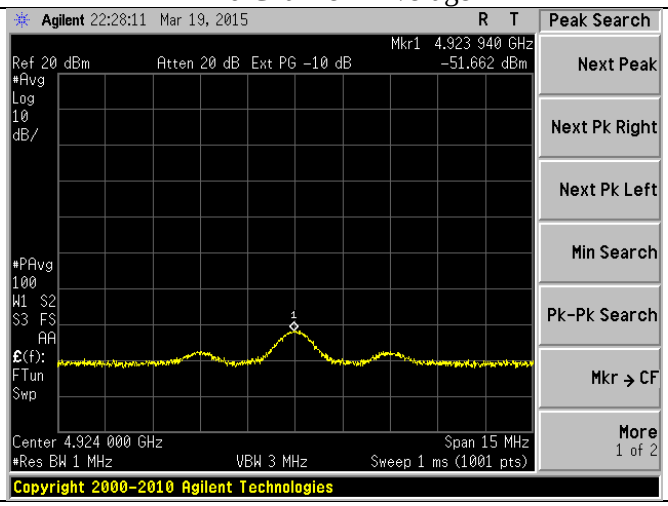

Low Channel - Peak



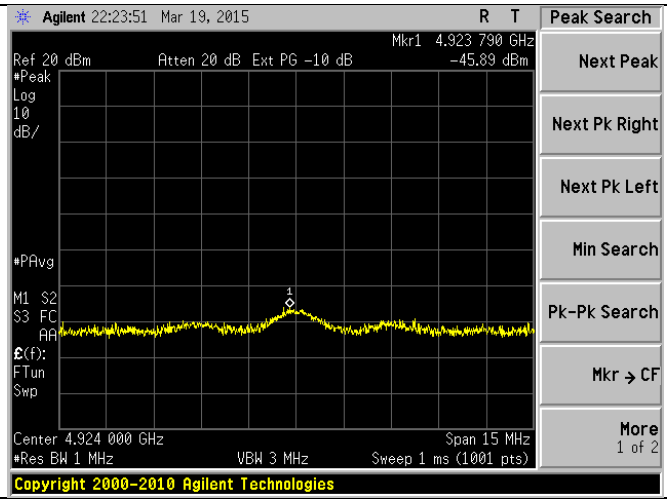

Mid Channel - Average




Mid Channel - Peak

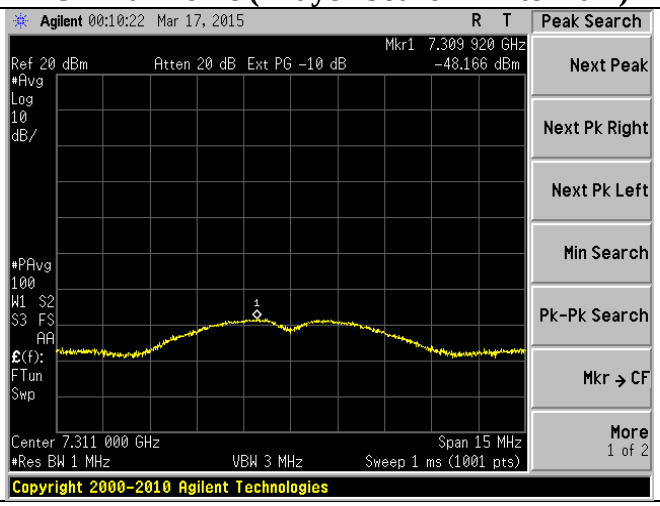



High Channel - Average

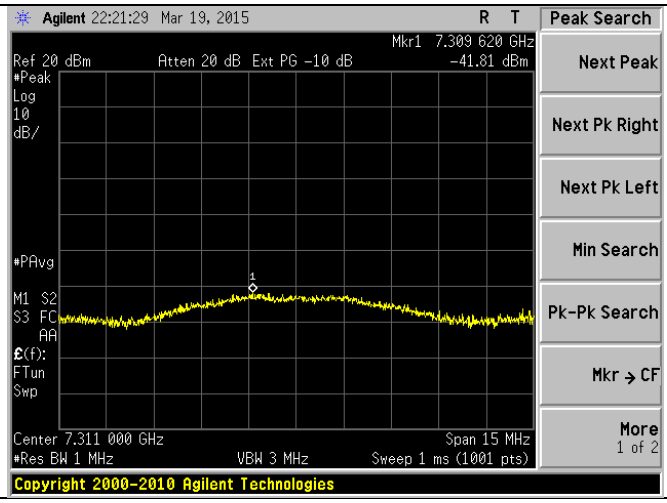



High Channel - Peak

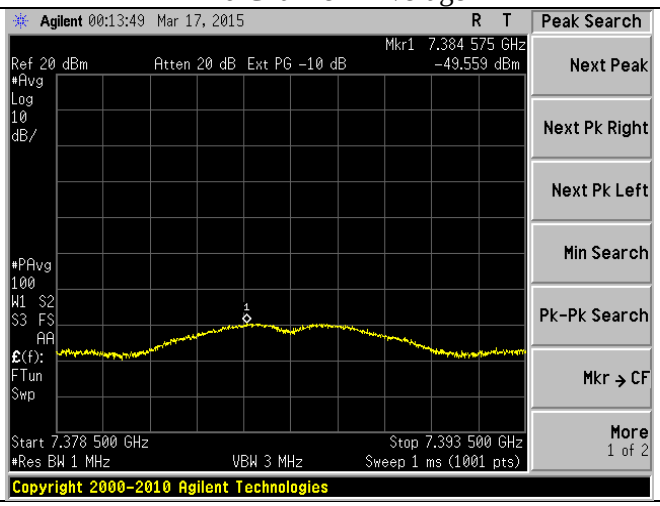
## 3rd Harmonic (4-layer board – Antenna 2)



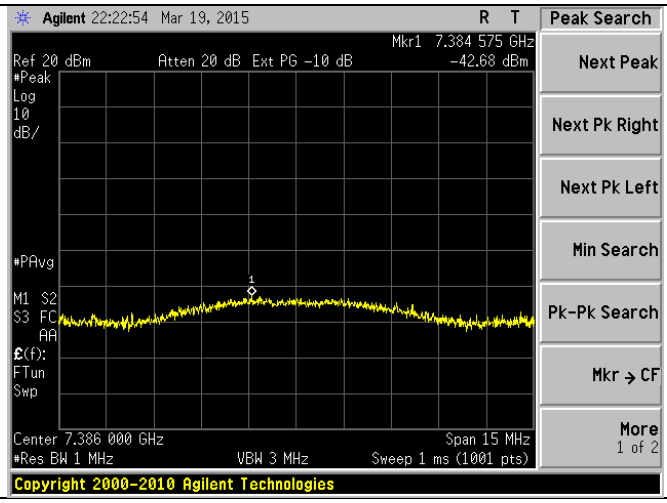

Mid Channel - Average




Mid Channel - Peak




High Channel - Average




High Channel - Peak

## Lower Band-Edge Restricted Band (2-layer board – Antenna 1)

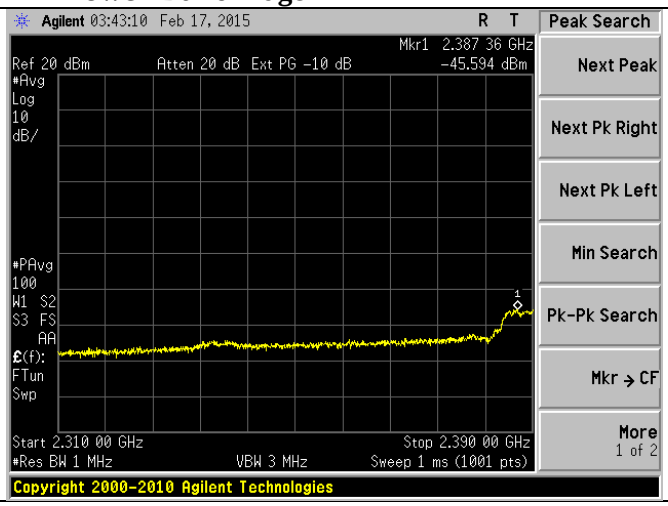
### Average

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38736 | -45.594 | 2.00 | 0.02 | 95.26 | 51.68 | 54 | 2.3 |
| g | 6 | 2.38952 | -45.192 | | 0.12 | | 52.18 | | 1.8 |
| n | MCS 0 | 2.38992 | -46.531 | | 0.13 | | 50.85 | | 3.1 |

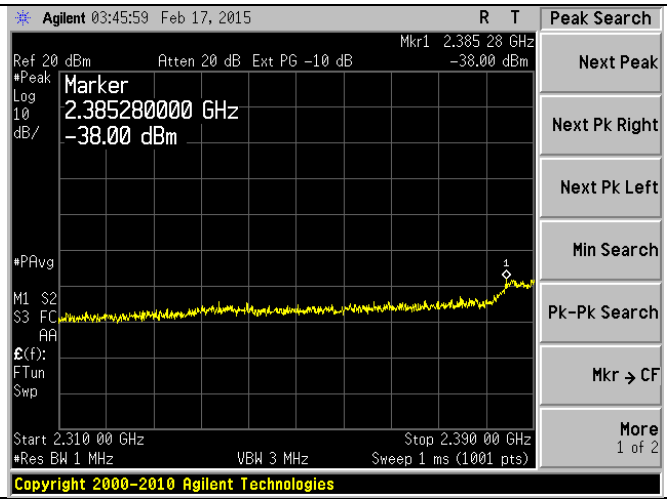
### Peak

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38528 | -38.00 | 2.00 | 95.26 | 59.26 | 74 | 14.7 |
| g | 6 | 2.38944 | -34.83 | | | 62.43 | | 11.6 |
| n | MCS0 | 2.38928 | -35.34 | | | 61.92 | | 12.1 |

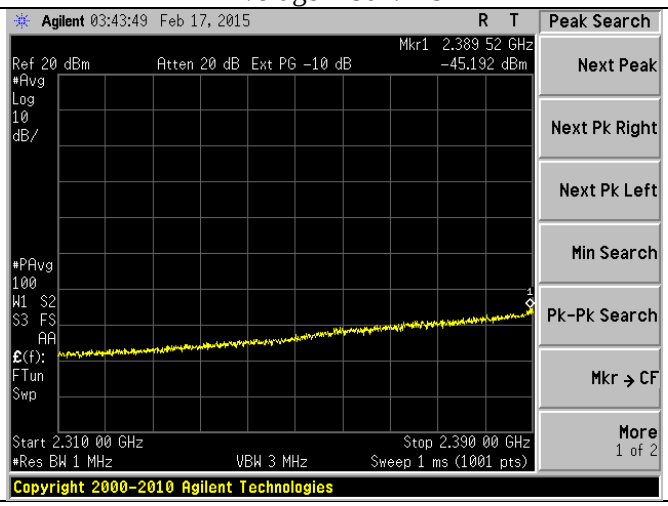
## Lower Band-Edge



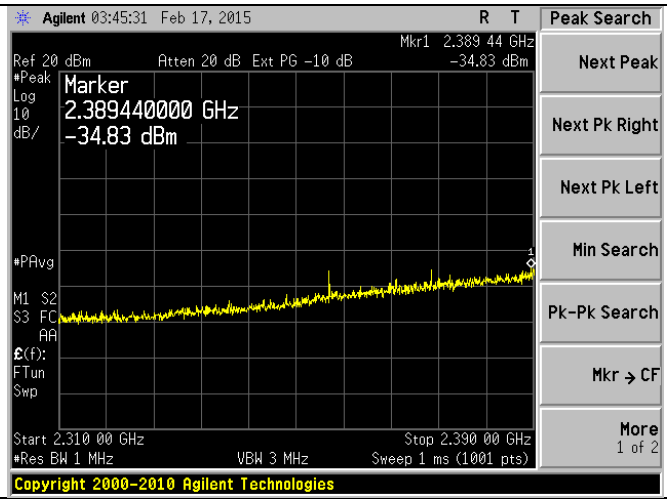

Average – 802.11b



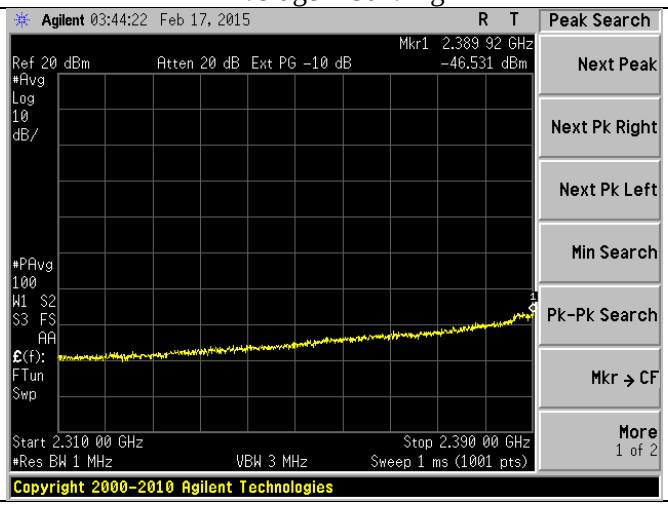

Peak – 802.11b



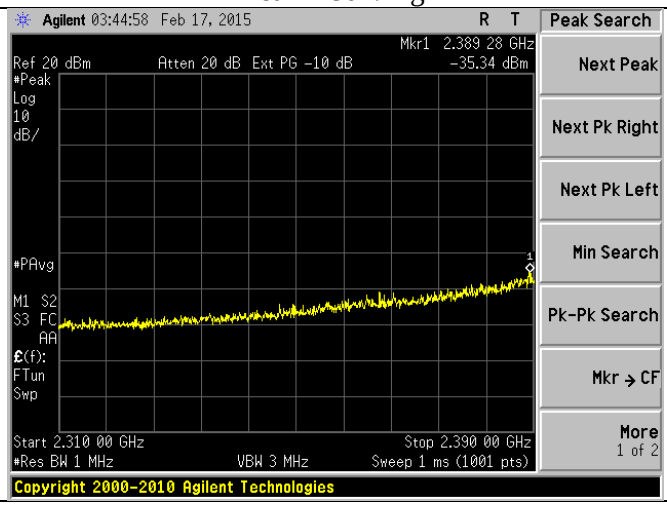

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

## Upper Band-Edge Restricted Band (2-layer board – Antenna 1)

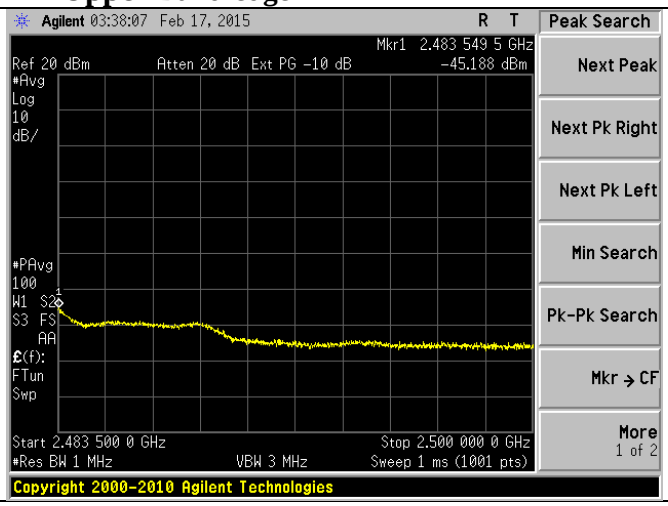
### Average

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4835 | -45.188 | 2.00 | 0.02 | 95.26 | 52.08 | 54 | 1.9 |
| g | 6 | 2.4838 | -46.478 | | 0.12 | | 50.90 | | 3.1 |
| n | MCS 0 | 2.4836 | -48.536 | | 0.13 | | 48.85 | | 5.2 |

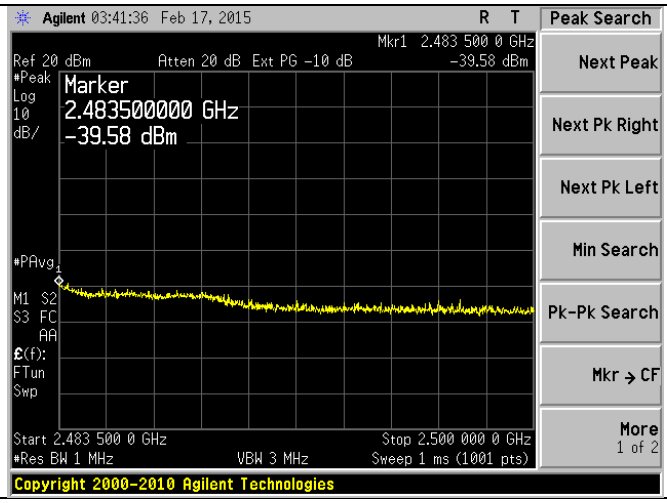
### Peak

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4835 | -39.58 | 2.00 | 95.26 | 57.68 | 74 | 16.3 |
| g | 6 | 2.4840 | -35.98 | | | 61.28 | | 12.7 |
| n | MCS0 | 2.4835 | -35.72 | | | 61.54 | | 12.5 |

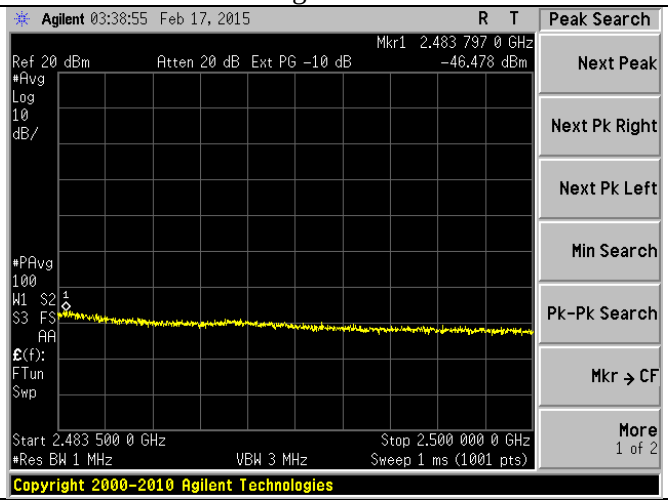
## Upper Band-edge



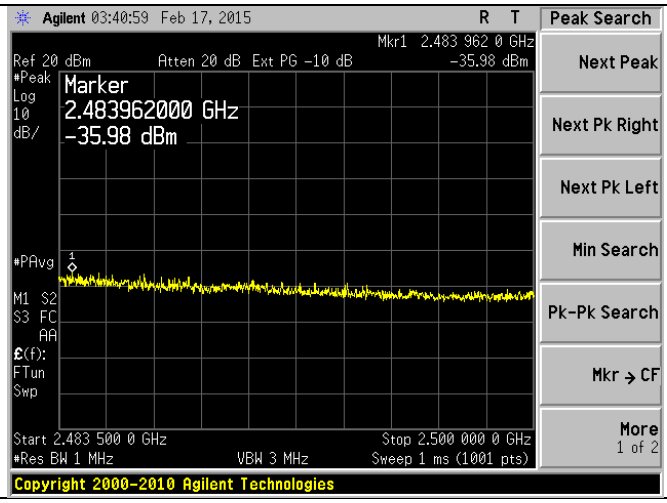

Average – 802.11b



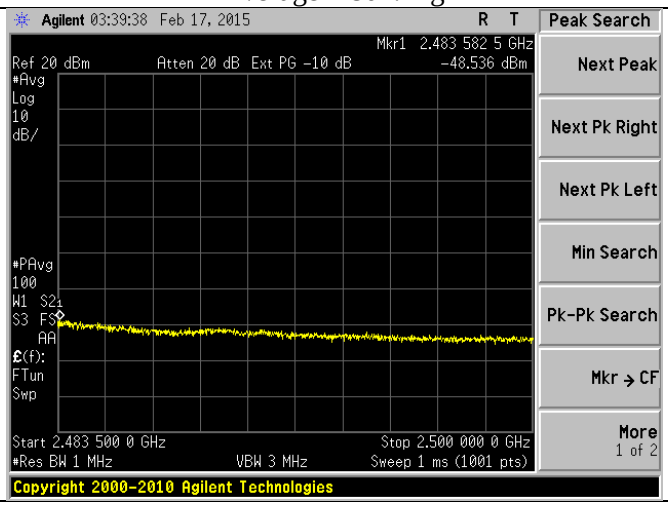

Peak – 802.11b



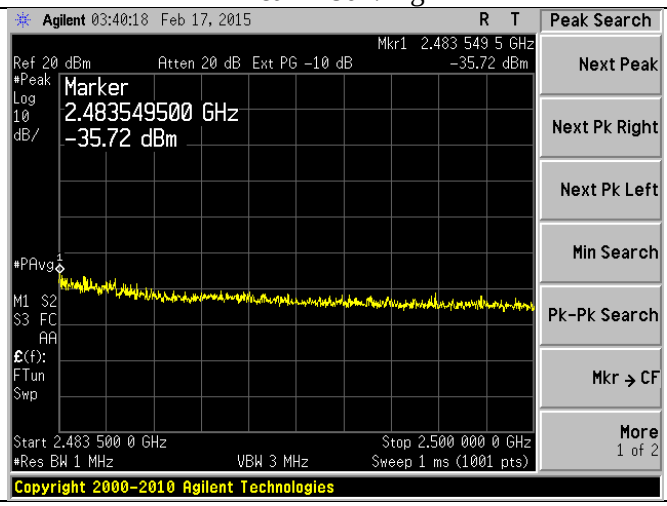

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

## Lower Band-Edge Restricted Band (2-layer board – Antenna 2)

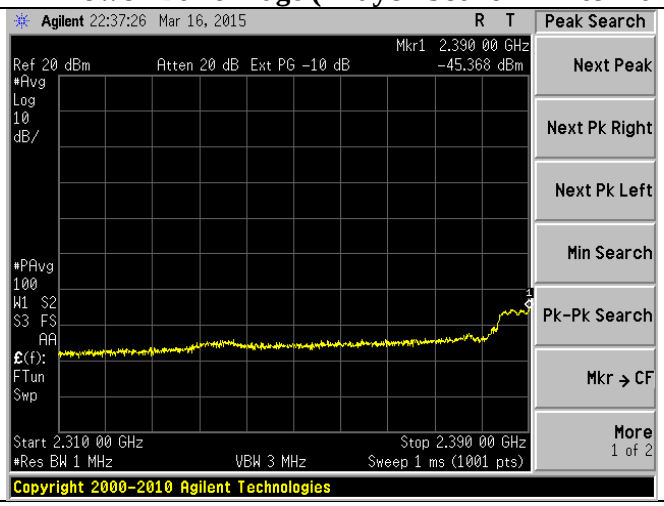
### Average

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.39000 | -45.368 | 2.00 | 0.02 | 95.26 | 51.90 | 54 | 2.1 |
| g | 6 | 2.38944 | -45.725 | | 0.12 | | 51.65 | | 2.4 |
| n | MCS 0 | 2.38800 | -46.728 | | 0.13 | | 50.66 | | 3.3 |

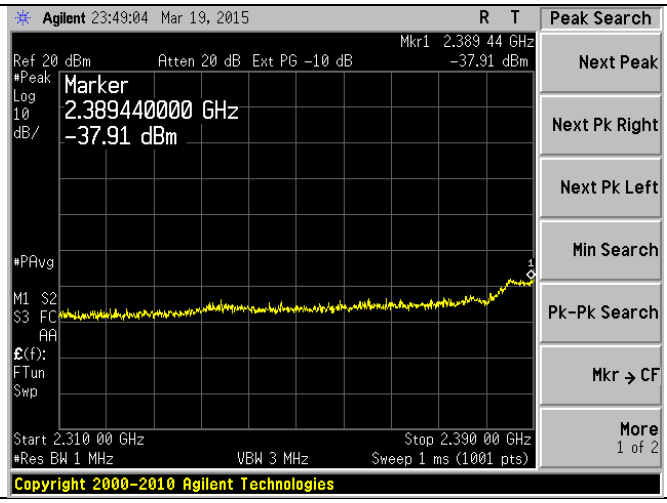
### Peak

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.38944 | -37.91 | 2.00 | 95.26 | 59.35 | 74 | 14.7 |
| g | 6 | 2.39000 | -33.54 | | | 63.72 | | 10.3 |
| n | MCS0 | 2.38848 | -33.26 | | | 64.00 | | 10.0 |

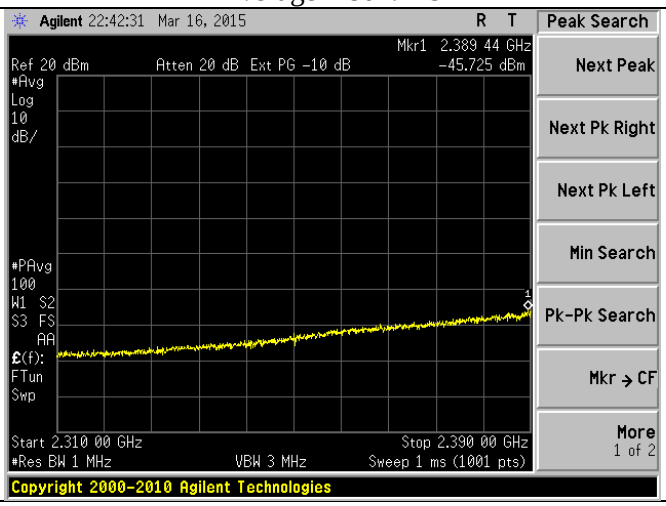
## Lower Band-Edge (2-layer board – Antenna 2)



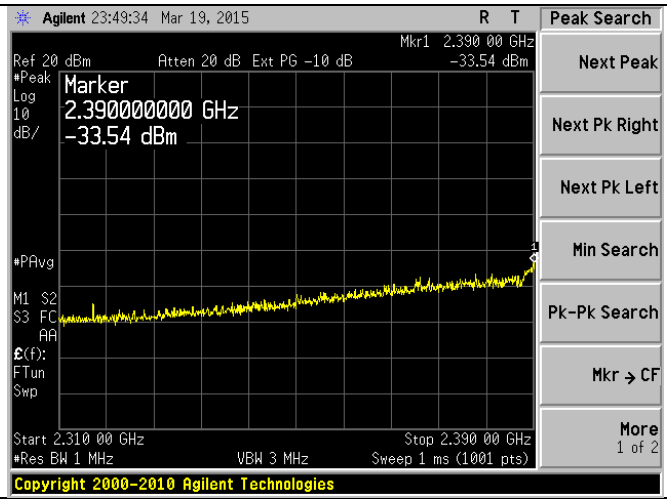

Average – 802.11b



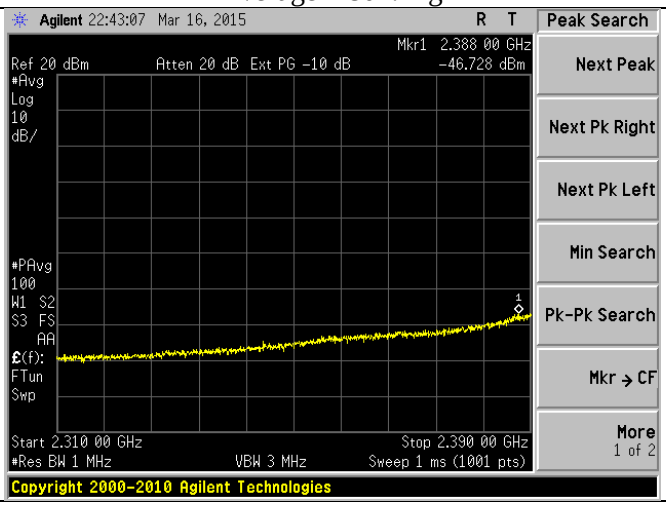

Peak – 802.11b



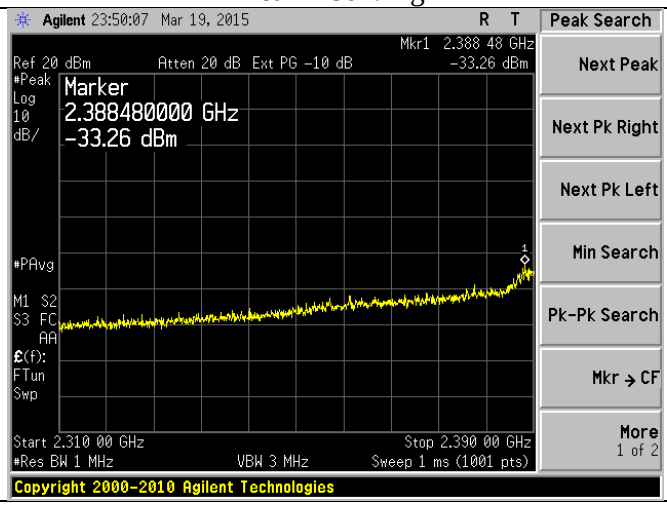

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

## Upper Band-Edge Restricted Band (2-layer board – Antenna 2)

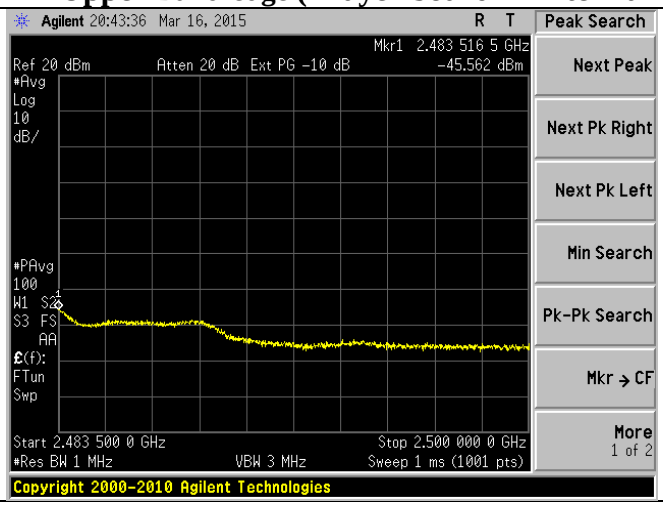
### Average

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4835 | -45.562 | 2.00 | 0.02 | 95.26 | 51.71 | 54 | 2.3 |
| g | 6 | 2.4842 | -48.230 | | 0.12 | | 49.14 | | 4.9 |
| n | MCS 0 | 2.4840 | -49.743 | | 0.13 | | 47.64 | | 6.4 |

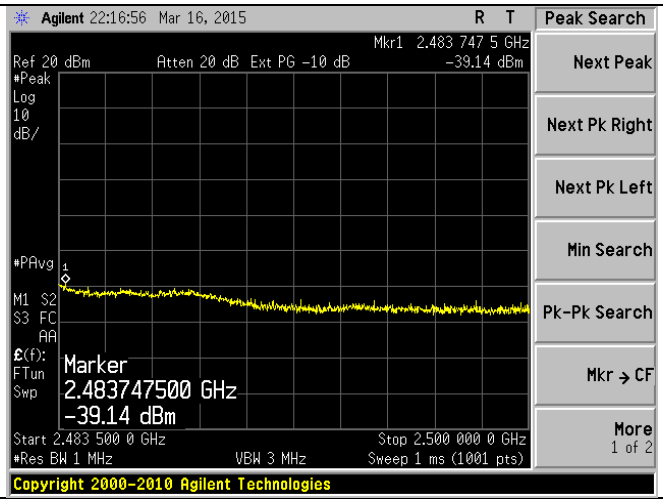
### Peak

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 2.4837 | -39.14 | 2.00 | 95.26 | 58.12 | 74 | 15.9 |
| g | 6 | 2.4846 | -35.99 | | | 61.27 | | 12.7 |
| n | MCS0 | 2.4843 | -37.99 | | | 59.27 | | 14.7 |

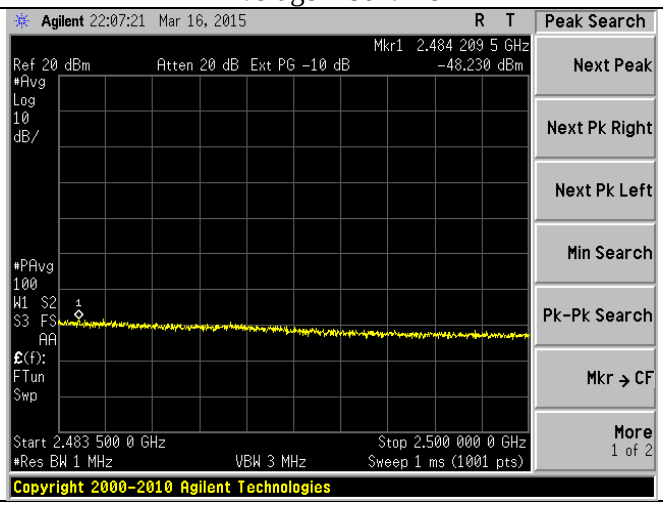
## Upper Band-edge (2-layer board – Antenna 2)



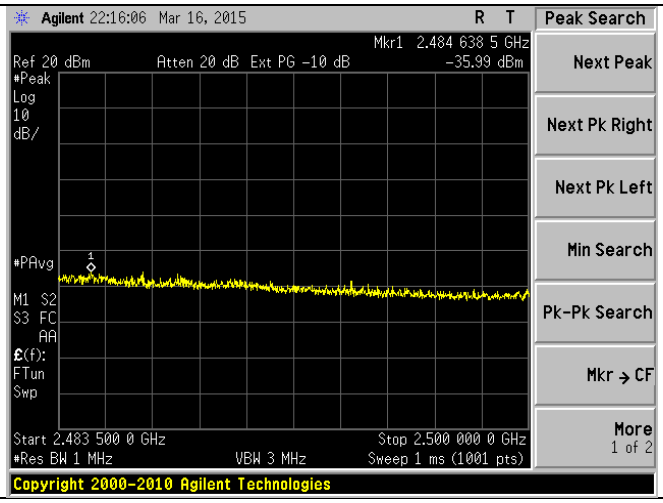

Average – 802.11b



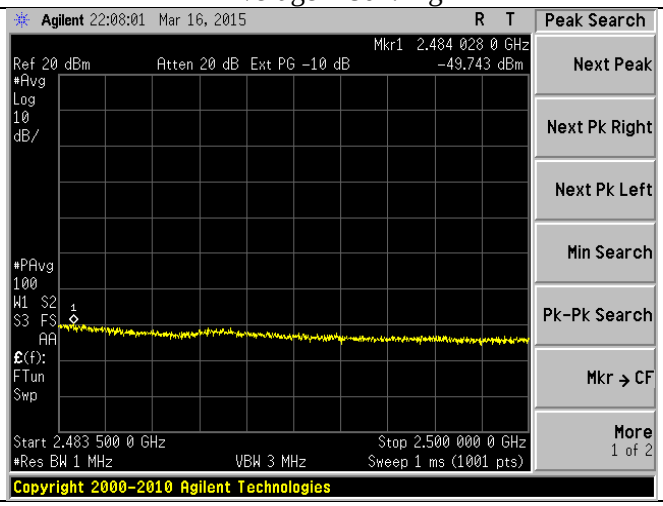

Peak – 802.11b



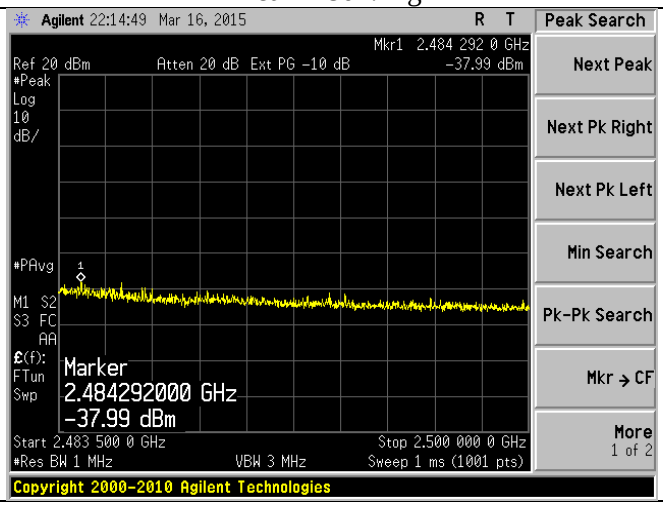

Average – 802.11g




Peak – 802.11g




Average – 802.11n




Peak – 802.11n

**Harmonics**
**2-layer board – Antenna 1**
**802.11b (worst case mode)**

**2nd Harmonic**

Average

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 4823.94 | -53.705 | 2.00 | 0.02 | 95.26 | 43.57 | 54 | 10.4 |
| | | 4873.91 | -53.793 | | 0.12 | | 43.58 | | 10.4 |
| | | 4923.94 | -57.501 | | 0.13 | | 39.88 | | 14.1 |

Peak

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 4823.72 | -50.74 | 2.00 | 95.26 | 46.52 | 74 | 27.5 |
| | | 4873.81 | -50.61 | | | 46.65 | | 27.4 |
| | | 4923.91 | -52.36 | | | 44.90 | | 29.1 |

**3rd Harmonic**

Average

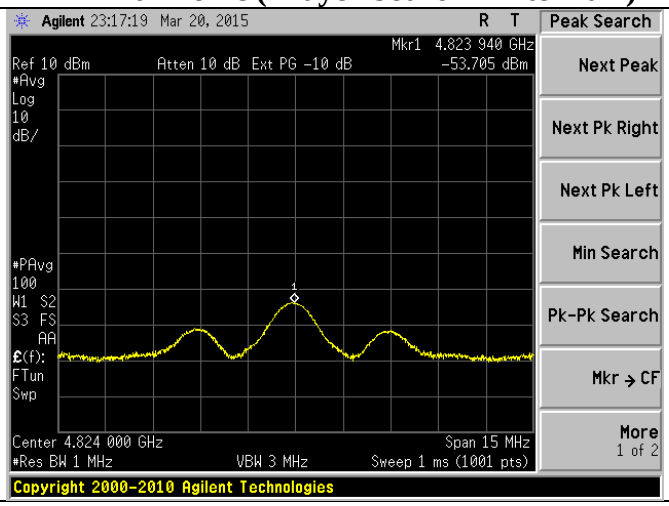
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 0.02 | 95.26 | - | 54 | - |
| | | 7310.09 | -51.374 | | 0.12 | | 46.00 | | 8.0 |
| | | 7384.86 | -53.941 | | 0.13 | | 43.44 | | 10.6 |

Peak

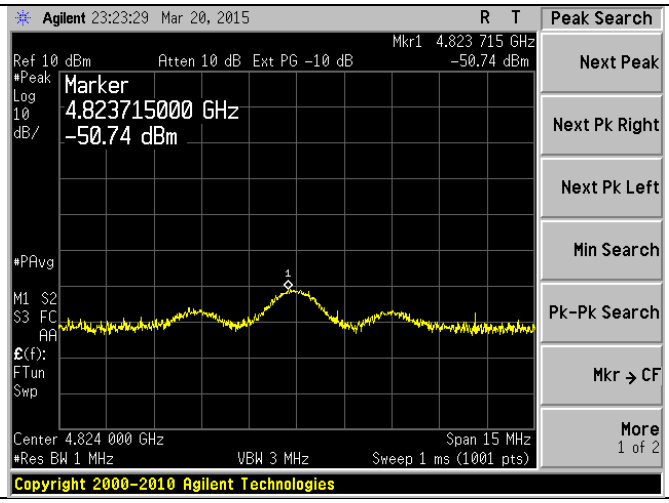
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 95.26 | - | 74 | - |
| | | 7310.94 | -46.59 | | | 50.67 | | 23.3 |
| | | 7386.08 | -48.06 | | | 49.20 | | 24.8 |

**Note:** Low Channel 3rd harmonic not in restricted band.

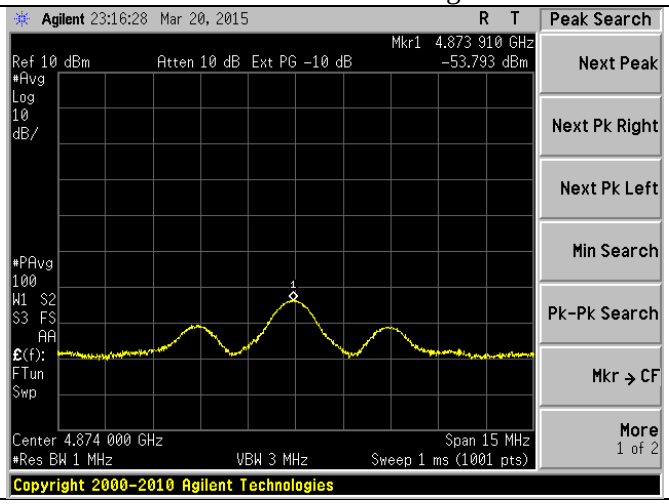
## 2nd Harmonic (2-layer board – Antenna 1)



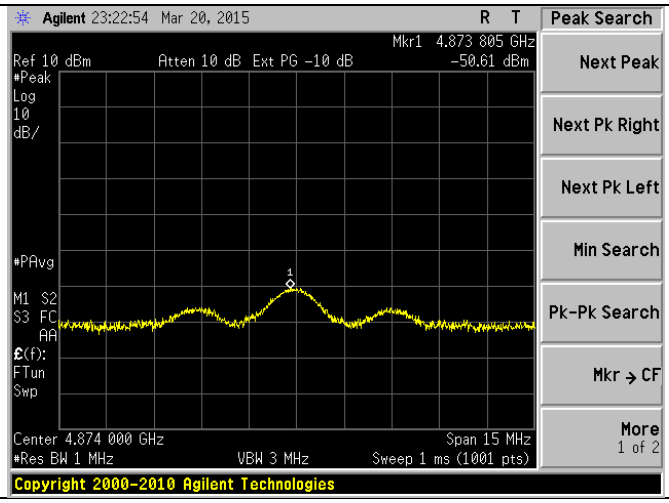

Low Channel - Average



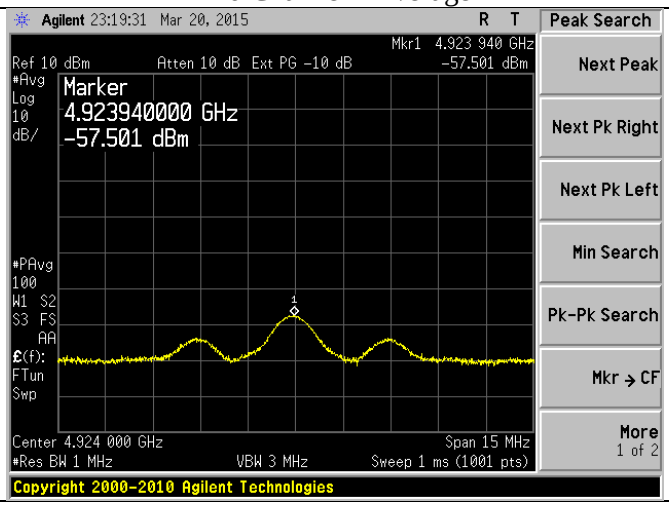

Low Channel - Peak



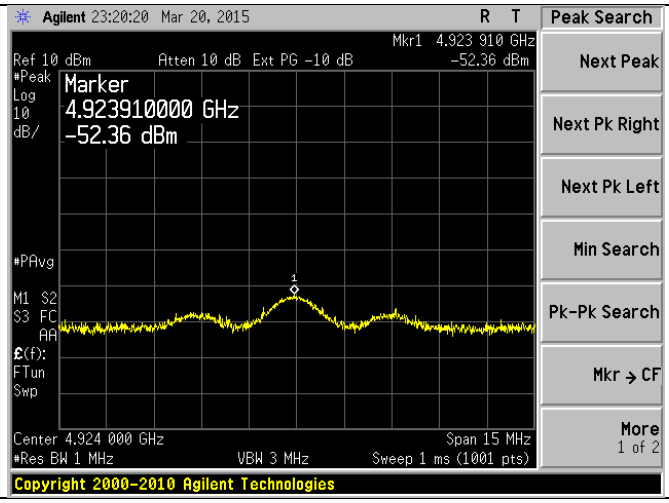

Mid Channel - Average




Mid Channel - Peak

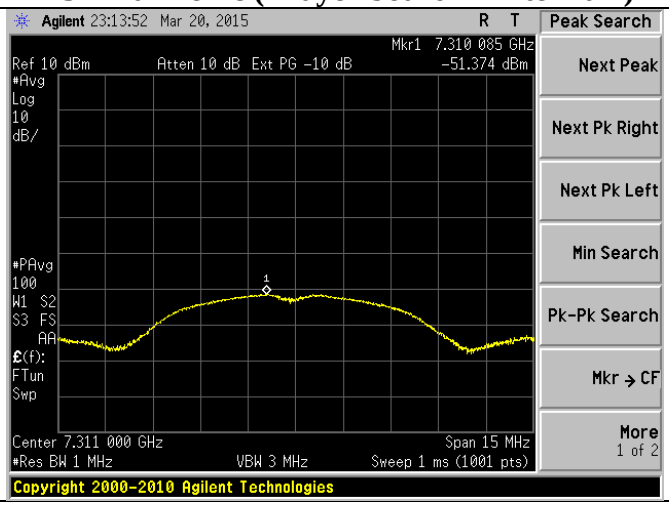



High Channel - Average

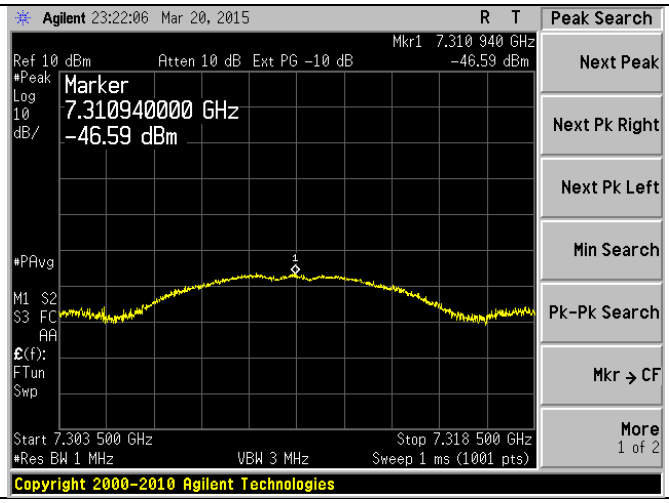



High Channel - Peak

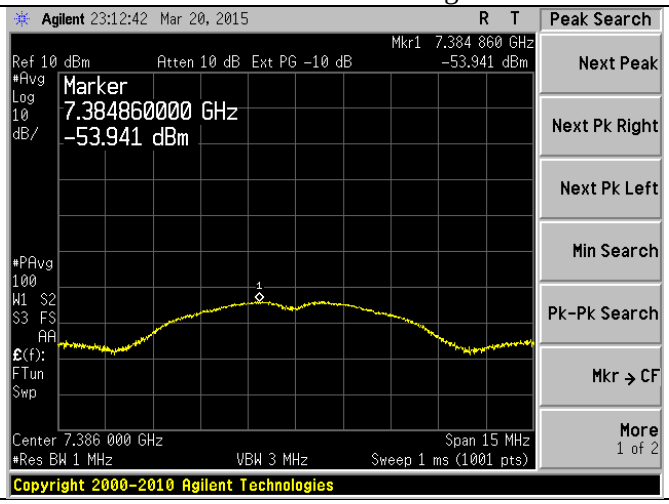
## 3rd Harmonic (2-layer board – Antenna 1)



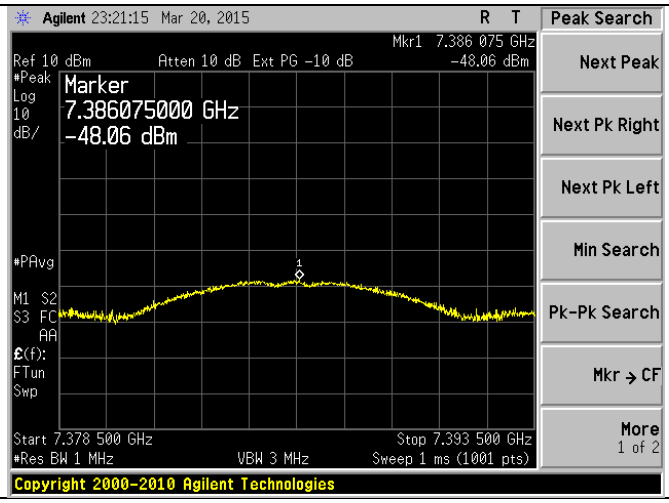

Mid Channel - Average




Mid Channel - Peak




High Channel - Average




High Channel - Peak

**Harmonics**
**2-layer board – Antenna 2**
**802.11b (worst case mode)**

**2nd Harmonic**
Average

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | 4823.91 | -56.255 | 2.00 | 0.02 | 95.26 | 41.02 | 54 | 13.0 |
| | | 4873.96 | -56.814 | | 0.12 | | 40.56 | | 13.4 |
| | | 4923.97 | -60.527 | | 0.13 | | 36.86 | | 17.1 |

Peak

| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | 4823.84 | -52.72 | 2.00 | 95.26 | 44.54 | 74 | 29.5 |
| | | 4874.03 | -53.29 | | | 43.97 | | 30.0 |
| | | 4924.17 | -55.34 | | | 41.92 | | 32.1 |

**3rd Harmonic**
Average

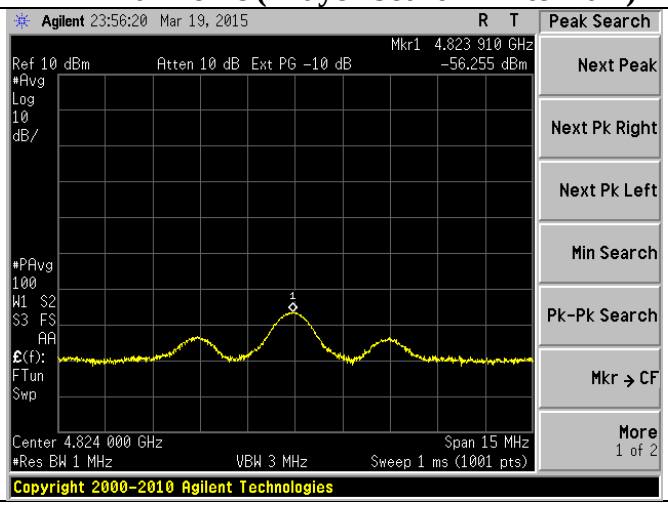
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Average Meas (dBm) | Antenna Gain (dBi) | Duty Cycle Correction | Conversion to (dBµV/m) | Average (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 0.02 | 95.26 | - | 54 | - |
| | | 7310.04 | -45.168 | | 0.12 | | 52.21 | | 1.8 |
| | | 7384.82 | -47.005 | | 0.13 | | 50.38 | | 3.6 |

Peak

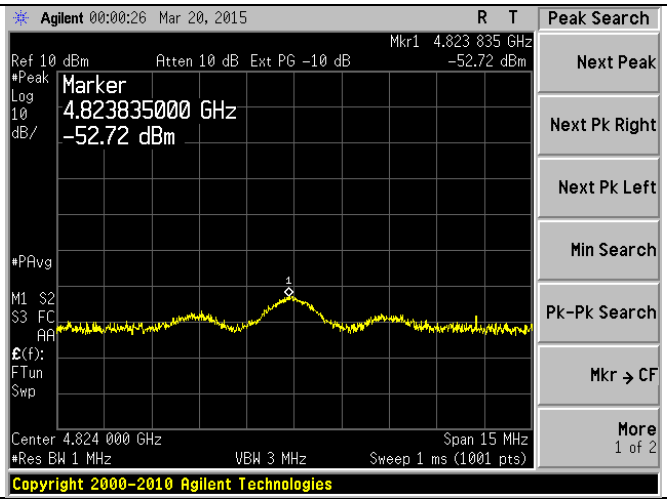
| Mode (802.11) | Mode (Mbps) | Frequency (MHz) | Peak Meas (dBm) | Antenna Gain (dBi) | Conversion to (dBµV/m) | Peak (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|---|---|---|
| b | 1 | - | - | 2.00 | 95.26 | - | 74 | - |
| | | 7310.90 | -41.40 | | | 55.86 | | 18.1 |
| | | 7384.79 | -43.08 | | | 54.18 | | 19.8 |

**Note:** Low Channel 3rd harmonic not in restricted band.

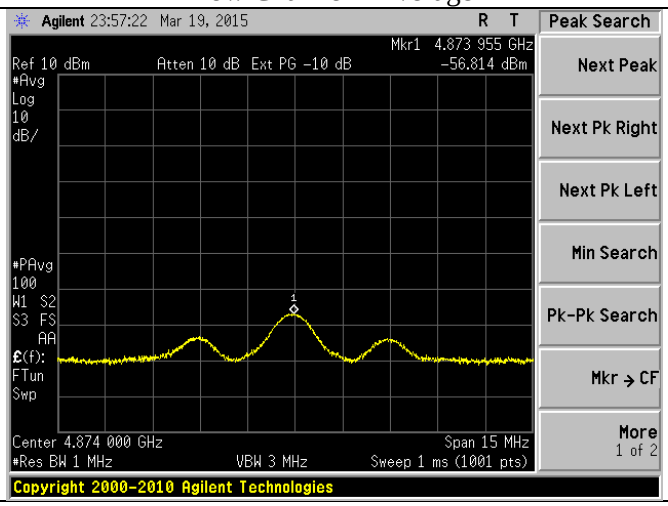
## 2nd Harmonic (2-layer board – Antenna 2)



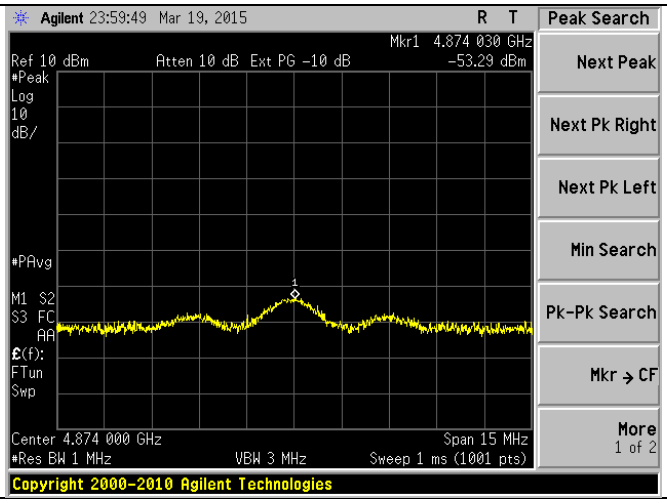

Low Channel - Average



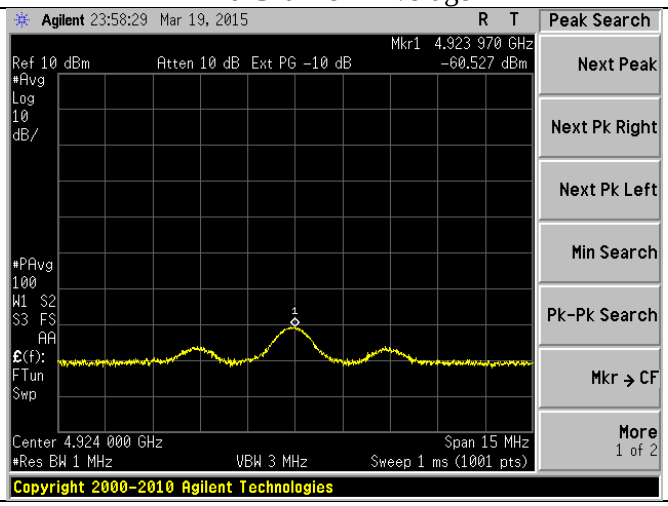

Low Channel - Peak



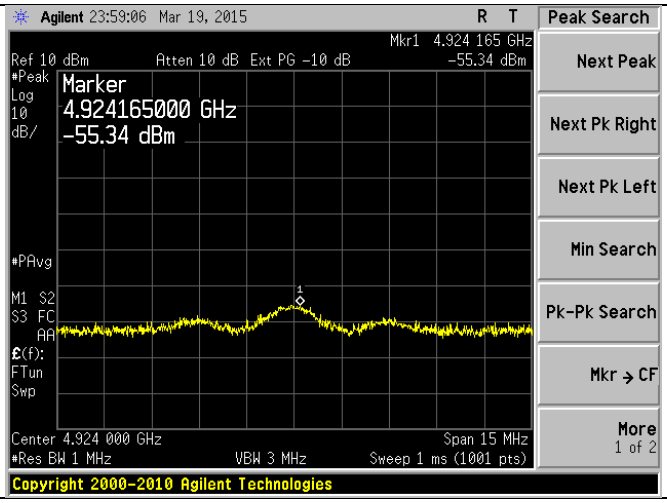

Mid Channel - Average




Mid Channel - Peak

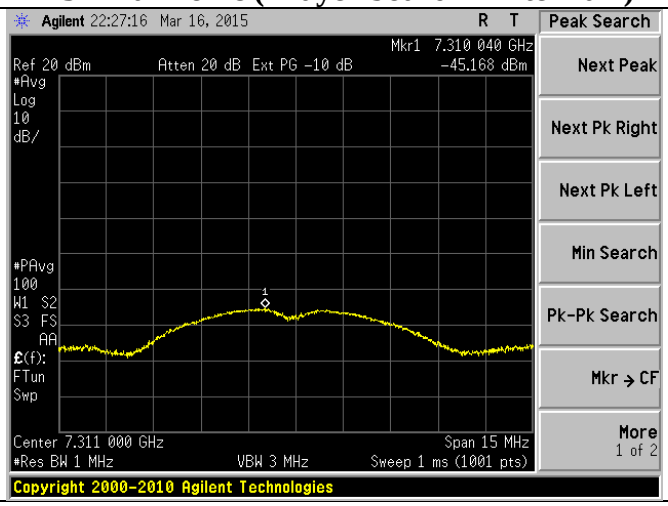



High Channel - Average

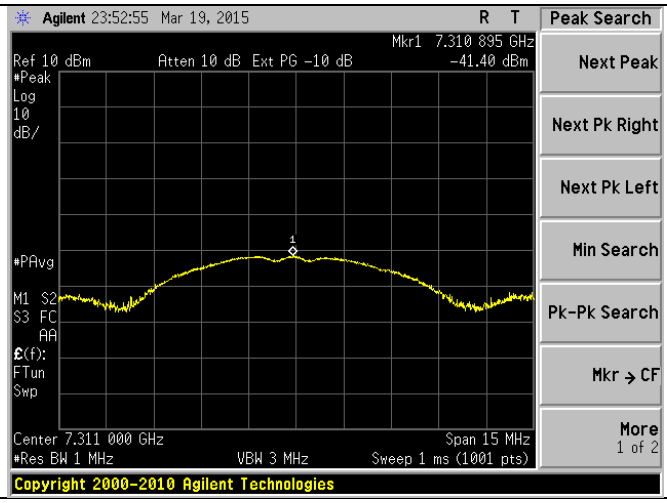



High Channel - Peak

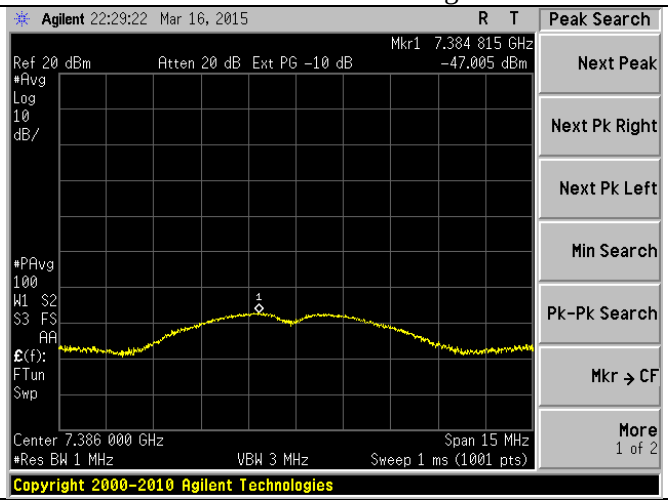
## 3rd Harmonic (2-layer board – Antenna 2)



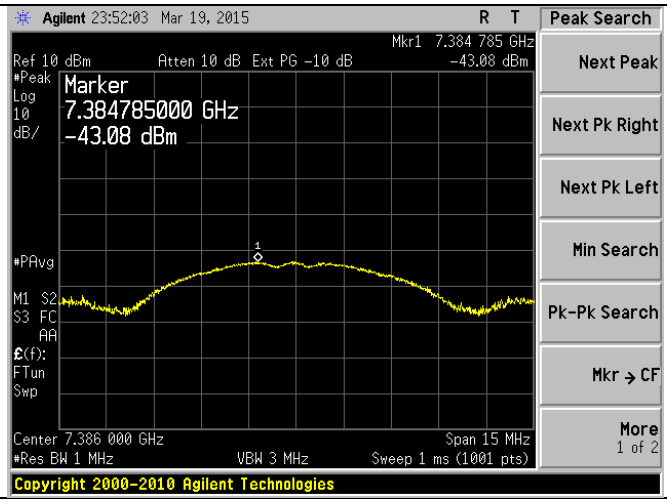

Mid Channel - Average




Mid Channel - Peak




High Channel - Average




High Channel - Peak

**Emissions in the 30-1000 MHz range**

**Evaluation per FCC KDB 558074 Section 12.2.2**

Worst case emission = -58.36 dBm @ 451 MHz (noise floor measurement)

E = EIRP – 20 log D + 104.8

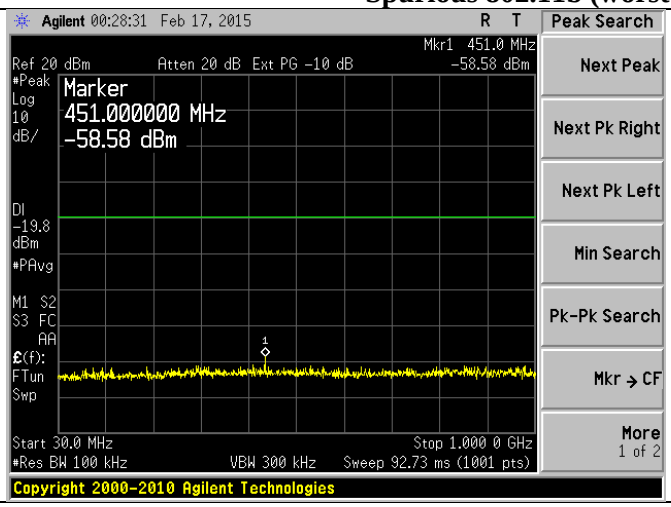
EIRP = measurement (dBm) + antenna gain (dBi) + ground plane reflection factor (dB)
D = specified measurement distance in meters.

E = (-58.36 + 2.0 + 4.7) – 20 log (3) +104.8
E = 43.6 dBµV/m (peak)

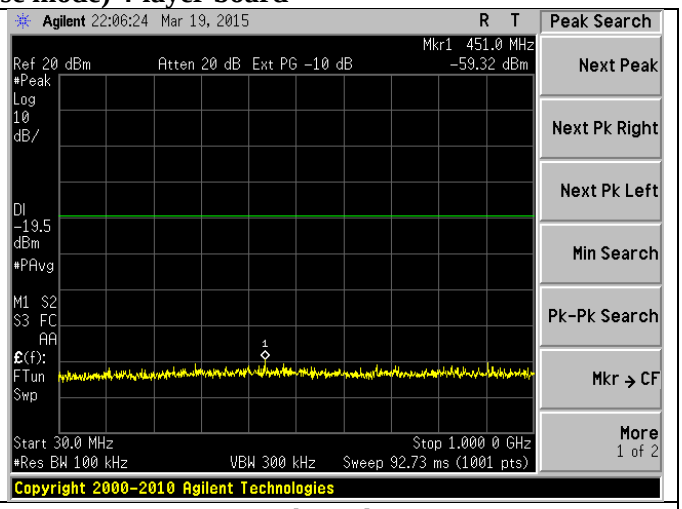
15.209 limit (Quasi-peak) @ 451 MHz = 46 dBµV/m

Margin = Limit – E
Margin = 46- 43.6 = 2.4 dB

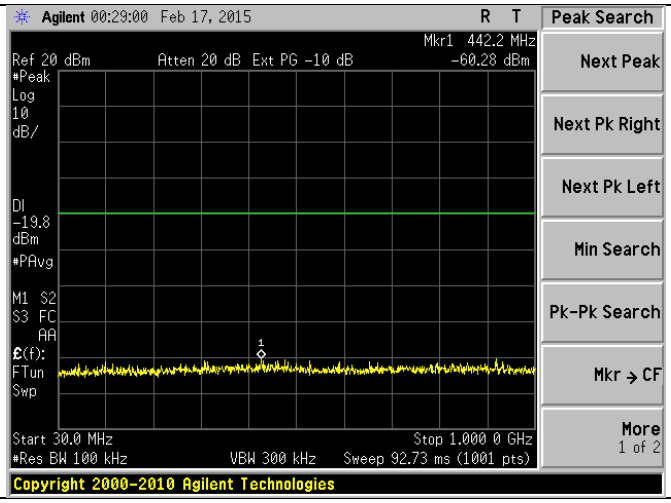
## Spurious 802.11b (worst case mode) 4-layer board



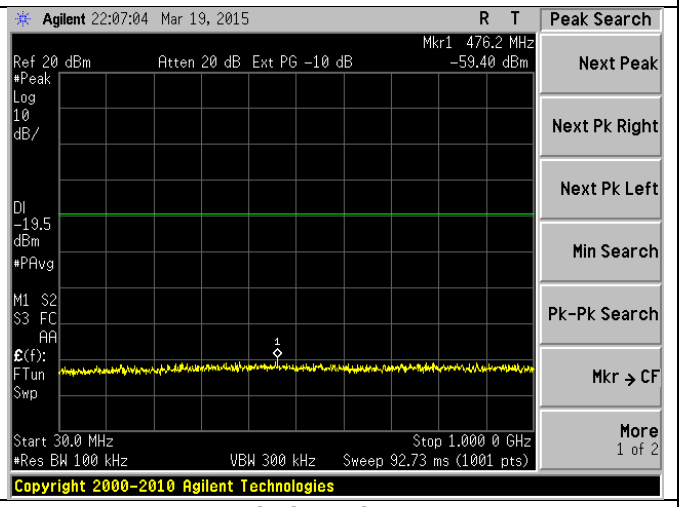

Ant 1 - Low Channel 30-1000 MHz



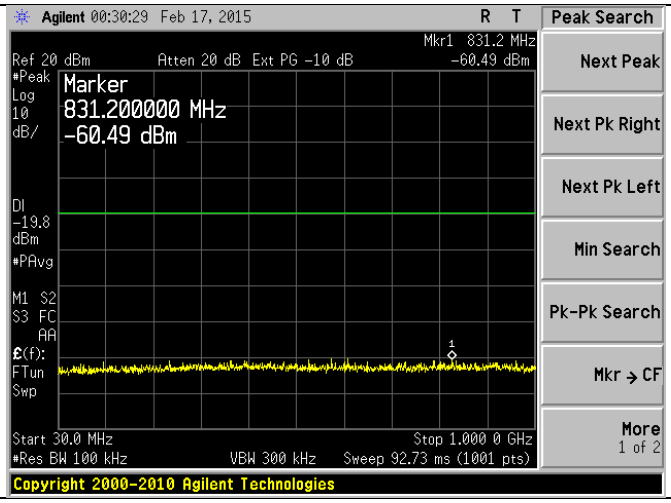

Ant 2 - Low Channel 30-1000 MHz



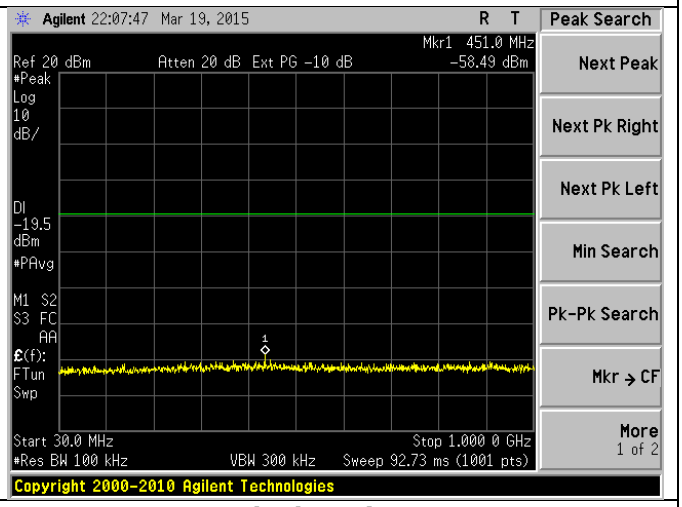

Ant 1 - Mid Channel 30-1000 MHz




Ant 2 - Mid Channel 30-1000 MHz

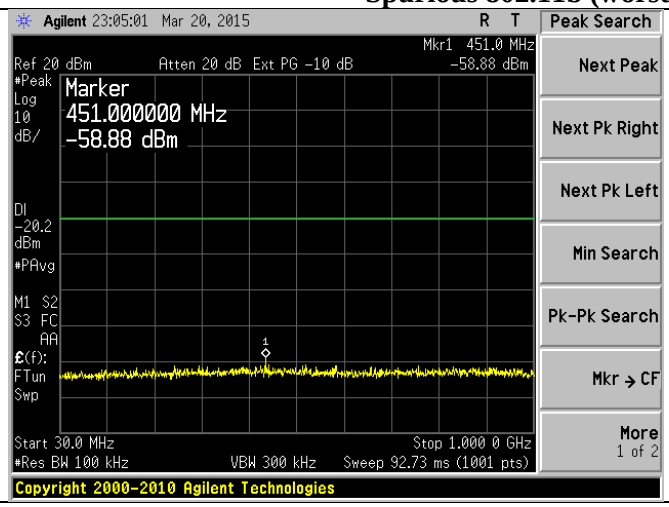



Ant 1 - High Channel 30-1000 MHz

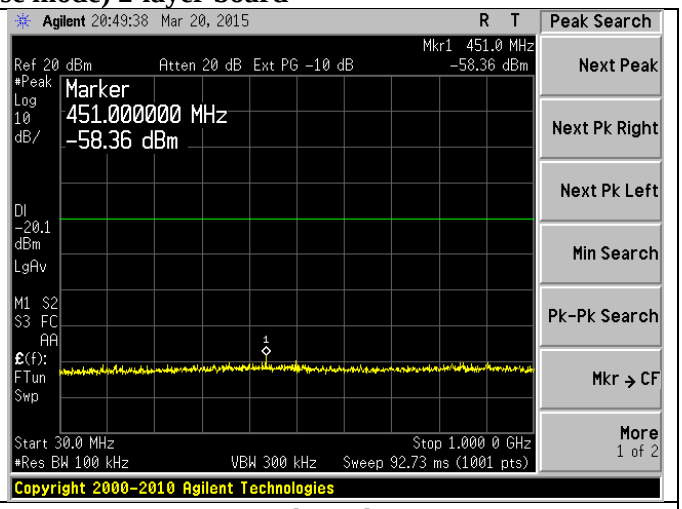



Ant 2 - High Channel 30-1000 MHz

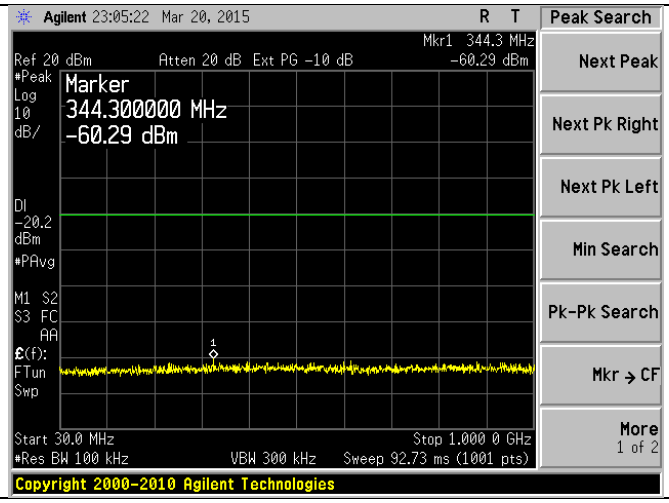
## Spurious 802.11b (worst case mode) 2-layer board



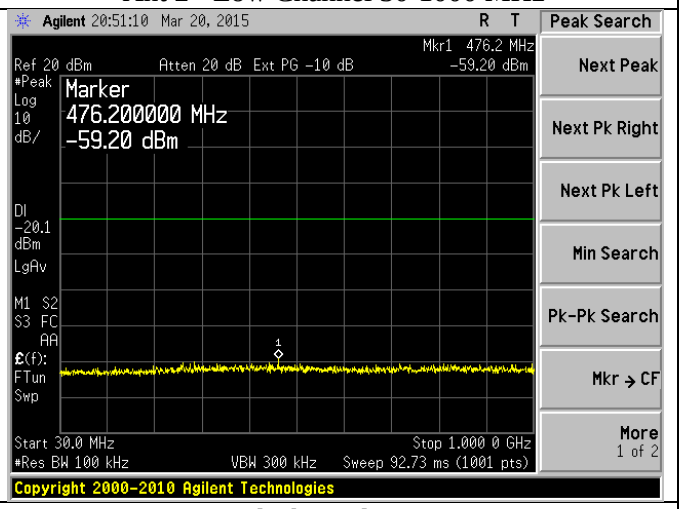

Ant 1 - Low Channel 30-1000 MHz



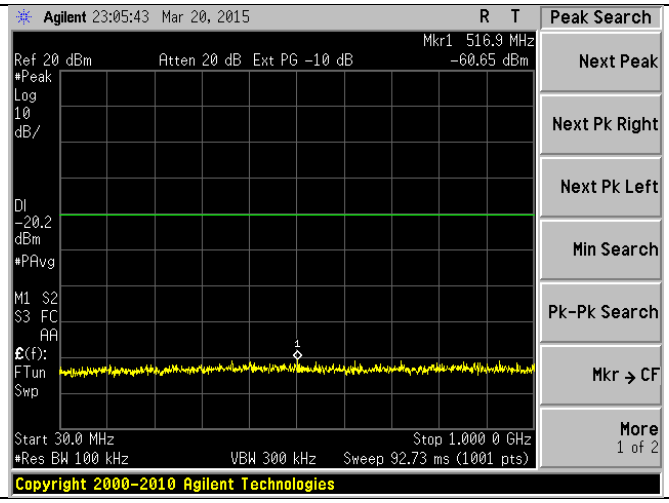

Ant 2 - Low Channel 30-1000 MHz



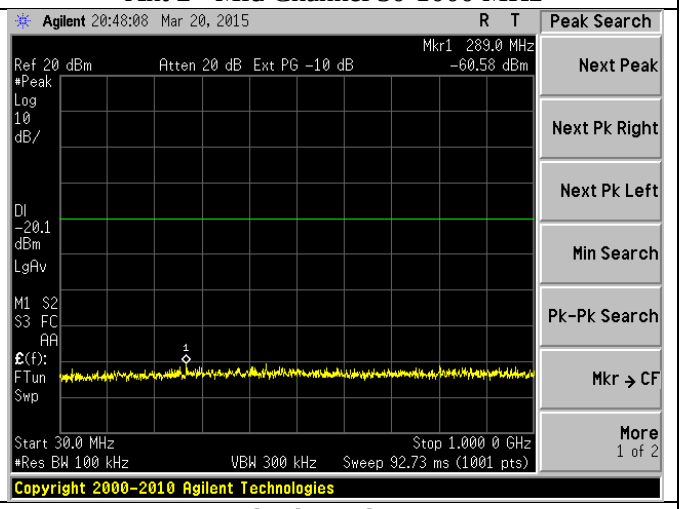

Ant 1 - Mid Channel 30-1000 MHz




Ant 2 - Mid Channel 30-1000 MHz




Ant 1 - High Channel 30-1000 MHz




Ant 2 - High Channel 30-1000 MHz

## B.1.6 – RF Conducted – Frequency Stability

| | |
|---|---|
| Manufacturer | LSR |
| Date | 2-16, 3-19, 3-20 2015 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | 15.247 / RSS-210 A8 |
| Specific Measurement Procedure | FCC KDB 558074 |
| Additional Description of Measurement | RF Conducted Measurement |
| Additional Notes | 1. Continuous transmit tx-tone mode used for this test. |

### 4-layer board – Antenna 1

| | 3.13 VDC | | 3.3 VDC | | 3.46 VDC | | |
|---|---|---|---|---|---|---|---|
| | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | FREQ DRIFT (Hz) |
| LOW CHANNEL | 10.9 | 2411988305 | 10.9 | 2411988290 | 10.9 | 2411988540 | 250 |
| MID CHANNEL | 10.7 | 2436987660 | 10.7 | 2436987440 | 10.7 | 2436987590 | 220 |
| HIGH CHANNEL | 10.6 | 2461987250 | 10.6 | 2461987450 | 10.6 | 2461987150 | 300 |

### 4-layer board – Antenna 2

| | 3.13 VDC | | 3.3 VDC | | 3.46 VDC | | |
|---|---|---|---|---|---|---|---|
| | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | FREQ DRIFT (Hz) |
| LOW CHANNEL | 10.83 | 2411986676 | 10.86 | 2411986920 | 10.85 | 2411986340 | 580 |
| MID CHANNEL | 10.16 | 2436987212 | 10.16 | 2436987044 | 10.24 | 2436986752 | 460 |
| HIGH CHANNEL | 10.11 | 2461986648 | 10.15 | 2461986414 | 10.15 | 2461986212 | 436 |

### 2-layer board – Antenna 1

| | 3.13 VDC | | 3.3 VDC | | 3.46 VDC | | |
|---|---|---|---|---|---|---|---|
| | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | FREQ DRIFT (Hz) |
| LOW CHANNEL | 11.23 | 2411954713 | 11.44 | 2411954374 | 11.51 | 2411954450 | 339 |
| MID CHANNEL | 11.45 | 2436954696 | 11.55 | 2436954501 | 11.64 | 2436954258 | 438 |
| HIGH CHANNEL | 14.69 | 2461952241 | 14.75 | 2461952559 | 14.75 | 2461952180 | 379 |

### 2-layer board – Antenna 2

| | 3.13 VDC | | 3.3 VDC | | 3.46 VDC | | |
|---|---|---|---|---|---|---|---|
| | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | POWER (dBm) | FREQUENCY (Hz) | FREQ DRIFT (Hz) |
| LOW CHANNEL | 10.99 | 2411955270 | 11.03 | 2411955465 | 11.00 | 2411955202 | 263 |
| MID CHANNEL | 10.39 | 2436954574 | 10.42 | 2436954425 | 10.45 | 2436954550 | 149 |
| HIGH CHANNEL | 10.03 | 2461954473 | 10.06 | 2461954336 | 10.01 | 2461954311 | 162 |

## B.2 – Radiated Emissions

| | | | | |
|---|---|---|---|---|
| Rule Part(s) | FCC: 15.247 / 15.205 / 15.209<br>IC: RSS-210 A8 / RSS-210 Section 2.2 | | | |
| Measurement Procedure | ANSI C63.4 - 2009<br>ANSI C63.10 – 2009<br>FCC KDB 558074 D01 DTS Meas Guidance v03r02 | | | |
| Test Location | LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber | | | |
| Test Distance | See data section | | | |
| EUT Placement | 80 cm height non-conductive table above reference ground plane | | | |
| Frequency Range of Measurement | Biconical:<br>30-300 MHz | Log Periodic Dipole Array:<br>300-1000 MHz | Double-Ridged Waveguide Horn:<br>1-18 GHz | Standard Gain Horn:<br>18-26GHz |
| Measurement Detectors | 30-1000MHz<br>RBW: 120 kHz<br>VBW: At least 300 kHz | | 1 - 40 GHz:<br>RBW : 1MHz<br>VBW: At least 3 (MHz) Peak<br>10 Hz Average | |
| Description of Measurement | 1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are preformed. The data is gathered and reported as the corrected values.<br><br>2) The EUT is placed on a non-conductive pedestal made of expanded polyethylene foam centered on a turn-table in the test location with the antenna at the test distance from the EUT<br><br>3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height. | | | |
| Example Calculations | Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable) | | | |

**FCC Part 15.209 / IC RSS-210 Section 2.7 Limits:**

| Frequency (MHz) | 3 m Limit (µV/m) | 3 m Limit (dBµV/m) | Type |
|---|---|---|---|
| 30-88 | 100 | 40.0 | Quasi-Peak |
| 88-216 | 150 | 43.5 | Quasi-Peak |
| 216-960 | 200 | 46.0 | Quasi-Peak |
| Above 960 | 500 | 54.0 | Average (>1 GHz) |

### B.2.1 – Transmitter Band-Edge Restricted Band

| | |
|---|---|
| Manufacturer | LSR |
| Date | 2-3, 2-4 3-23, 3-25 2015 |
| Operator | Adam A |
| Temp. / R.H. | 20 - 25º C / 30-60% R.H. |
| Rule Part | 15.247/ 15.205 / 15.209 |
| Measurement Procedure | ANSI C63.4 - 2009<br>ANSI C63.10 - 2009<br>FCC KDB 558074 v03r02 Section 12.2.7 Radiated spurious emission test |
| Test Distance | 3 meter |
| EUT Placement | 80 cm height non-conductive table centered on turn-table, EUT rotated in three orientations |
| Detectors | Peak; RBW 1MHz VBW 3 MHz (10Hz VBW for average measurements) |
| Additional Notes | 1) Tested in the worst case of continuous transmit modulated mode based on conducted measurements with EUT rotated in three orientations.<br>2) EUT maximized in azimuth and antenna height with maximum results reported.<br>3) 4-layer and 2-layer boards tested.<br>4) U.FL antenna port terminated with matching 50 ohm termination tested.<br>5) Antenna 1 and Antenna 2 tested. |

**Example Calculation:**
FCC 15.209 Average Limit @ 3 meter (dBµV/m) – Average Reading (dBµV/m) = Margin
FCC 15.209 Peak Limit @ 3 meter (dBµV/m) – Peak Reading (dBµV/m) = Margin

### Upper Band-Edge Restricted Band - High Channel
### 4-layer board – Antenna 1 – Chip Antenna

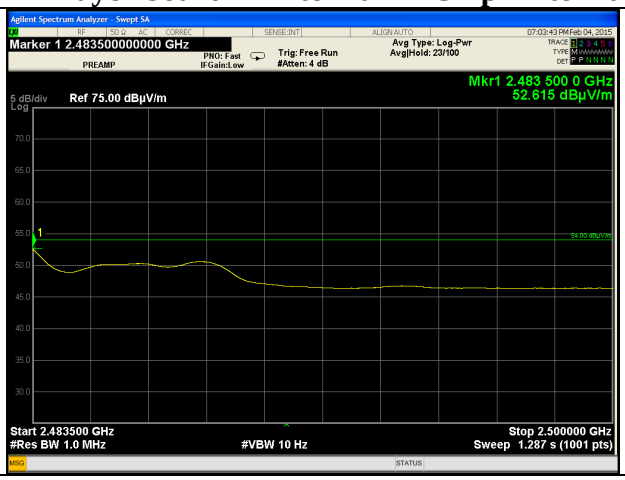
**Average**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBµV/m) | Average Limit (dBµV/m) | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.483500 | 52.615 | 54 | 1.4 |
| g | 6 | 2.483500 | 50.646 | | 3.4 |
| n | MCS 0 | 2.483599 | 52.036 | | 2.0 |

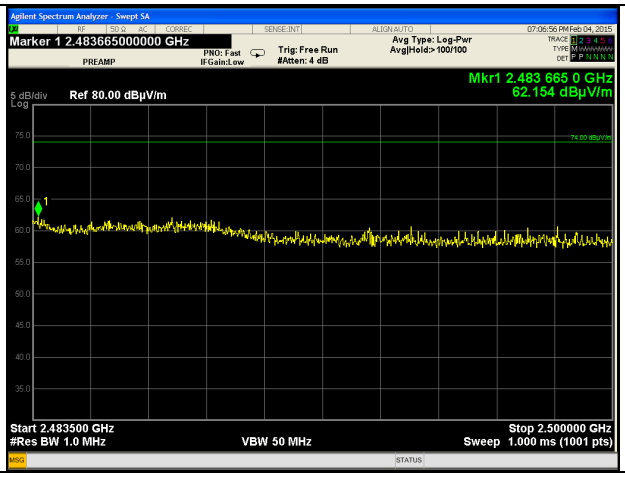
**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.4836650 | 62.154 | 74 | 11.8 |
| g | 6 | 2.4885975 | 65.161 | | 8.8 |
| n | MCS 0 | 2.4849685 | 65.429 | | 8.6 |

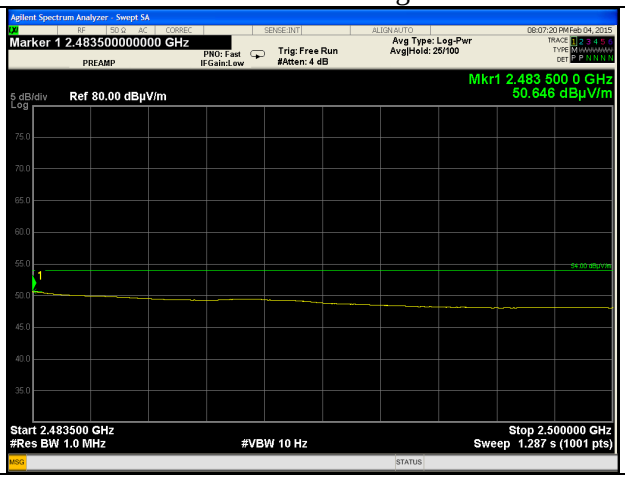
## 4-layer board – Antenna 1 – Chip Antenna



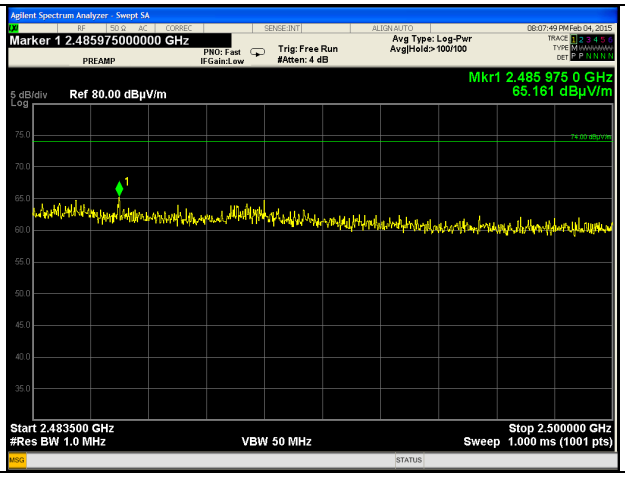

802.11b – Average



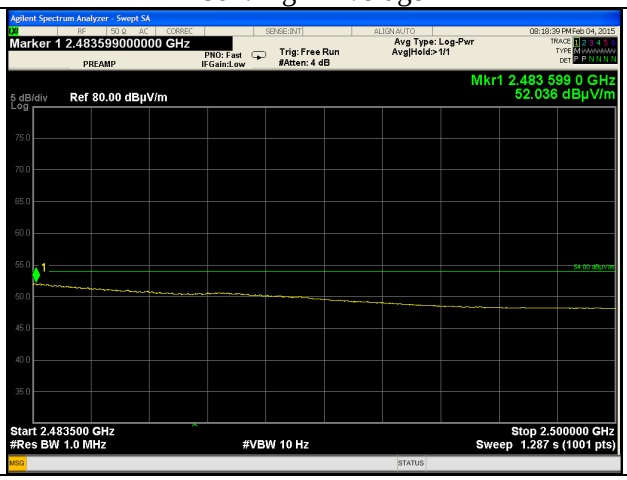

802.11b – Peak



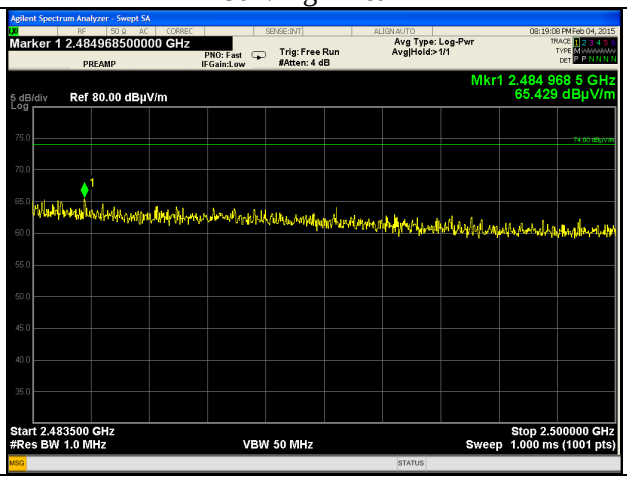

802.11g – Average




802.11g – Peak




802.11n – Average




802.11n – Peak

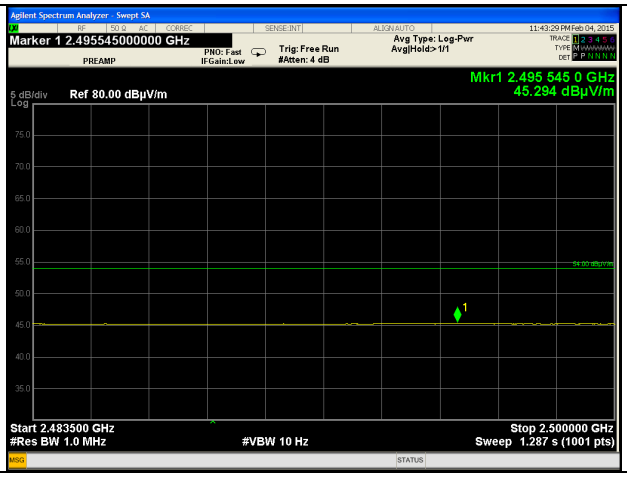
## Upper Band-Edge Restricted Band - High Channel
## 4-layer board – Antenna 1 – u.fl port with termination
## 802.11b (worst case mode)

**Average**

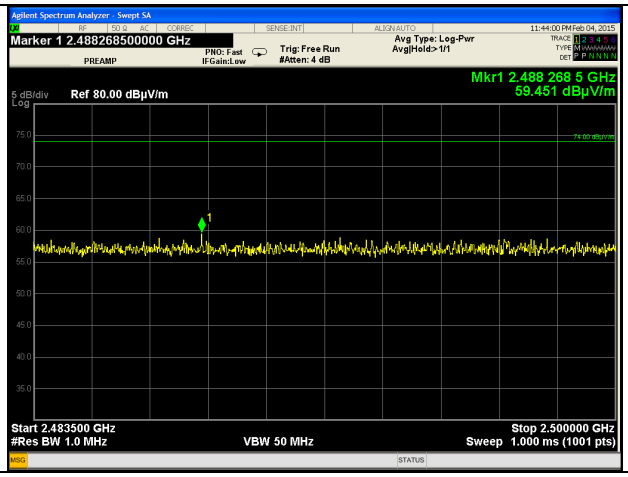
| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBµV/m) | Average Limit (dBµV/m) | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.495545 | 45.294 | 54 | 8.7 |

**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.4882685 | 59.451 | 74 | 14.5 |




Average




Peak

## Lower Band-Edge Restricted Band – Low Channel
## 4-layer board – Antenna 1 – Chip Antenna

**Average**

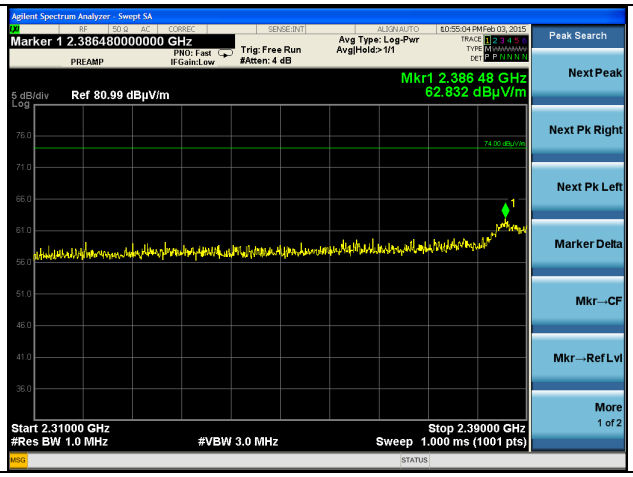
| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBµV/m) | Average Limit (dBµV/m) | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.385760 | 52.259 | 54 | 1.7 |
| g | 6 | 2.390000 | 52.275 | | 1.7 |
| n | MCS 0 | 2.390000 | 51.887 | | 2.1 |

**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.3864800 | 62.832 | 74 | 11.2 |
| g | 6 | 2.3893600 | 69.782 | | 4.2 |
| n | MCS 0 | 2.3894400 | 71.888 | | 2.1 |

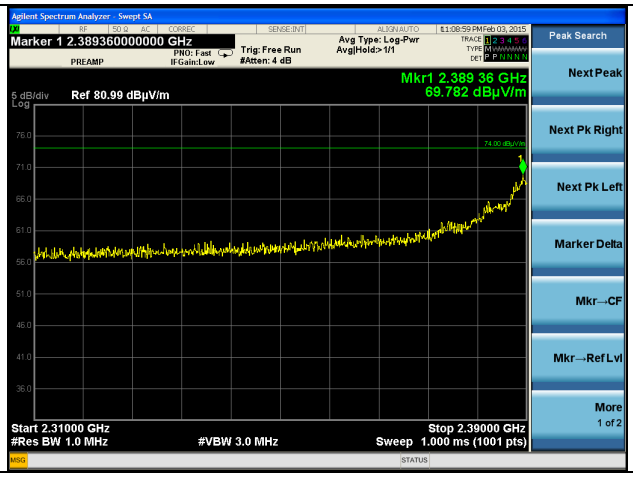
## 4-layer board – Antenna 1 – Chip Antenna


802.11b – Average



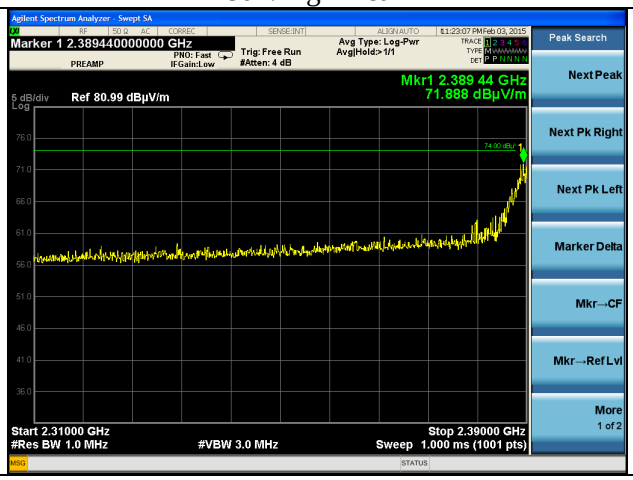

802.11b – Peak


802.11g – Average




802.11g – Peak


802.11n – Average




802.11n – Peak

## Lower Band-Edge Restricted Band – Low Channel
## 4-layer board – Antenna 1 – u.fl port with termination
## 802.11b (worst case mode)

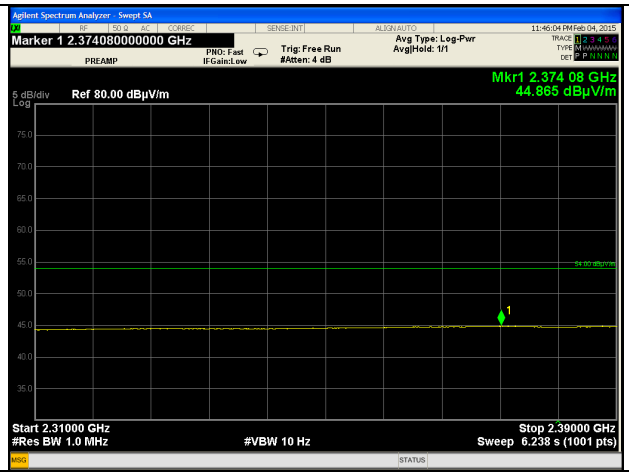
**Average**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBµV/m) | Average Limit (dBµV/m) | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.374080 | 44.865 | 54 | 9.1 |

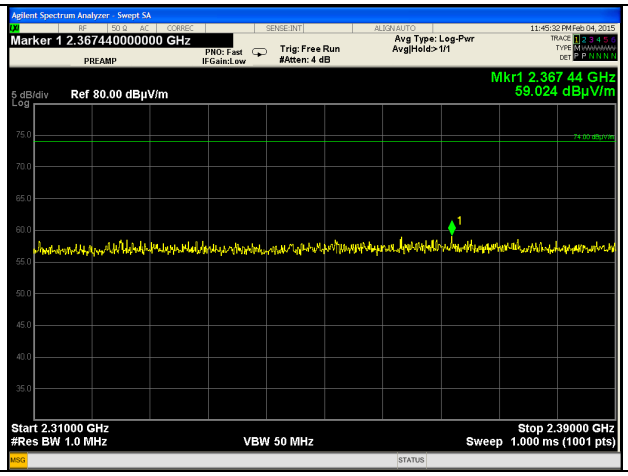
**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.3674400 | 59.024 | 74 | 15.0 |

**Plots**




Average




Peak

**Upper Band-Edge Restricted Band**
**4-layer board – Antenna 2 – Chip Antenna**
**Average**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Average Meas (dBµV/m) | Average Limit (dBµV/m) | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.483500 | 49.202 | 54 | 4.8 |
| g | 6 | 2.483500 | 48.250 | | 5.8 |
| n | MCS 0 | 2.483500 | 46.772 | | 7.2 |

**Peak**

| Mode (802.11) | Mode (Mbps) | Frequency (GHz) | Peak Meas (dBµV/m) | Limit | Margin |
|---|---|---|---|---|---|
| b | 1 | 2.4835990 | 61.996 | 74 | 12.0 |
| g | 6 | 2.4842920 | 62.305 | | 11.7 |
| n | MCS 0 | 2.4841270 | 61.309 | | 12.7 |