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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:

Michael Hintzke EMC Engineer

Signature:

Date: 2/21/15

Report by:

Adam Alger, EMC Engineer

Signature:

Date: 2-18-15

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Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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LS Research, LLC in Review

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



TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

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



Federal Communications Commission (FCC) – USA

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



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



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

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
FCC : 15.109 IC : RSS GEN	Receive Mode (Digital Device) Radiated Emissions	Yes
FCC : 2.1055 (d)	Frequency Stability	Yes
FCC : 15.207 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.

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
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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:	<u>4-layer</u> Chip Antenna (20E1F0018); U.FL (20E2D0037) <u>2-layer</u> 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

Prepared For: LSR	Name: TiWi-C-W
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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: 20-25° 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

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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.

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LSR: C-2114	Serial: See Section 3.1

Appendix A – Test Equipment



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	K/M	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	Adu. Micro / EMC	w/LA622-4 / 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: Adam Alger Quality Assurance: Adam Alger

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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 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.

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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 - 25° 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 ANSI C63.10-2009 Section 6.9 RSS-GEN Section 6.6
Additional Description of Measurement	Peak detector used
Additional Notes	1. Continuous transmit modulated used for this test. 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

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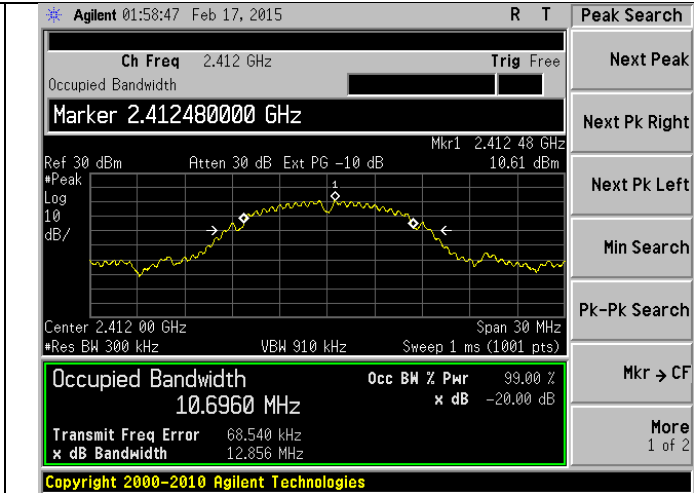
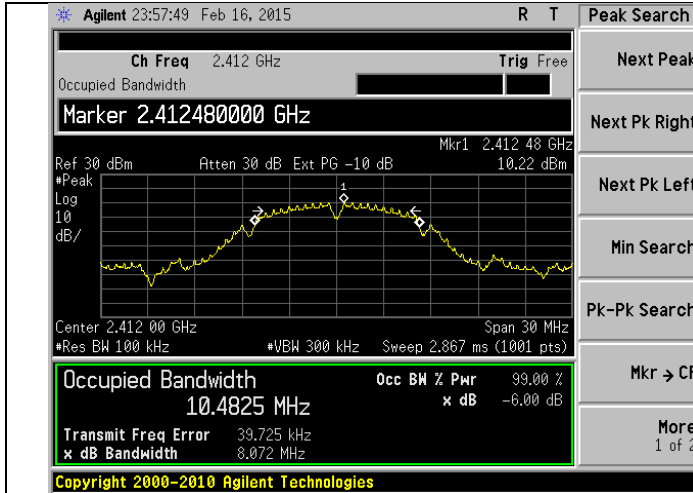
LSR: C-2114

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Model: TiWi-C-W

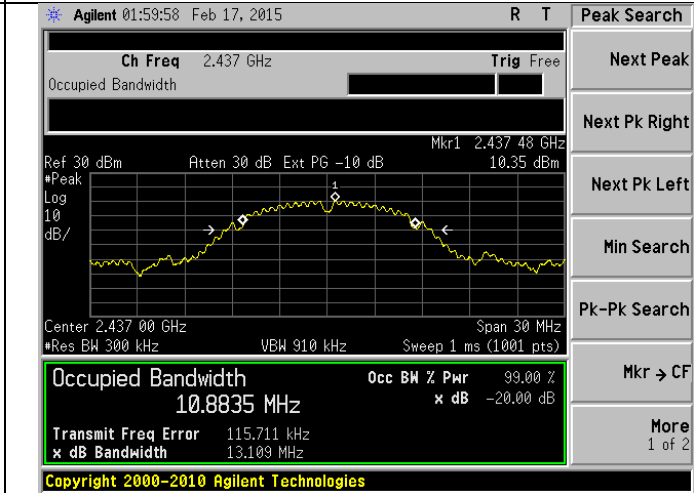
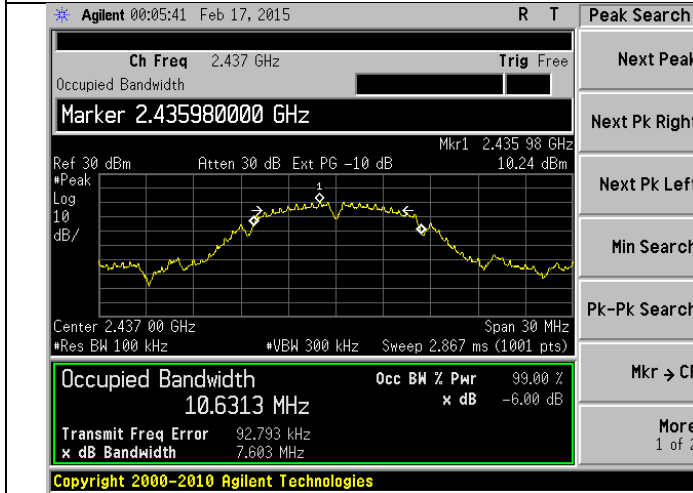
Serial: See Section 3.1

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



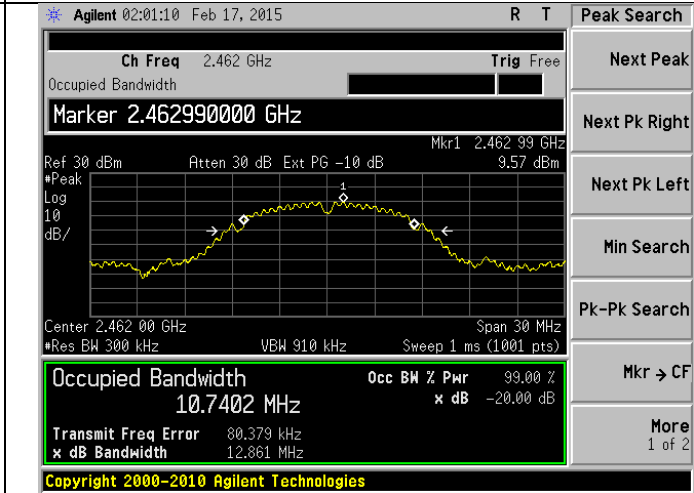
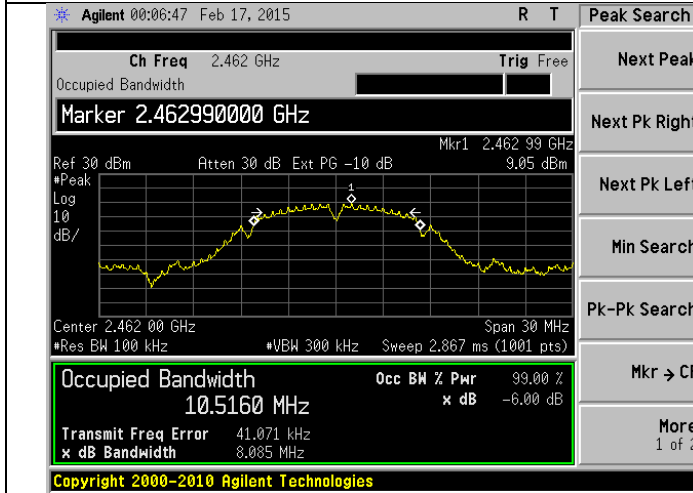
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



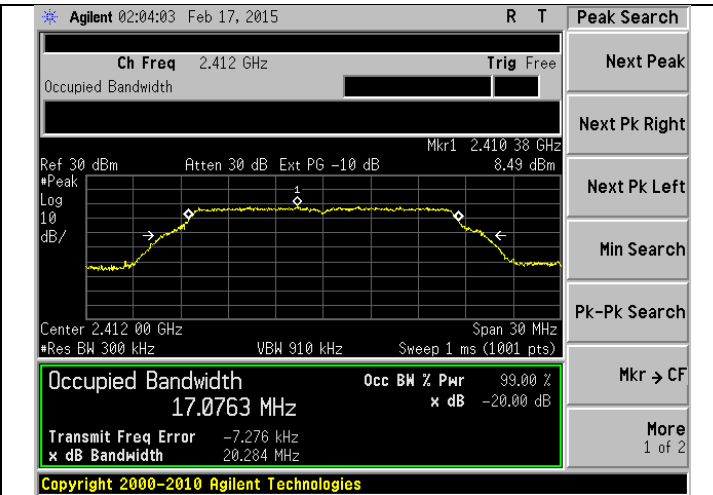
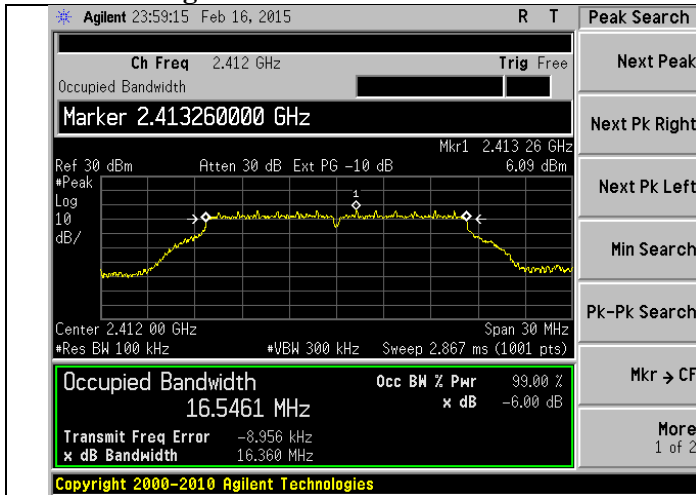
High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

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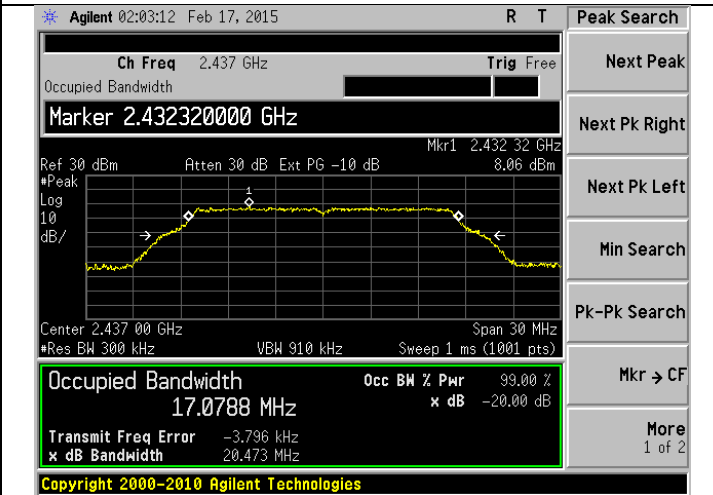
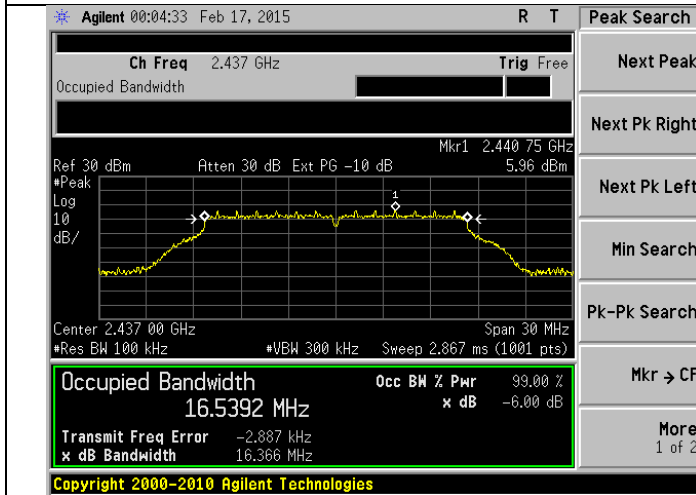
Name: TiWi-C-W
Model: TiWi-C-W
Serial: See Section 3.1

802.11g



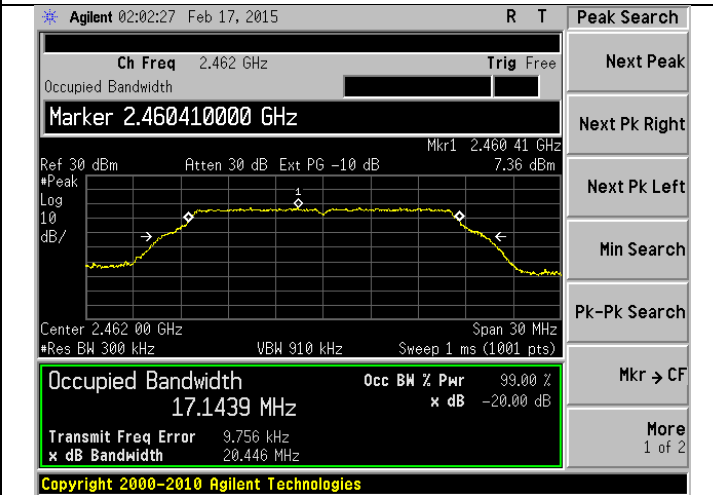
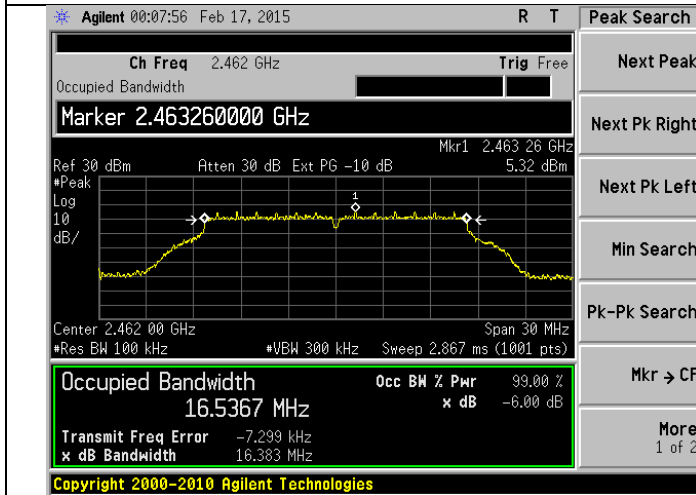
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

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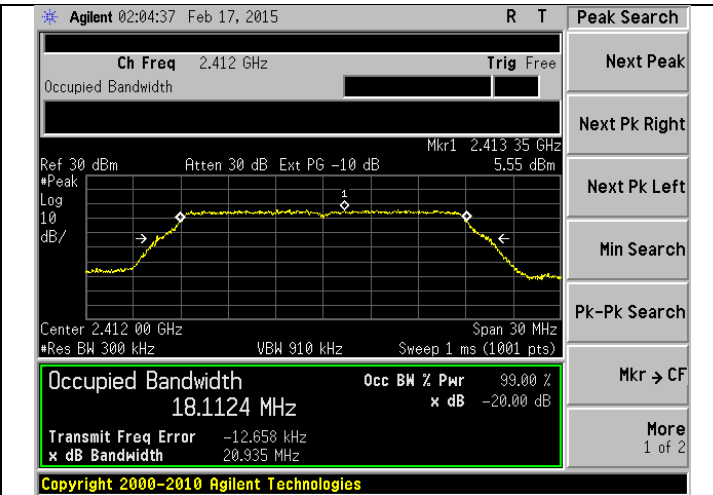
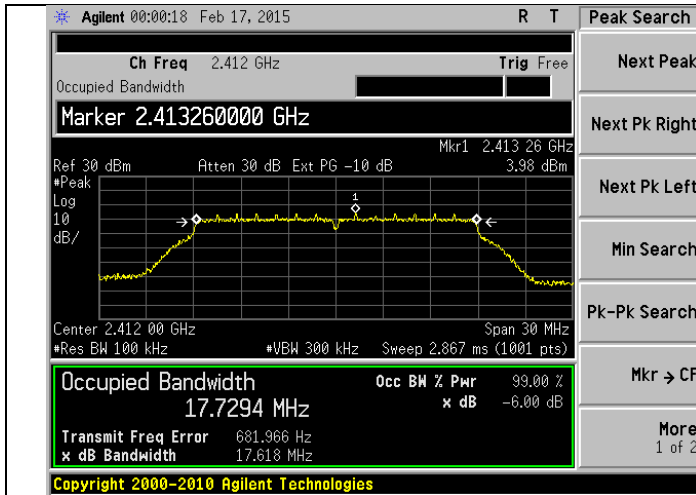
LSR: C-2114

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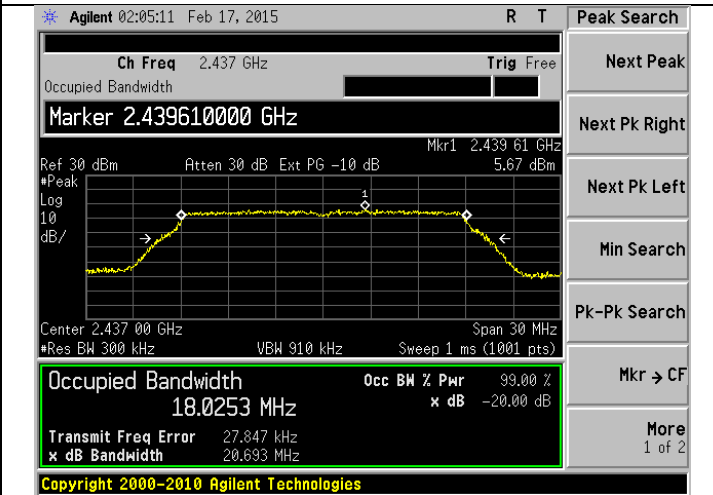
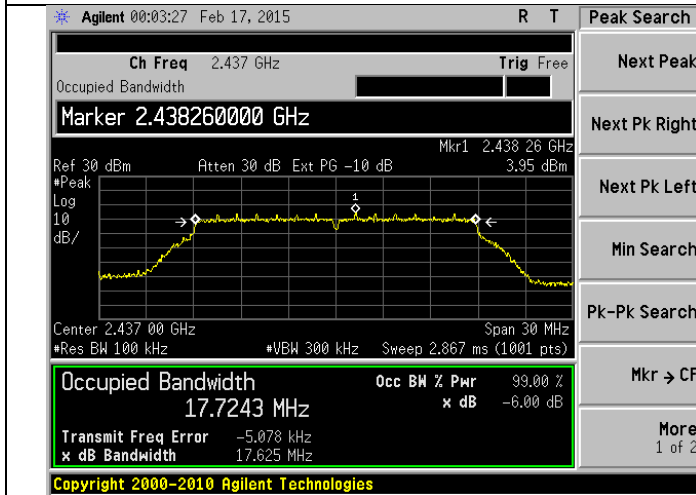
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802.11n



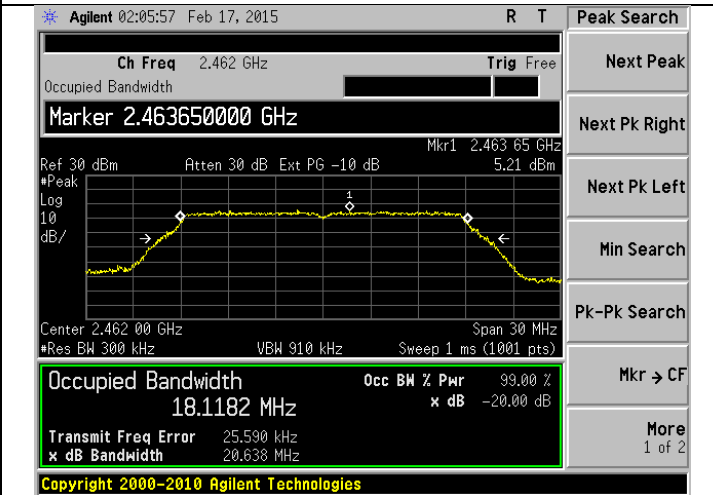
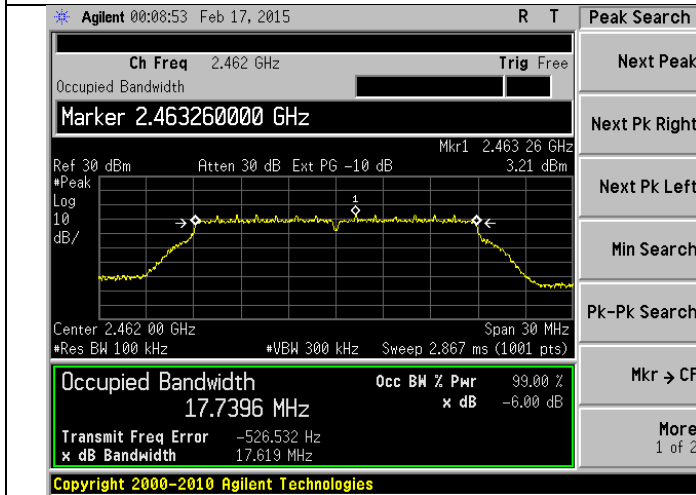
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

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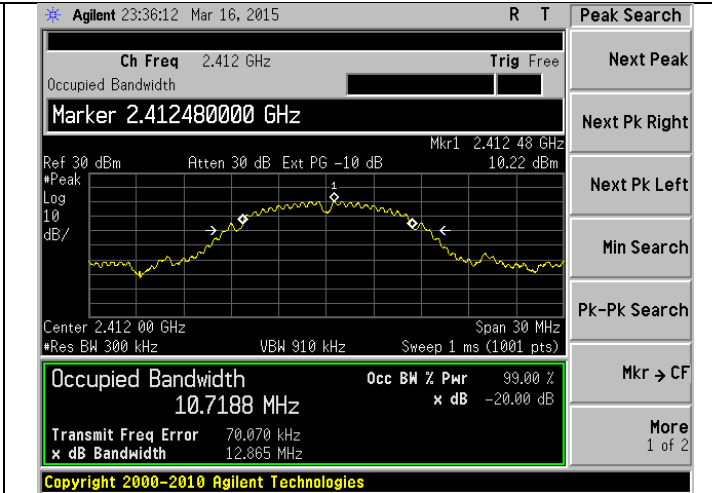
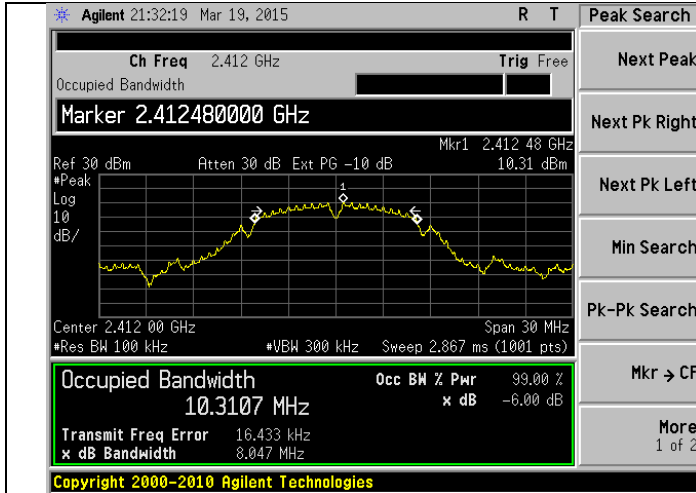
LSR: C-2114

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Model: TiWi-C-W

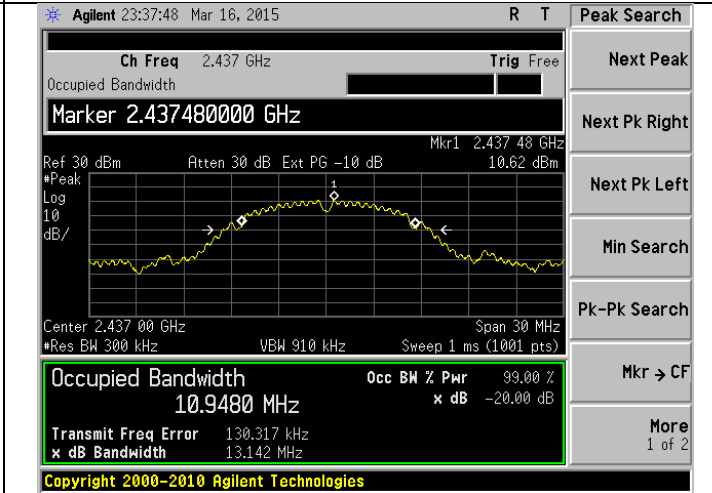
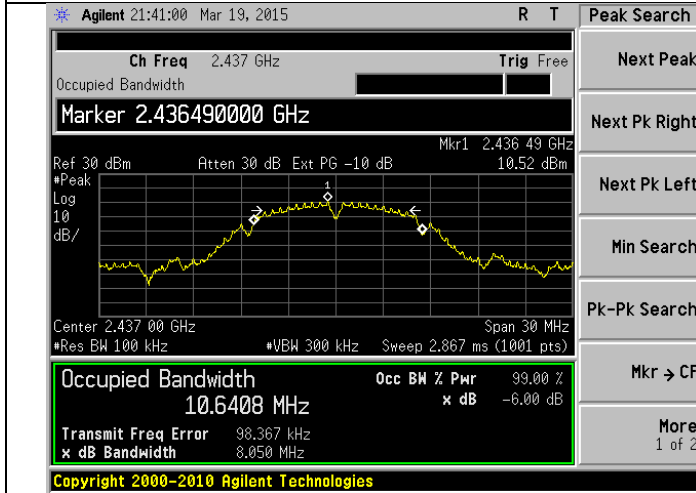
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**PLOTS (4-layer board – Antenna 2)
802.11b**



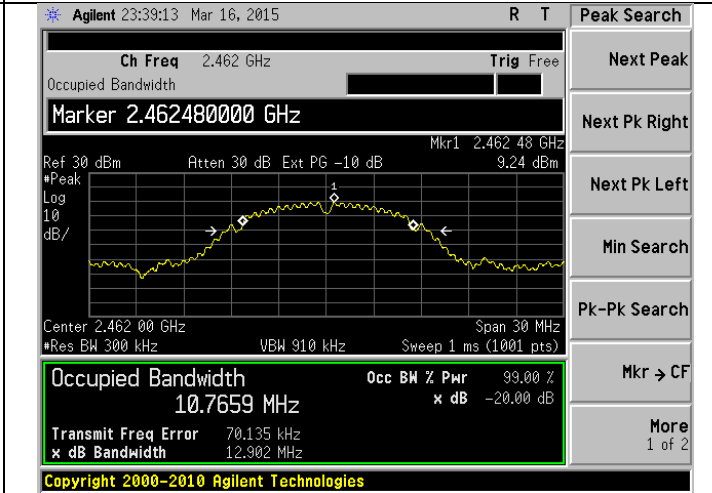
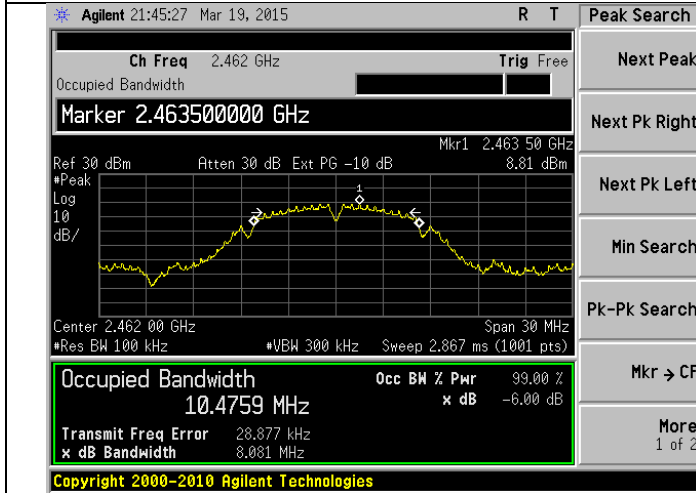
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

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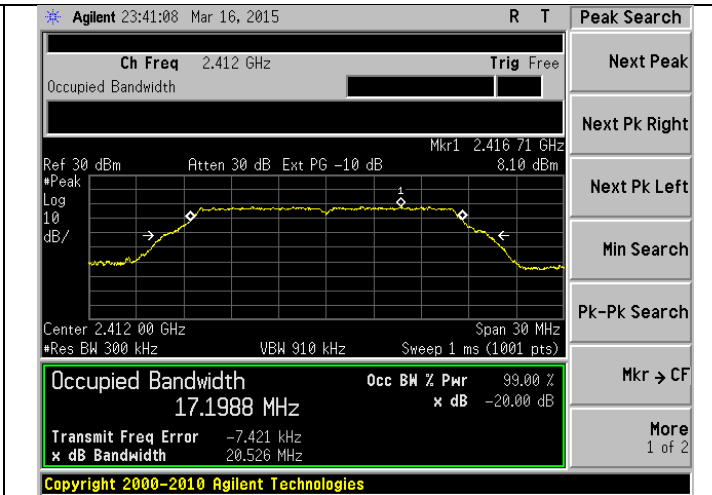
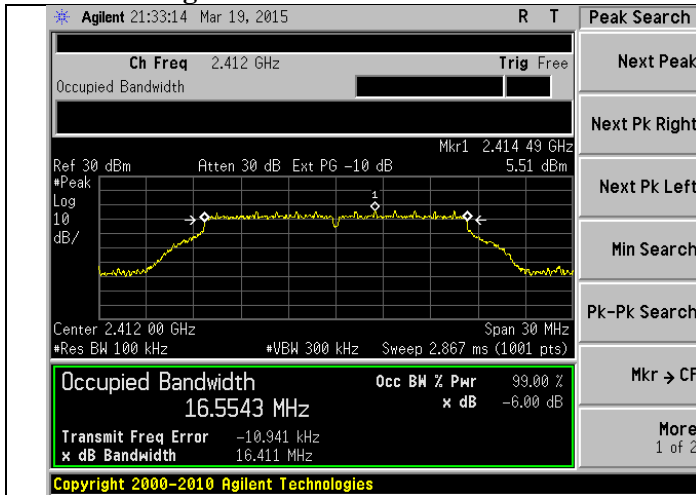
LSR: C-2114

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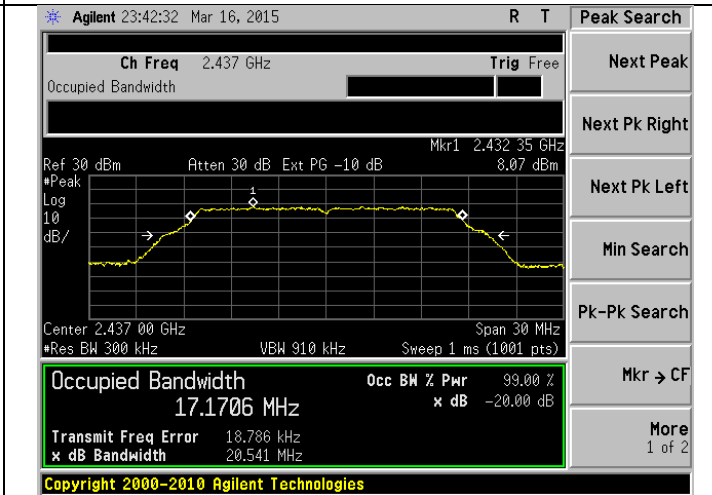
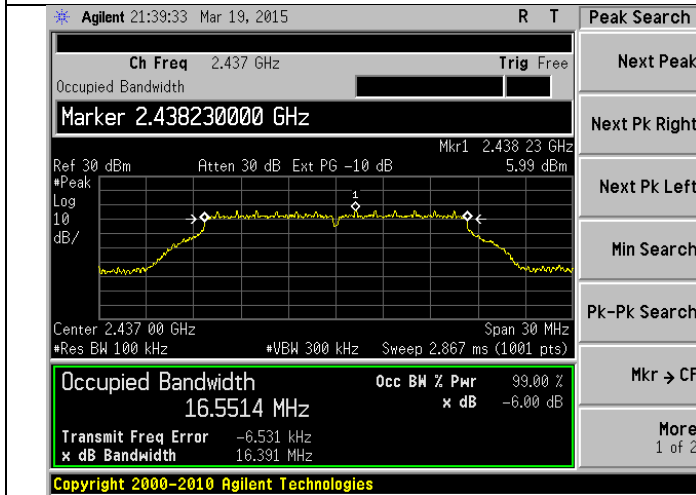
Model: TiWi-C-W

Serial: See Section 3.1

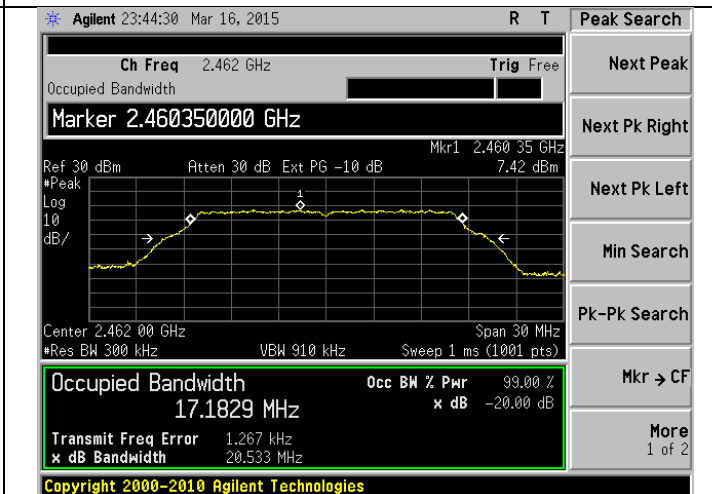
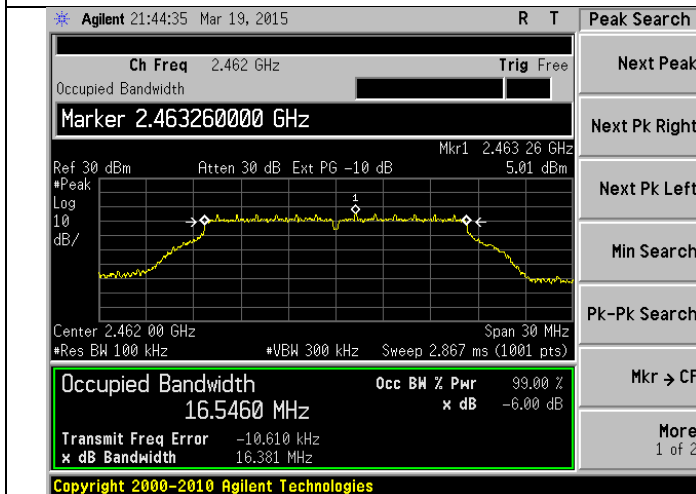
802.11g



Low Channel - 6 dB DTS BW



Mid Channel - 6 dB DTS BW



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

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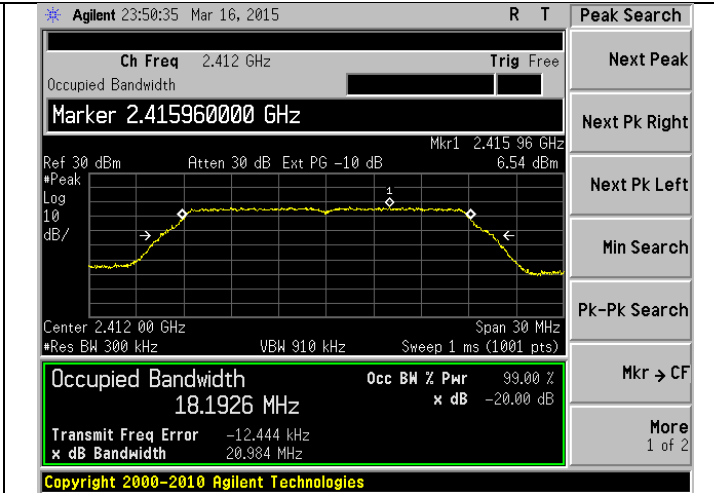
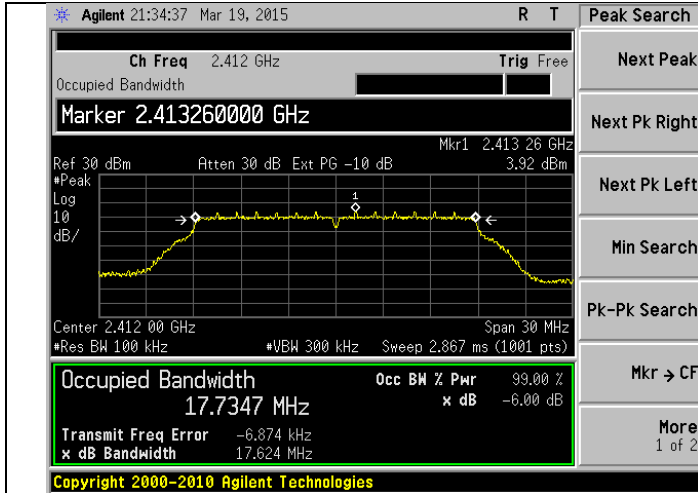
LSR: C-2114

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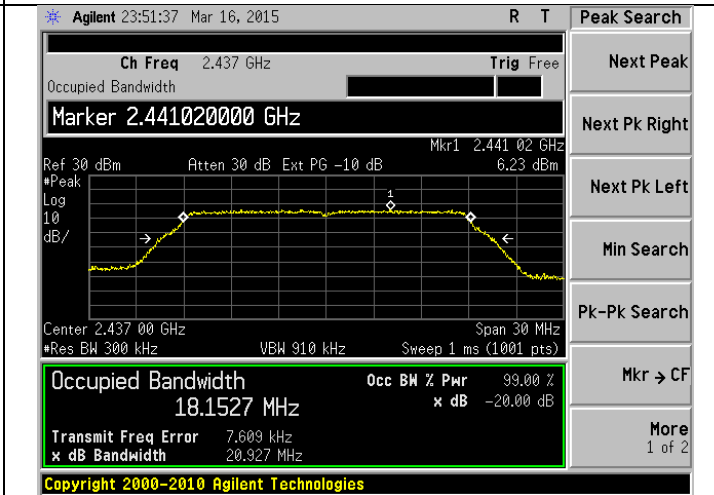
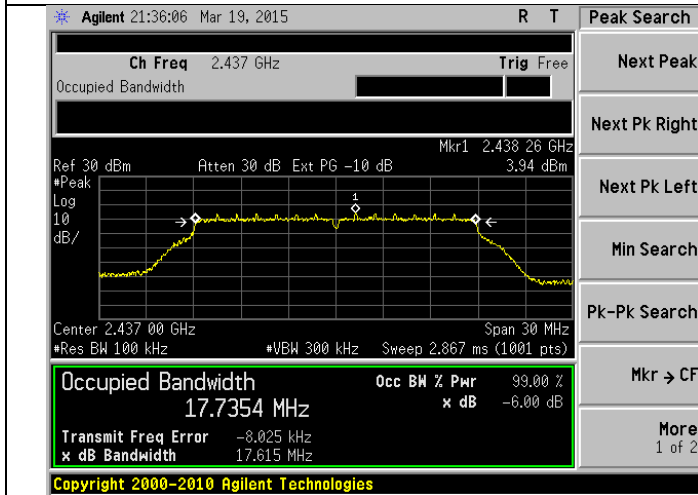
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802.11n



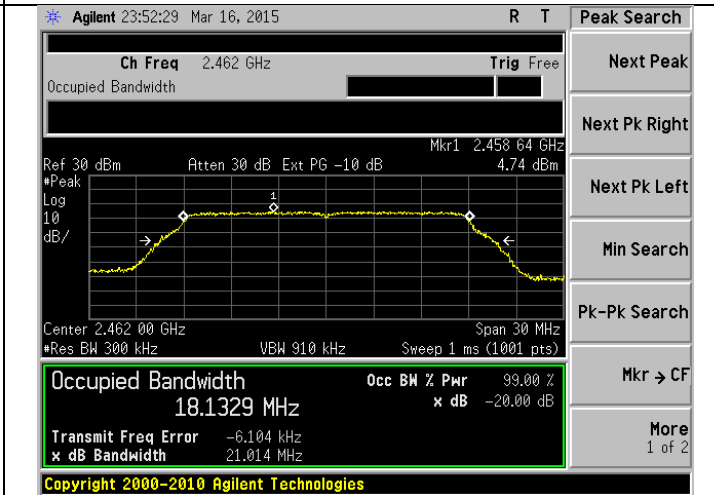
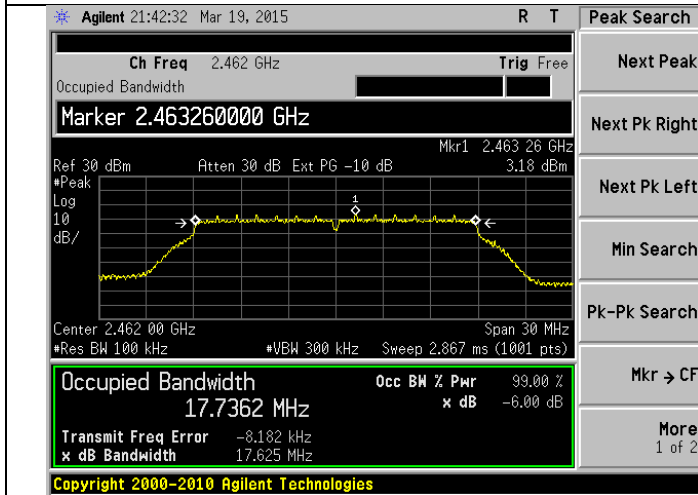
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

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LSR: C-2114

Serial: See Section 3.1

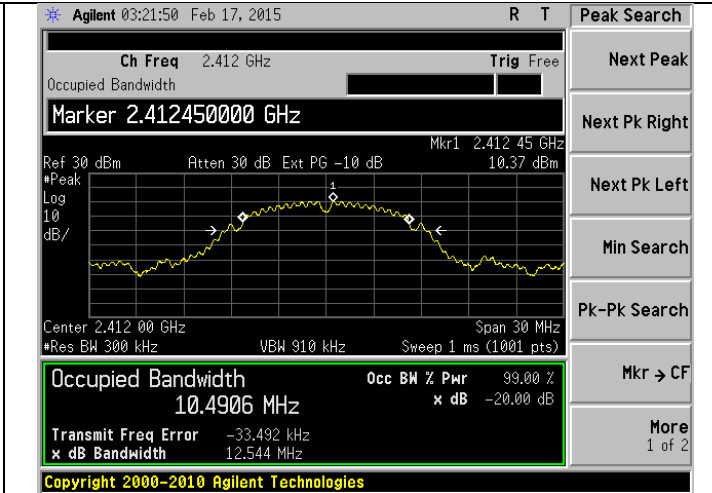
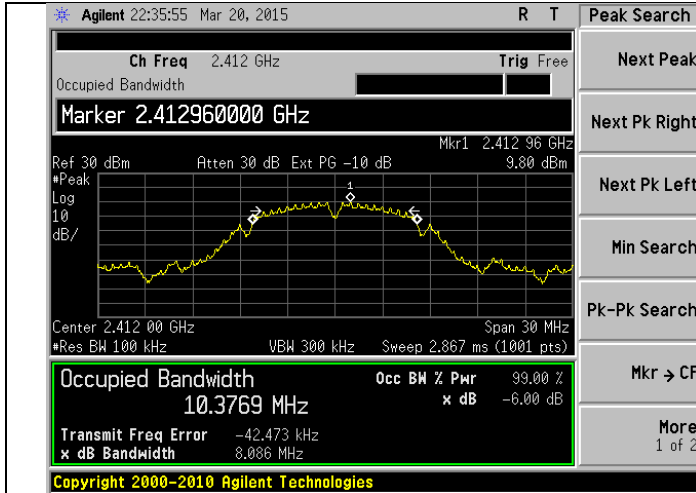
**Table
2-layer board – Antenna 1**

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

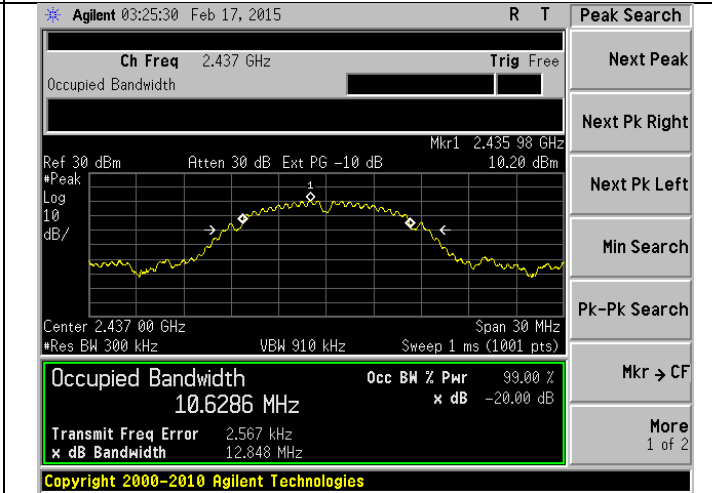
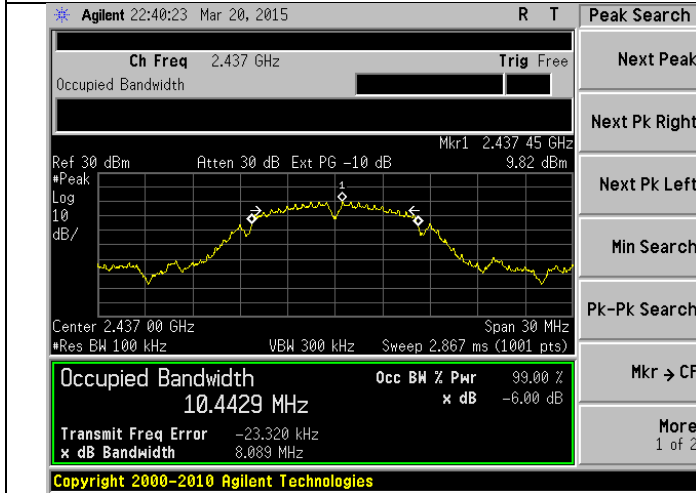
2-layer board – Antenna 2

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

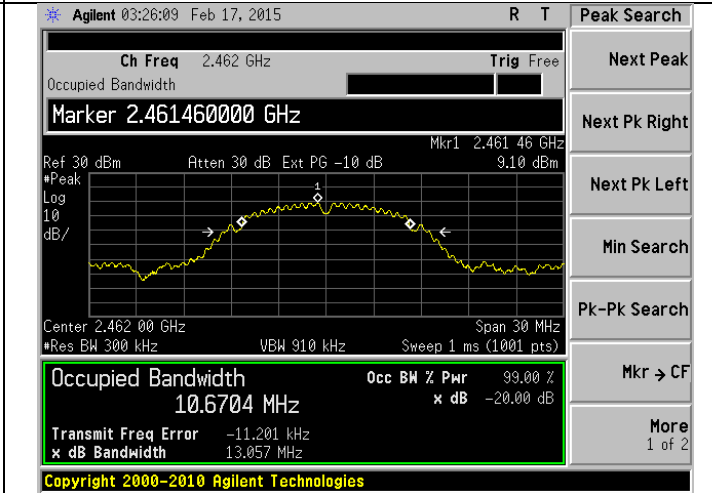
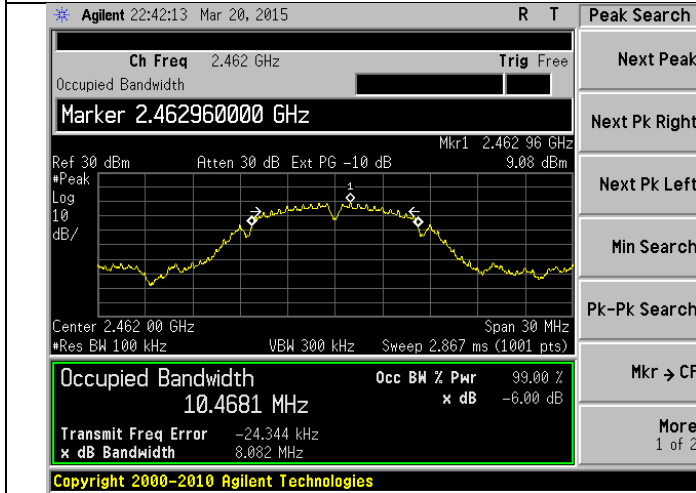
**PLOTS (2-layer board – Antenna 1)
802.11b**



Low Channel - 6 dB DTS BW



Mid Channel - 6 dB DTS BW

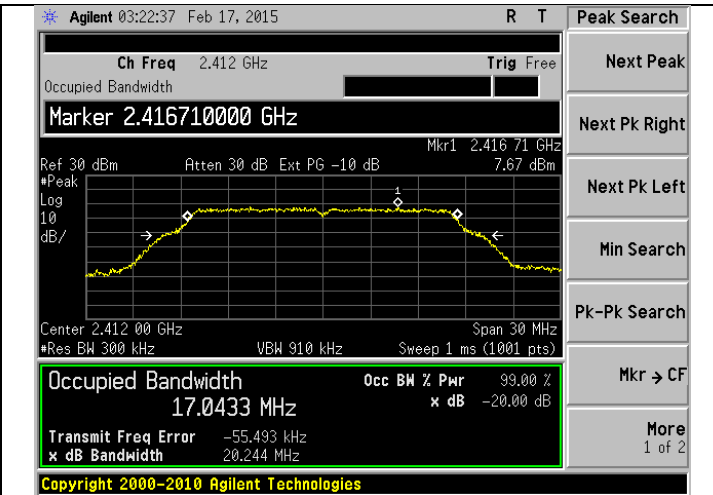
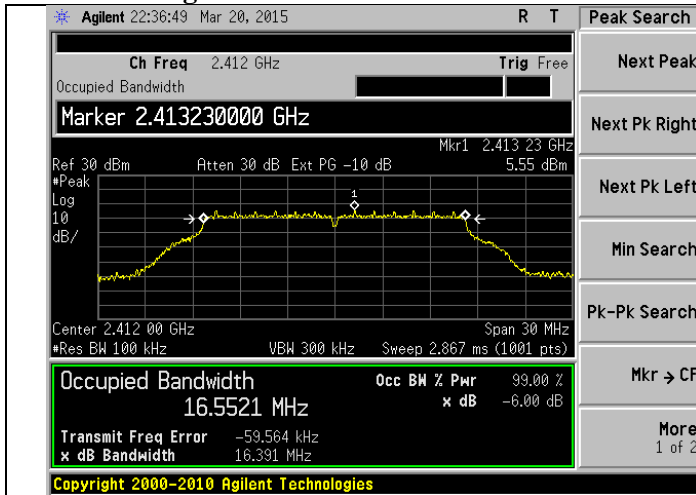


High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

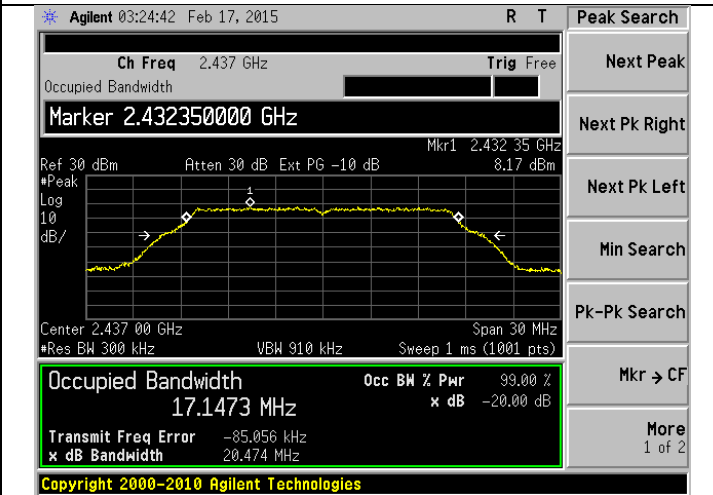
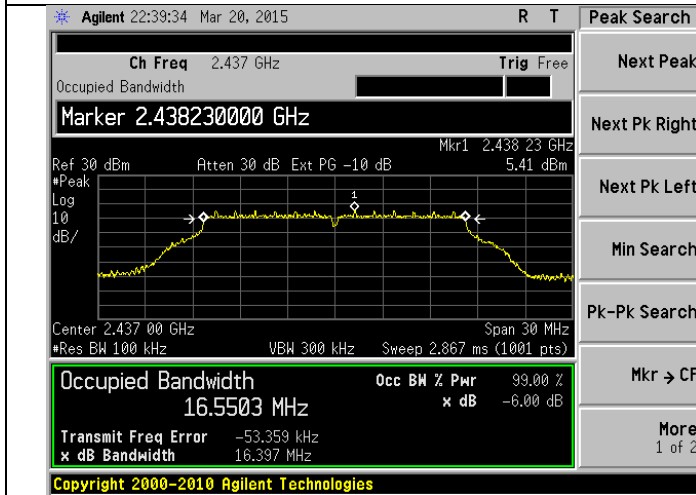
Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

802.11g



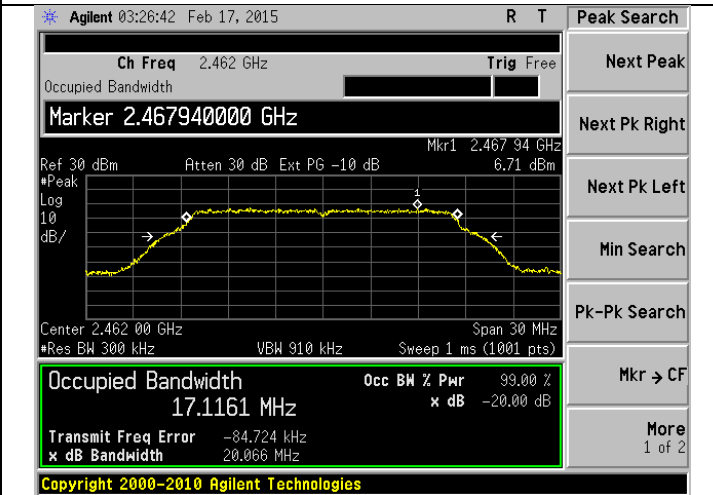
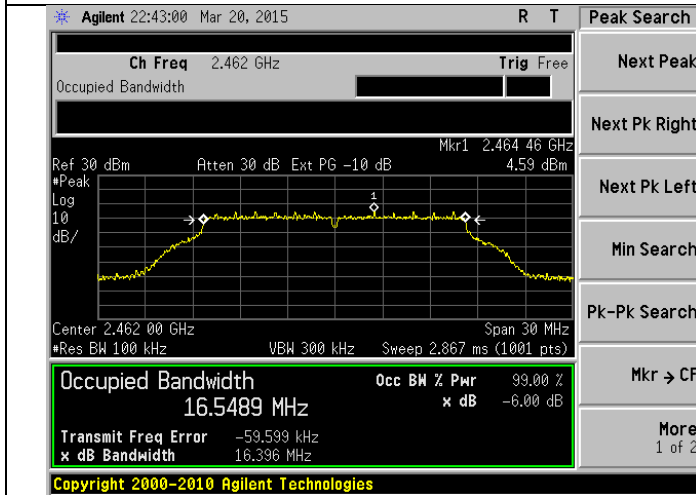
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

Prepared For: LSR

Report: TR 314413

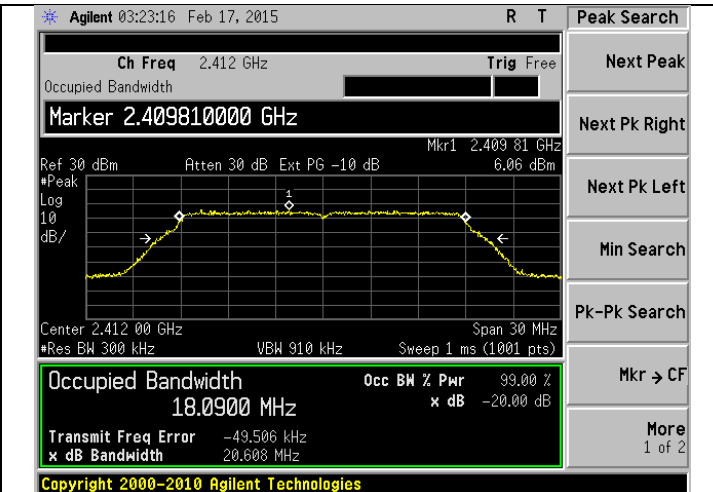
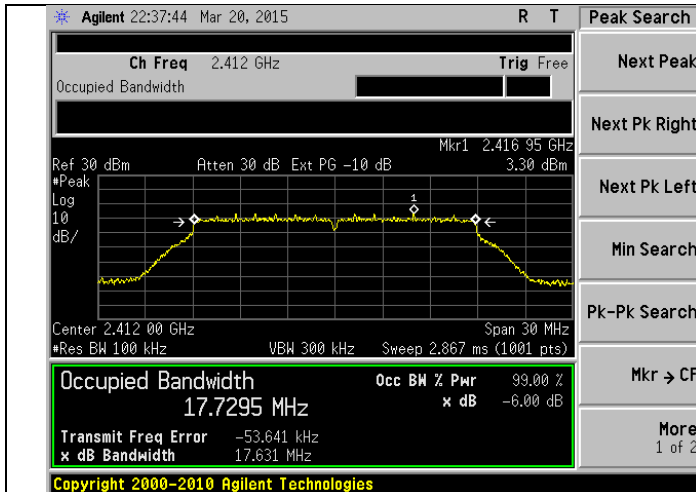
LSR: C-2114

Name: TiWi-C-W

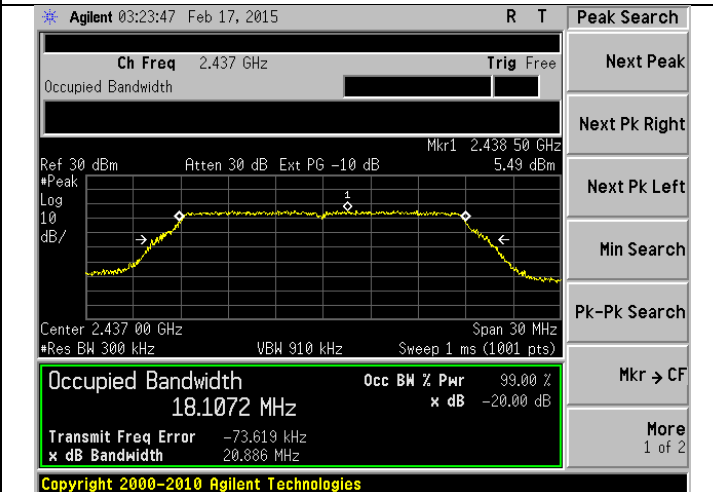
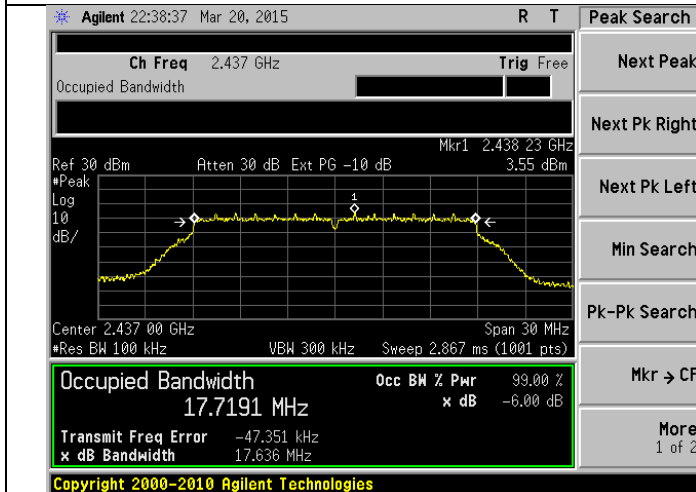
Model: TiWi-C-W

Serial: See Section 3.1

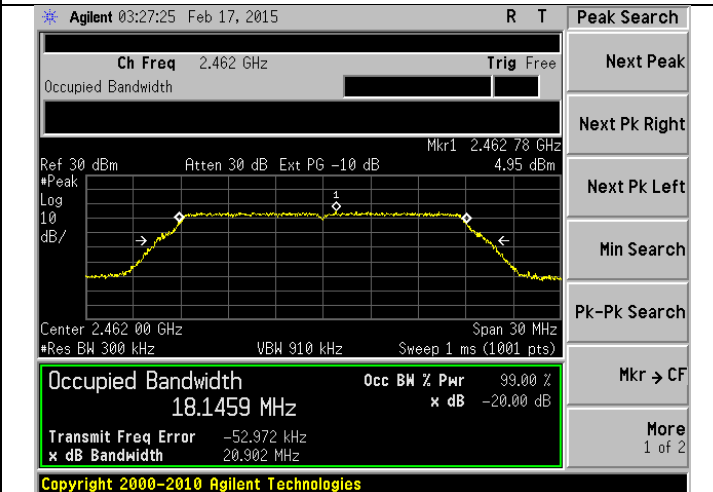
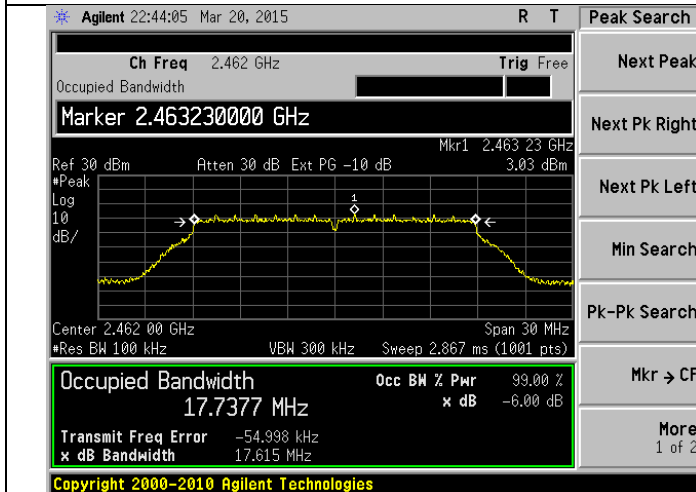
802.11n



Low Channel - 6 dB DTS BW



Mid Channel - 6 dB DTS BW



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

Prepared For: LSR

Report: TR 314413

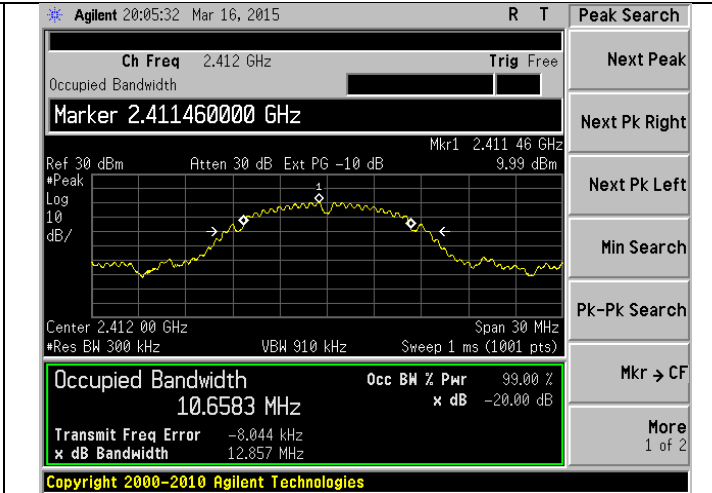
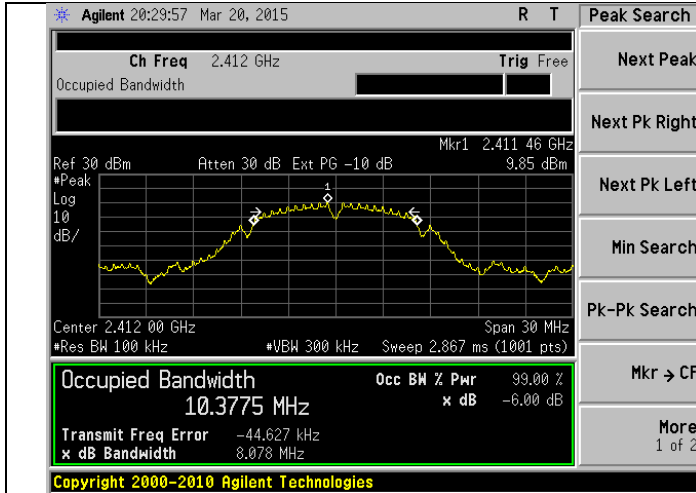
LSR: C-2114

Name: TiWi-C-W

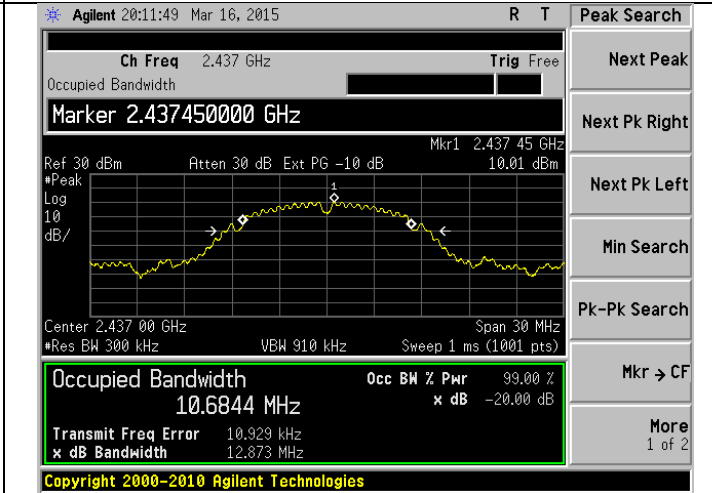
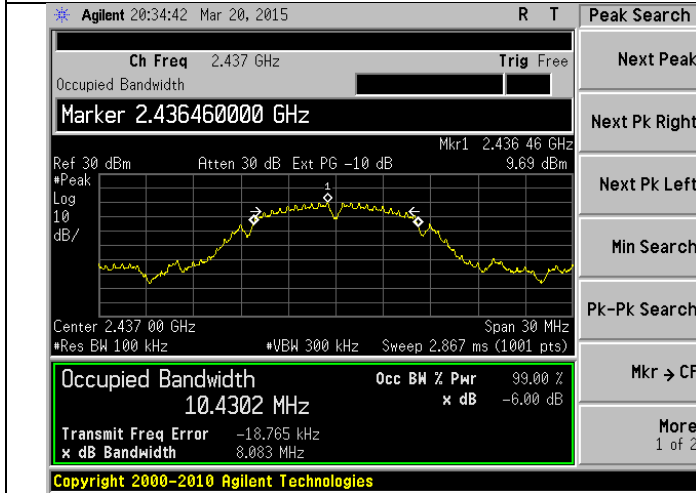
Model: TiWi-C-W

Serial: See Section 3.1

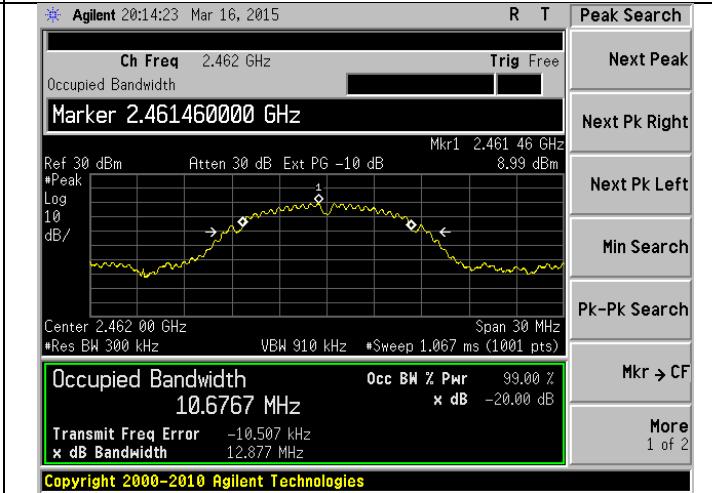
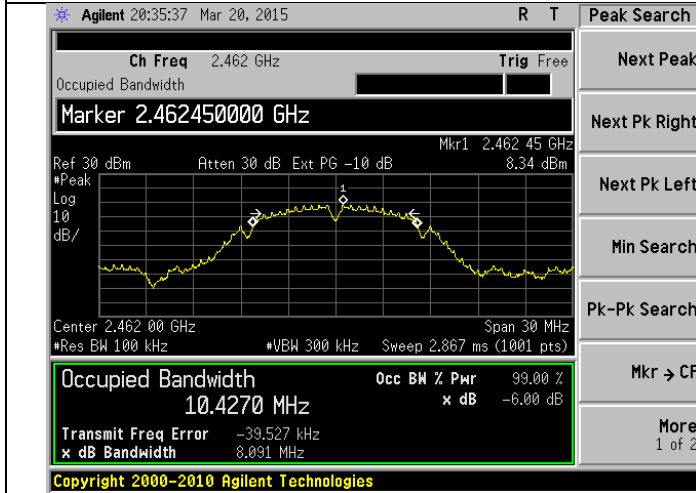
**PLOTS (2-layer board – Antenna 2)
802.11b**



Low Channel - 6 dB DTS BW



Mid Channel - 6 dB DTS BW



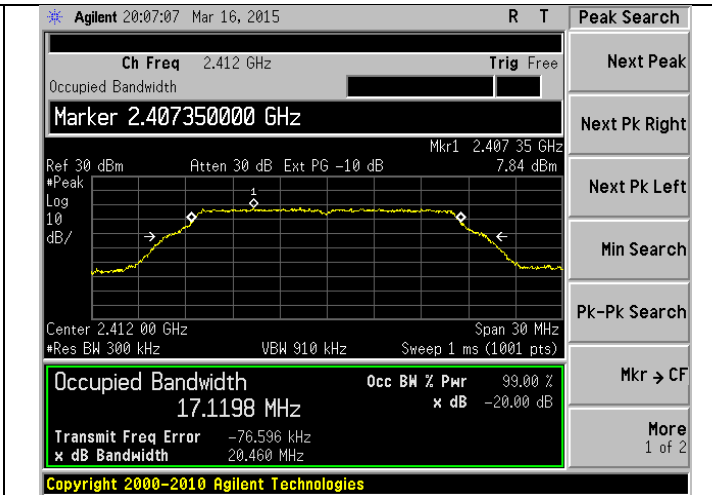
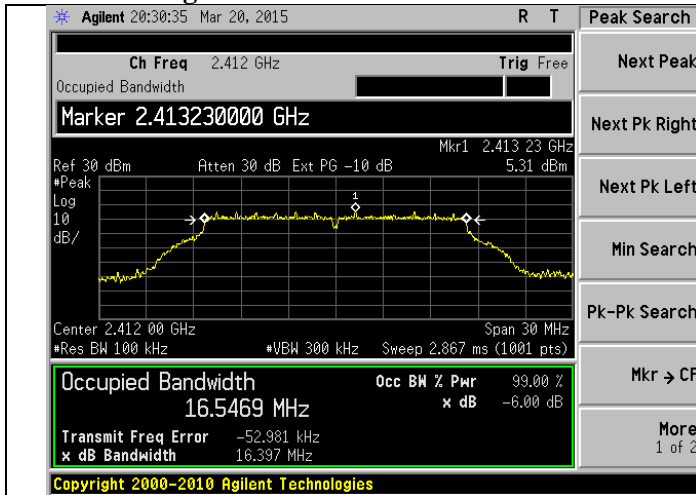
High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

Prepared For: LSR
Report: TR 314413
LSR: C-2114

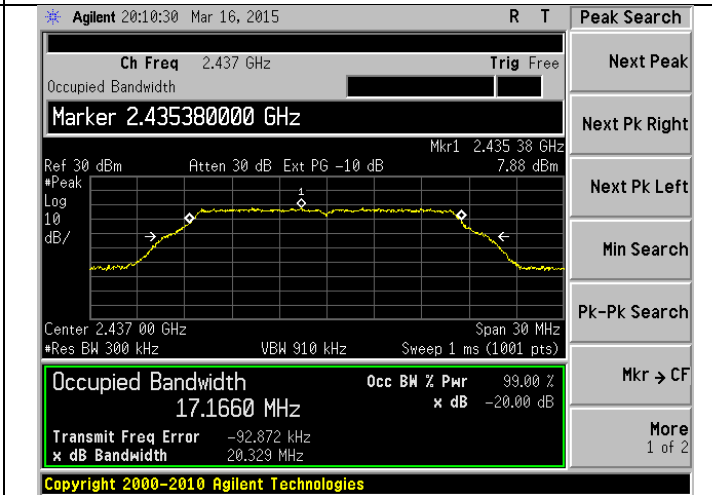
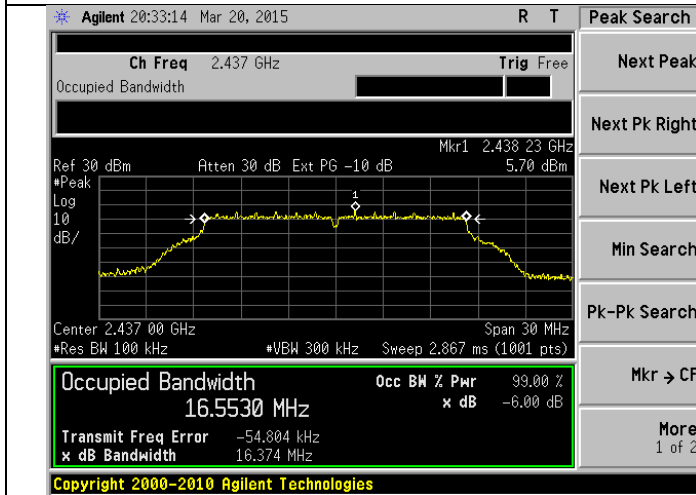
Name: TiWi-C-W
Model: TiWi-C-W
Serial: See Section 3.1

802.11g



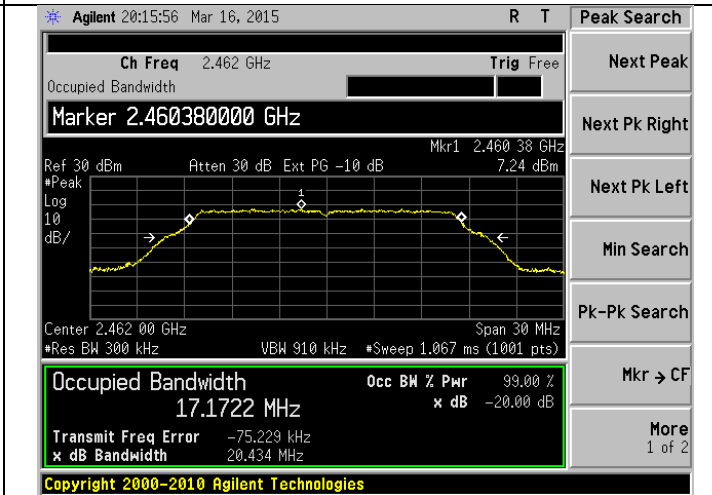
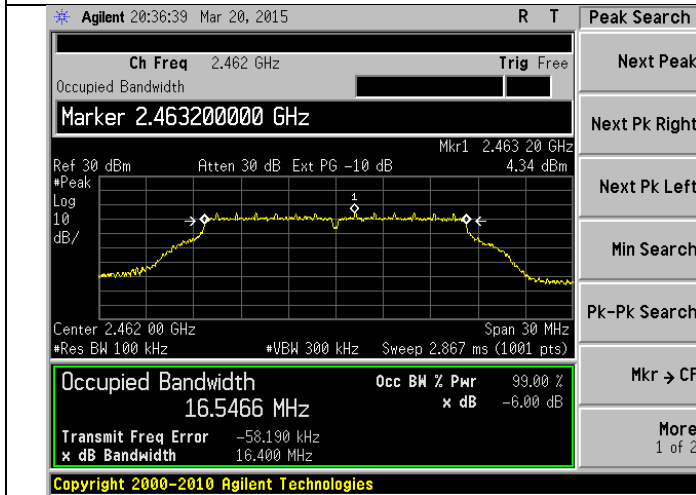
Low Channel - 6 dB DTS BW

Low Channel - OBW / 99 %



Mid Channel - 6 dB DTS BW

Mid Channel - OBW / 99 %



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

Prepared For: LSR

Report: TR 314413

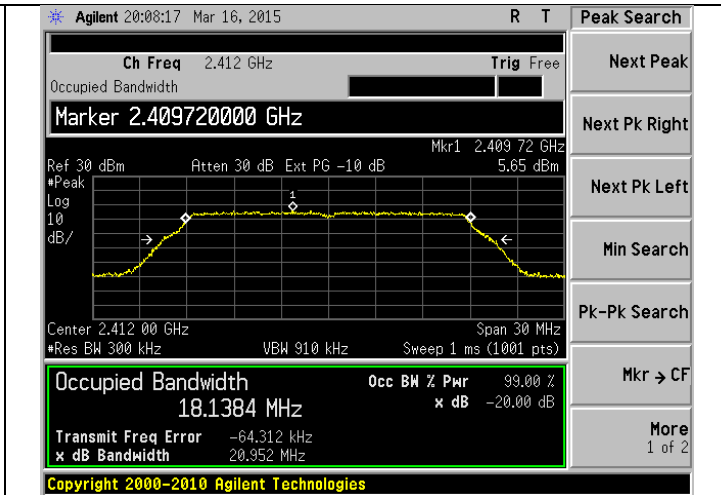
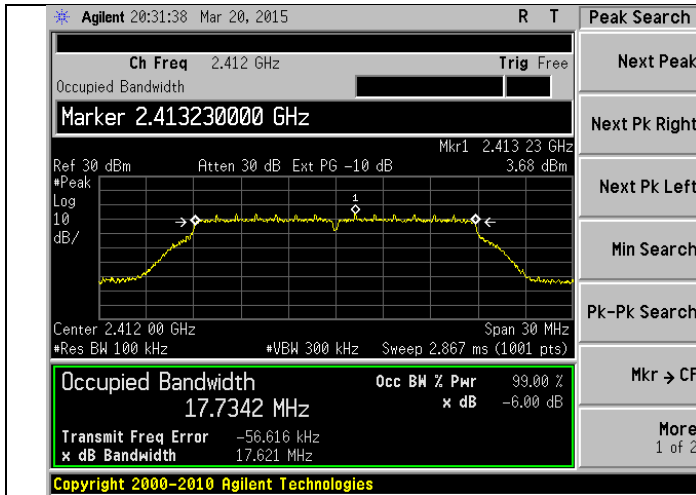
LSR: C-2114

Name: TiWi-C-W

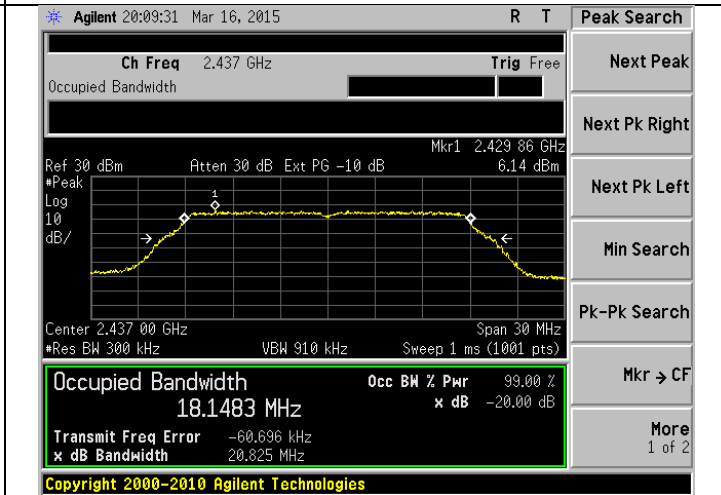
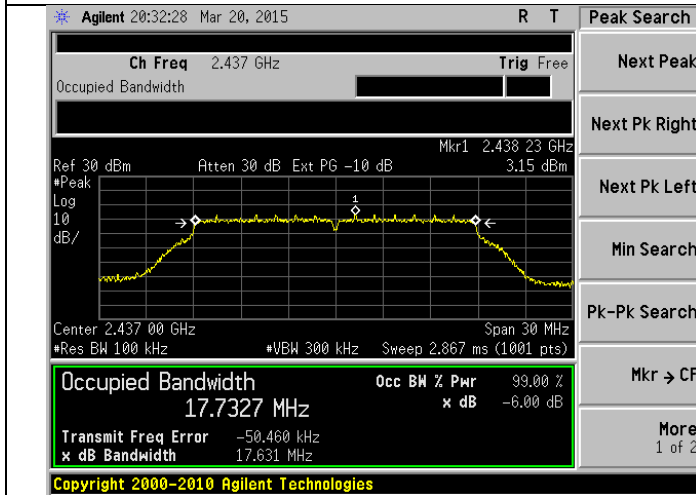
Model: TiWi-C-W

Serial: See Section 3.1

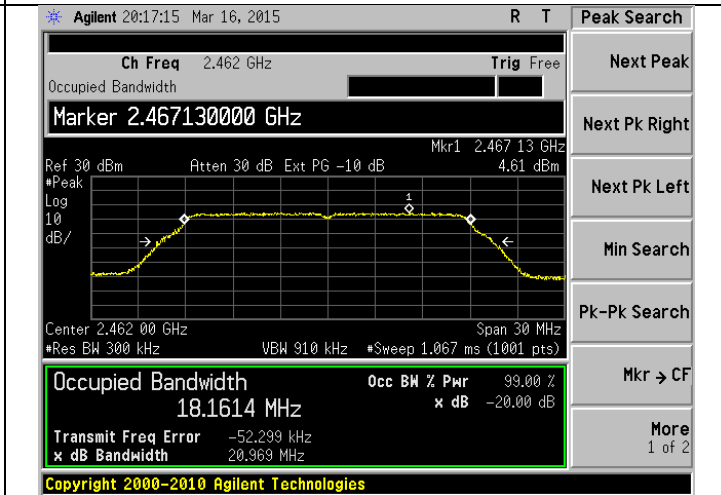
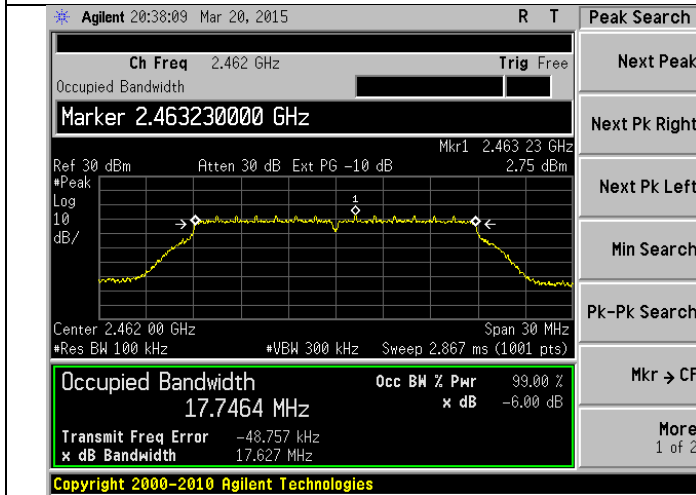
802.11n



Low Channel - 6 dB DTS BW



Mid Channel - 6 dB DTS BW



High Channel - 6 dB DTS BW

High Channel - OBW / 99 %

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

B.1.2 – RF Conducted – Duty Cycle

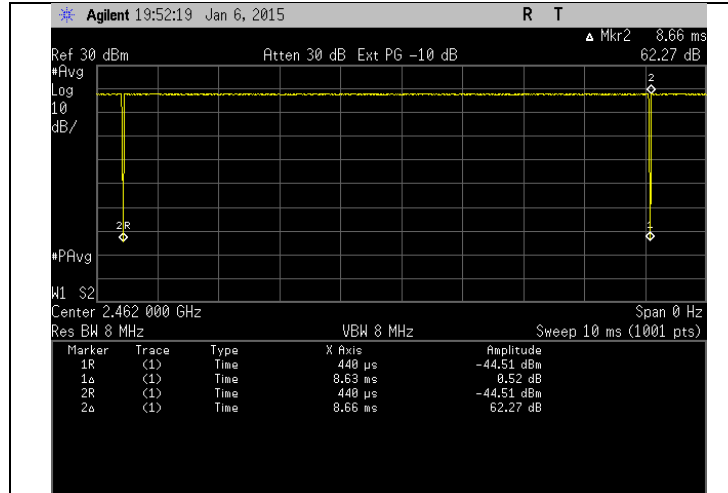
Manufacturer	LSR
Date	1-6-15
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 6
Additional Description of Measurement	Peak Detector with Maximum RBW available
Additional Notes	1. Continuous transmit modulated used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

Table

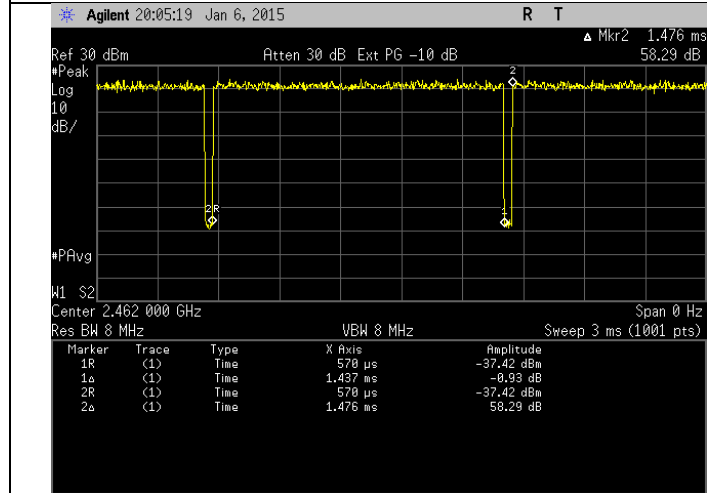
Mode (802.11)	Mode (Mbps)	On-time (ms)	Total Time (ms)	Duty	Duty Cycle correction (dB)
b	1	8.630	8.660	1.00	0.02
g	6	1.437	1.476	0.97	0.12
n	MCS0	1.342	1.382	0.97	0.13

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

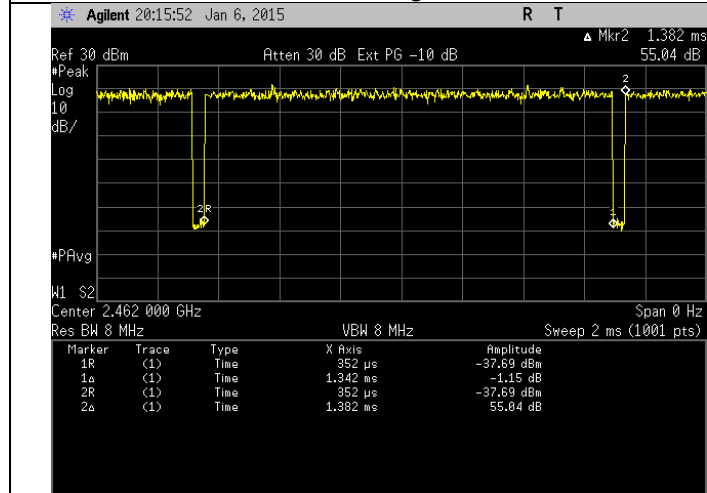
Plots



802.11b



802.11g



802.11n

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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 - 25° 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) FCC KDB 558074 Section 10.3
Additional Description of Measurement	Average Output Power and Average PSD methods utilized for measurement 100 kHz resolution bandwidth used for Power Spectral Density measurement
Additional Notes	1. Continuous transmit modulated used for this test. 2. 4-layer and 2-layer tested. Antenna 1 and antenna 2 tested. Sample Calculation: Margin (dB) = Limit – Measured Level

**Table
4-layer board – Antenna 1**

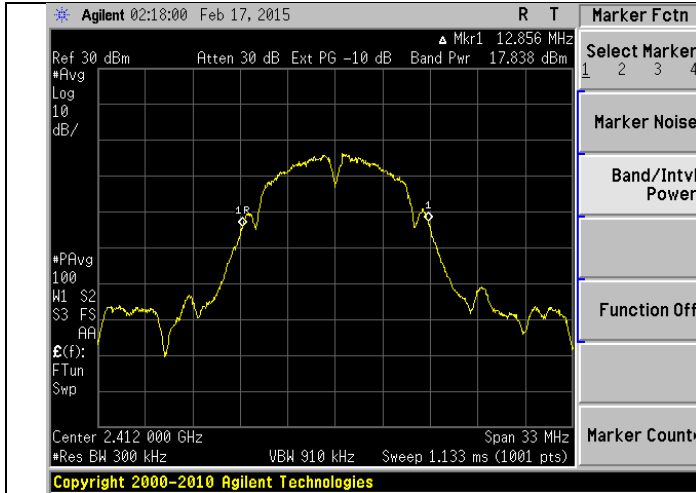
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	6 dB DTS BW (MHz)	99 % BW (MHz)	20 dB OBW (MHz)	Meas Power (dBm)	Duty (dB)	Max Avg. Power (dBm)	Max Avg. Power Limit (dBm)	Max Avg. Power Margin (dB)	Meas PSD 100 kHz (dBm)	Duty (dB)	Max Avg. PSD 100 kHz (dBm)	Max Avg. PSD Limit (dBm / 3 kHz)	Max Avg. PSD Margin (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

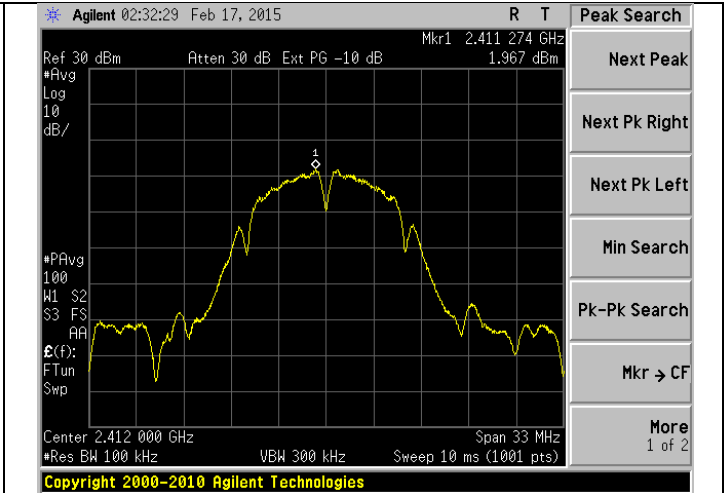
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	6 dB DTS BW (MHz)	99 % BW (MHz)	20 dB OBW (MHz)	Meas Power (dBm)	Duty (dB)	Max Avg. Power (dBm)	Max Avg. Power Limit (dBm)	Max Avg. Power Margin (dB)	Meas PSD 100 kHz (dBm)	Duty (dB)	Max Avg. PSD 100 kHz (dBm)	Max Avg. PSD Limit (dBm / 3 kHz)	Max Avg. PSD Margin (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

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

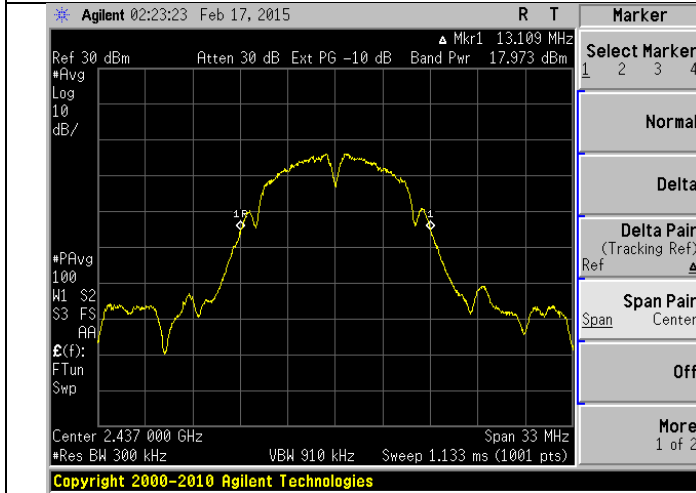
**PLOTS (4-layer board – Antenna 1)
802.11b**



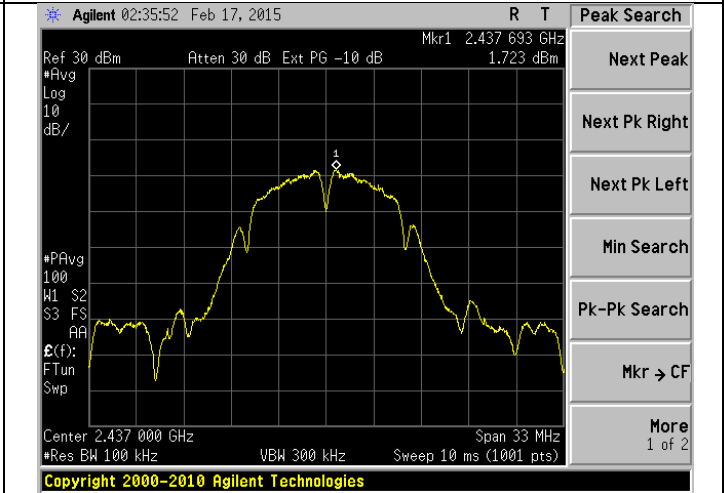
Low Channel - Power



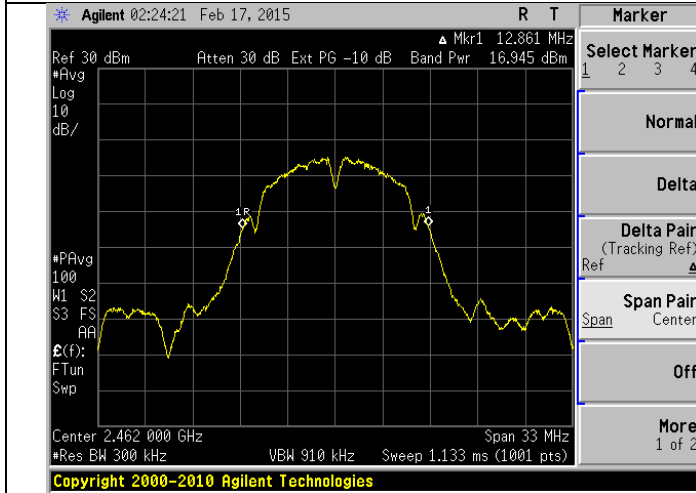
Low Channel - PSD



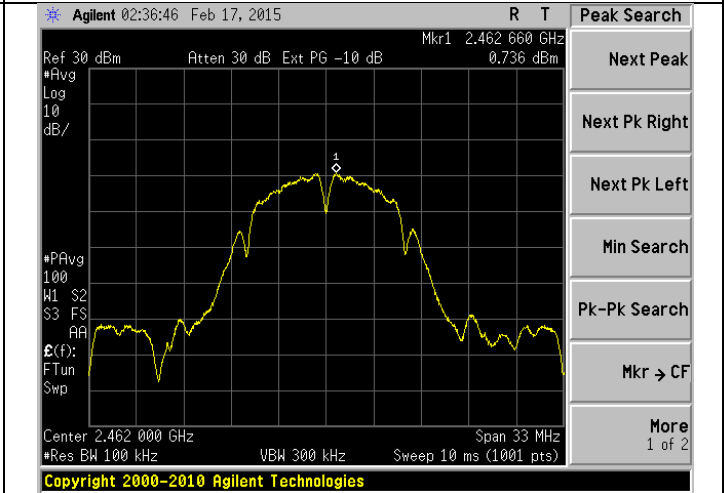
Mid Channel - Power



Mid Channel - PSD



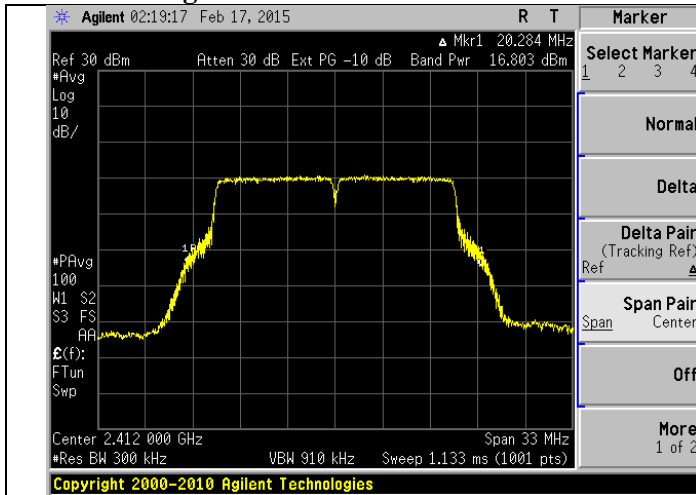
High Channel - Power



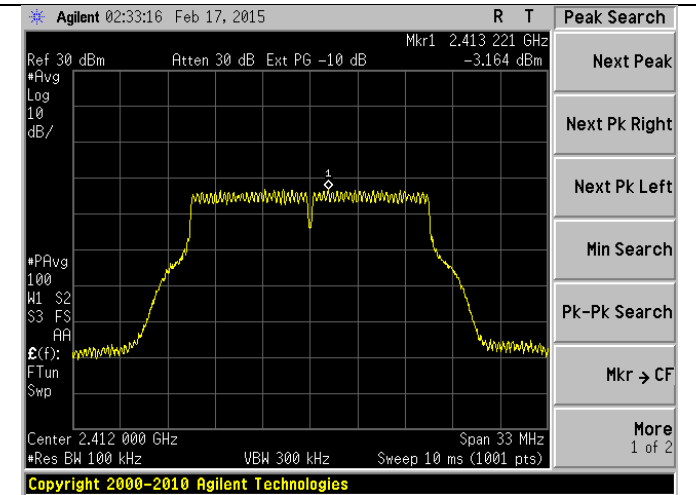
High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

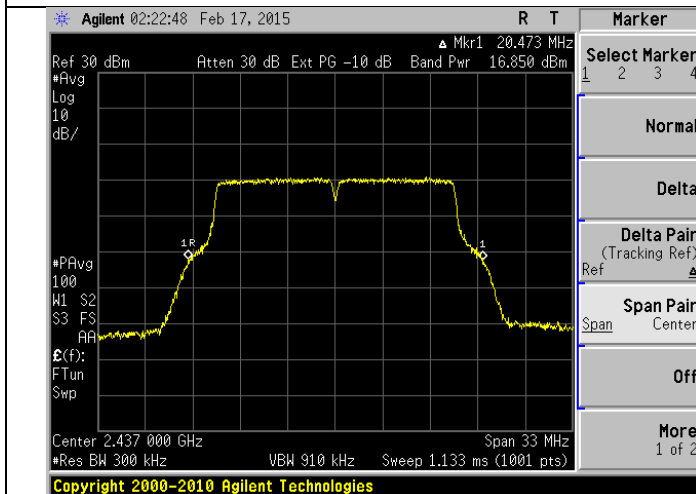
802.11g



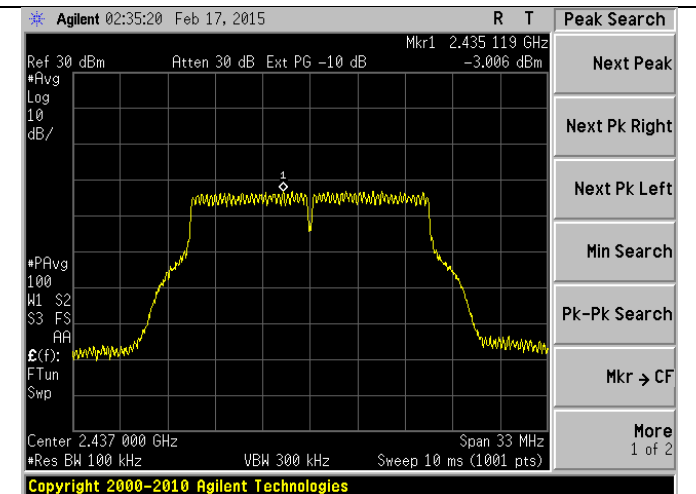
Low Channel - Power



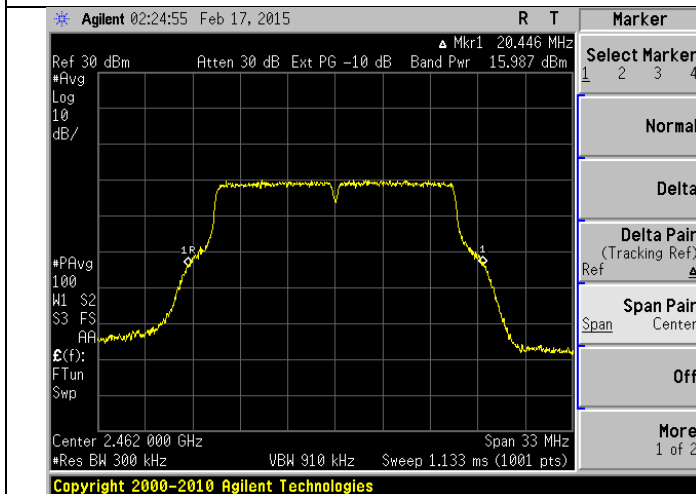
Low Channel - PSD



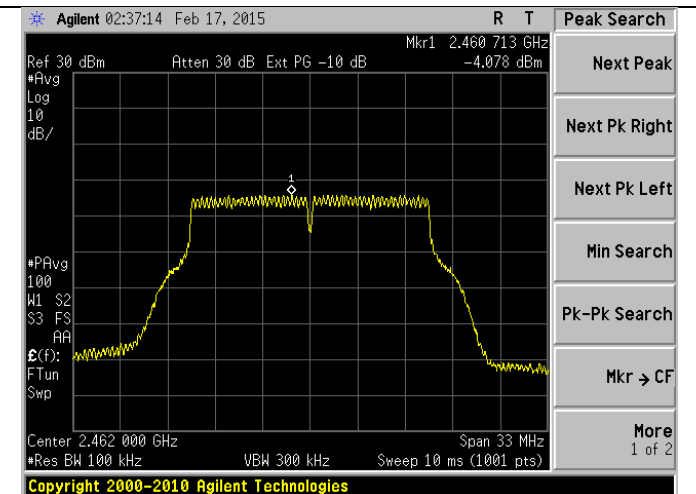
Mid Channel - Power



Mid Channel - PSD



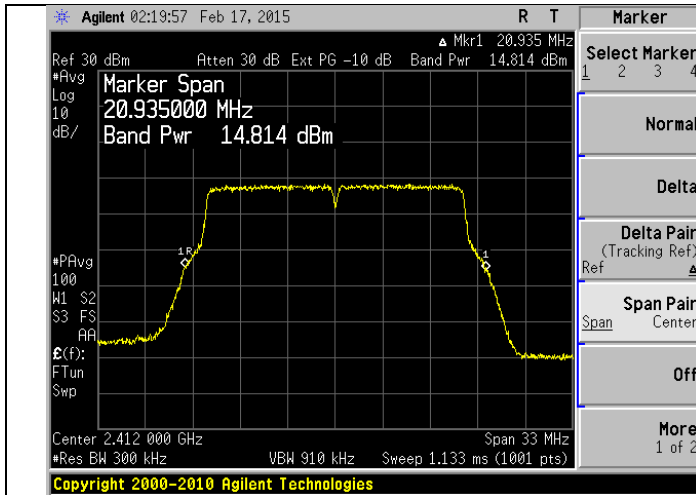
High Channel - Power



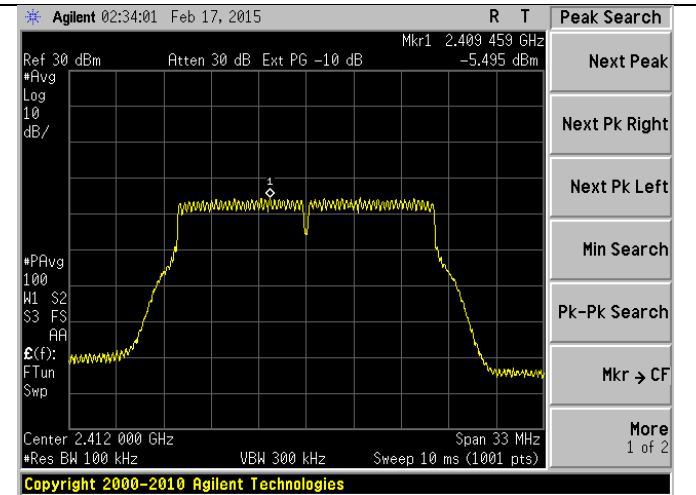
High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

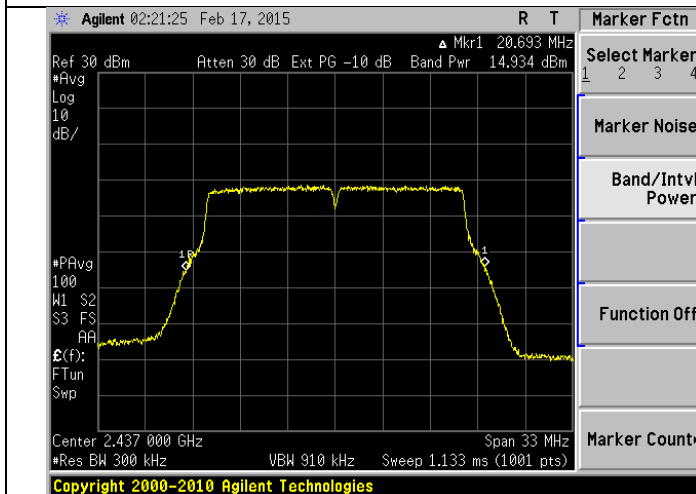
802.11n



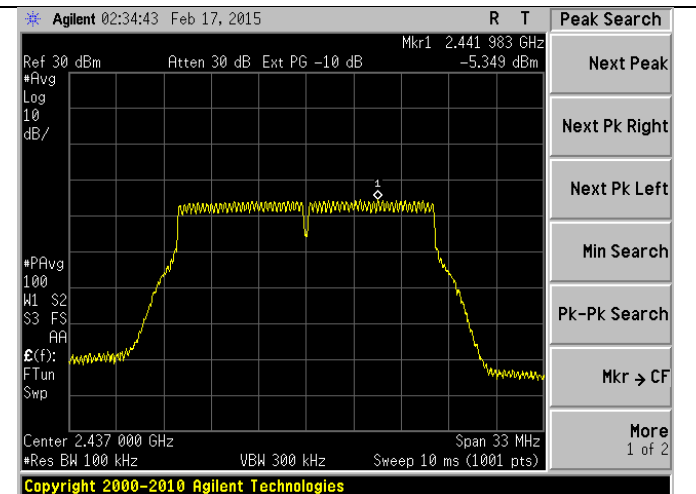
Low Channel - Power



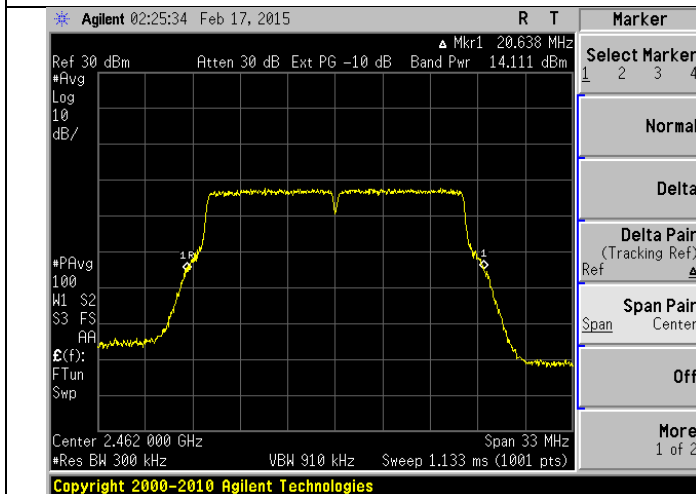
Low Channel - PSD



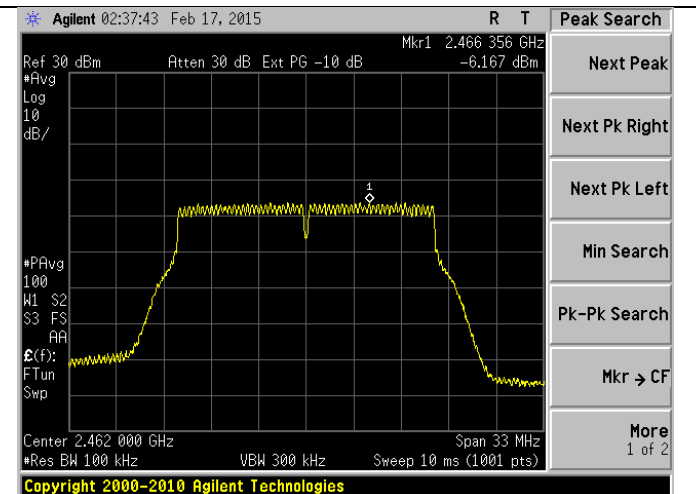
Mid Channel - Power



Mid Channel - PSD



High Channel - Power



High Channel - PSD

Prepared For: LSR

Report: TR 314413

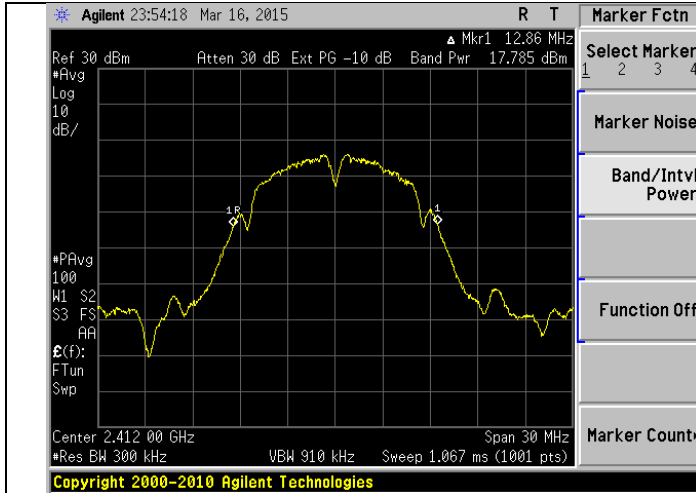
LSR: C-2114

Name: TiWi-C-W

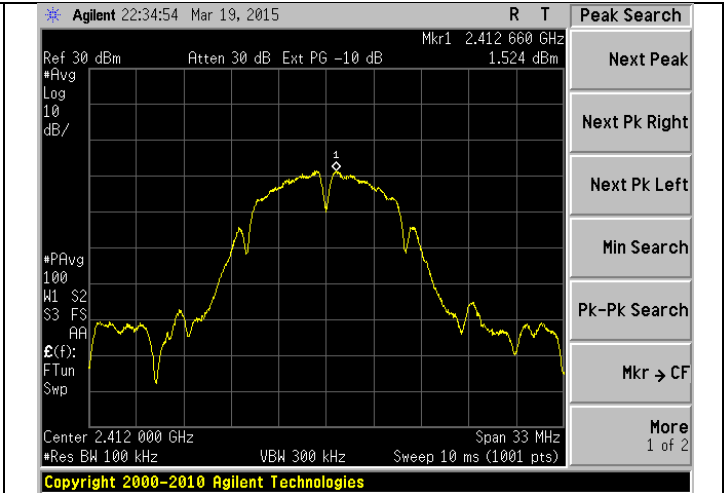
Model: TiWi-C-W

Serial: See Section 3.1

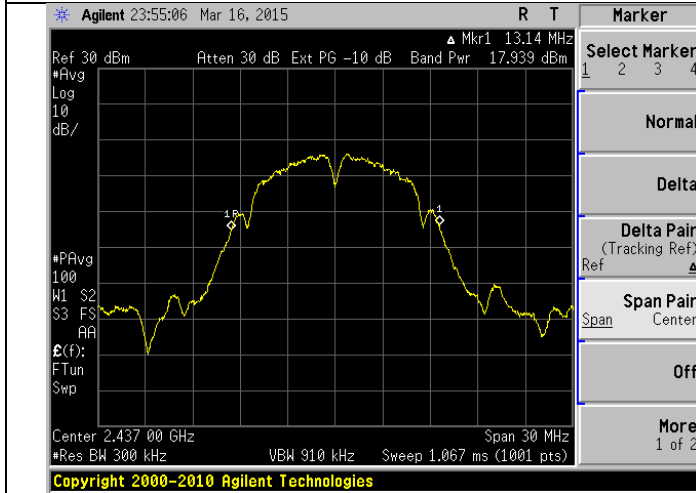
**PLOTS (4-layer board – Antenna 2)
802.11b**



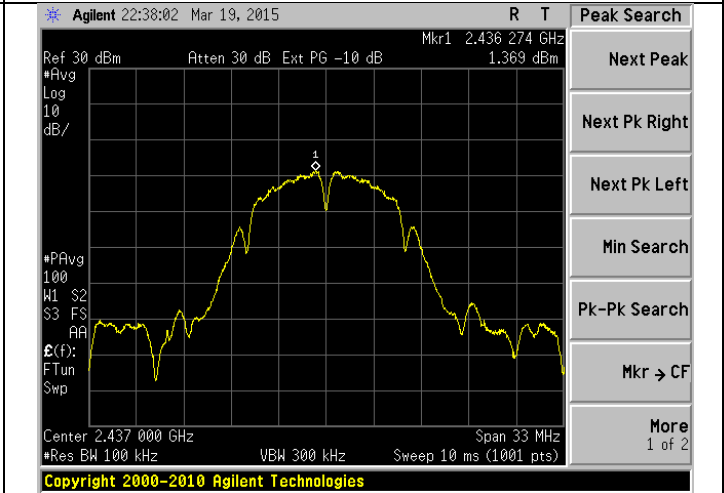
Low Channel - Power



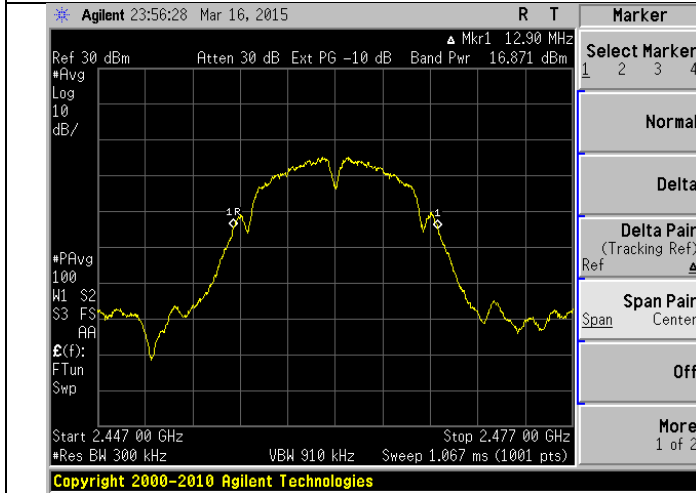
Low Channel - PSD



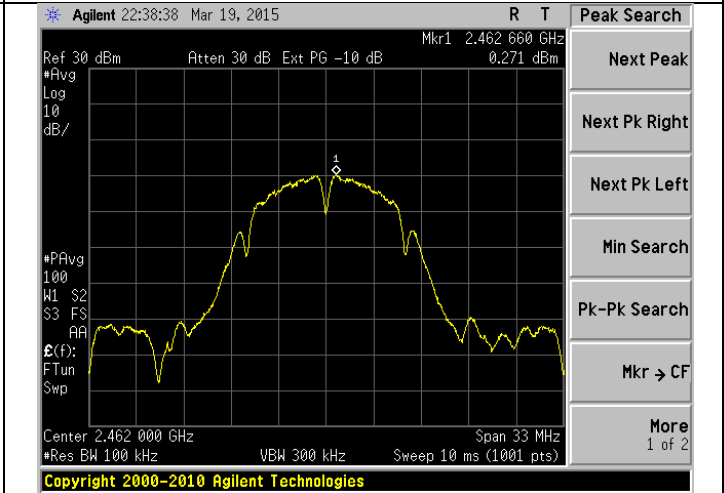
Mid Channel - Power



Mid Channel - PSD



High Channel - Power



High Channel - PSD

Prepared For: LSR

Report: TR 314413

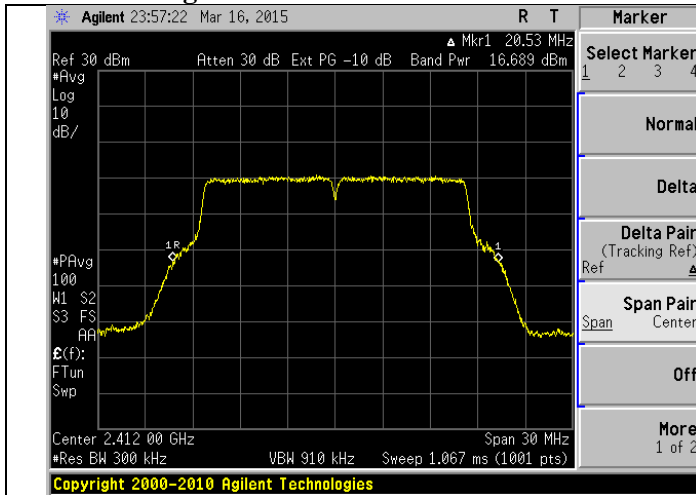
LSR: C-2114

Name: TiWi-C-W

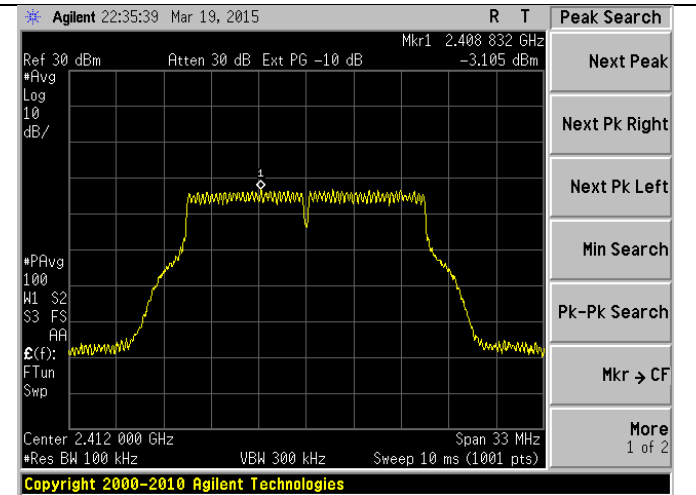
Model: TiWi-C-W

Serial: See Section 3.1

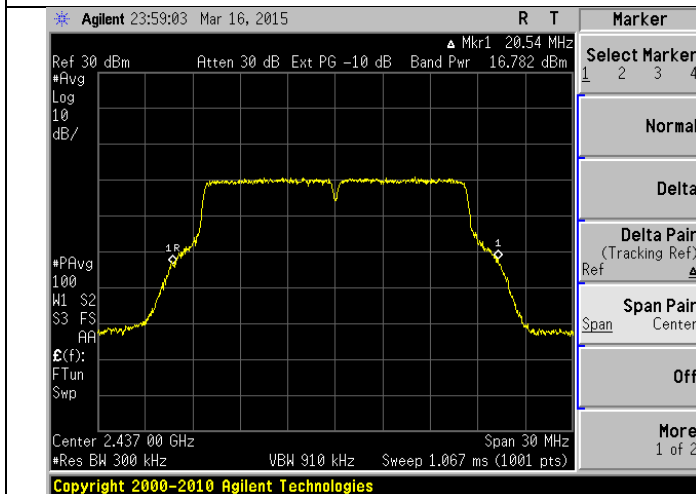
802.11g



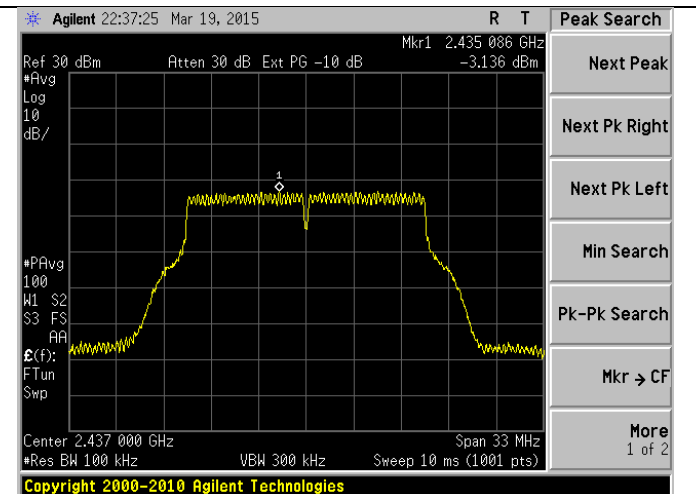
Low Channel - Power



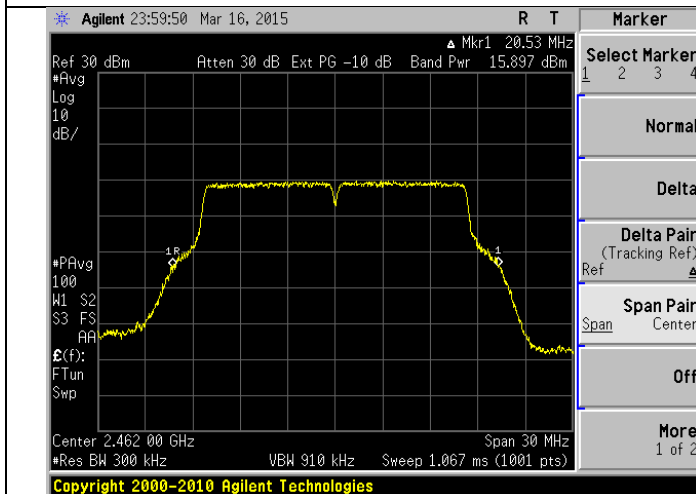
Low Channel - PSD



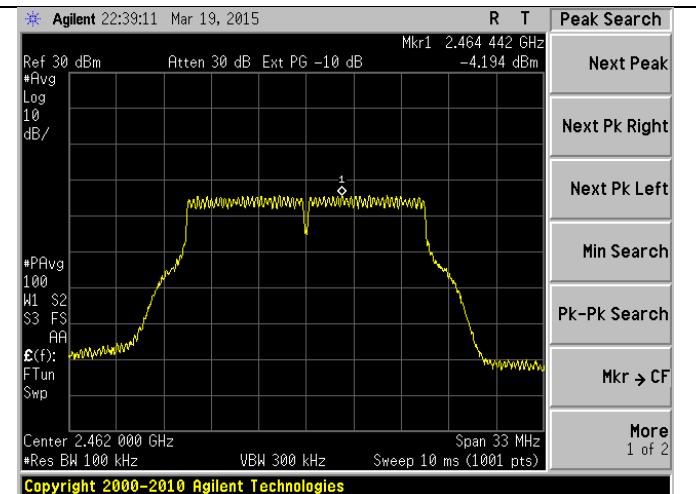
Mid Channel - Power



Mid Channel - PSD



High Channel - Power



High Channel - PSD

Prepared For: LSR

Report: TR 314413

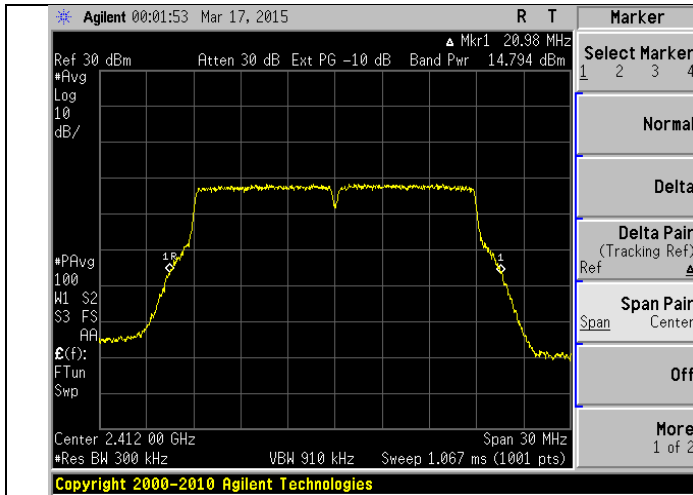
LSR: C-2114

Name: TiWi-C-W

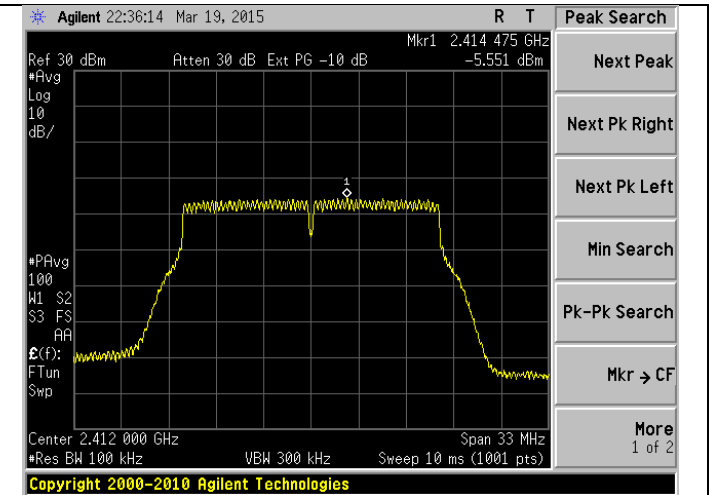
Model: TiWi-C-W

Serial: See Section 3.1

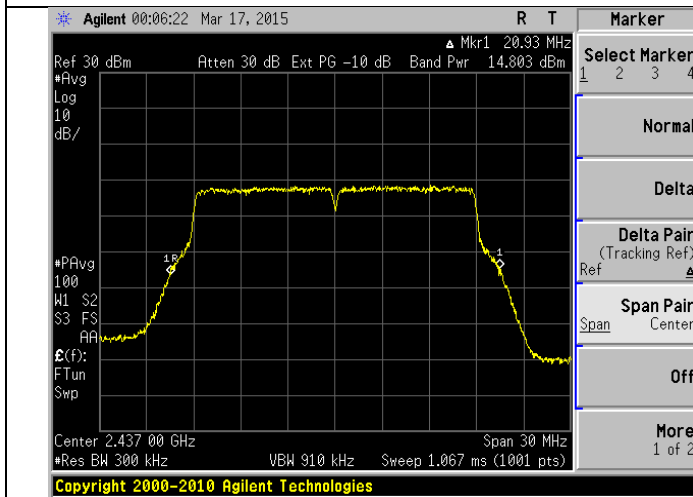
802.11n



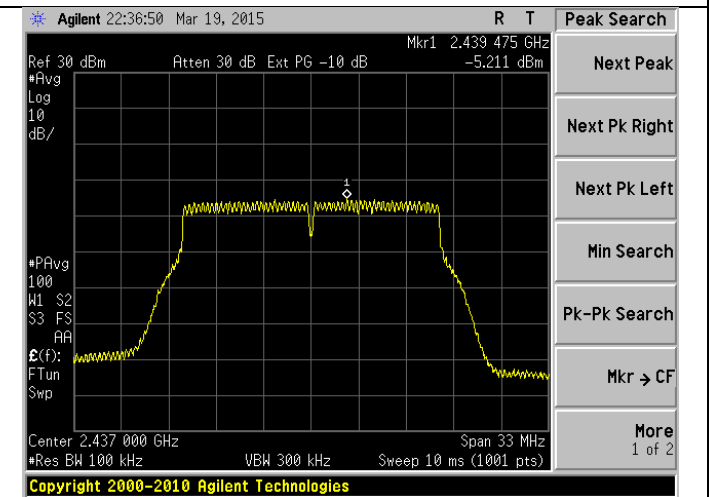
Low Channel - Power



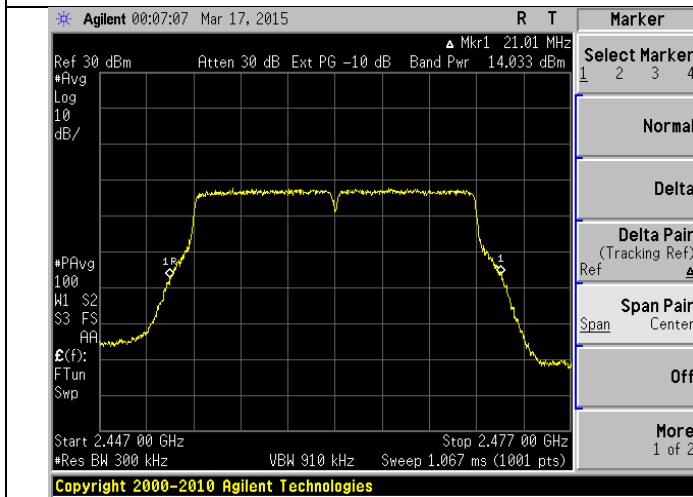
Low Channel - PSD



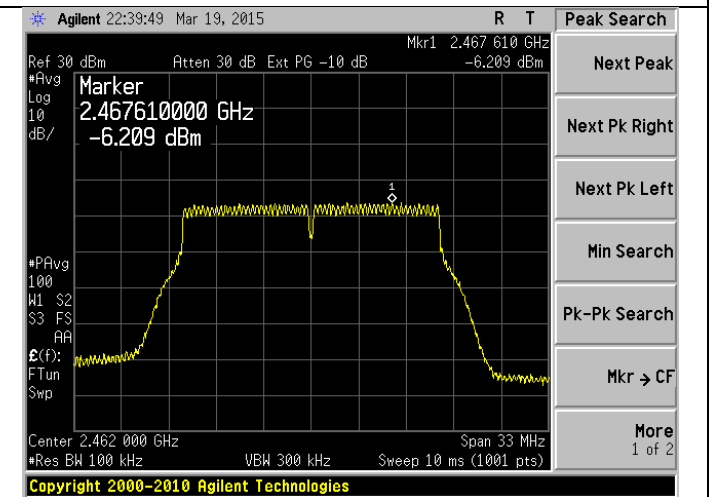
Mid Channel - Power



Mid Channel - PSD



High Channel - Power



High Channel - PSD

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

**Table
2-layer board – Antenna 1**

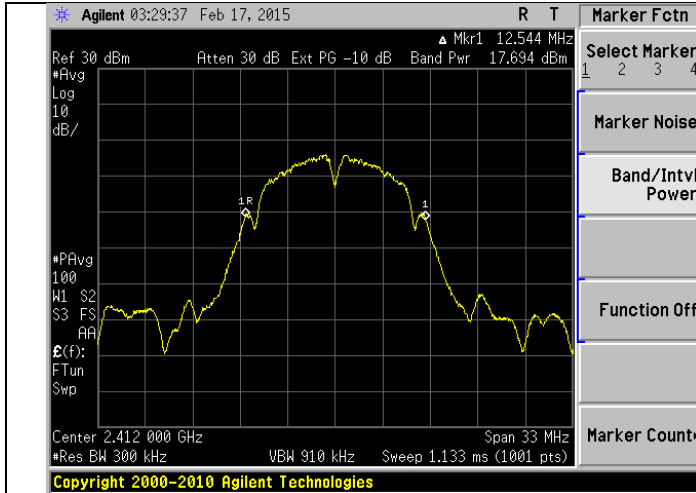
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	6 dB DTS BW (MHz)	99 % BW (MHz)	20 dB OBW (MHz)	Meas Power (dBm)	Duty (dB)	Max Avg. Power (dBm)	Max Avg. Power Limit (dBm)	Max Avg. Power Margin (dB)	Meas PSD 100 kHz (dBm)	Duty (dB)	Max Avg. PSD 100 kHz (dBm)	Max Avg. PSD Limit (dBm / 3 kHz)	Max Avg. PSD Margin (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	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

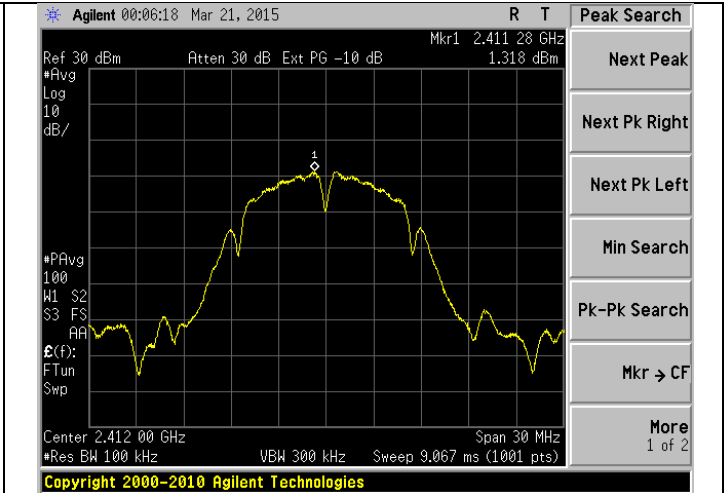
Mode (802.11)	Mode (Mbps)	Frequency (MHz)	6 dB DTS BW (MHz)	99 % BW (MHz)	20 dB OBW (MHz)	Meas Power (dBm)	Duty (dB)	Max Avg. Power (dBm)	Max Avg. Power Limit (dBm)	Max Avg. Power Margin (dB)	Meas PSD 100 kHz (dBm)	Duty (dB)	Max Avg. PSD 100 kHz (dBm)	Max Avg. PSD Limit (dBm / 3 kHz)	Max Avg. PSD Margin (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	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

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

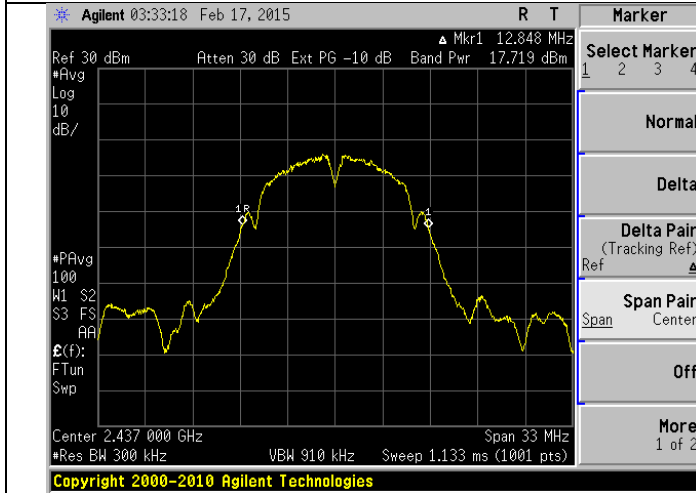
**PLOTS (2-layer board – Antenna 1)
802.11b**



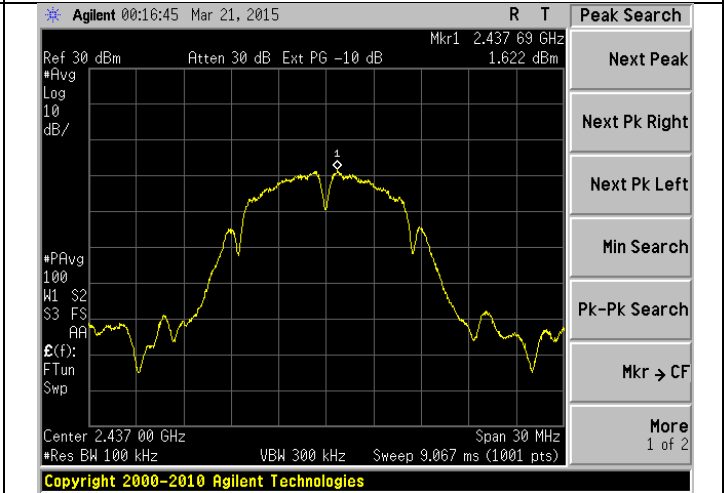
Low Channel - Power



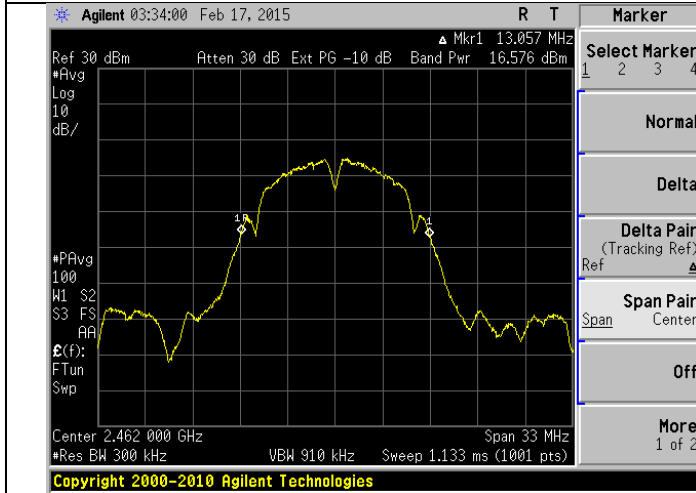
Low Channel - PSD



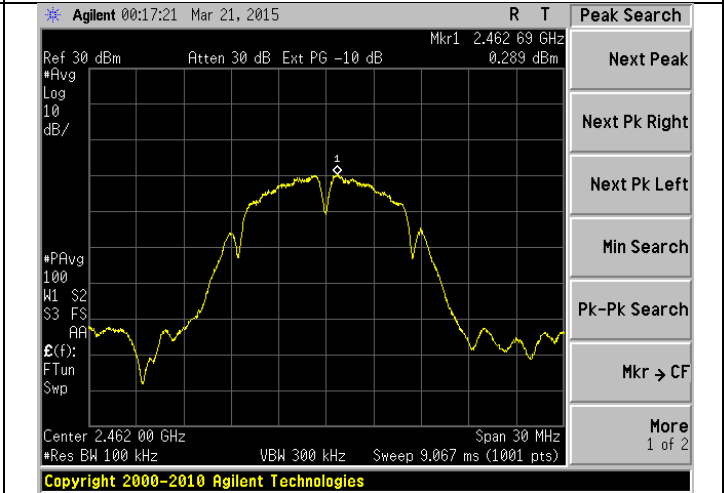
Mid Channel - Power



Mid Channel - PSD



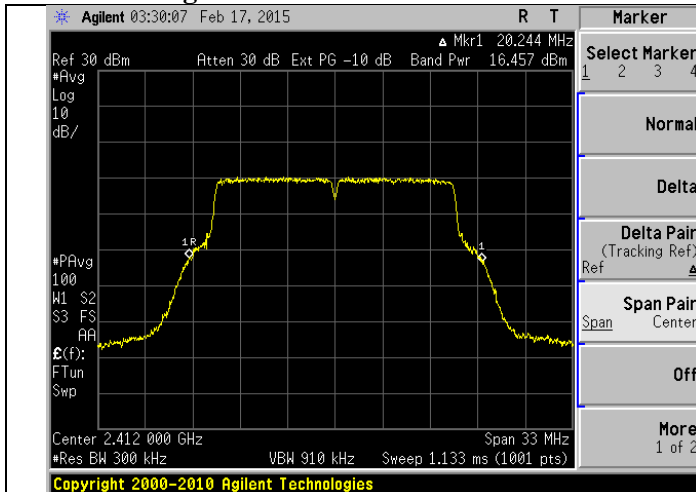
High Channel - Power



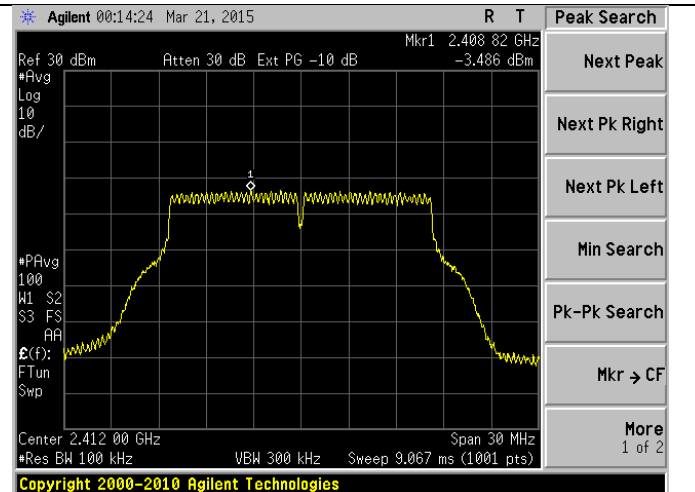
High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

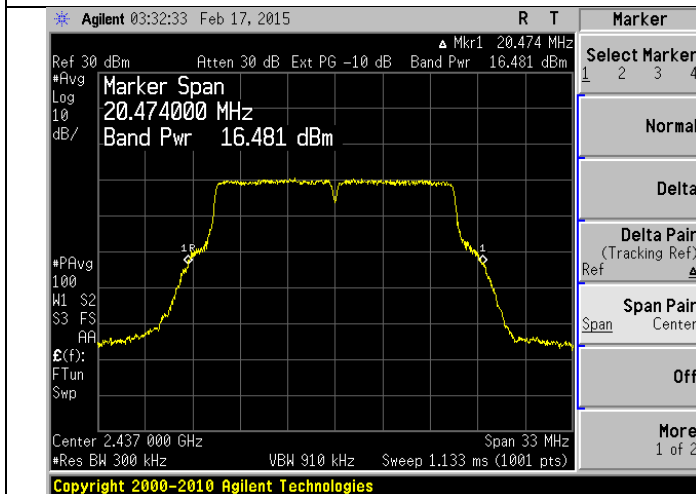
802.11g



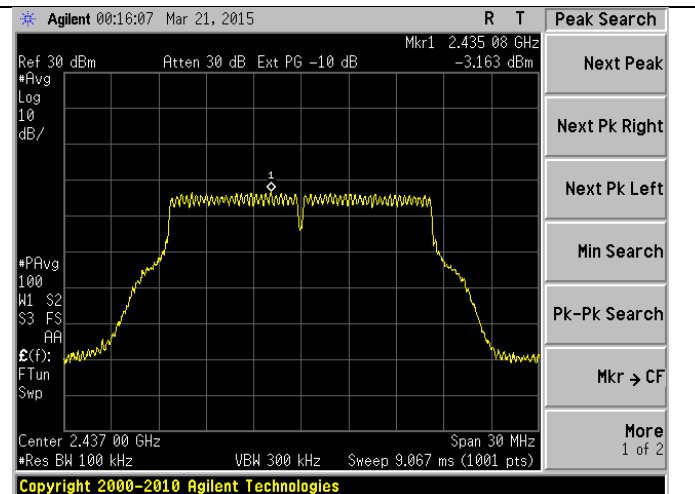
Low Channel - Power



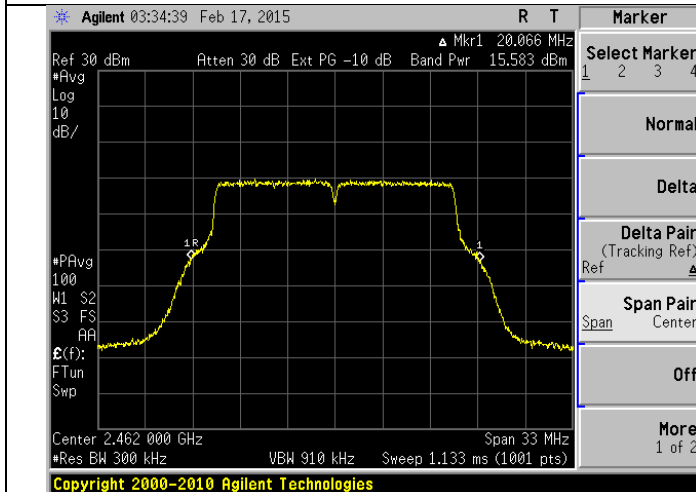
Low Channel - PSD



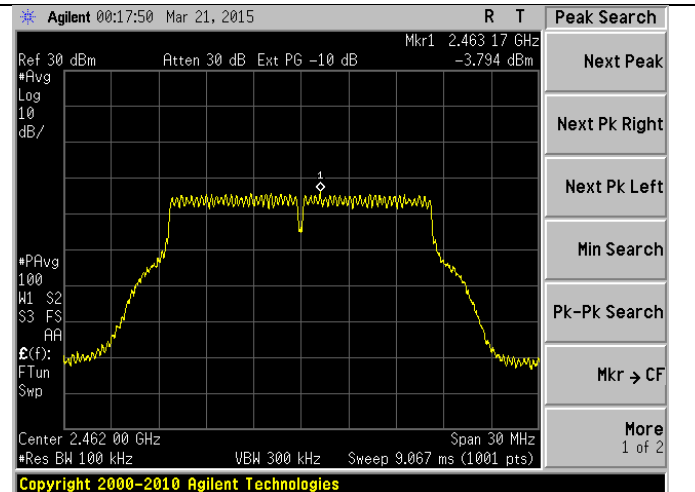
Mid Channel - Power



Mid Channel - PSD



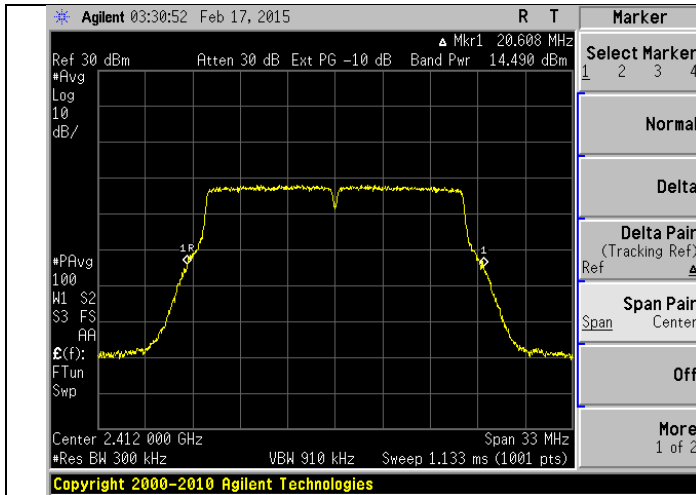
High Channel - Power



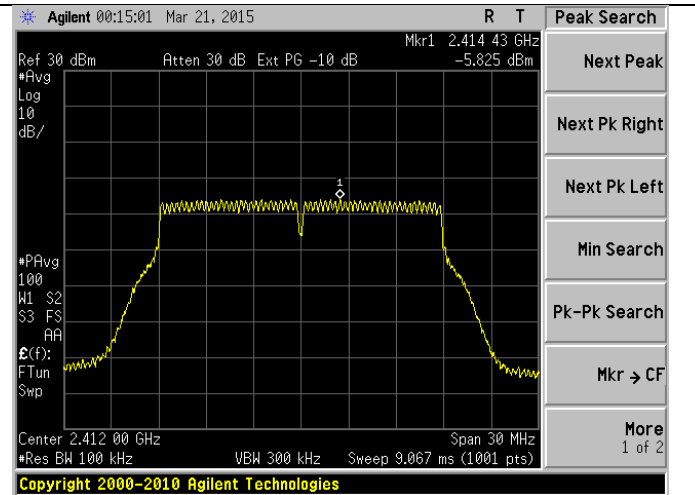
High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

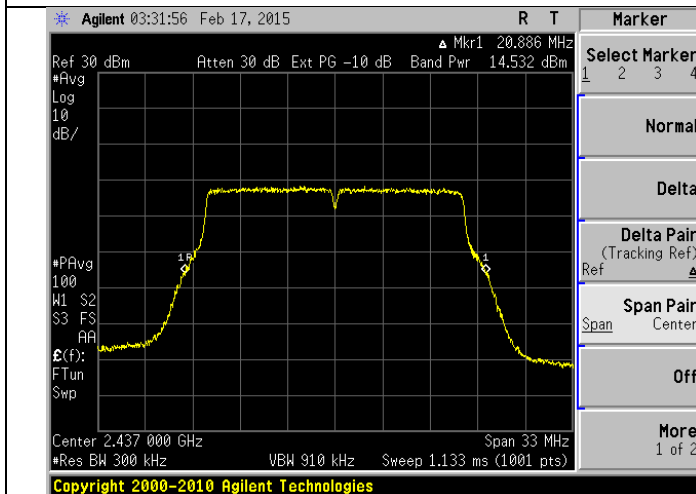
802.11n



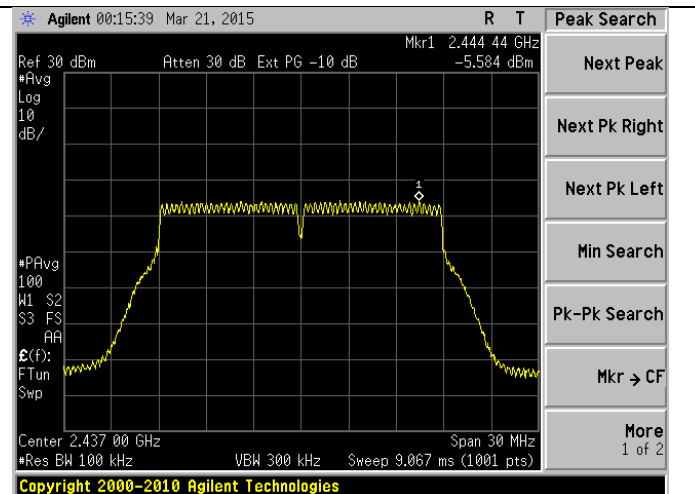
Low Channel - Power



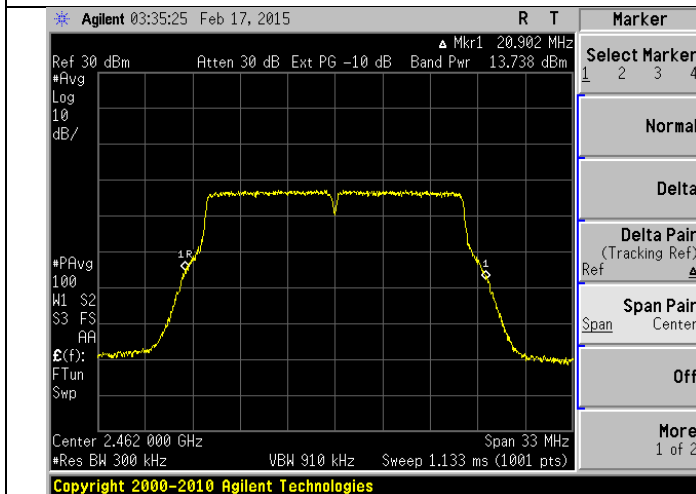
Low Channel - PSD



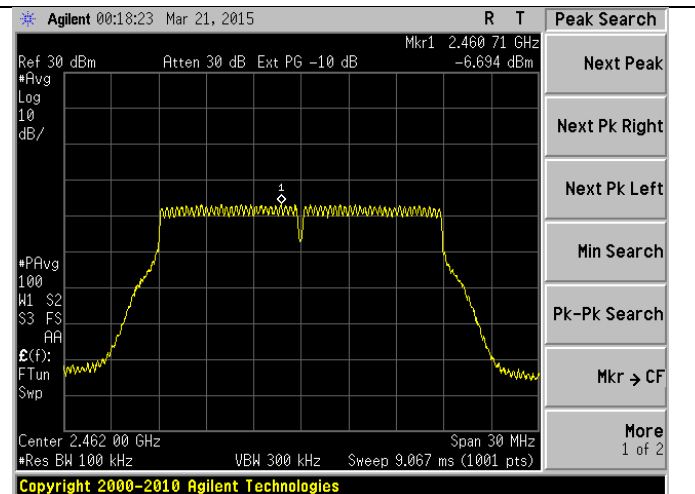
Mid Channel - Power



Mid Channel - PSD



High Channel - Power



High Channel - PSD

Prepared For: LSR

Report: TR 314413

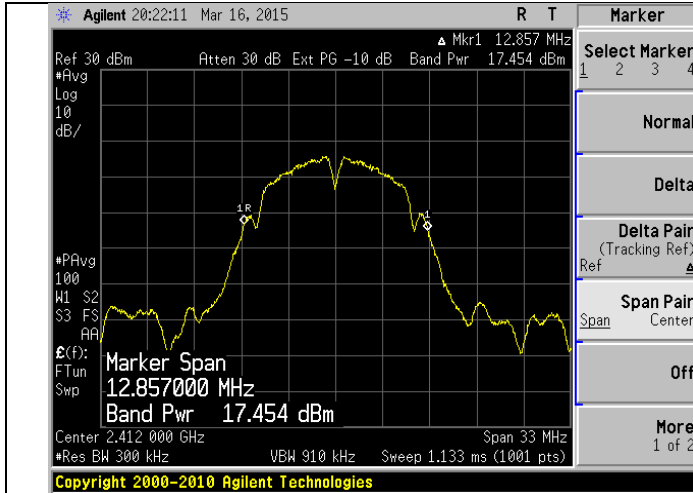
LSR: C-2114

Name: TiWi-C-W

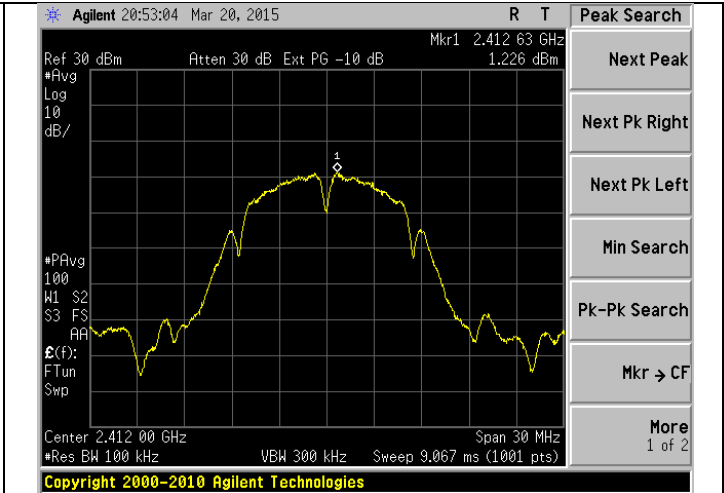
Model: TiWi-C-W

Serial: See Section 3.1

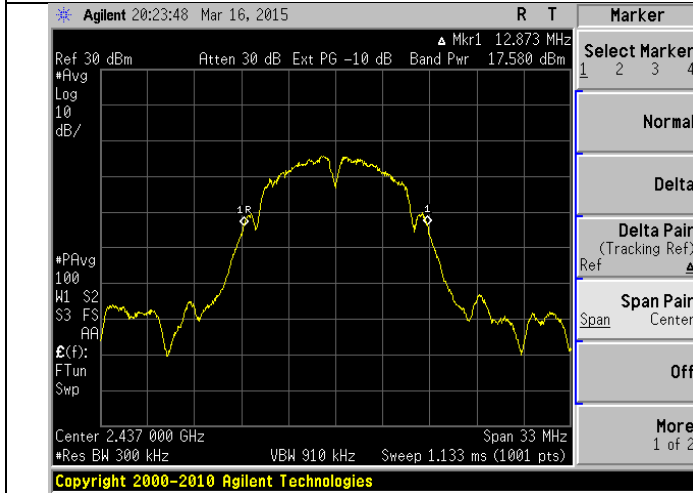
**PLOTS (2-layer board – Antenna 2)
802.11b**



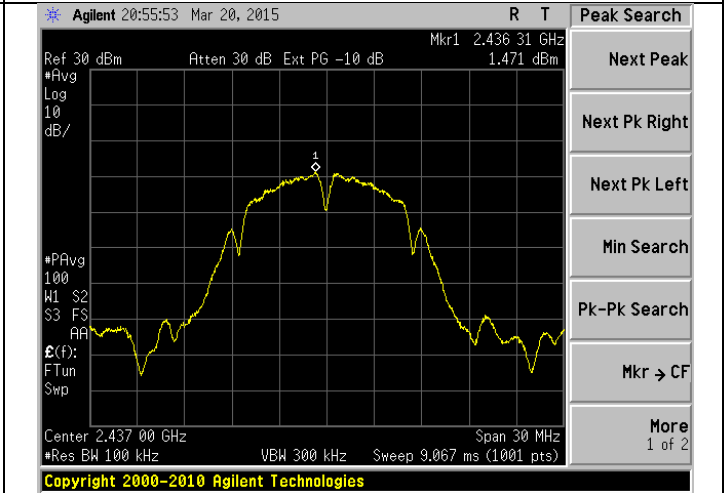
Low Channel - Power



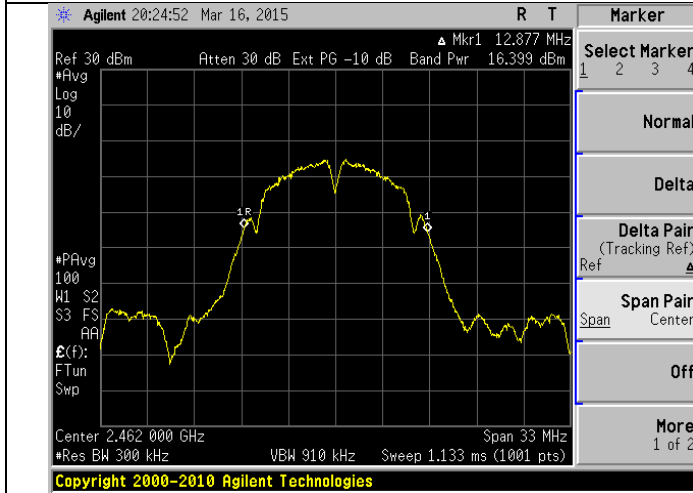
Low Channel - PSD



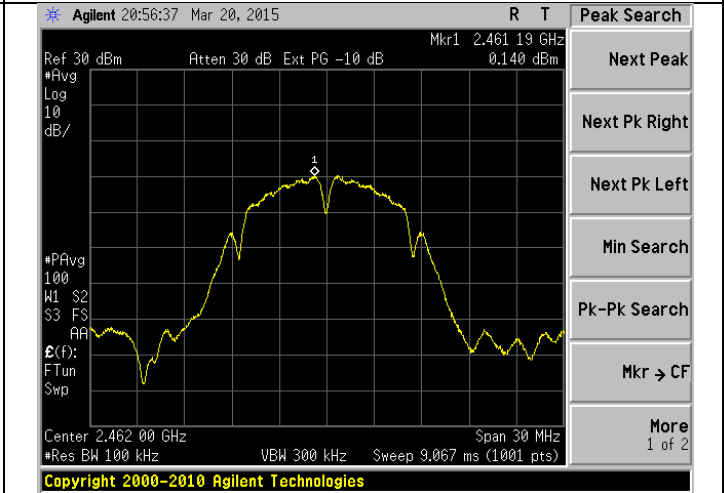
Mid Channel - Power



Mid Channel - PSD



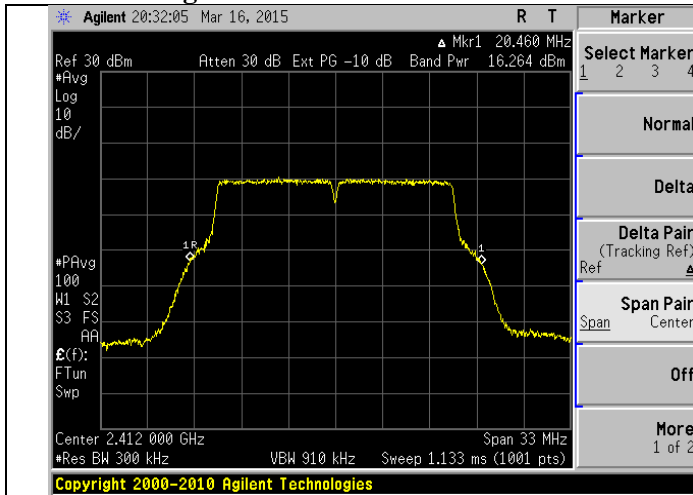
High Channel - Power



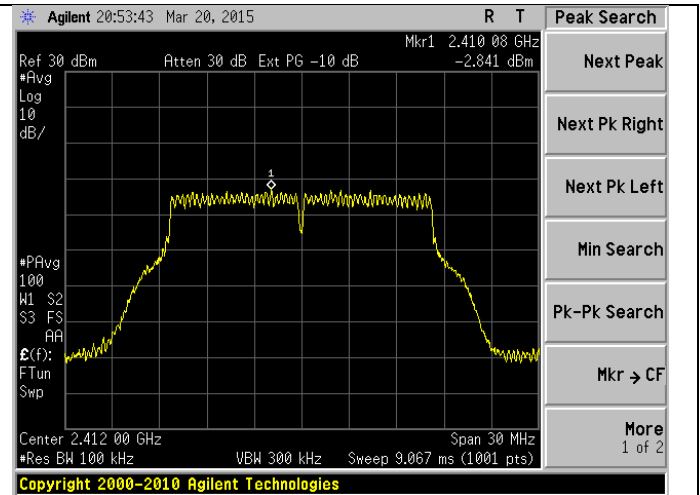
High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

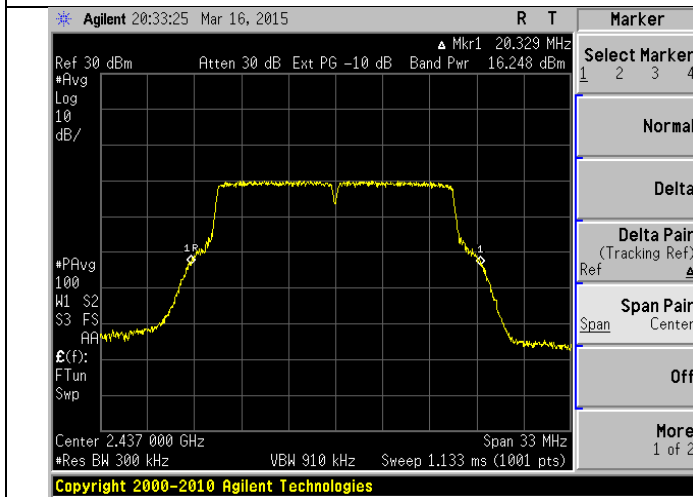
802.11g



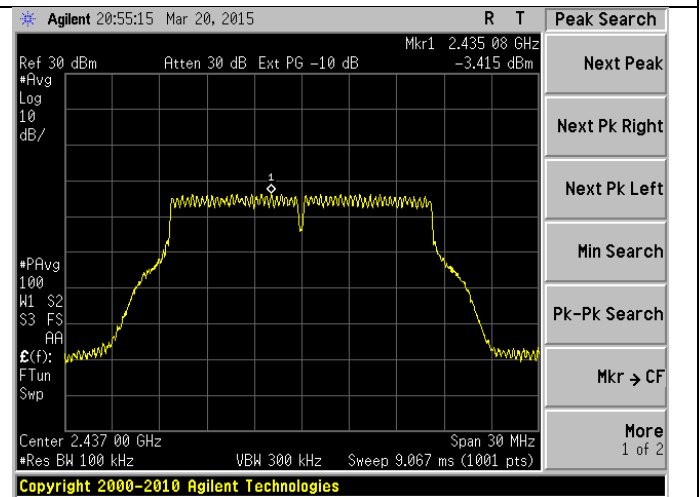
Low Channel - Power



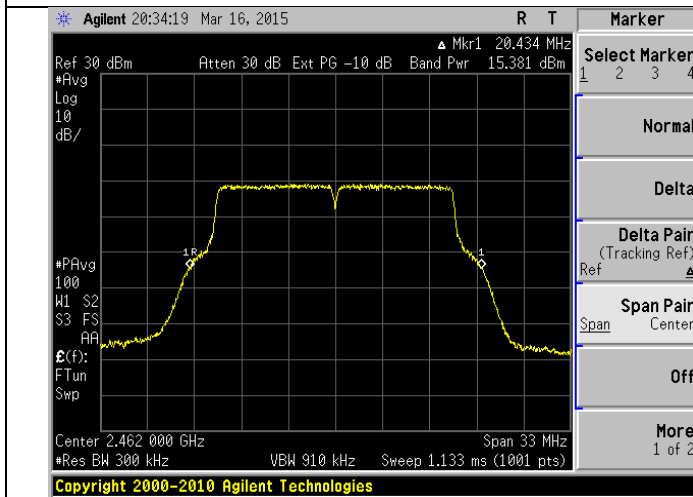
Low Channel - PSD



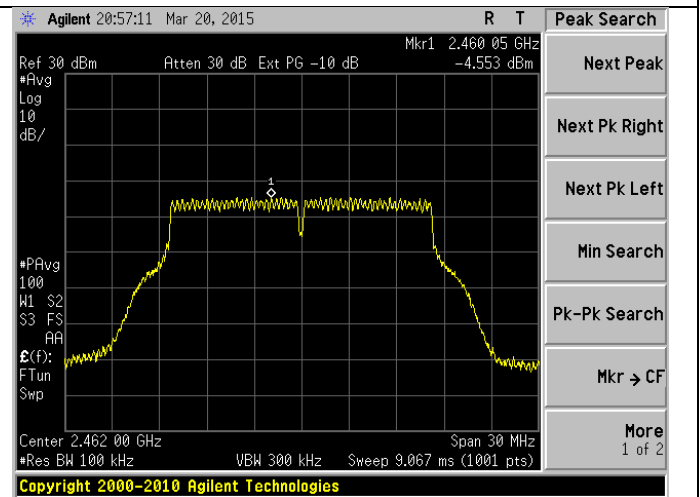
Mid Channel - Power



Mid Channel - PSD



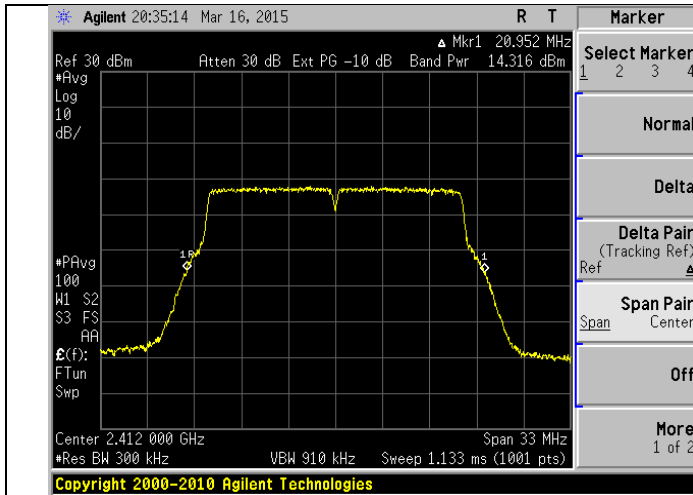
High Channel - Power



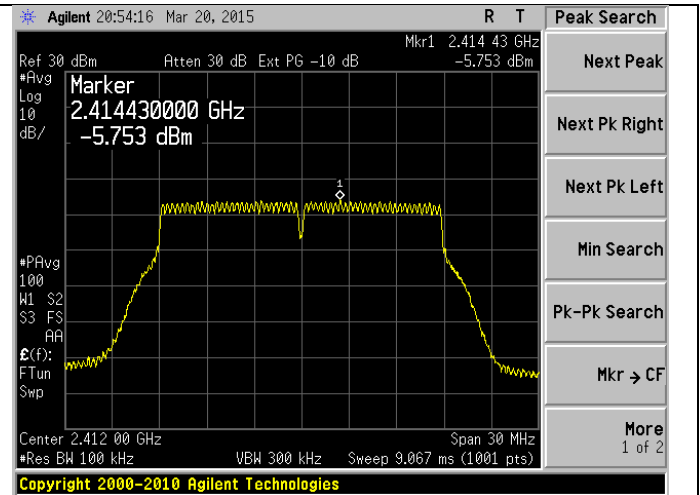
High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

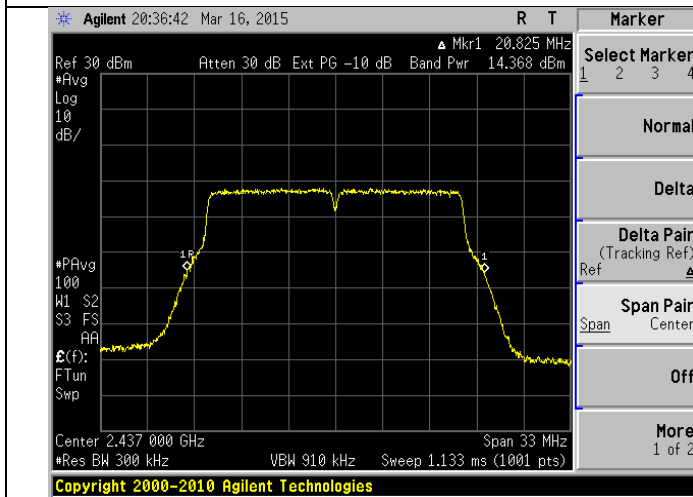
802.11n



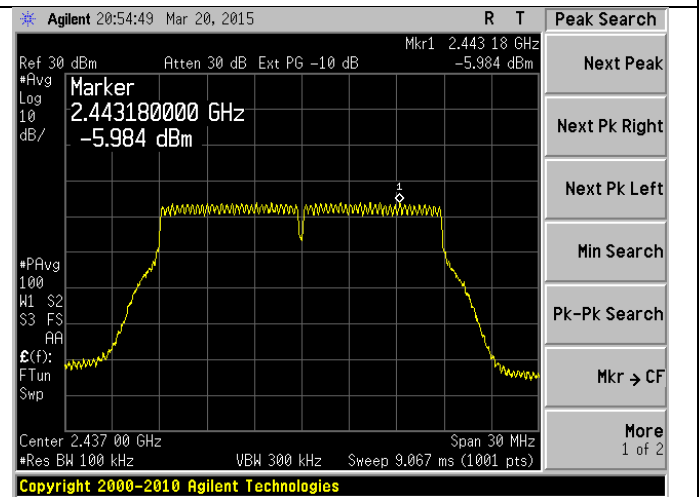
Low Channel - Power



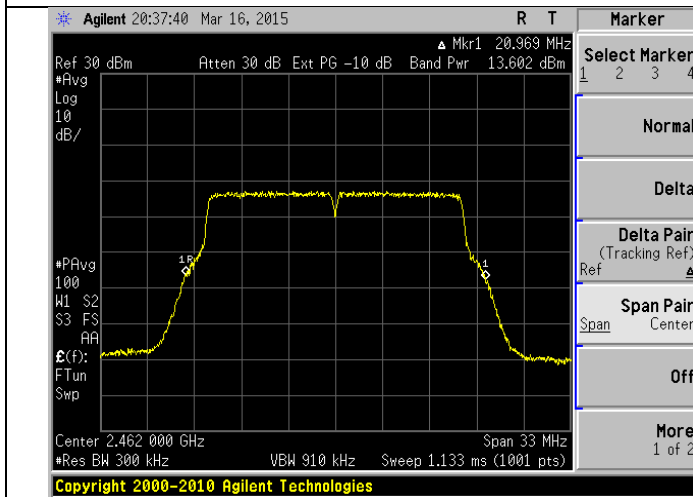
Low Channel - PSD



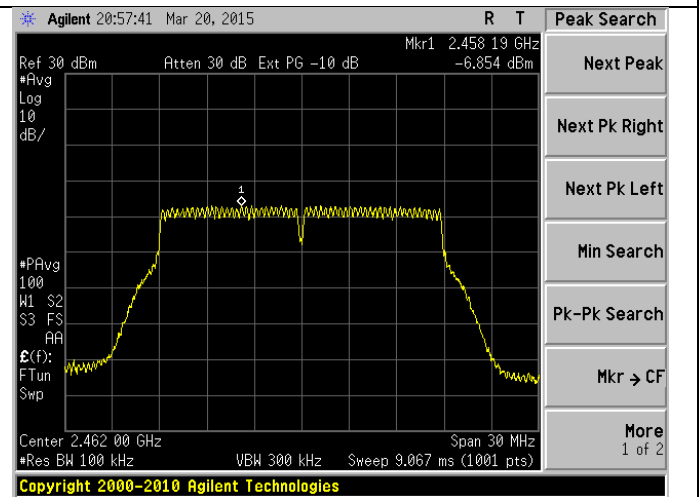
Mid Channel - Power



Mid Channel - PSD



High Channel - Power



High Channel - PSD

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

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 - 25° 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. 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

Prepared For: LSR

Name: TiWi-C-W

Report: TR 314413

Model: TiWi-C-W

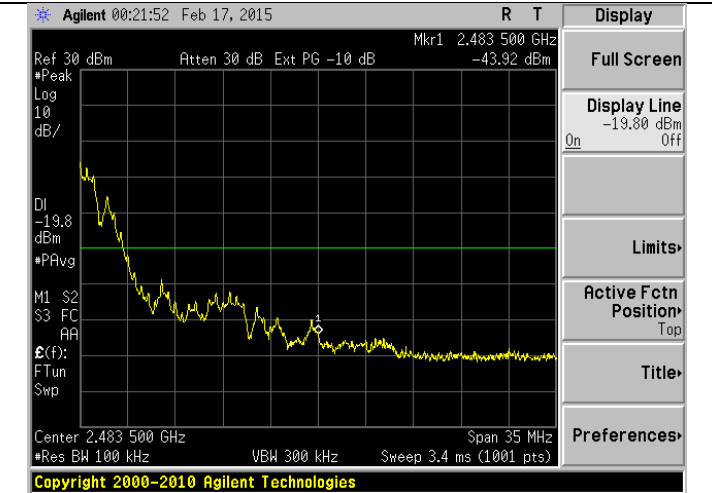
LSR: C-2114

Serial: See Section 3.1

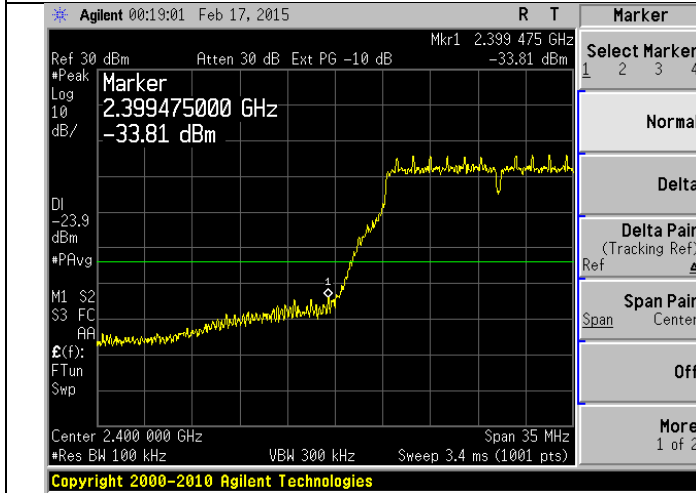
**Plots (4-layer board – Antenna 1)
Band-edge**



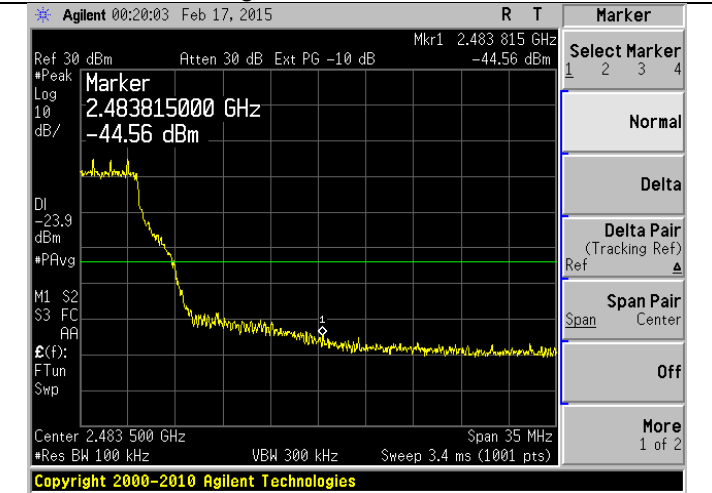
Low Channel – 802.11b



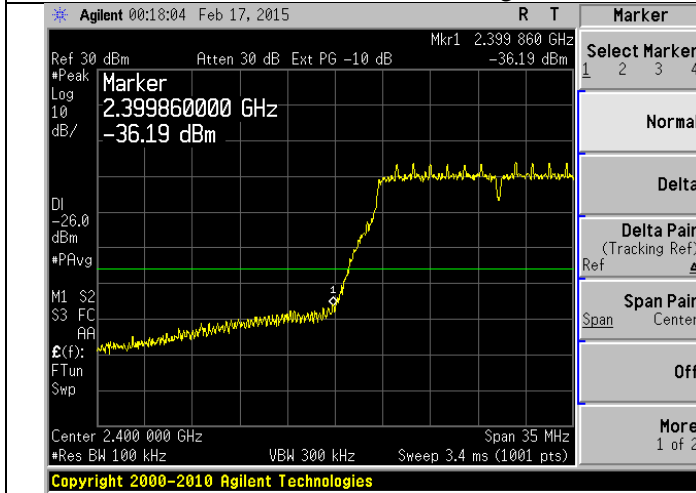
High Channel – 802.11b



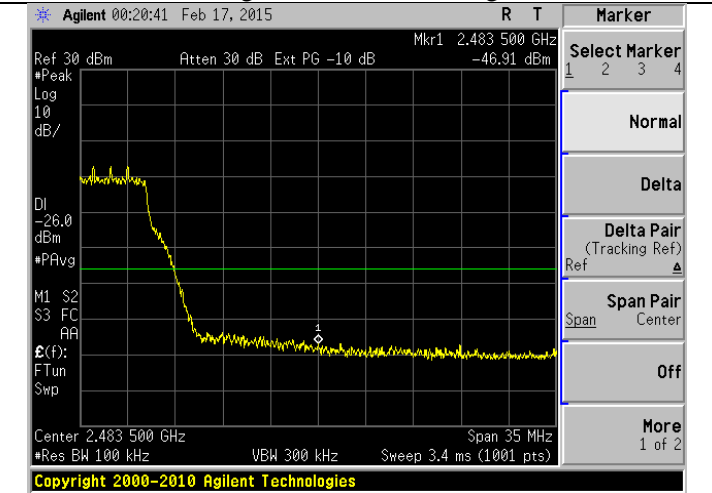
Low Channel – 802.11g



High Channel – 802.11g



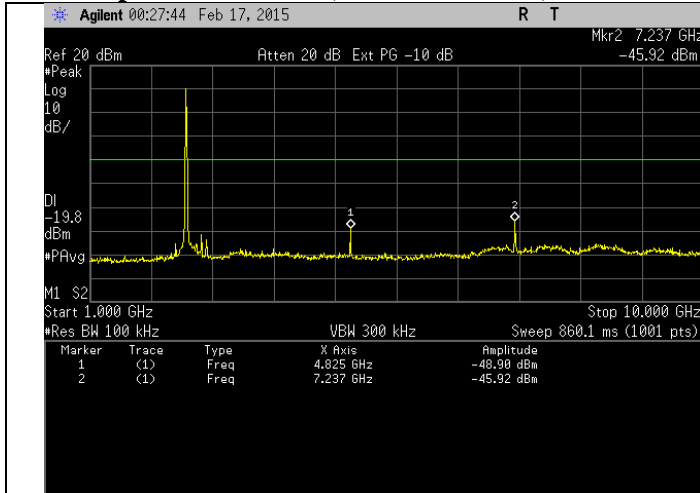
Low Channel – 802.11n



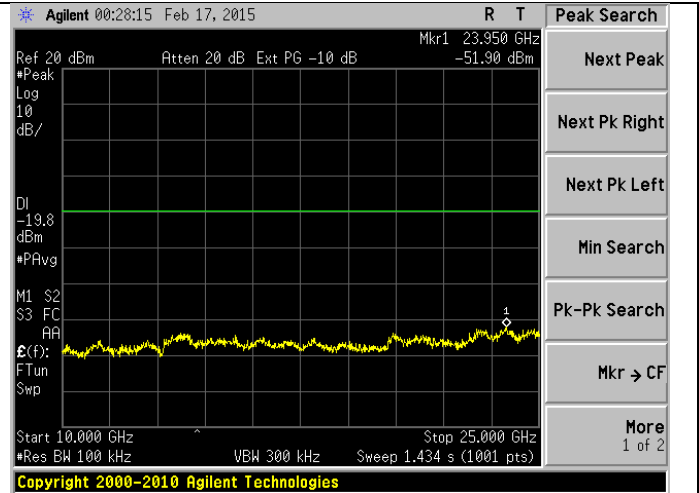
High Channel – 802.11n

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

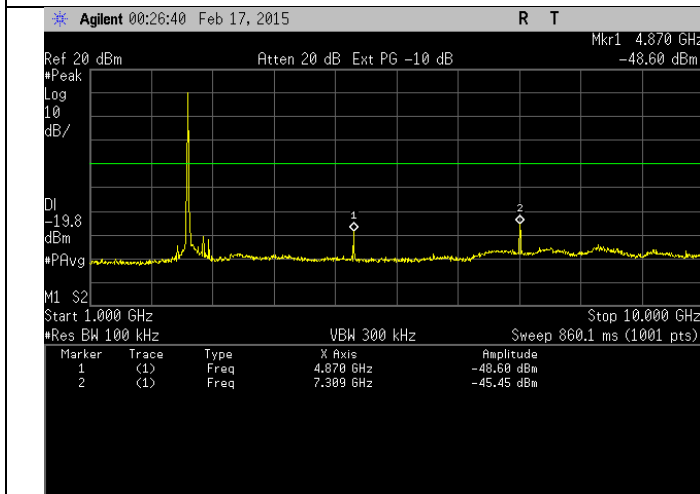
Spurious 802.11b (worst case mode)



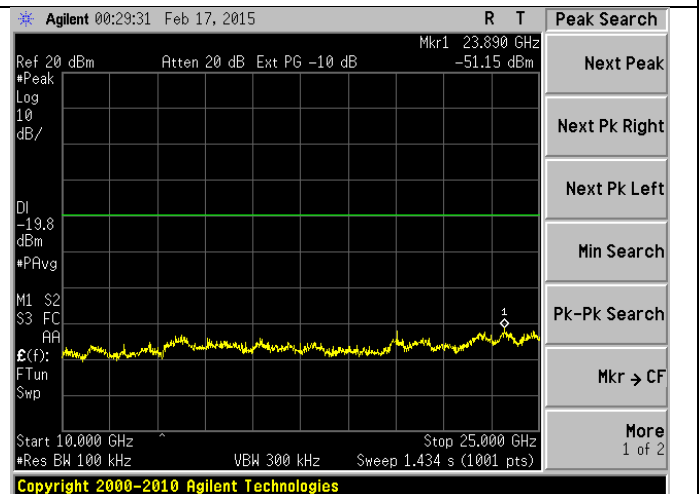
Low Channel 1-10 GHz



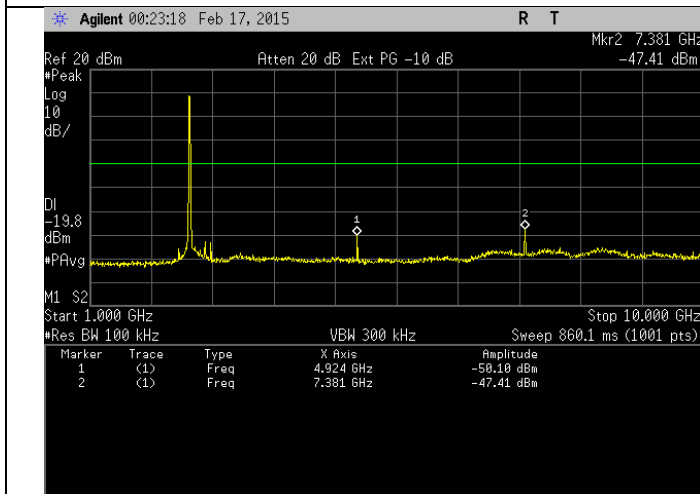
Low Channel 10-25 GHz



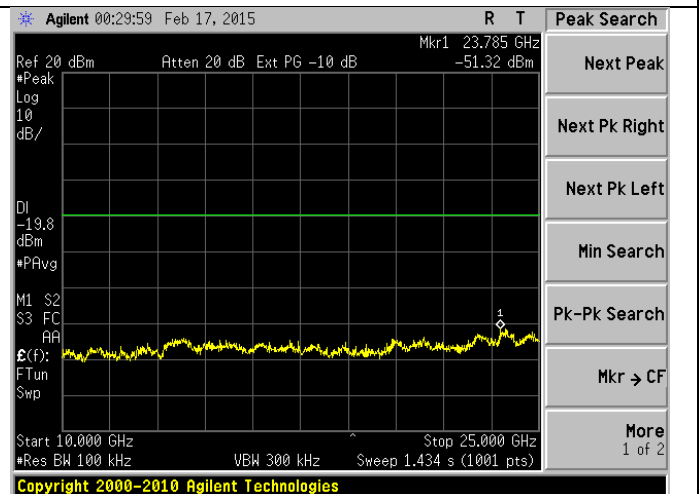
Mid Channel 1-10 GHz



Mid Channel 10-25 GHz



High Channel 1-10 GHz



High Channel 10-25 GHz

Prepared For: LSR

Report: TR 314413

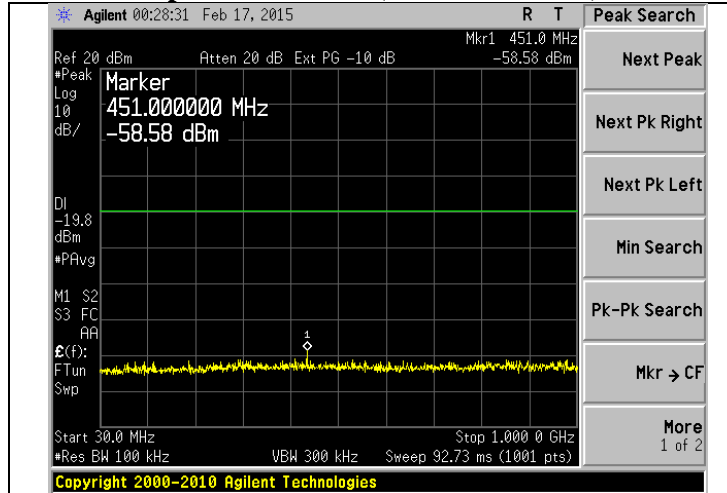
LSR: C-2114

Name: TiWi-C-W

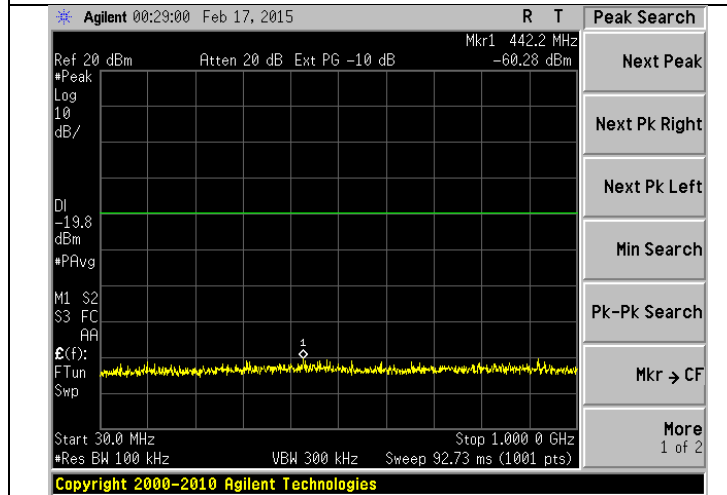
Model: TiWi-C-W

Serial: See Section 3.1

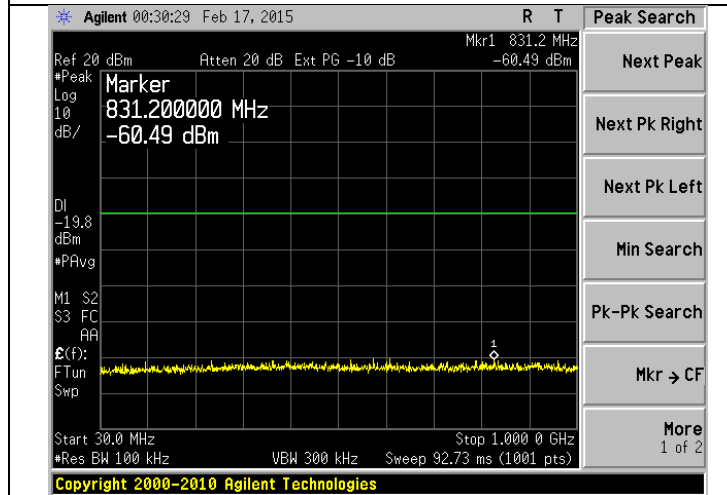
Spurious 802.11b (worst case mode)



Low Channel 30-1000 MHz



Mid Channel 30-1000 MHz



High Channel 30-1000 MHz

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

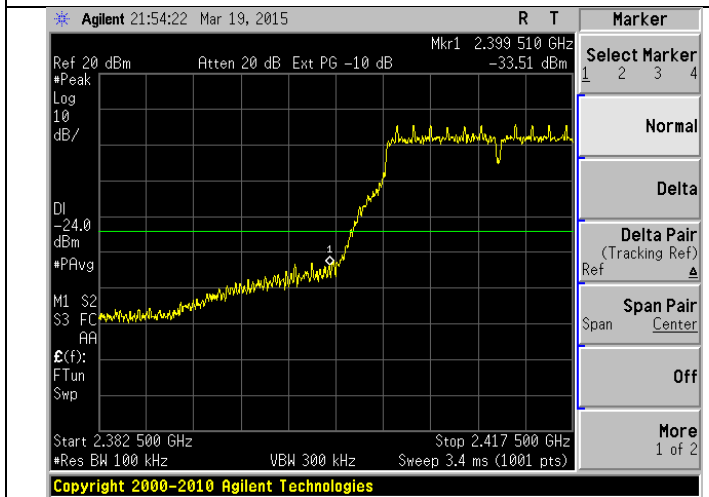
**Plots (4-layer board – Antenna 2)
Band-edge**



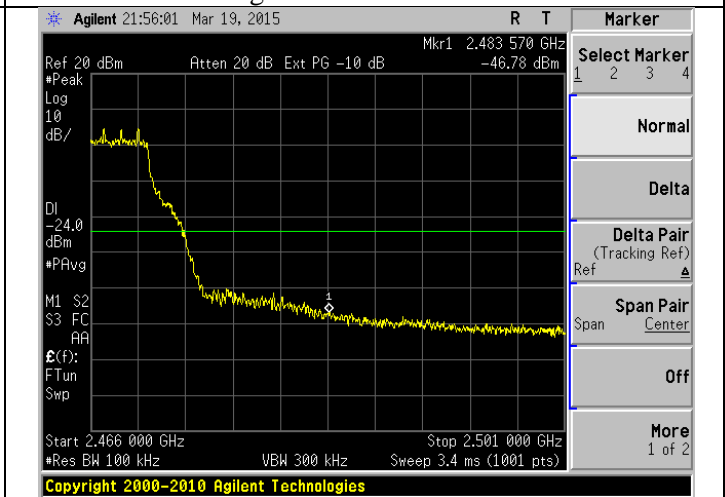
Low Channel – 802.11b



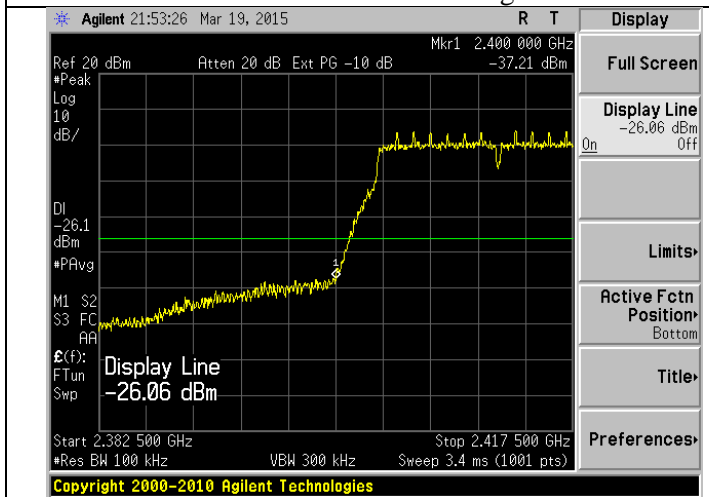
High Channel – 802.11b



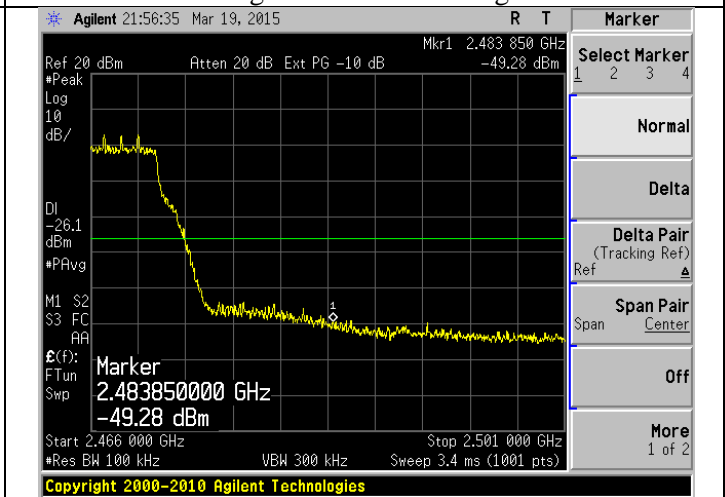
Low Channel – 802.11g



High Channel – 802.11g



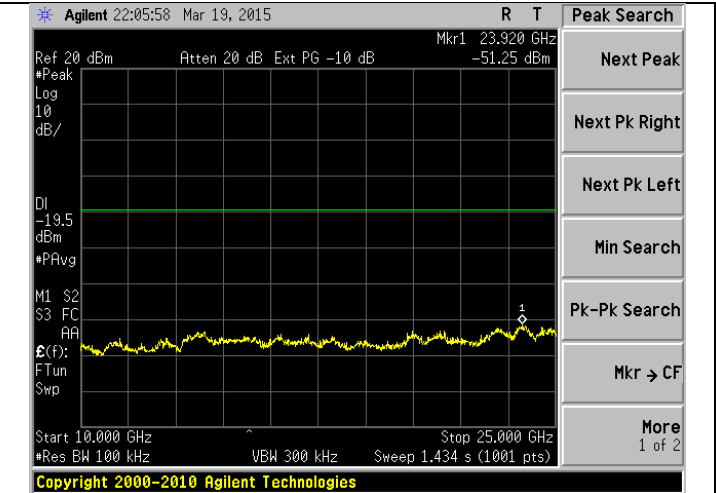
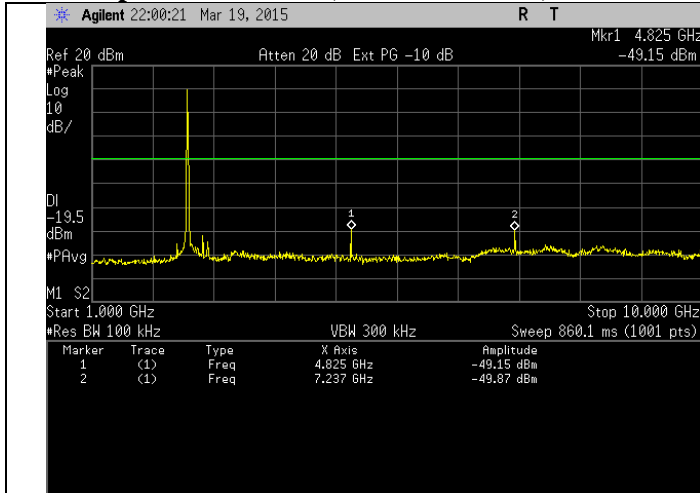
Low Channel – 802.11n



High Channel – 802.11n

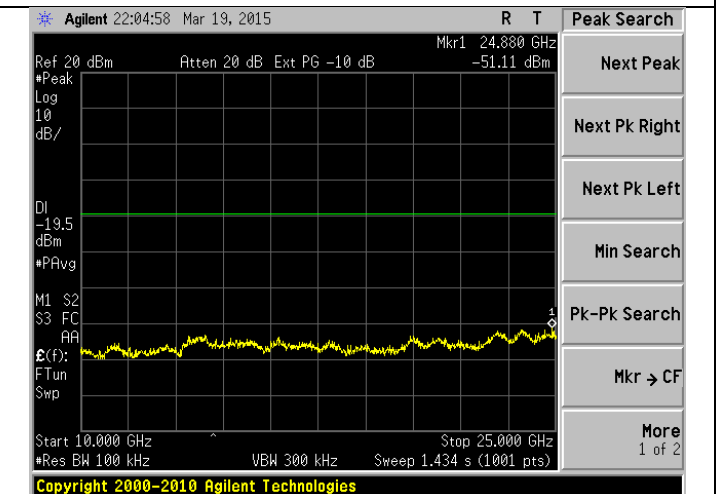
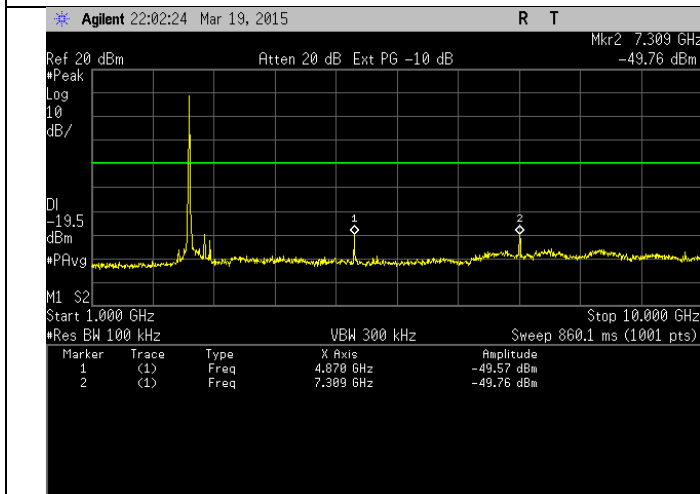
Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

Spurious 802.11b (worst case mode)



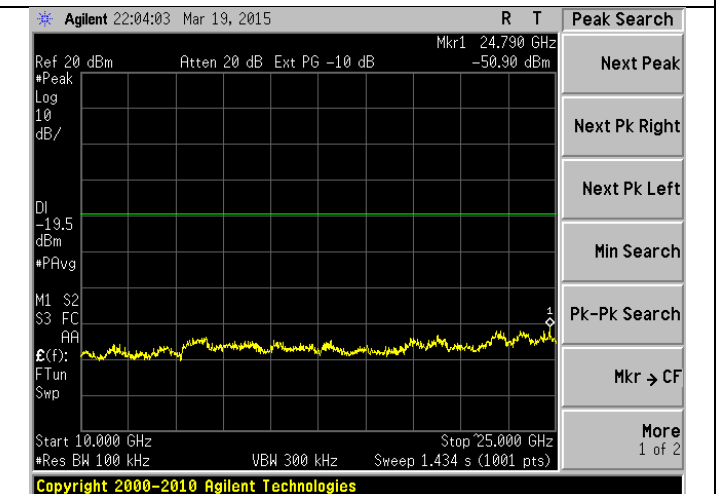
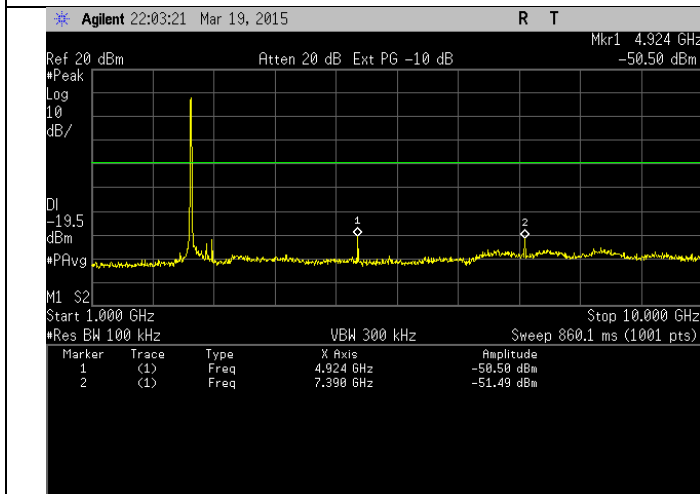
Low Channel 1-10 GHz

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

Prepared For: LSR

Report: TR 314413

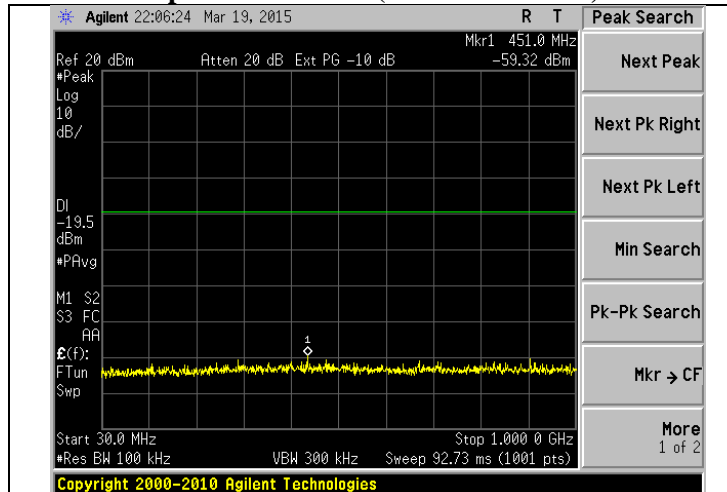
LSR: C-2114

Name: TiWi-C-W

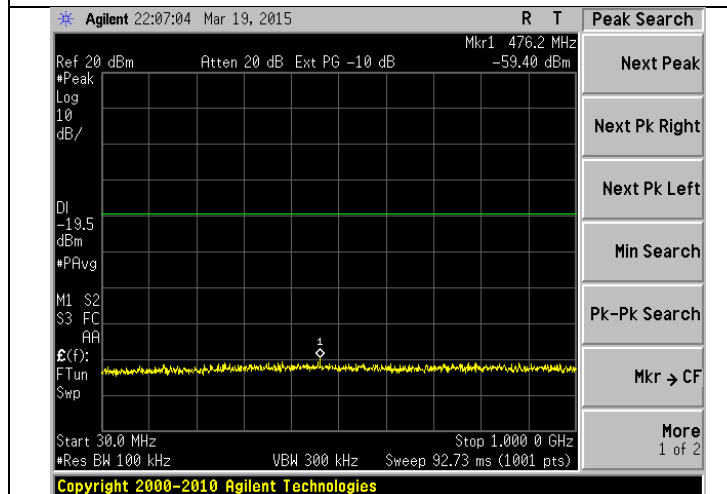
Model: TiWi-C-W

Serial: See Section 3.1

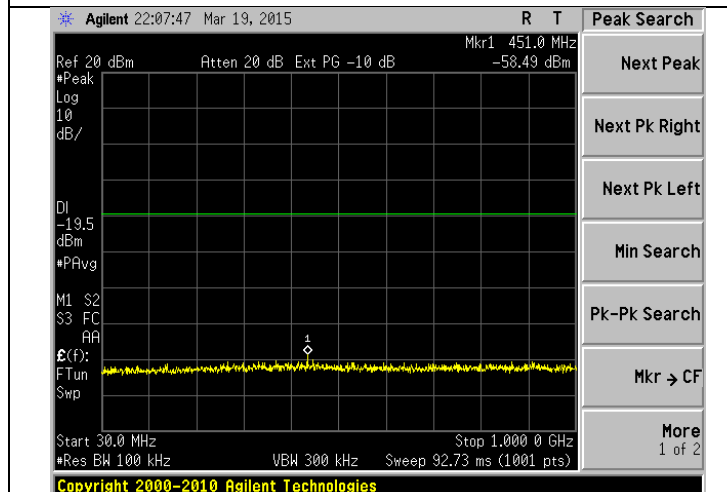
Spurious 802.11b (worst case mode)



Low Channel 30-1000 MHz



Mid Channel 30-1000 MHz



High Channel 30-1000 MHz

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

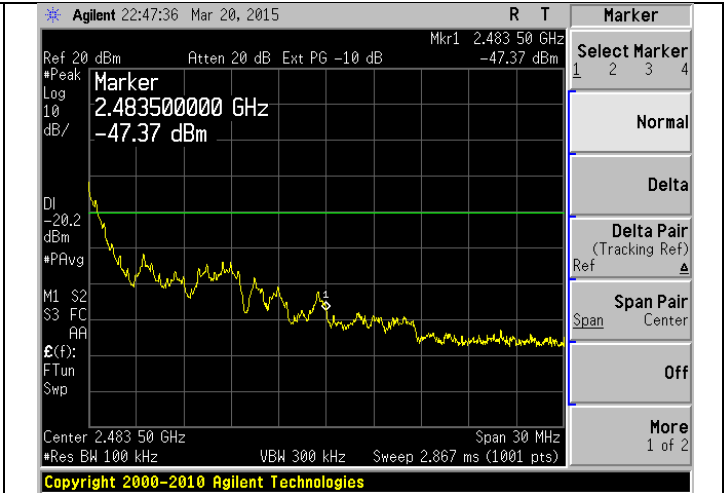
Model: TiWi-C-W

Serial: See Section 3.1

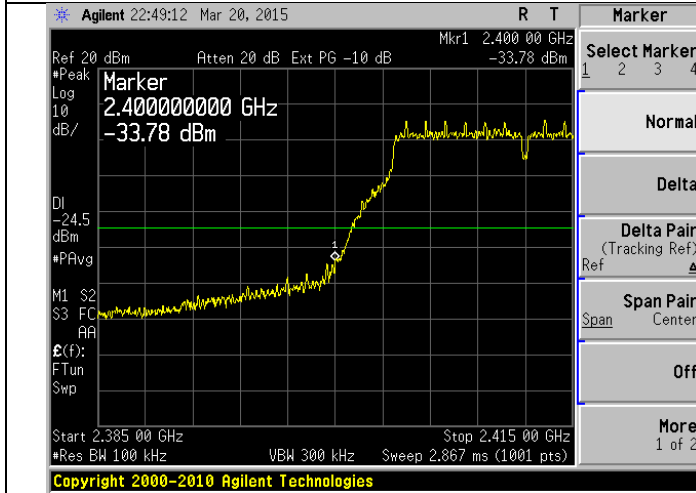
Plots (2-layer board – Antenna 1) Band-edge



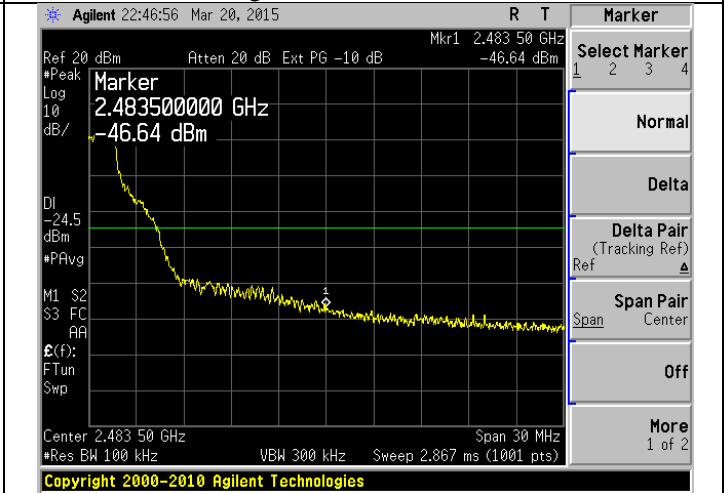
Low Channel – 802.11b



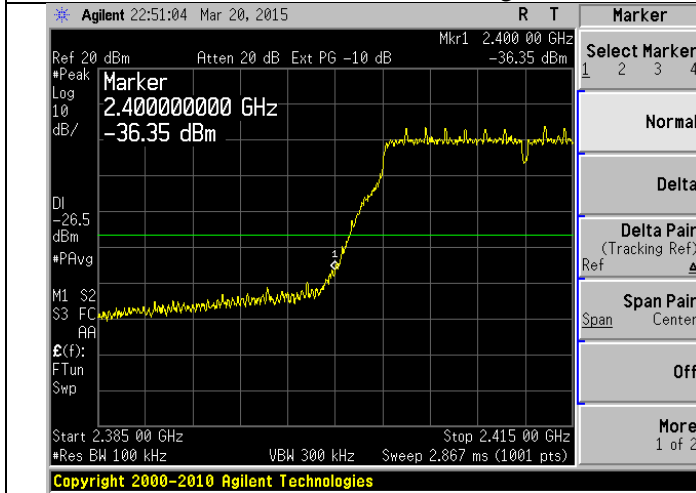
High Channel – 802.11b



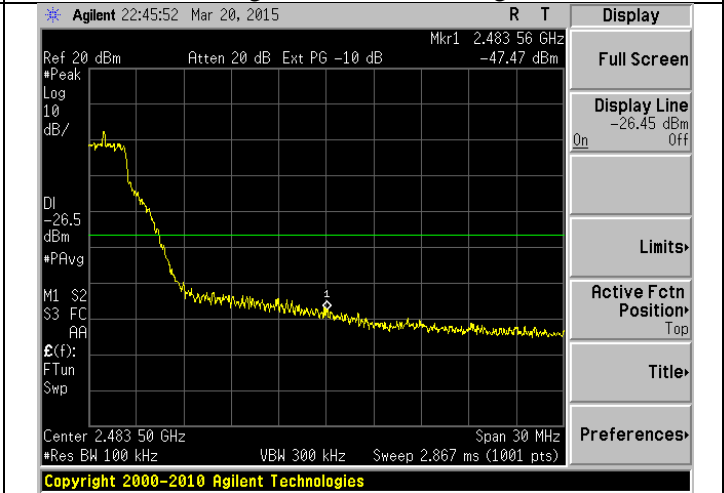
Low Channel – 802.11g



High Channel – 802.11g



Low Channel – 802.11n

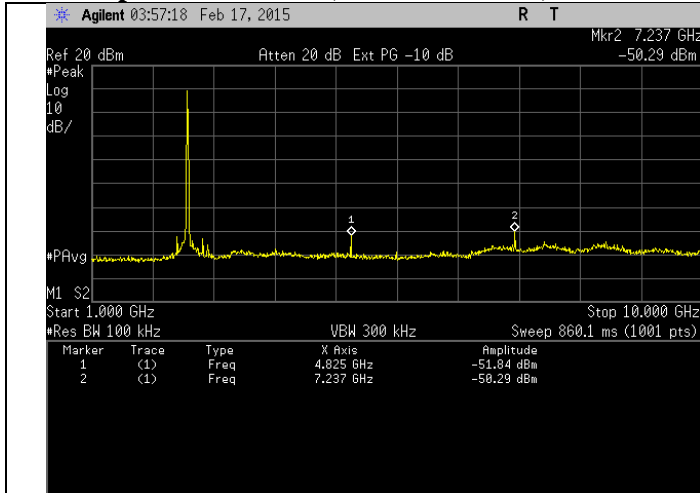


High Channel – 802.11n

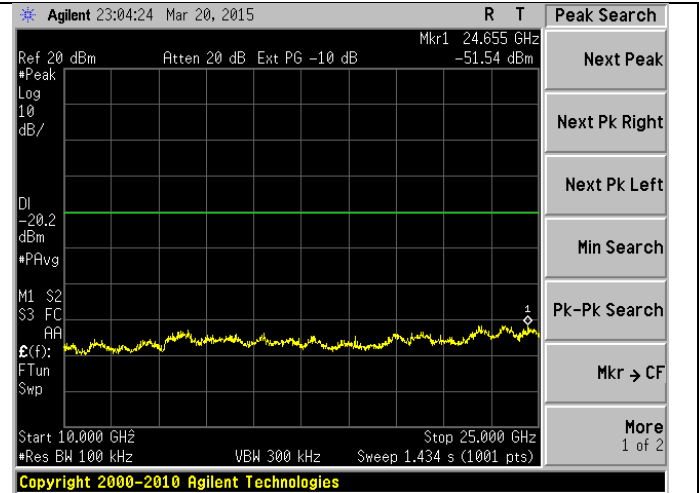
Prepared For: LSR
Report: TR 314413
LSR: C-2114

Name: TiWi-C-W
Model: TiWi-C-W
Serial: See Section 3.1

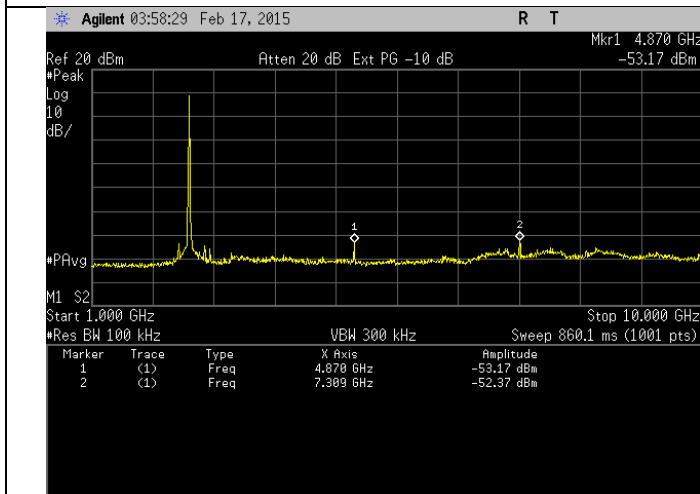
Spurious 802.11b (worst case mode)



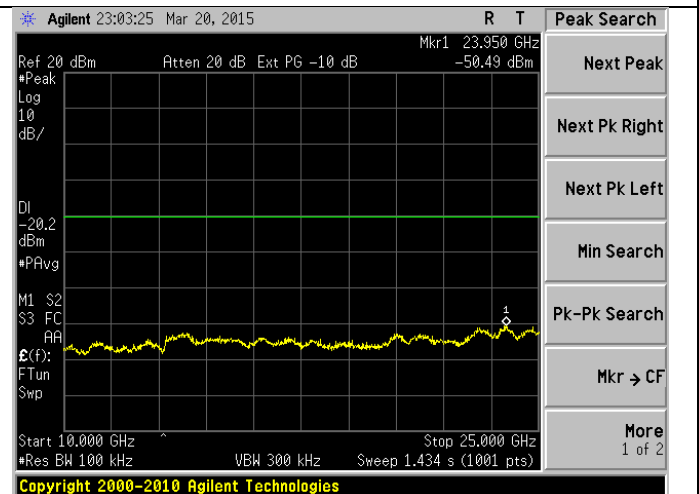
Low Channel 1-10 GHz



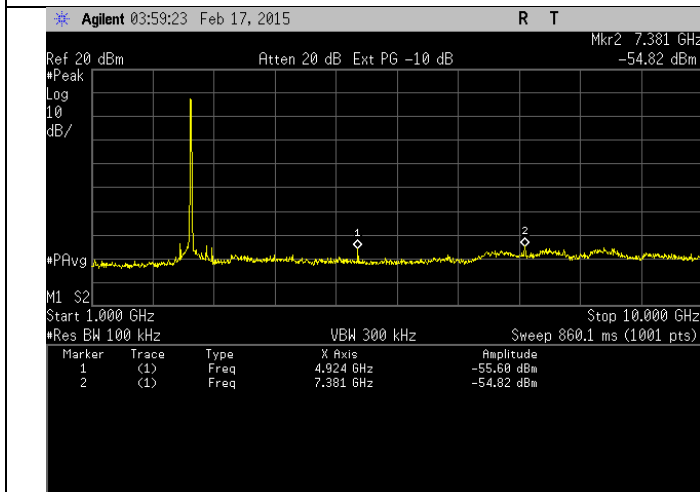
Low Channel 10-25 GHz



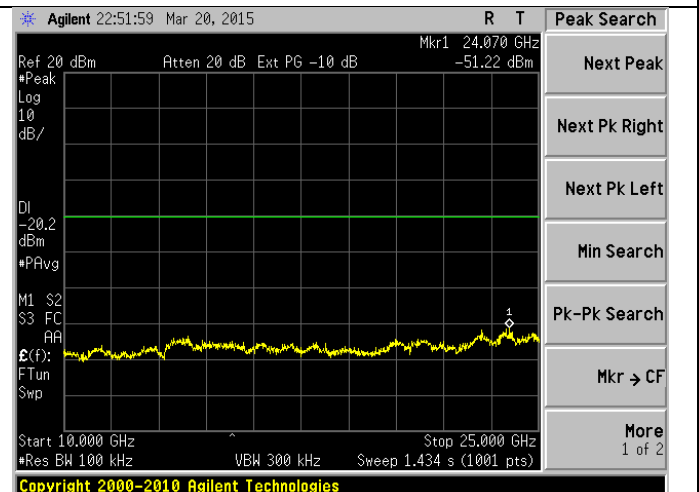
Mid Channel 1-10 GHz



Mid Channel 10-25 GHz



High Channel 1-10 GHz



High Channel 10-25 GHz

Prepared For: LSR

Report: TR 314413

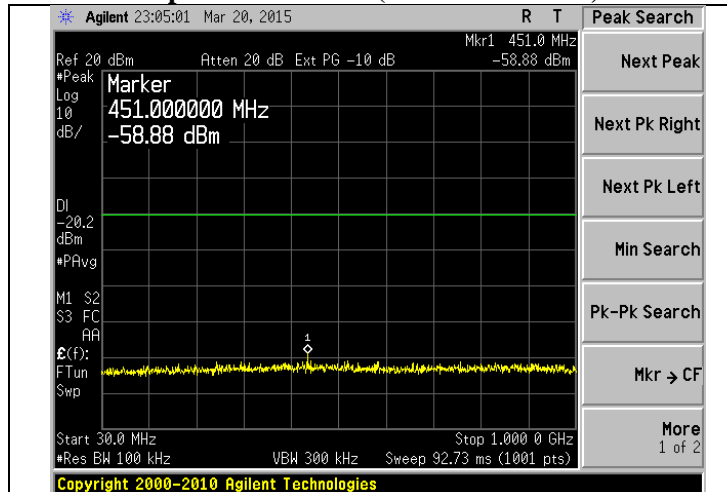
LSR: C-2114

Name: TiWi-C-W

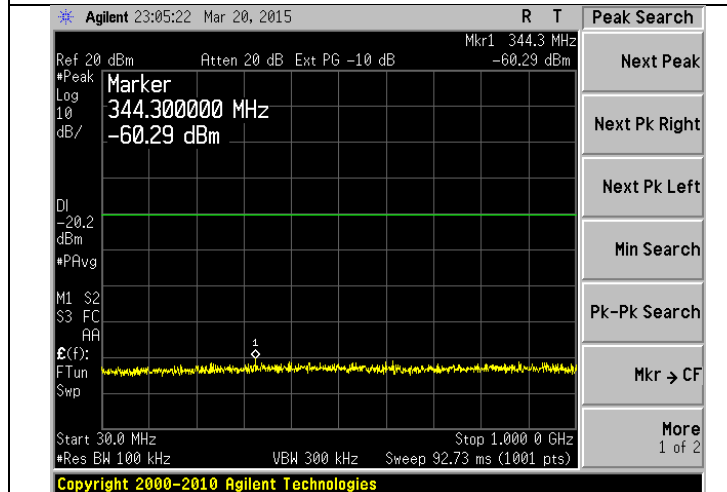
Model: TiWi-C-W

Serial: See Section 3.1

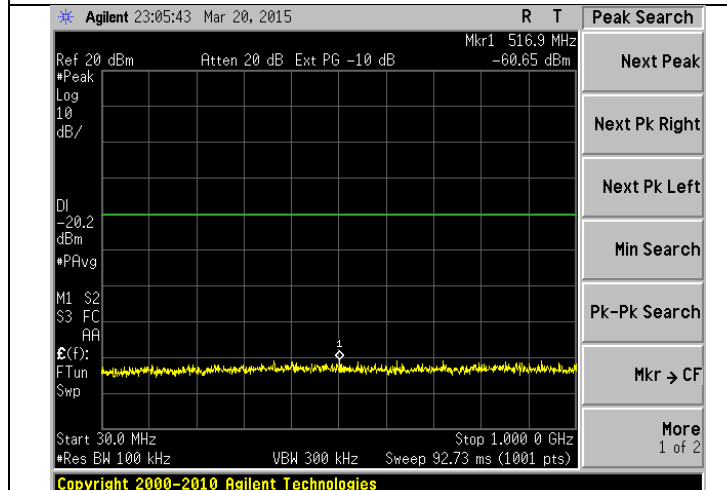
Spurious 802.11b (worst case mode)



Low Channel 30-1000 MHz



Mid Channel 30-1000 MHz



High Channel 30-1000 MHz

Prepared For: LSR

Report: TR 314413

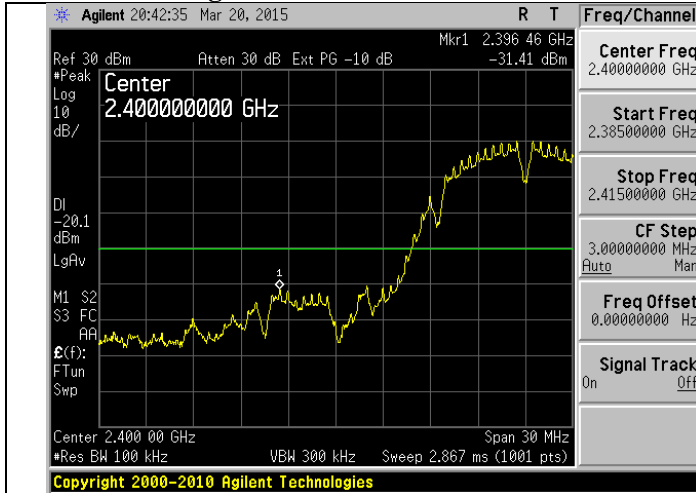
LSR: C-2114

Name: TiWi-C-W

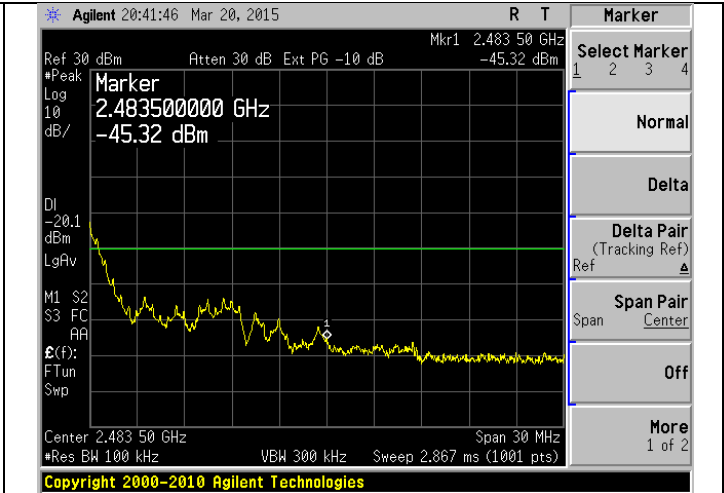
Model: TiWi-C-W

Serial: See Section 3.1

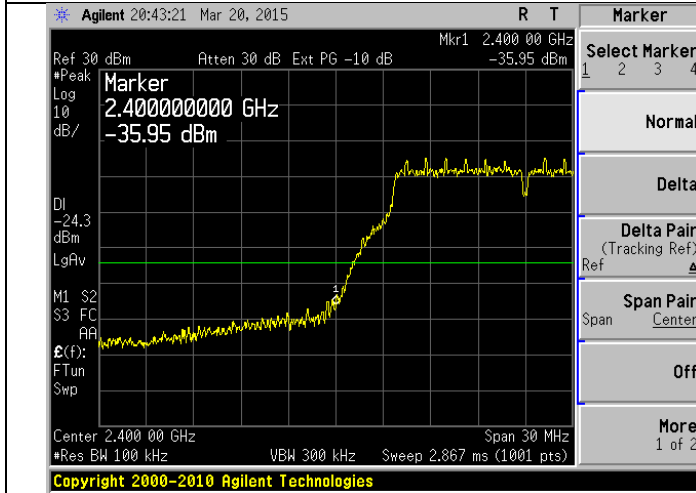
**Plots (2-layer board – Antenna 2)
Band-edge**



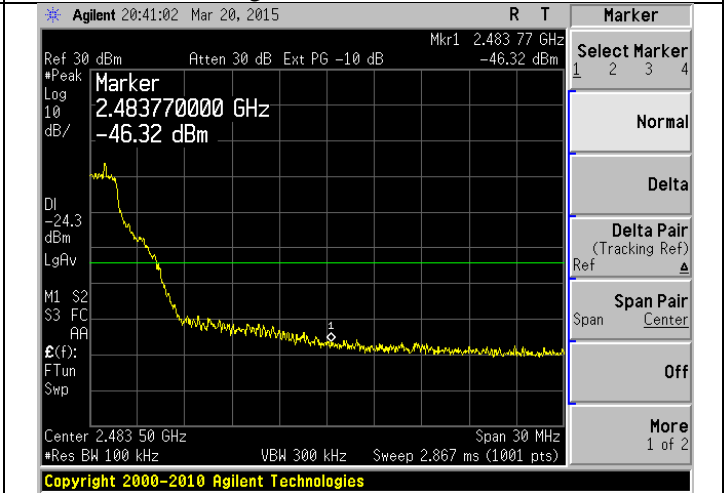
Low Channel – 802.11b



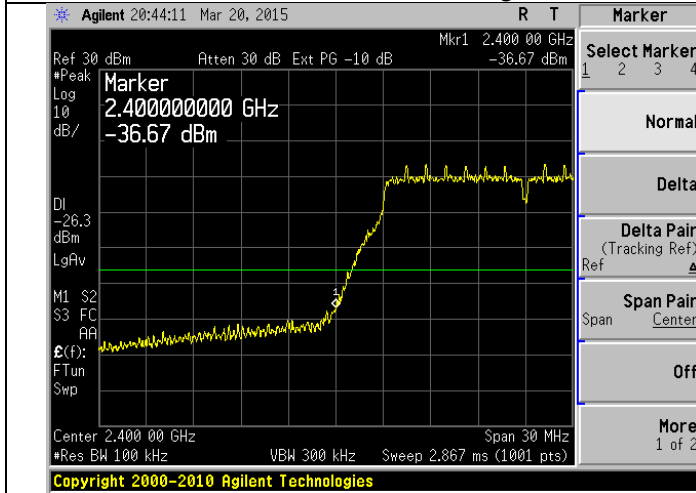
High Channel – 802.11b



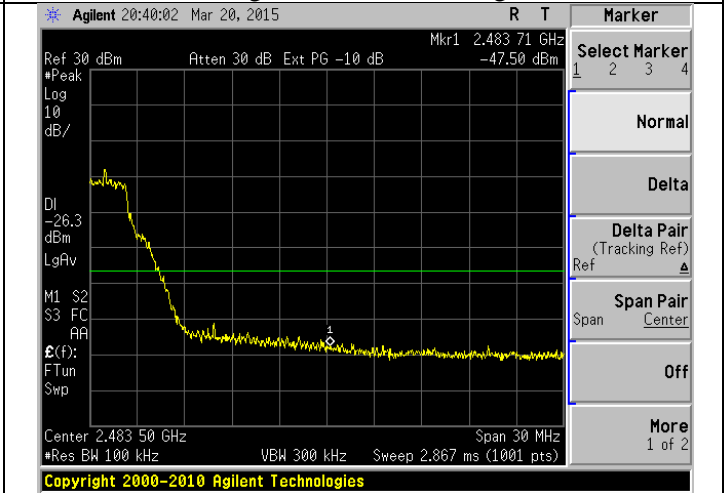
Low Channel – 802.11g



High Channel – 802.11g



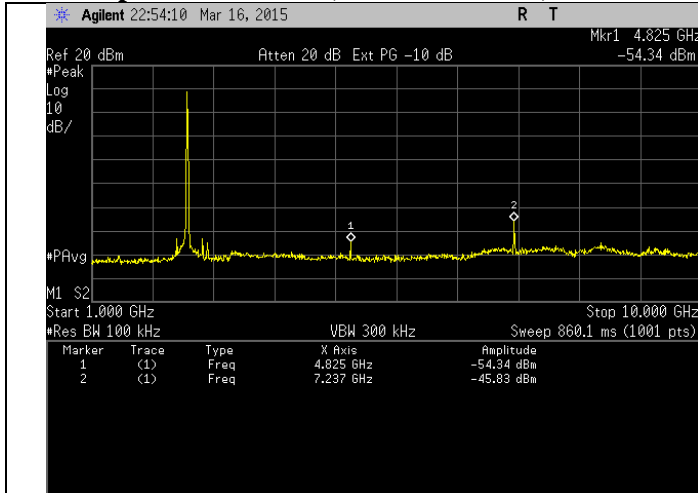
Low Channel – 802.11n



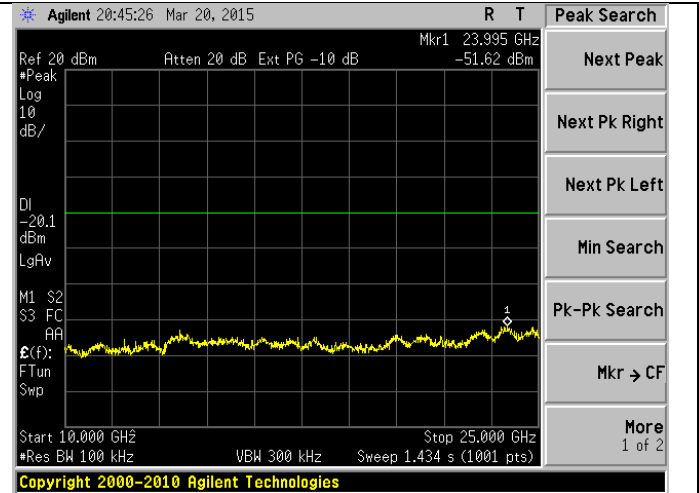
High Channel – 802.11n

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

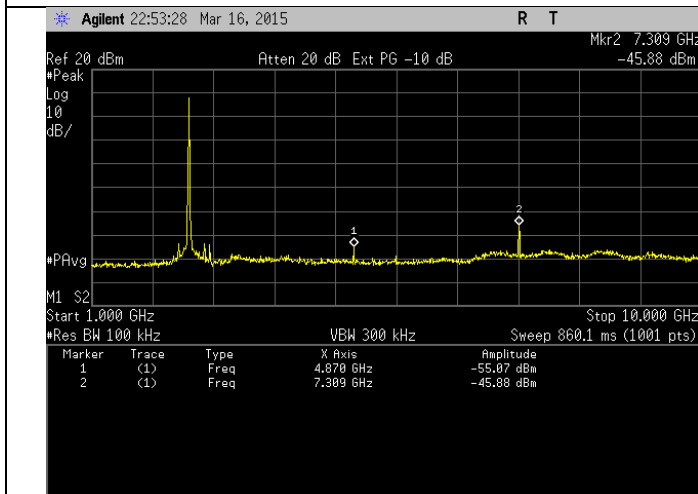
Spurious 802.11b (worst case mode)



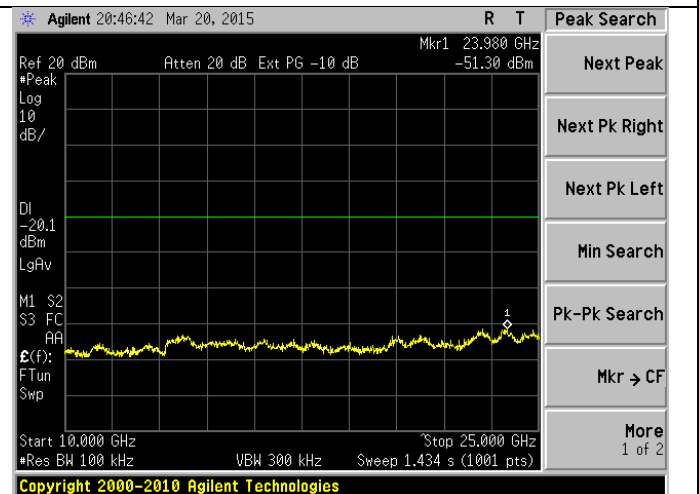
Low Channel 1-10 GHz



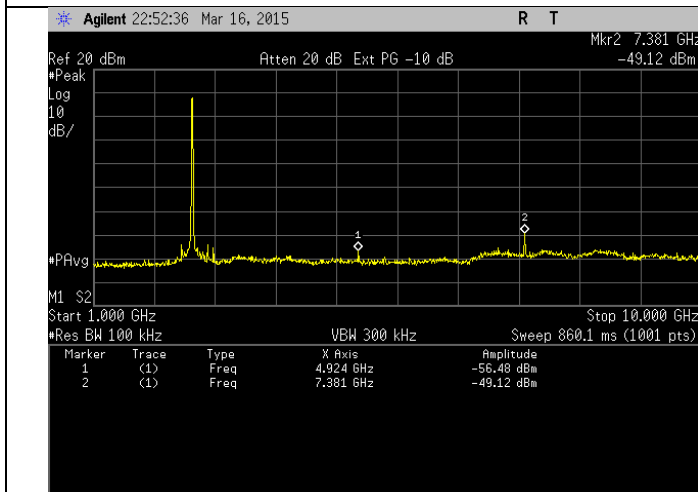
Low Channel 10-25 GHz



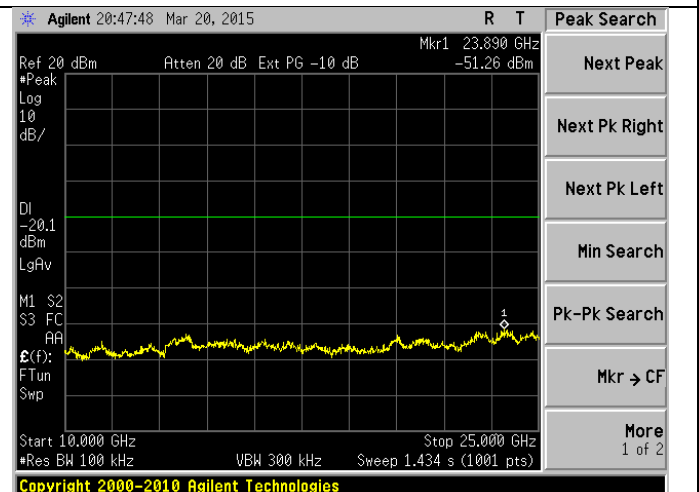
Mid Channel 1-10 GHz



Mid Channel 10-25 GHz



High Channel 1-10 GHz



High Channel 10-25 GHz

Prepared For: LSR

Report: TR 314413

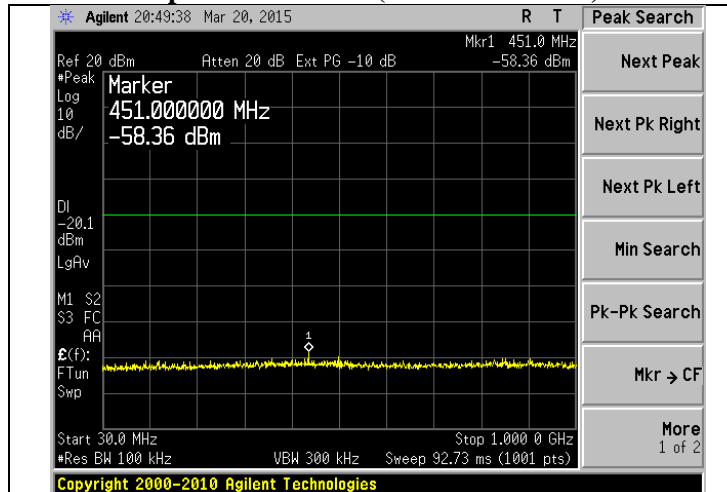
LSR: C-2114

Name: TiWi-C-W

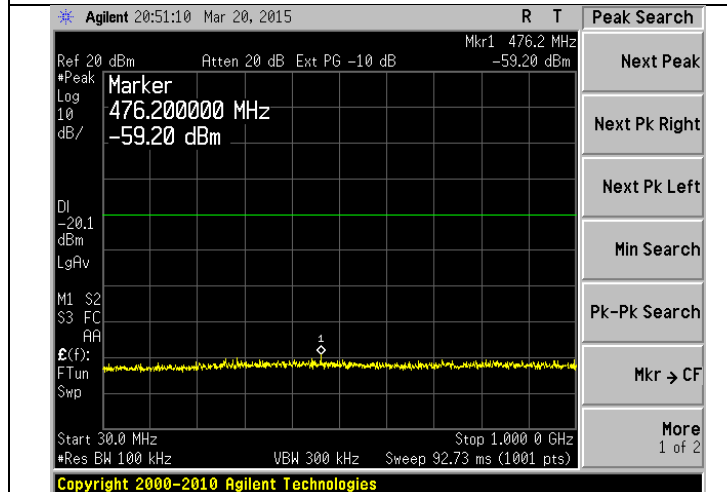
Model: TiWi-C-W

Serial: See Section 3.1

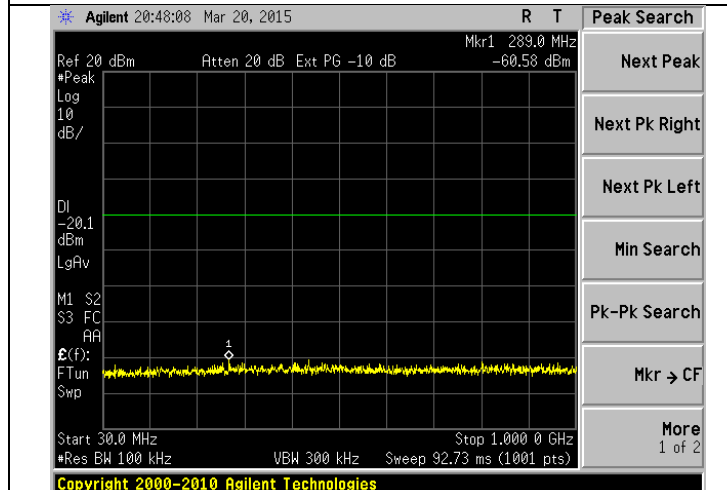
Spurious 802.11b (worst case mode)



Low Channel 30-1000 MHz



Mid Channel 30-1000 MHz



High Channel 30-1000 MHz

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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 - 25° 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 Section 12.2.5.2 (Average Measurements)
Additional Description of Measurement	RF Conducted Measurement 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

Prepared For: LSR

Name: TiWi-C-W

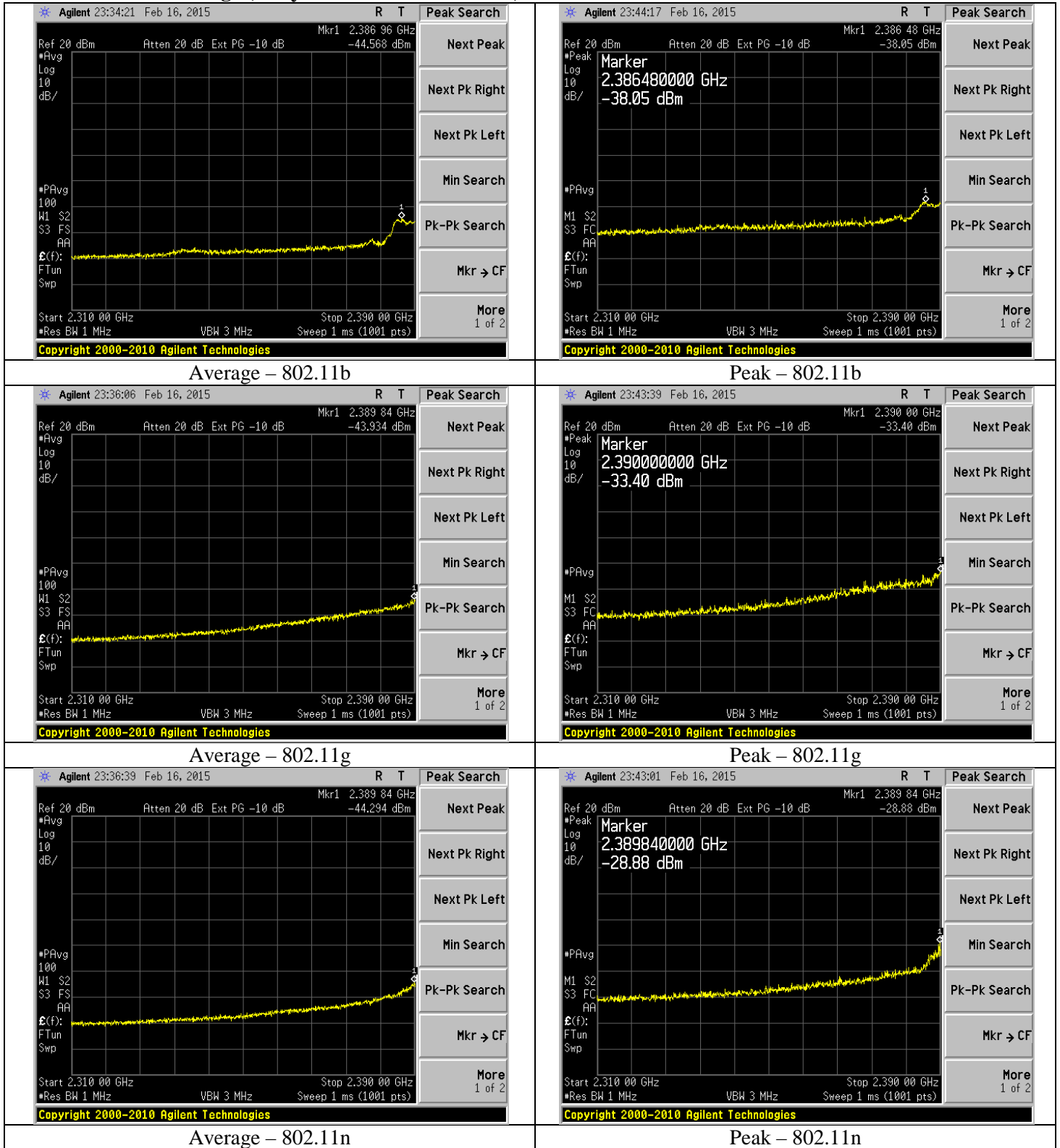
Report: TR 314413

Model: TiWi-C-W

LSR: C-2114

Serial: See Section 3.1

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



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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

Prepared For: LSR

Name: TiWi-C-W

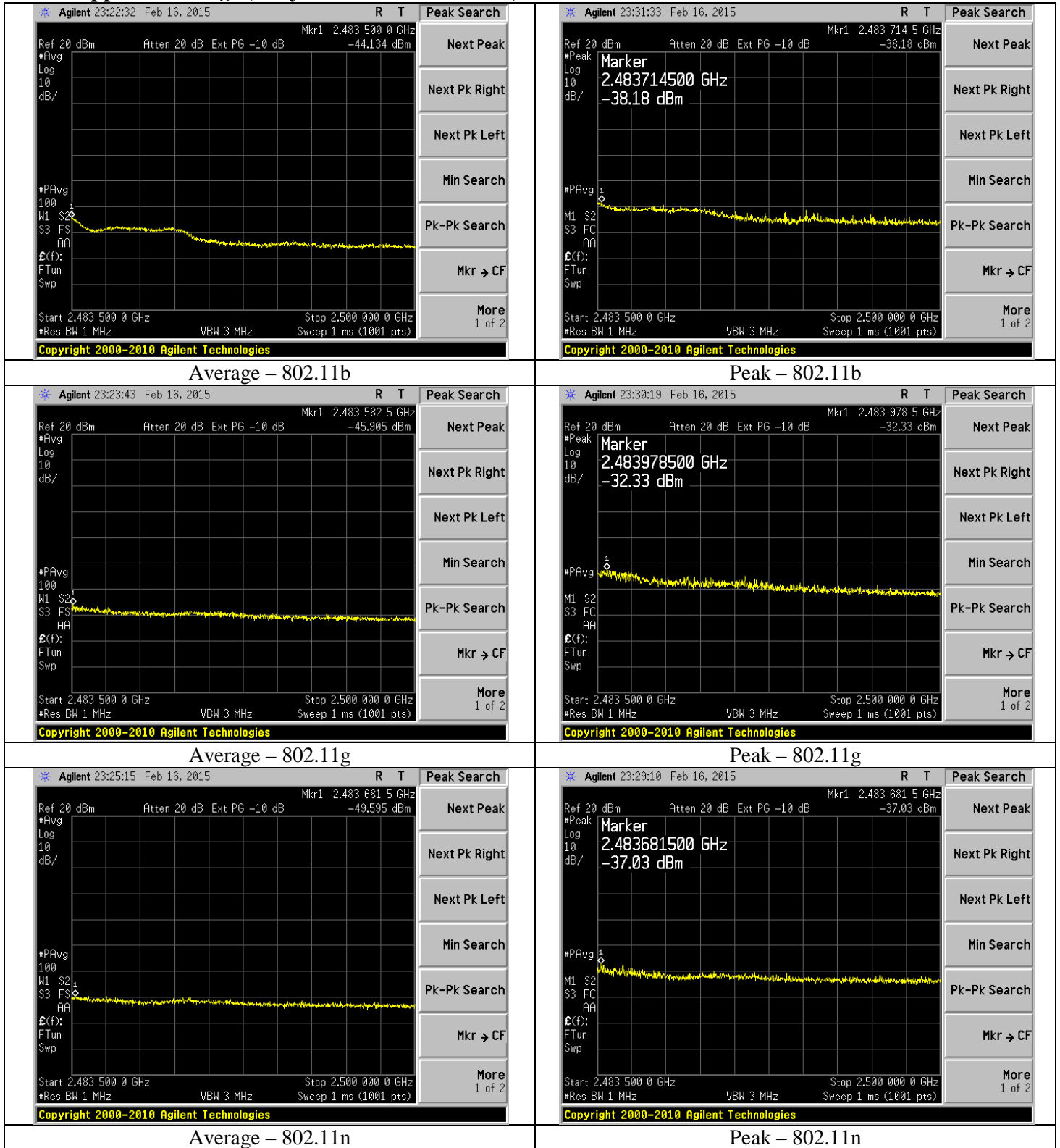
Report: TR 314413

Model: TiWi-C-W

LSR: C-2114

Serial: See Section 3.1

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



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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

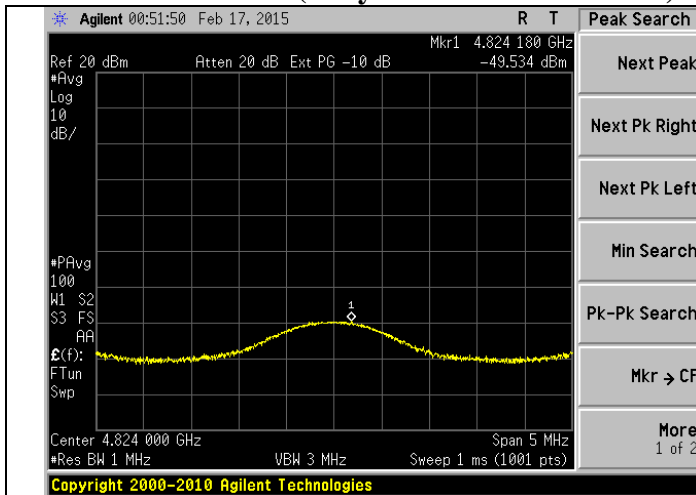
Peak

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

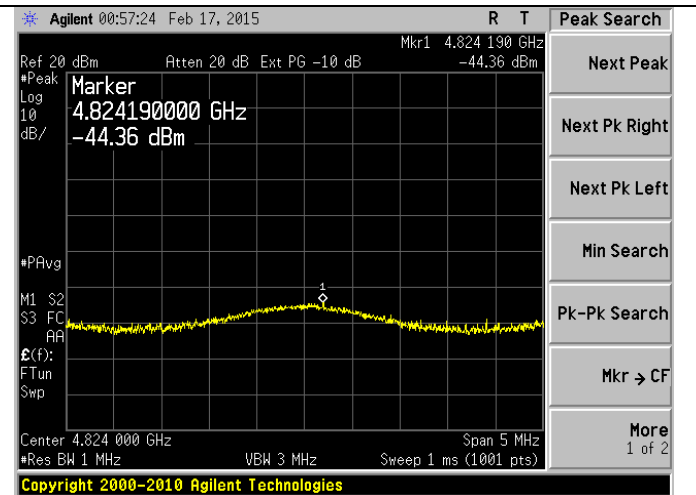
Note: Low Channel 3rd harmonic not in restricted band.

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

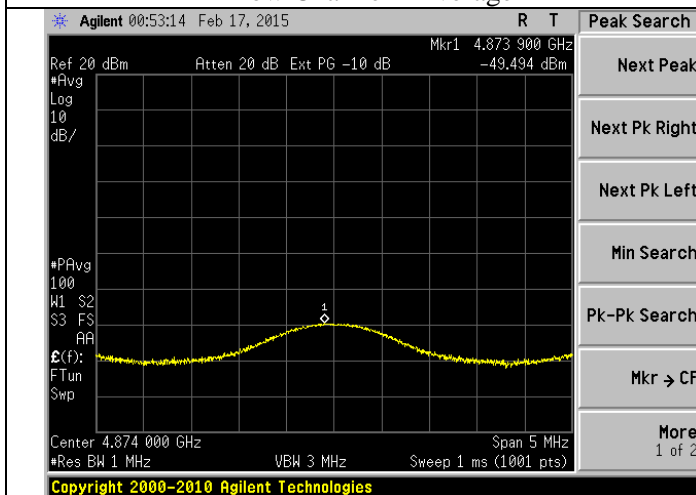
2nd Harmonic (4-layer board – Antenna 1)



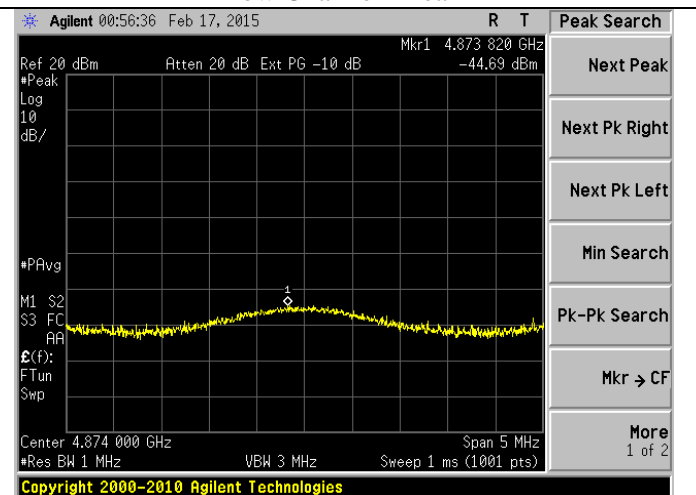
Low Channel - Average



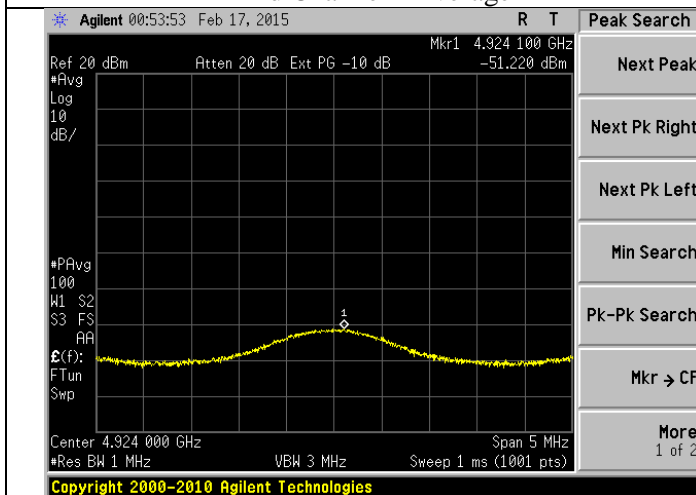
Low Channel - Peak



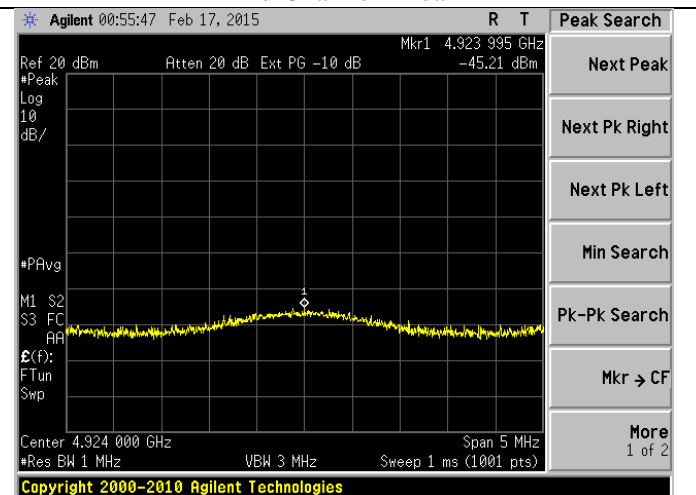
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

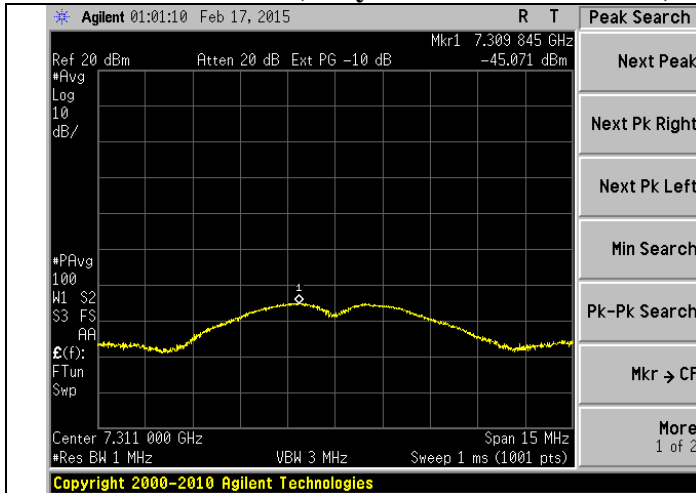
LSR: C-2114

Name: TiWi-C-W

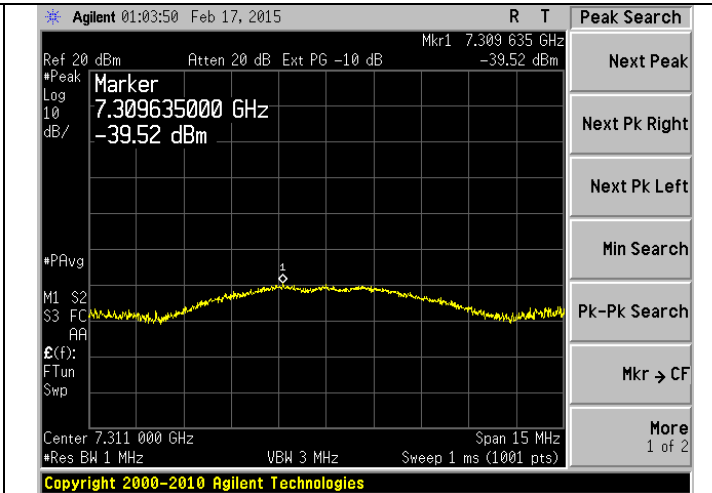
Model: TiWi-C-W

Serial: See Section 3.1

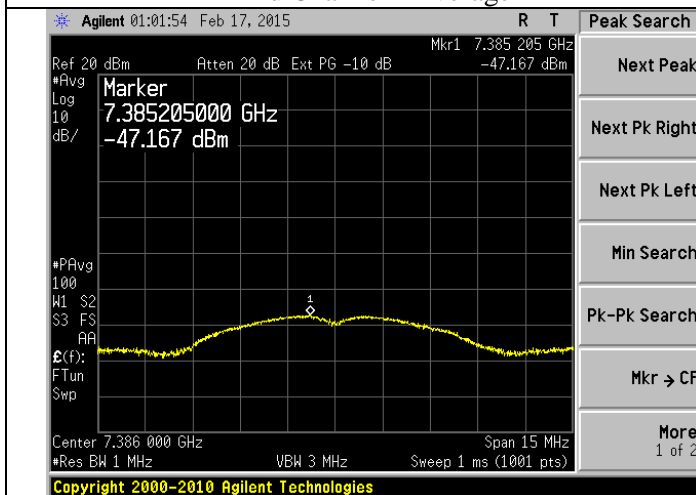
3rd Harmonic (4-layer board – Antenna 1)



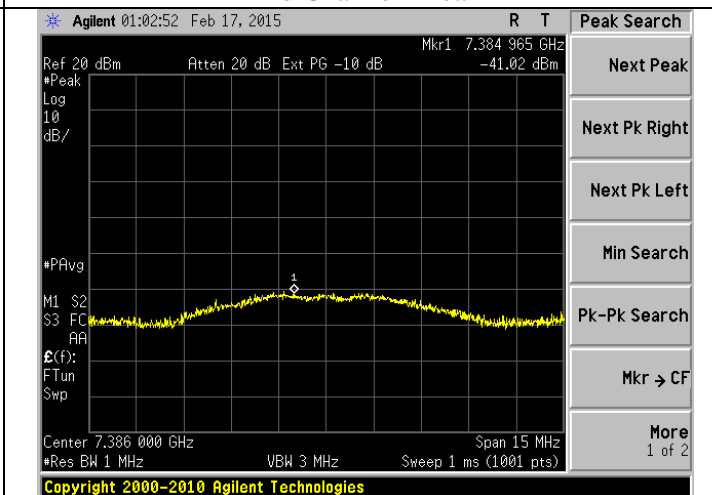
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

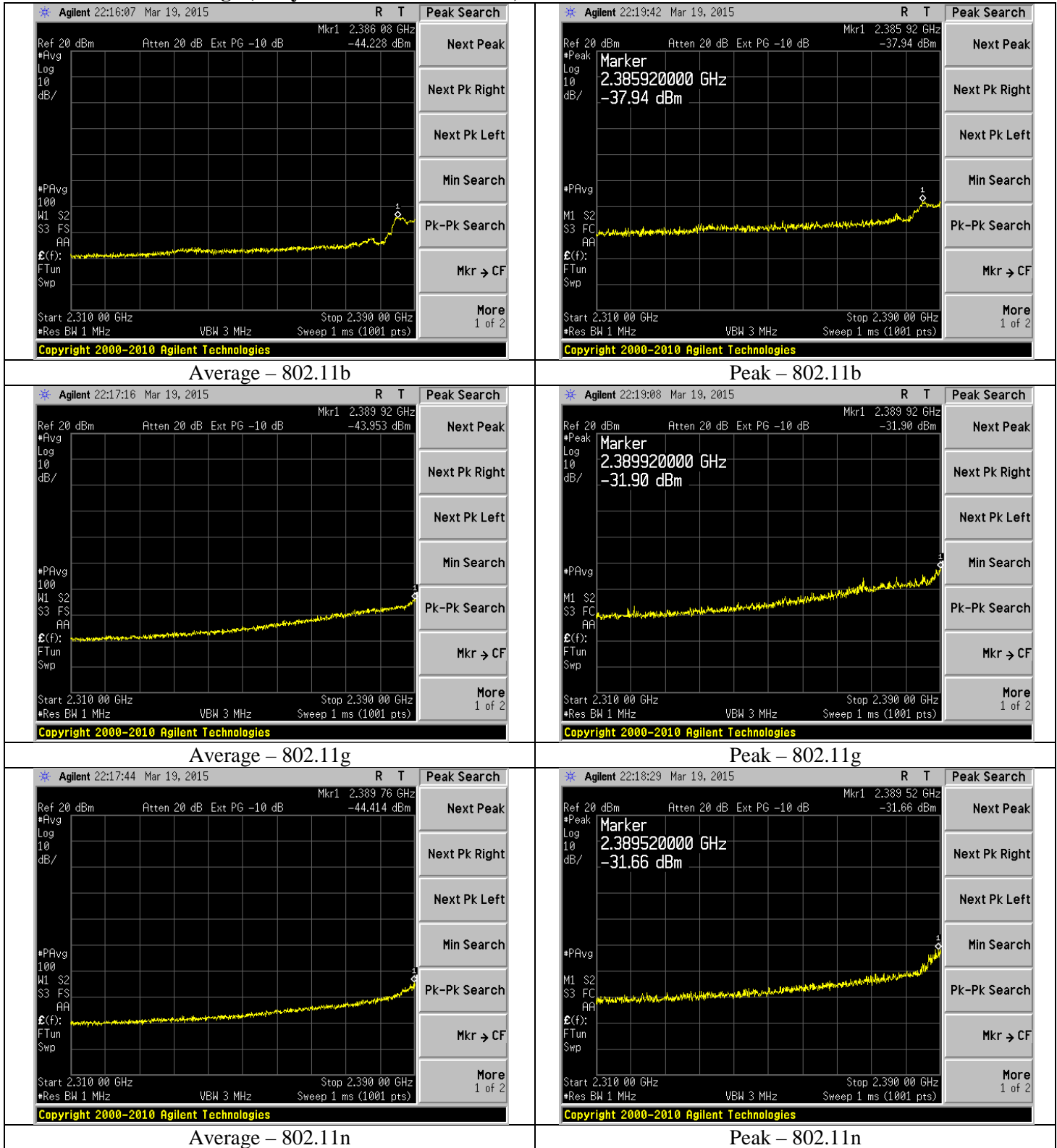
4-layer board – Antenna 2
Lower band edge restricted band
Average

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)



Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

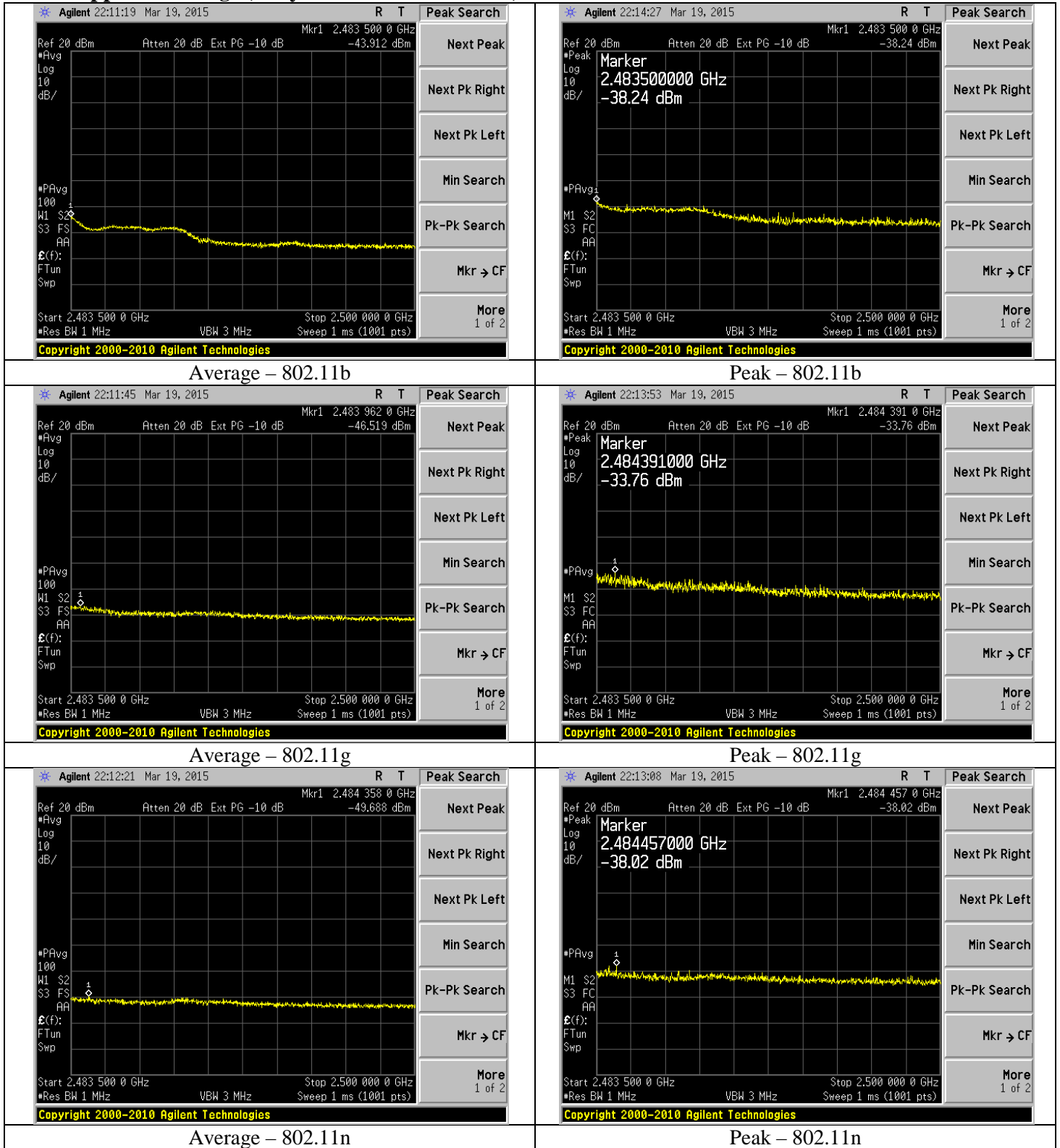
4-layer board – Antenna 2
Upper band edge restricted band
Average

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)



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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

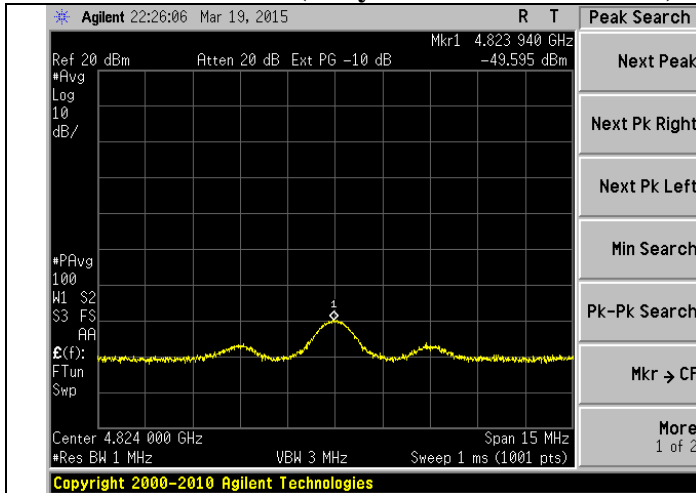
Peak

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

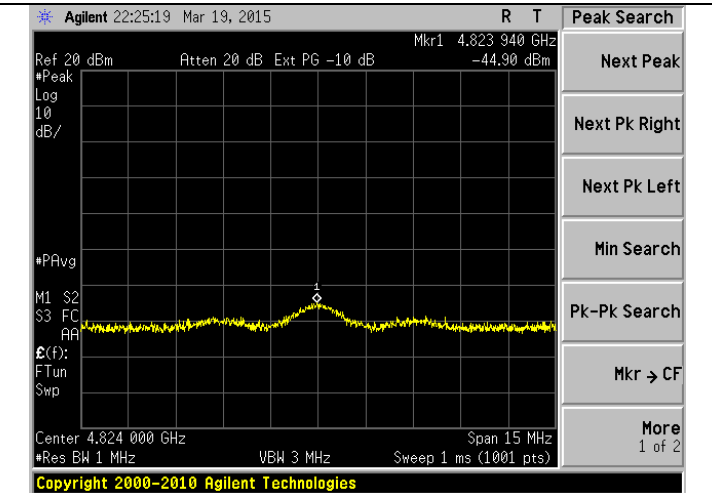
Note: Low Channel 3rd harmonic not in restricted band.

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

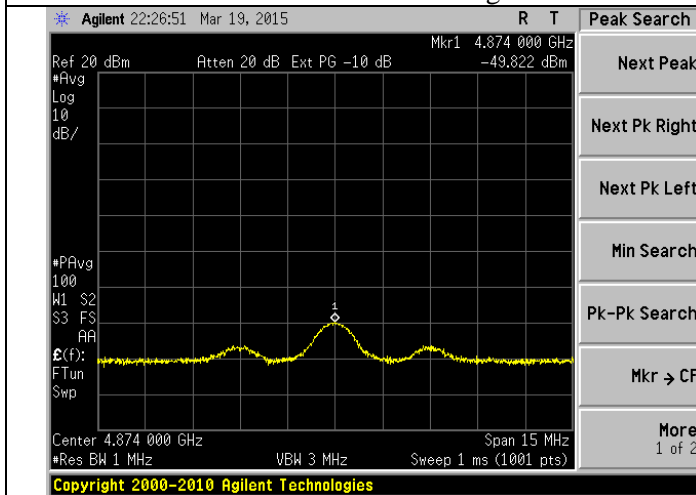
2nd Harmonic (4-layer board – Antenna 2)



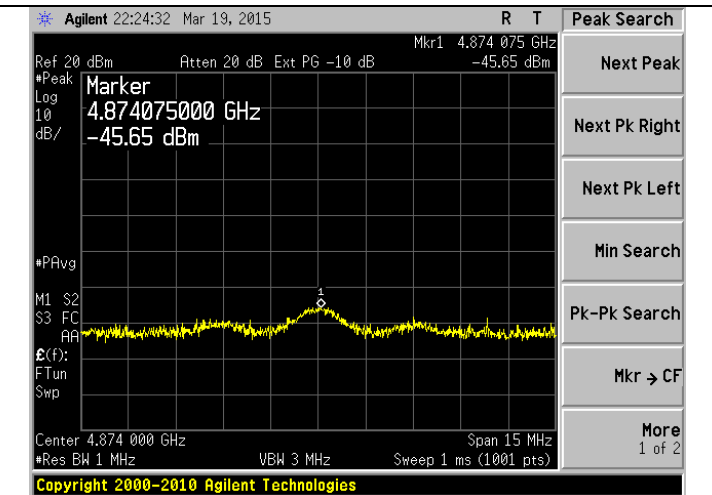
Low Channel - Average



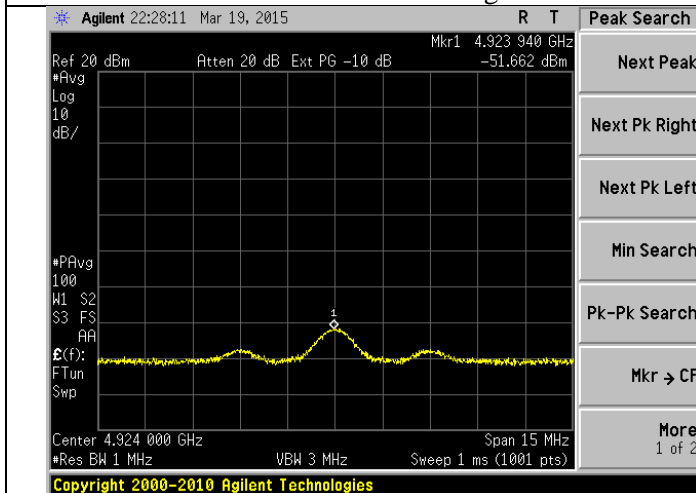
Low Channel - Peak



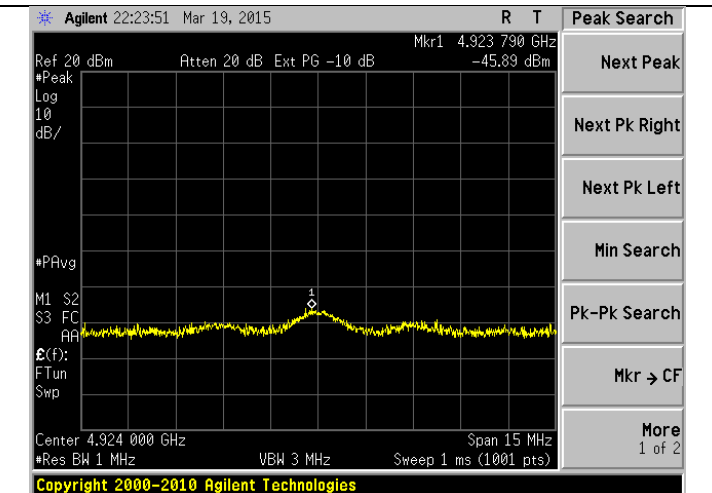
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

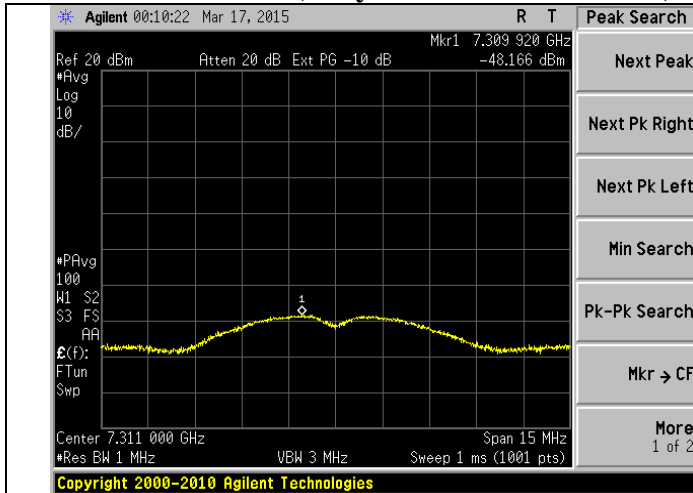
LSR: C-2114

Name: TiWi-C-W

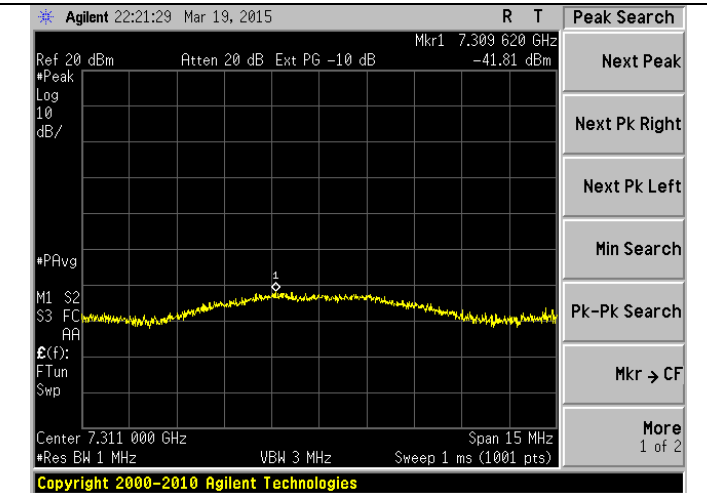
Model: TiWi-C-W

Serial: See Section 3.1

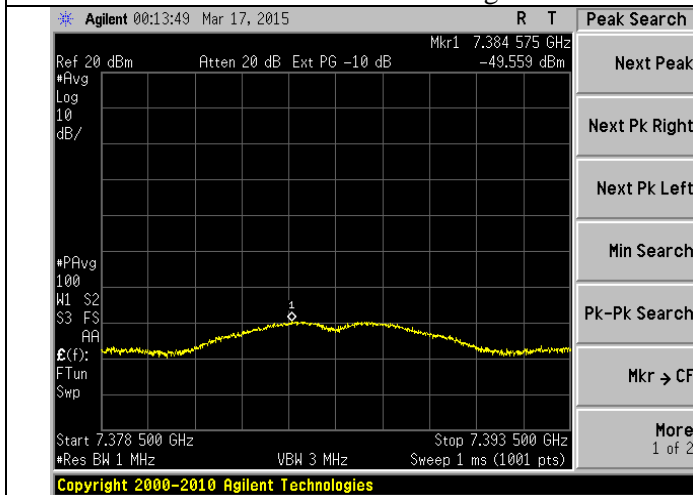
3rd Harmonic (4-layer board – Antenna 2)



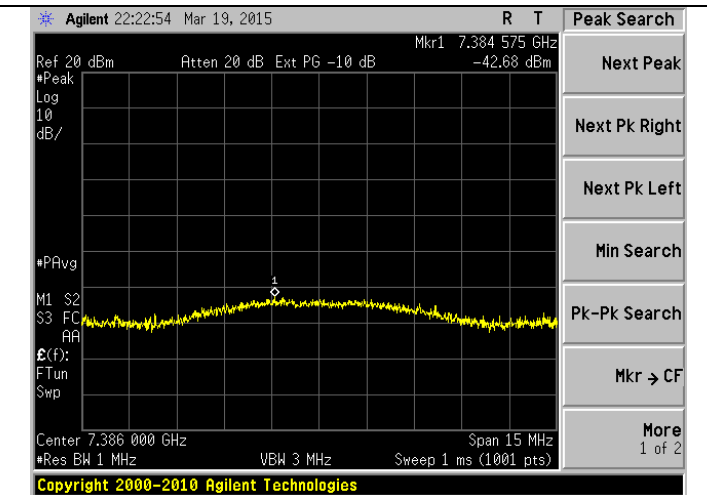
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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

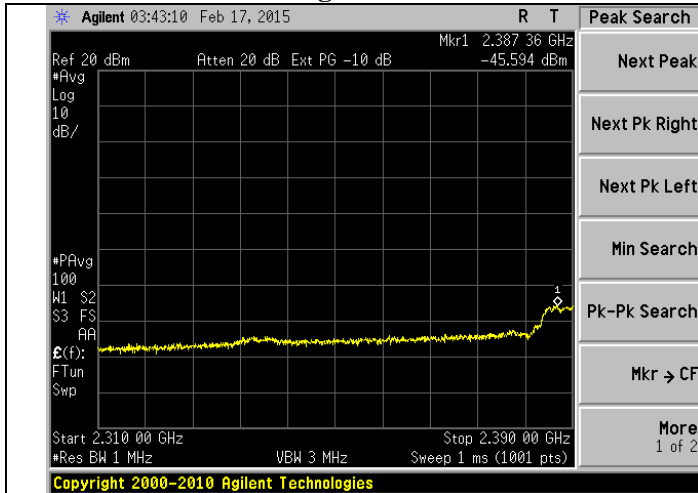
Average

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

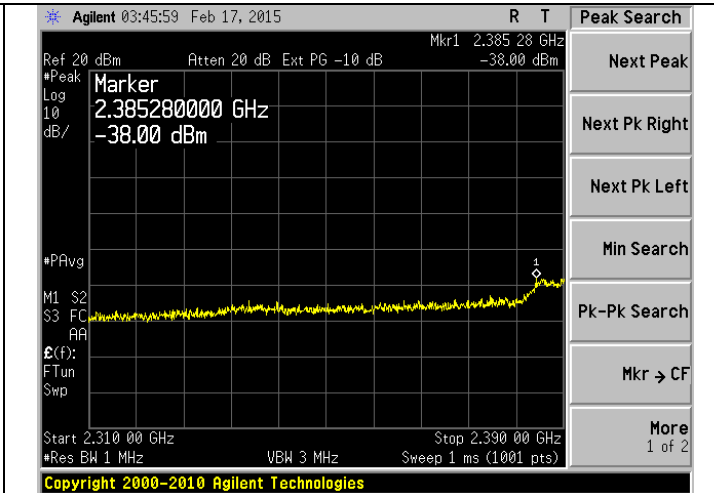
Peak

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

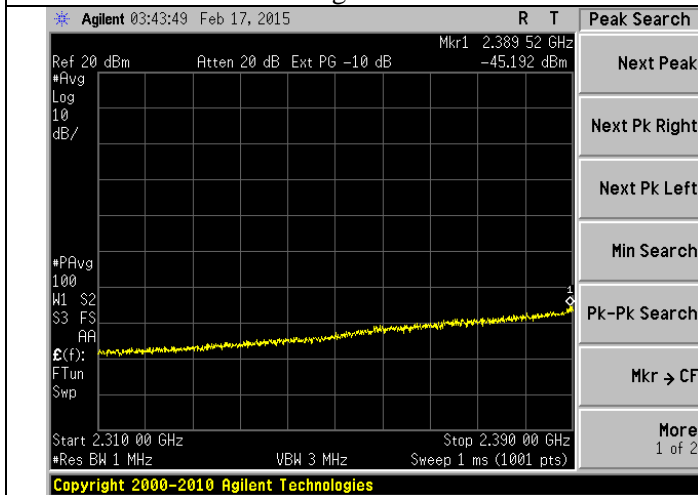
Lower Band-Edge



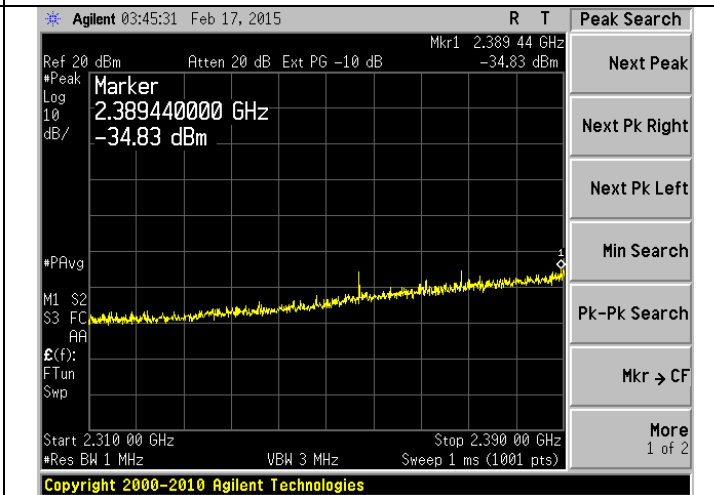
Average - 802.11b



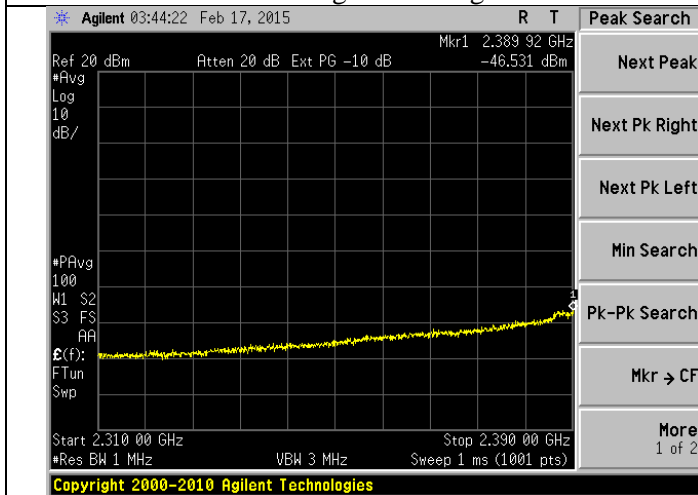
Peak - 802.11b



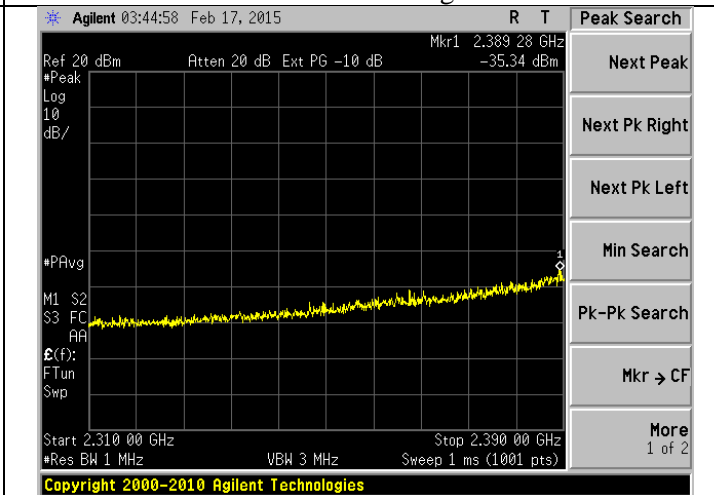
Average - 802.11g



Peak - 802.11g



Average - 802.11n



Peak - 802.11n

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

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

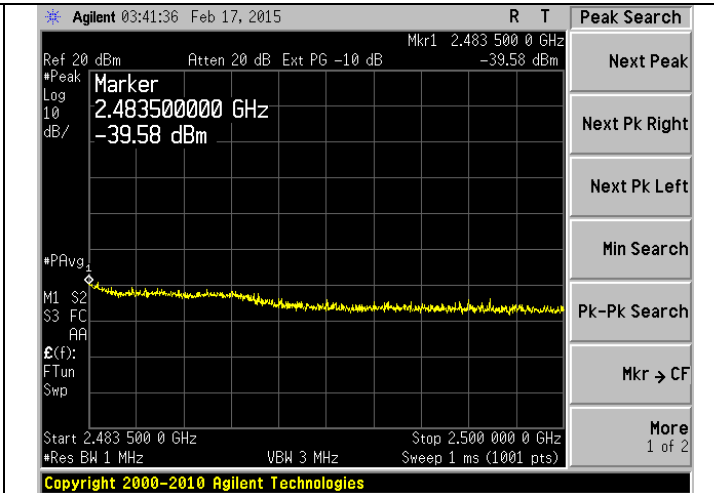
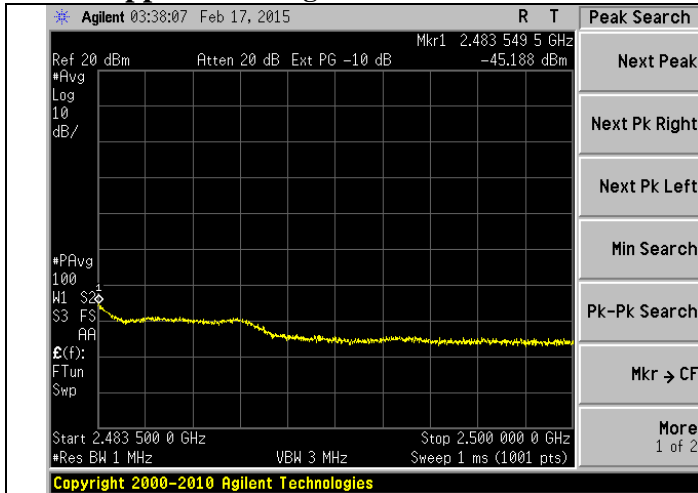
Average

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

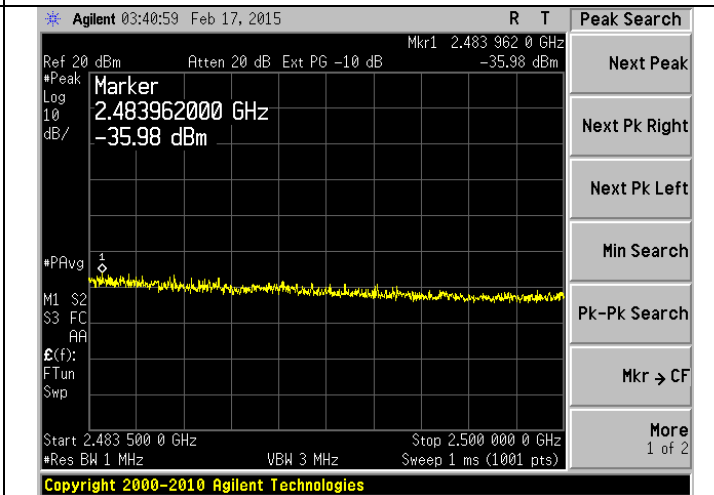
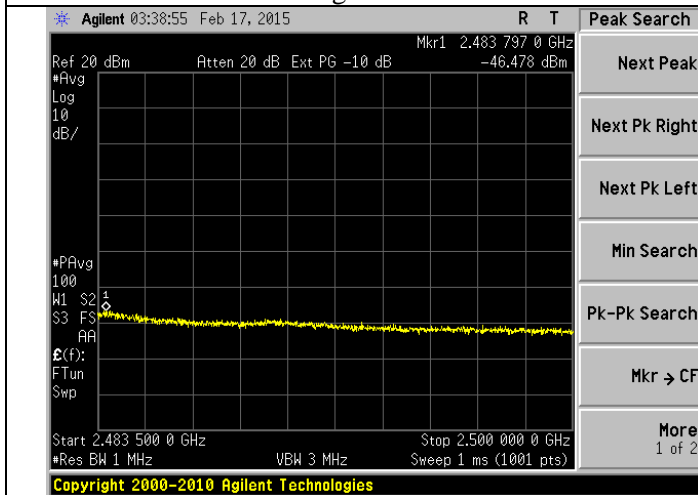
Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBμV/m)	Peak (dBμV/m)	Limit	Margin
b	1	2.4835	-39.58	2.00	95.26	57.68	74	16.3
g	6	2.4840	-35.98			61.28		12.7
n	MCS0	2.4835	-35.72			61.54		12.5

Upper Band-edge



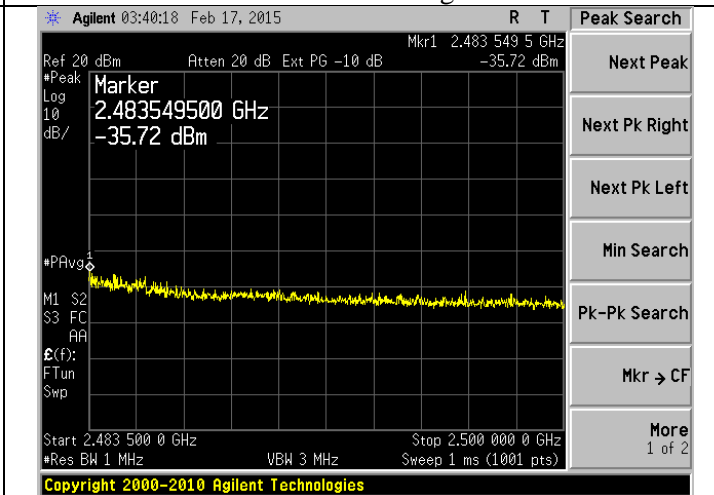
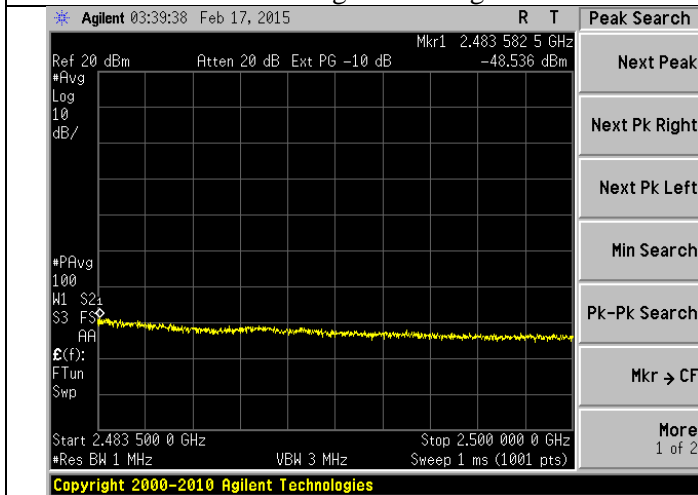
Average - 802.11b

Peak - 802.11b



Average - 802.11g

Peak - 802.11g



Average - 802.11n

Peak - 802.11n

Prepared For: LSR
 Report: TR 314413
 LSR: C-2114

Name: TiWi-C-W
 Model: TiWi-C-W
 Serial: See Section 3.1

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

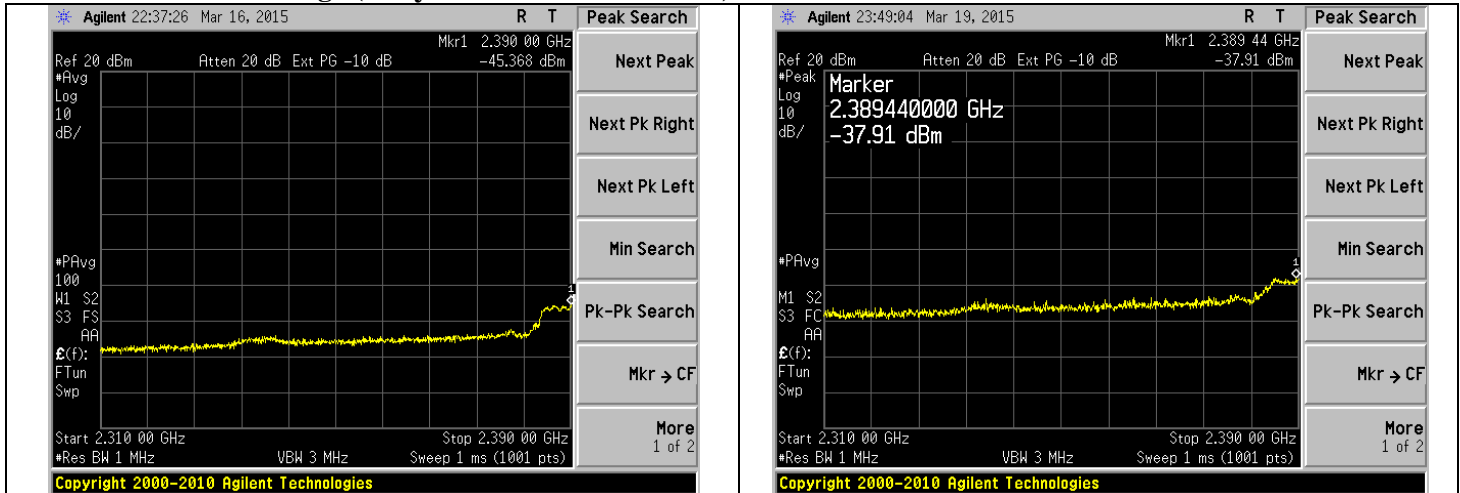
Average

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

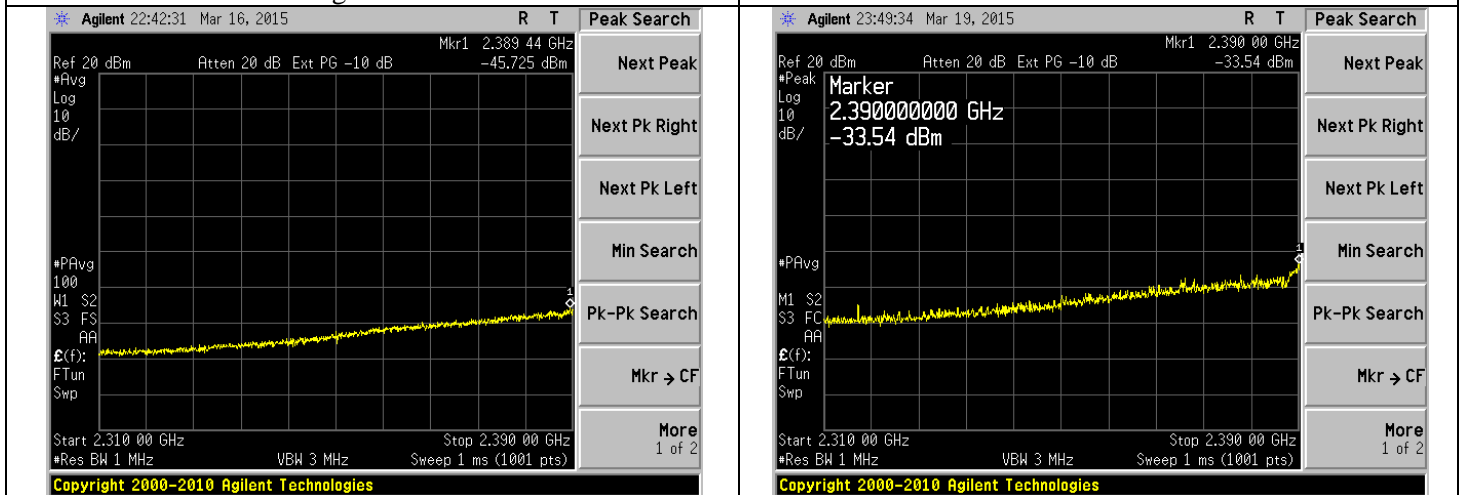
Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBm)	Antenna Gain (dBi)	Conversion to (dBμV/m)	Peak (dBμV/m)	Limit	Margin
b	1	2.38944	-37.91	2.00	95.26	59.35	74	14.7
g	6	2.39000	-33.54			63.72		10.3
n	MCS0	2.38848	-33.26			64.00		10.0

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



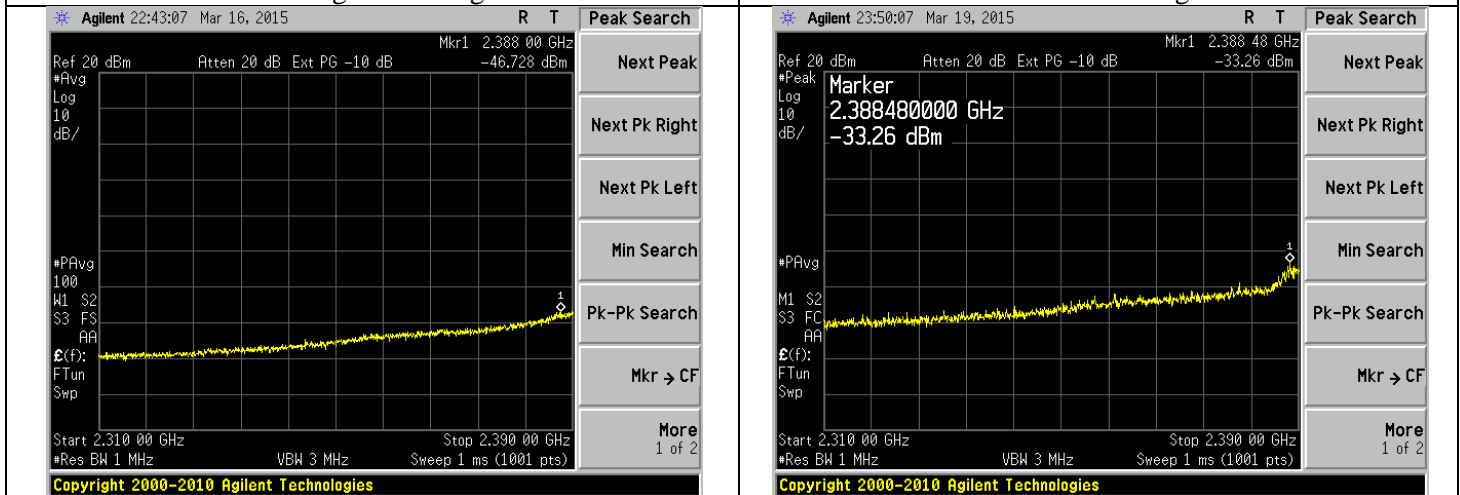
Average – 802.11b

Peak – 802.11b



Average – 802.11g

Peak – 802.11g



Average – 802.11n

Peak – 802.11n

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

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

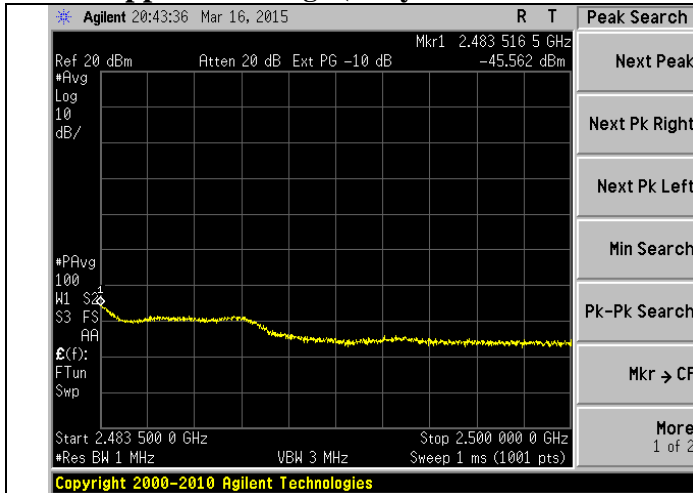
Average

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

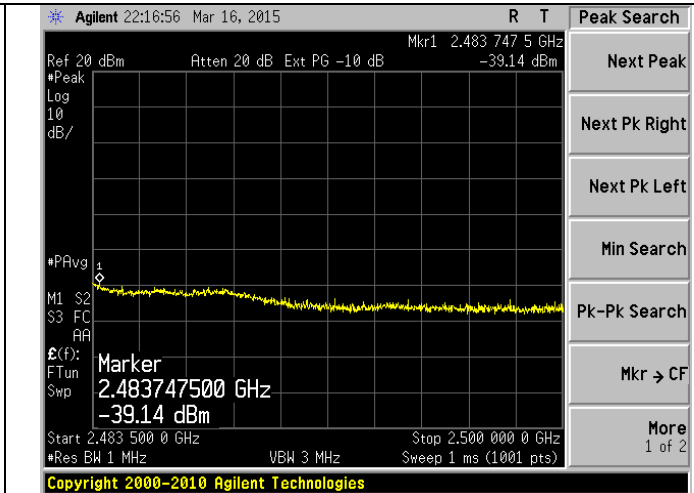
Peak

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

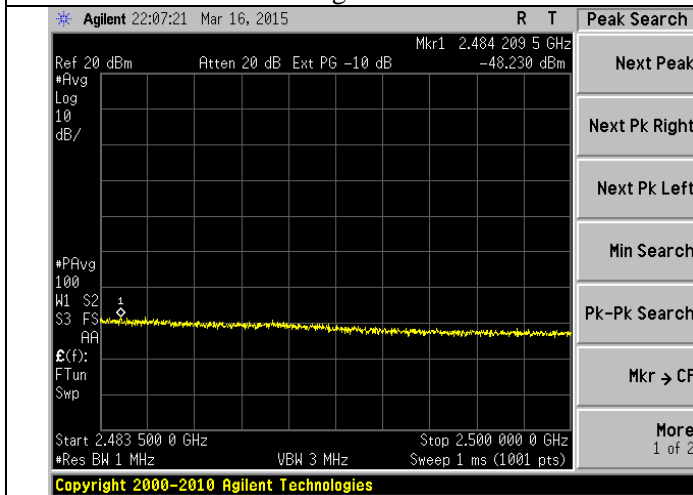
Upper Band-edge (2-layer board – Antenna 2)



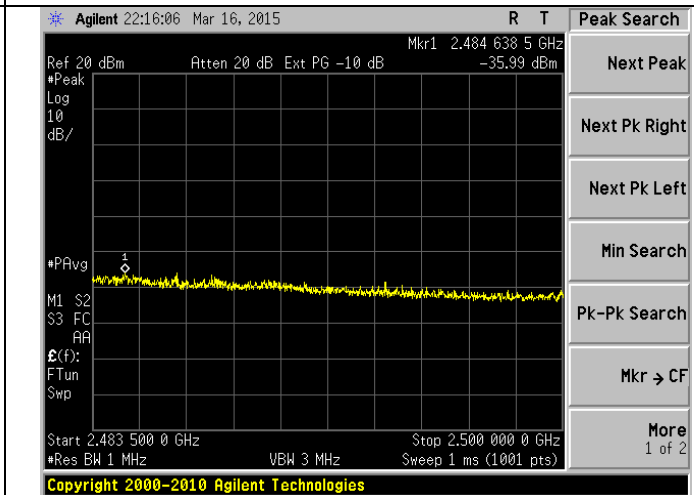
Average – 802.11b



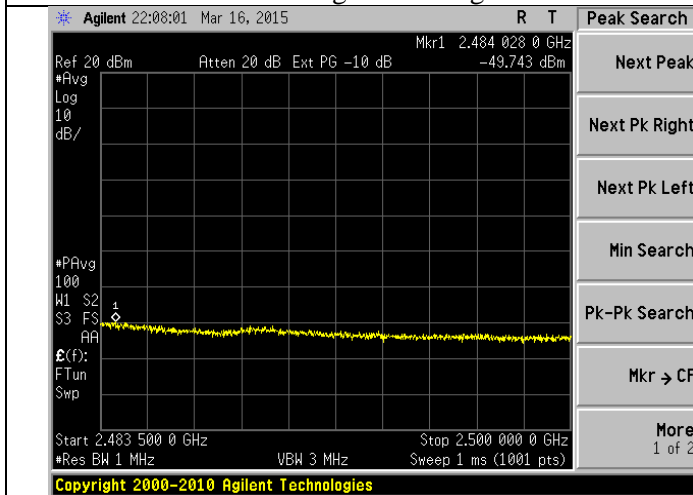
Peak – 802.11b



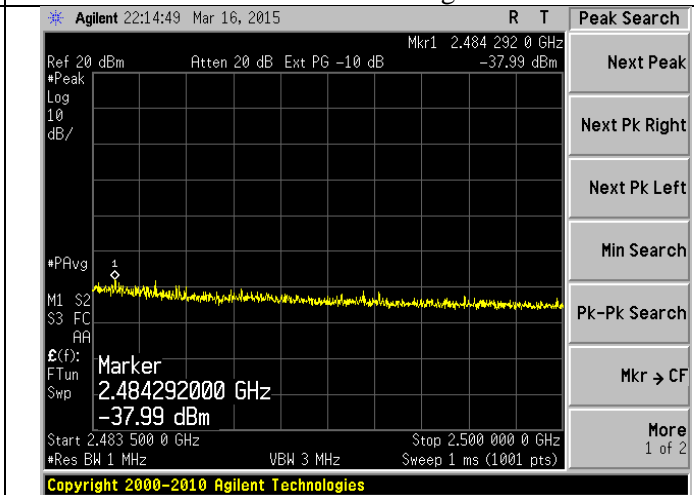
Average – 802.11g



Peak – 802.11g



Average – 802.11n



Peak – 802.11n

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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

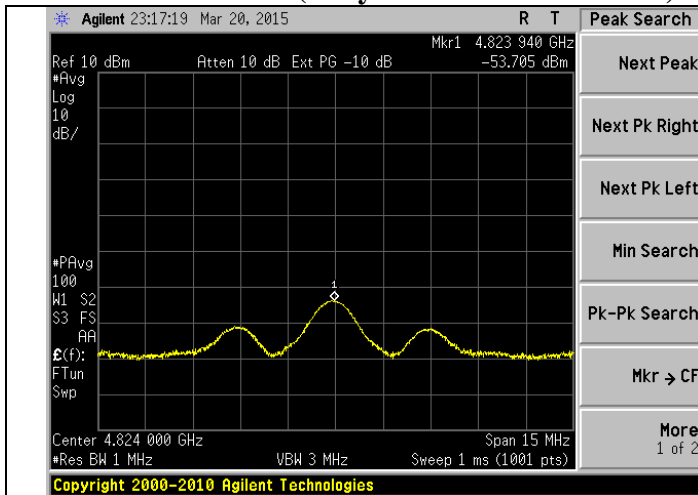
Peak

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

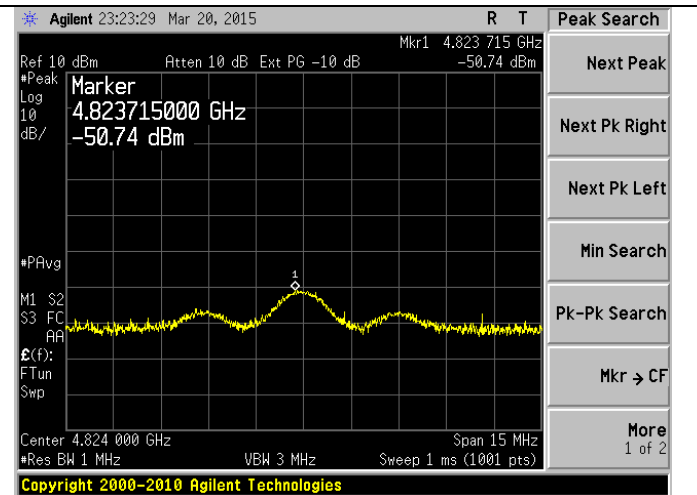
Note: Low Channel 3rd harmonic not in restricted band.

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

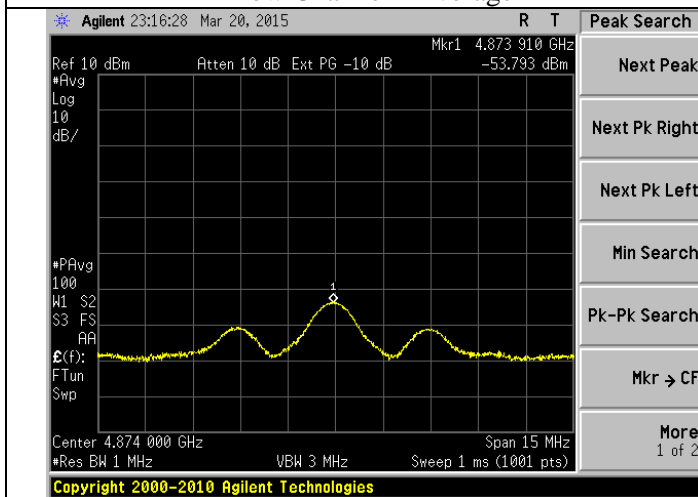
2nd Harmonic (2-layer board – Antenna 1)



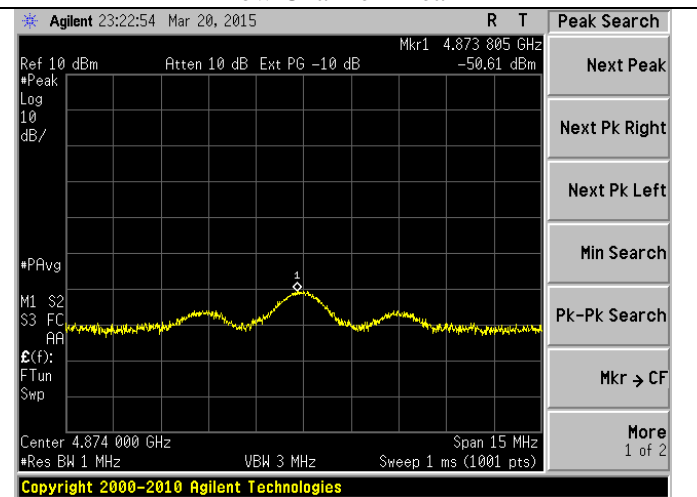
Low Channel - Average



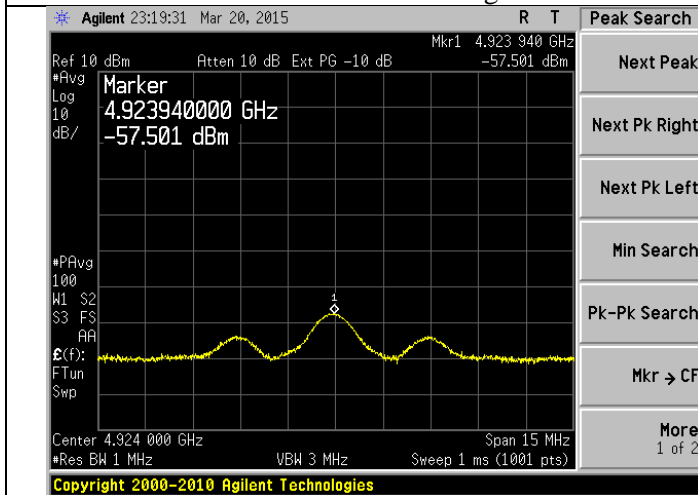
Low Channel - Peak



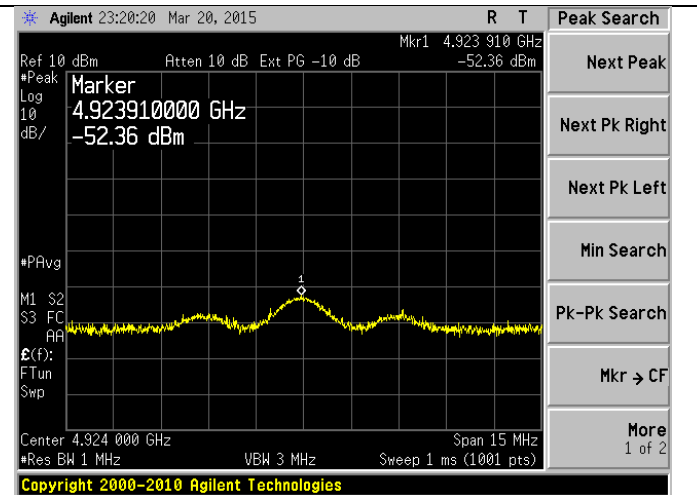
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

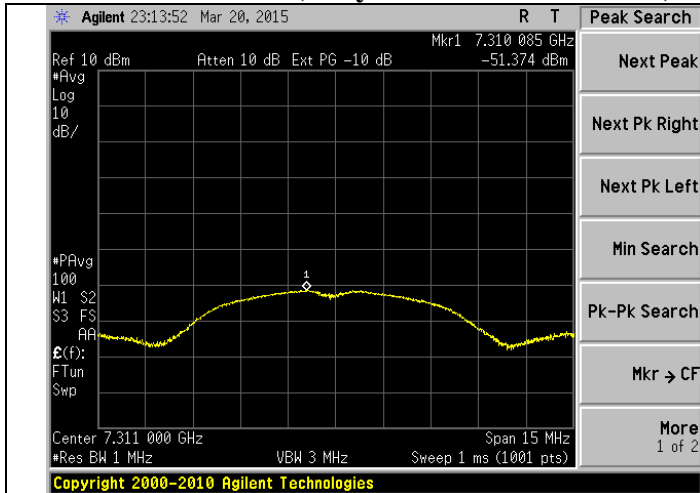
LSR: C-2114

Name: TiWi-C-W

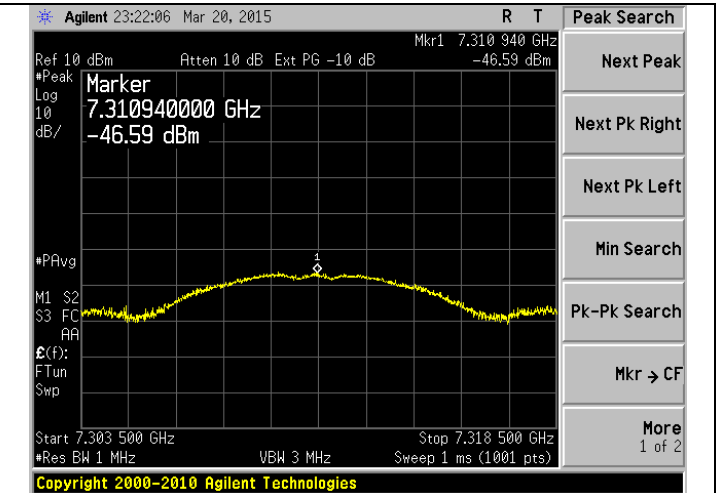
Model: TiWi-C-W

Serial: See Section 3.1

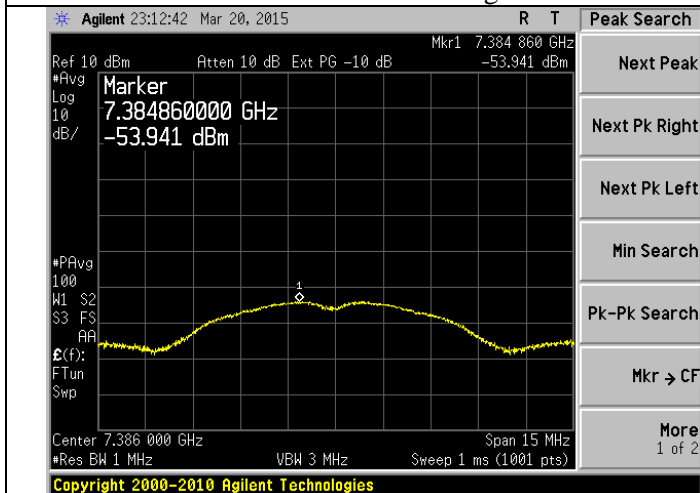
3rd Harmonic (2-layer board – Antenna 1)



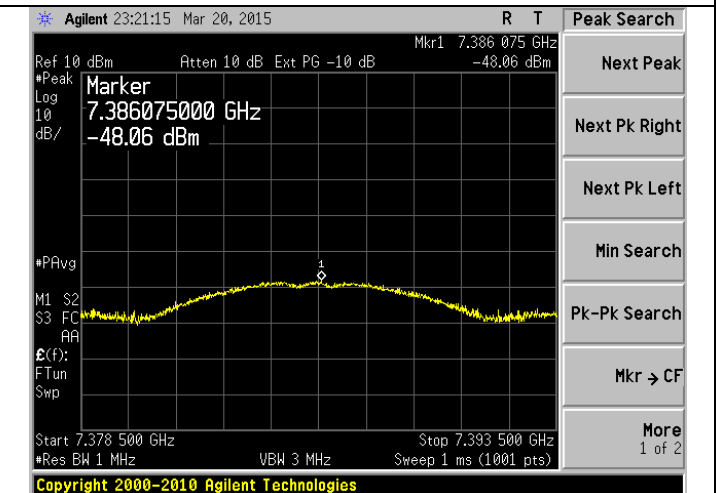
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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

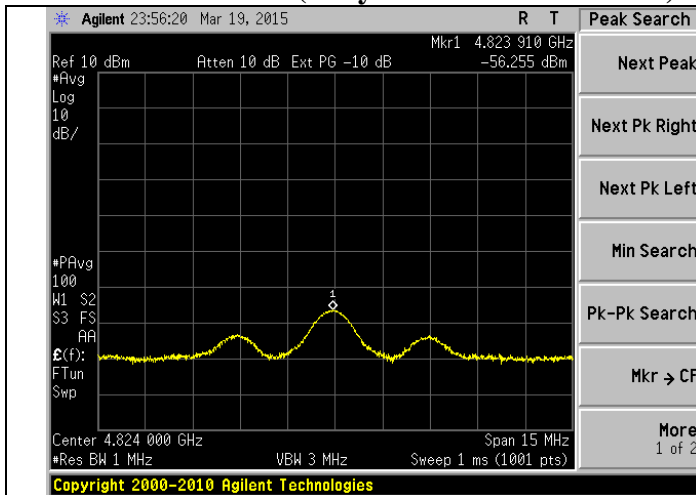
Peak

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

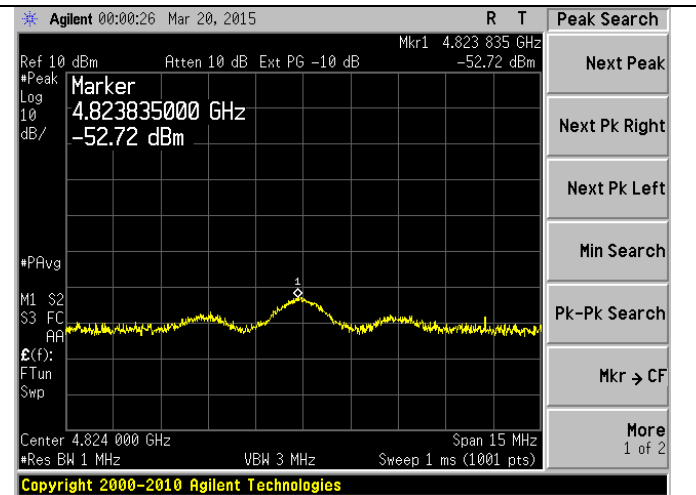
Note: Low Channel 3rd harmonic not in restricted band.

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

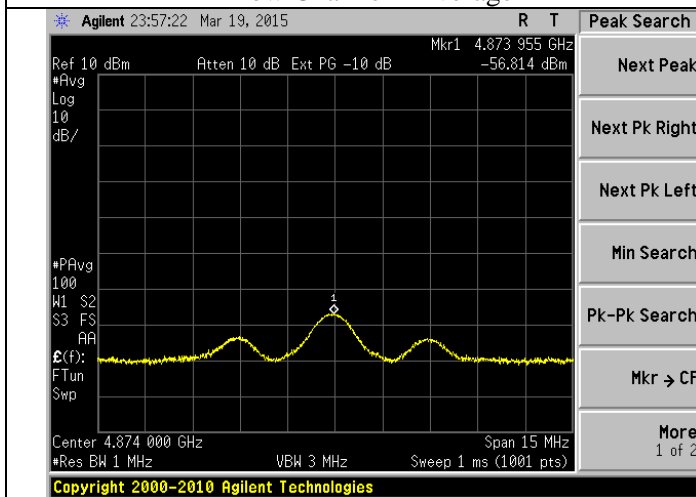
2nd Harmonic (2-layer board – Antenna 2)



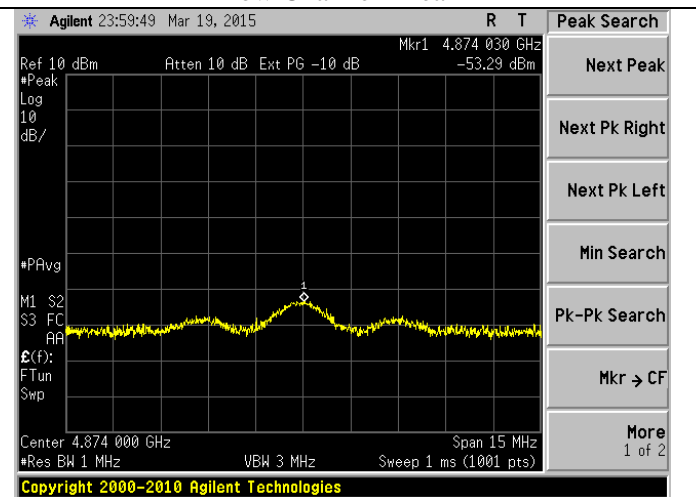
Low Channel - Average



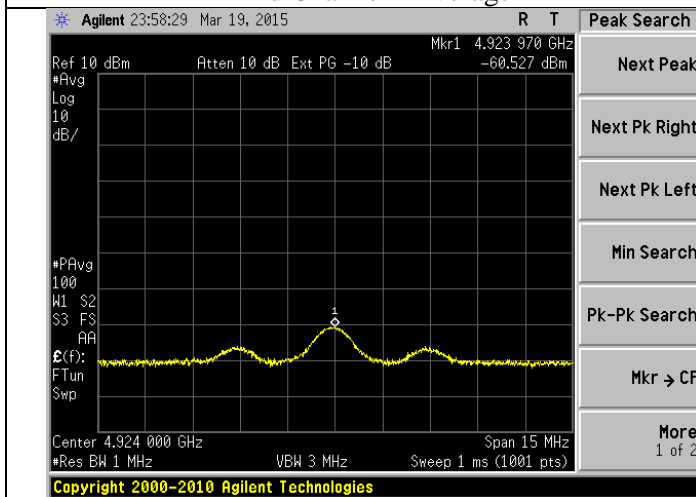
Low Channel - Peak



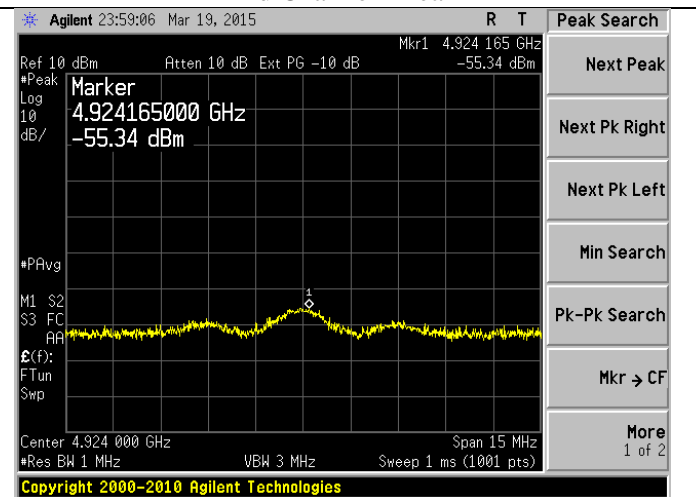
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

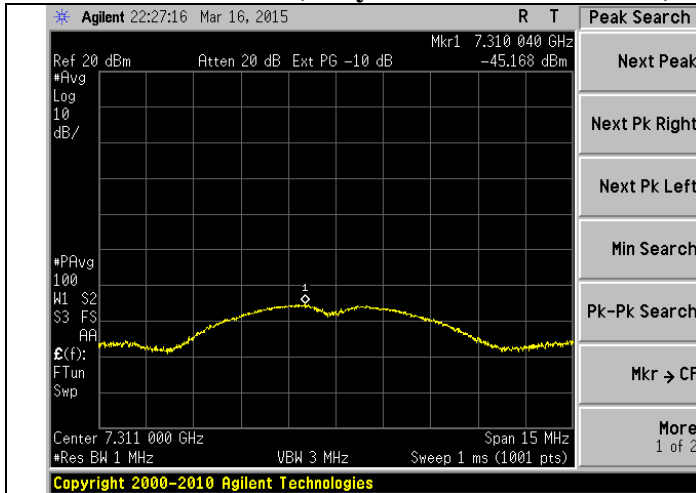
LSR: C-2114

Name: TiWi-C-W

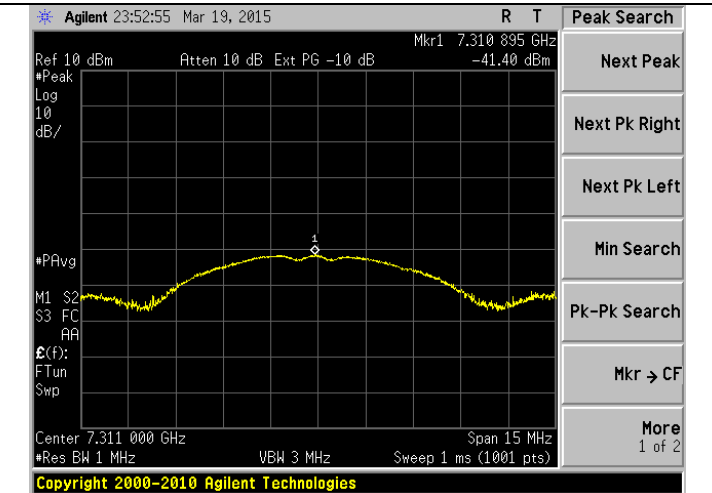
Model: TiWi-C-W

Serial: See Section 3.1

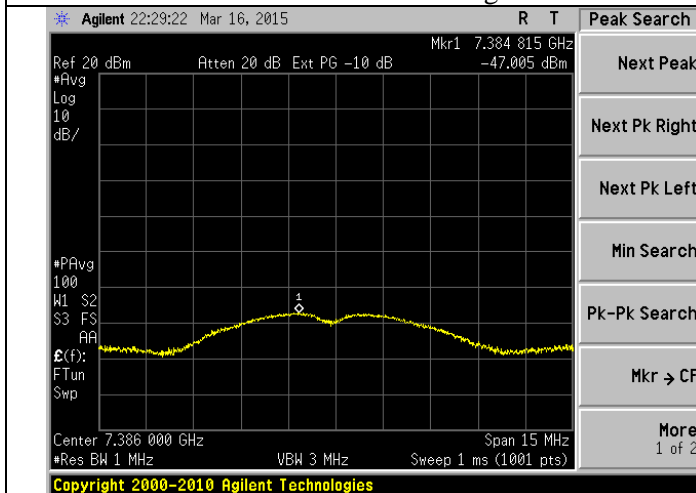
3rd Harmonic (2-layer board – Antenna 2)



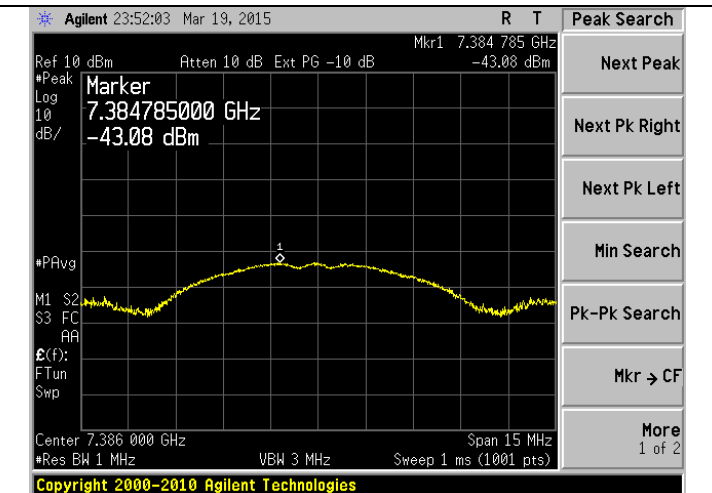
Mid Channel - Average



Mid Channel - Peak



High Channel - Average



High Channel - Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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)

$$E = \text{EIRP} - 20 \log D + 104.8$$

EIRP = measurement (dBm) + antenna gain (dBi) + ground plane reflection factor (dB)

D = specified measurement distance in meters.

$$E = (-58.36 + 2.0 + 4.7) - 20 \log (3) + 104.8$$

$$E = 43.6 \text{ dB}\mu\text{V/m (peak)}$$

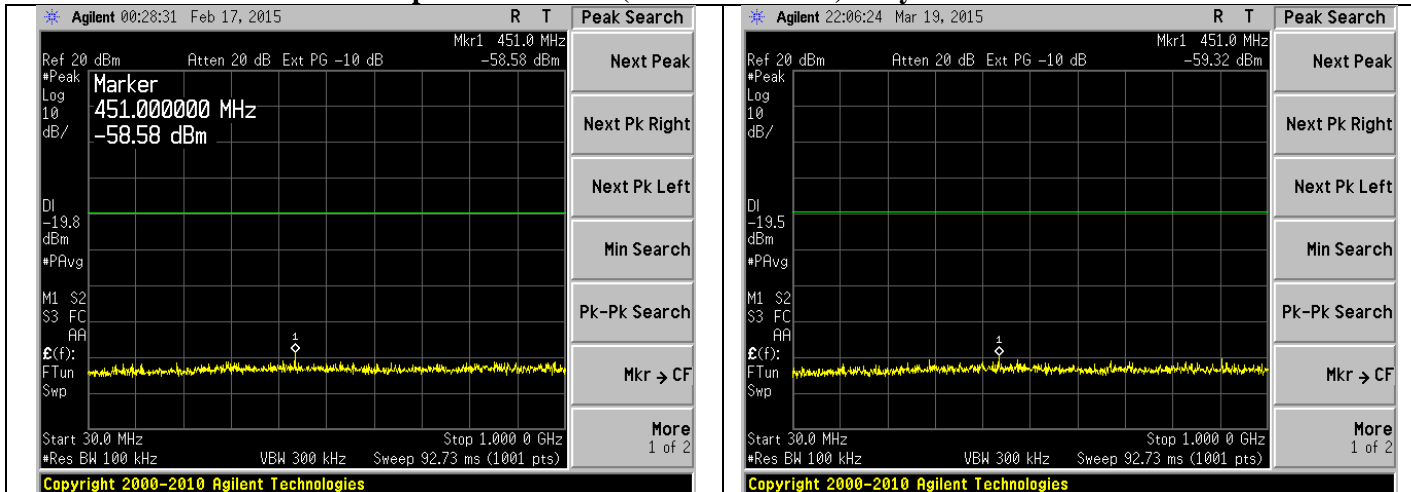
15.209 limit (Quasi-peak) @ 451 MHz = 46 dB μ V/m

$$\text{Margin} = \text{Limit} - E$$

$$\text{Margin} = 46 - 43.6 = 2.4 \text{ dB}$$

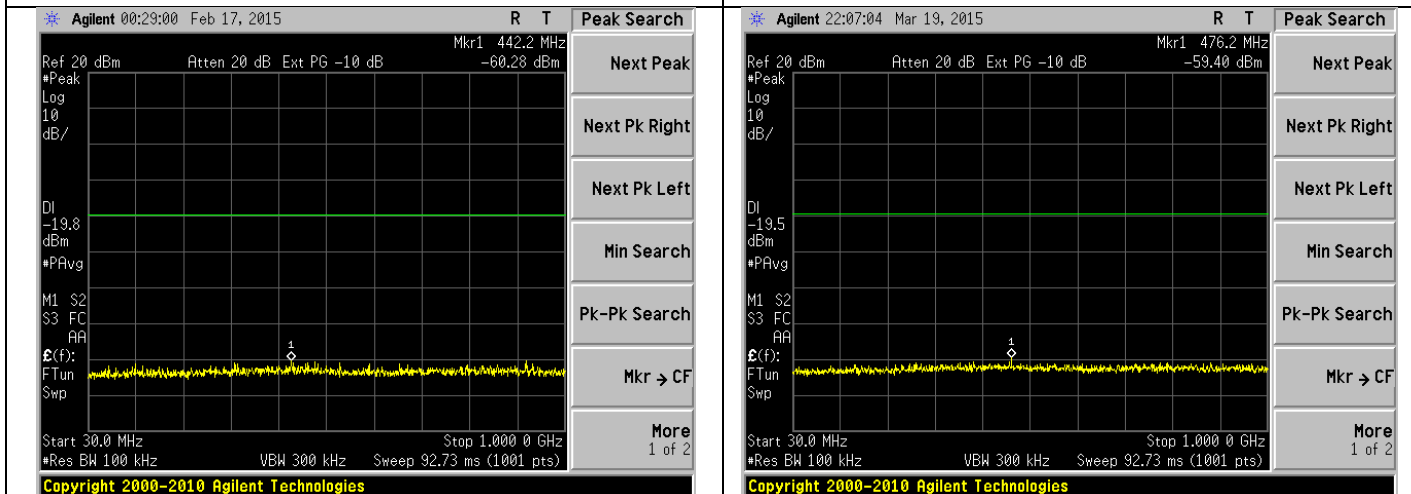
Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

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



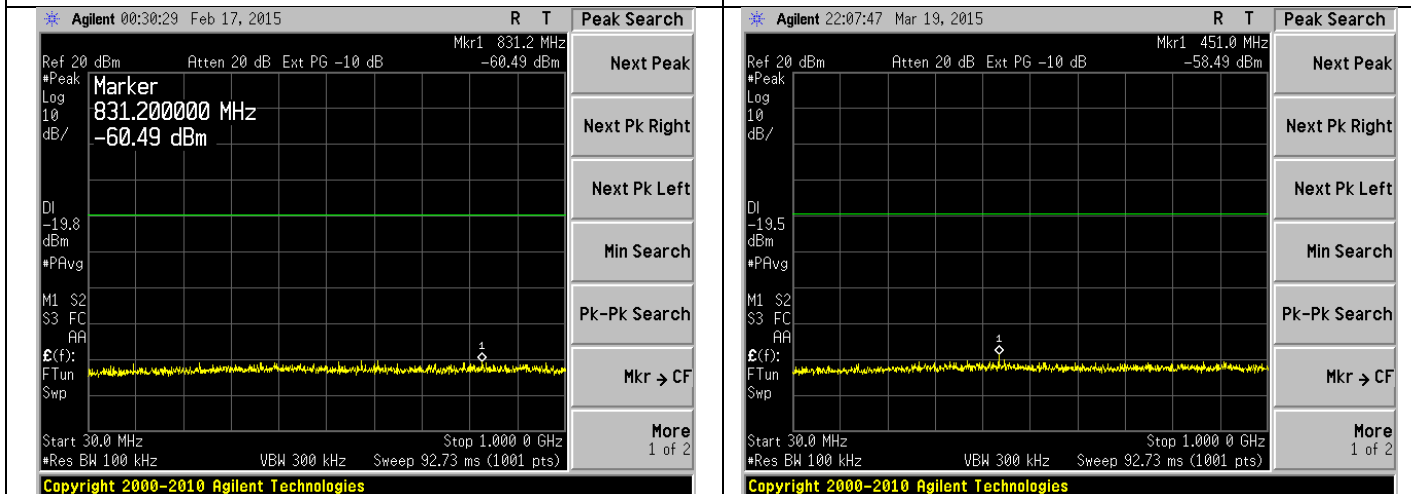
Ant 1 - Low Channel 30-1000 MHz

Ant 2 - Low Channel 30-1000 MHz



Ant 1 - Mid Channel 30-1000 MHz

Ant 2 - Mid Channel 30-1000 MHz

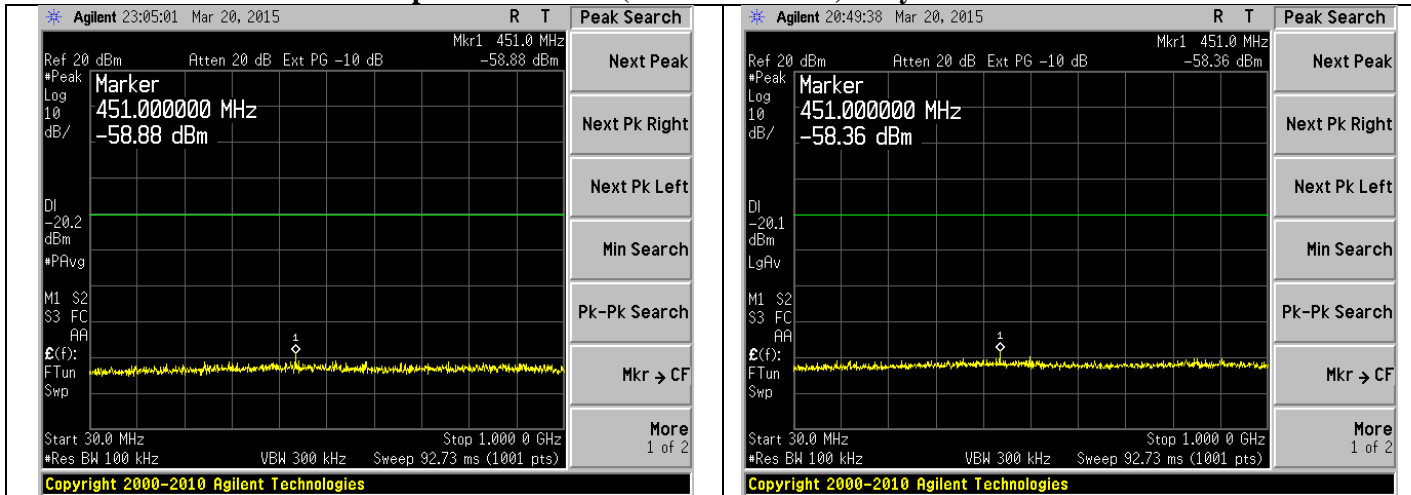


Ant 1 - High Channel 30-1000 MHz

Ant 2 - High Channel 30-1000 MHz

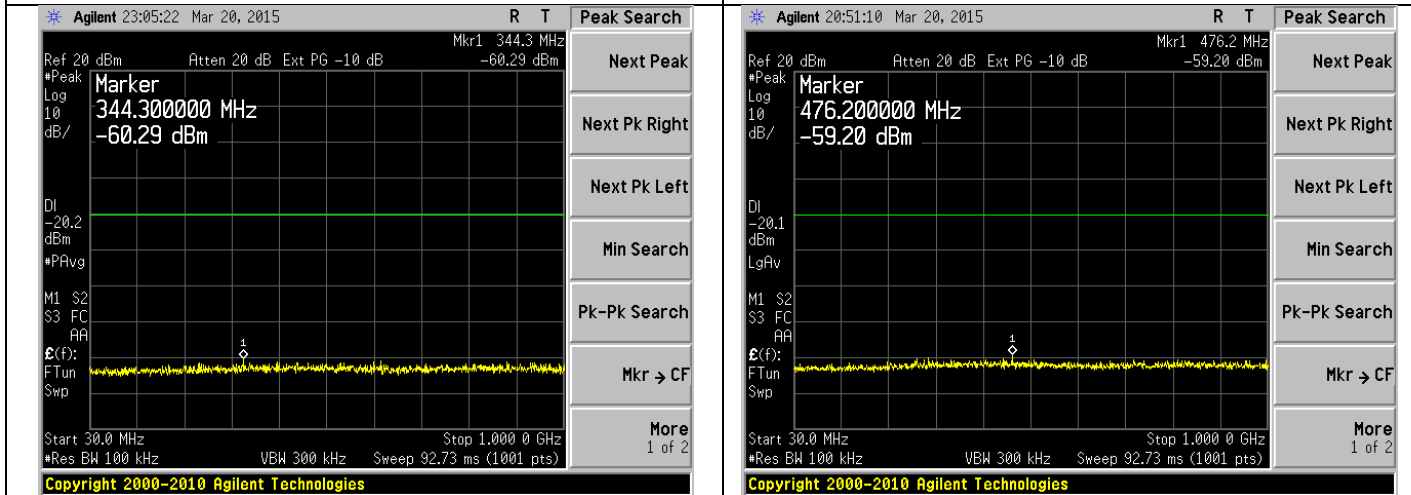
Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

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



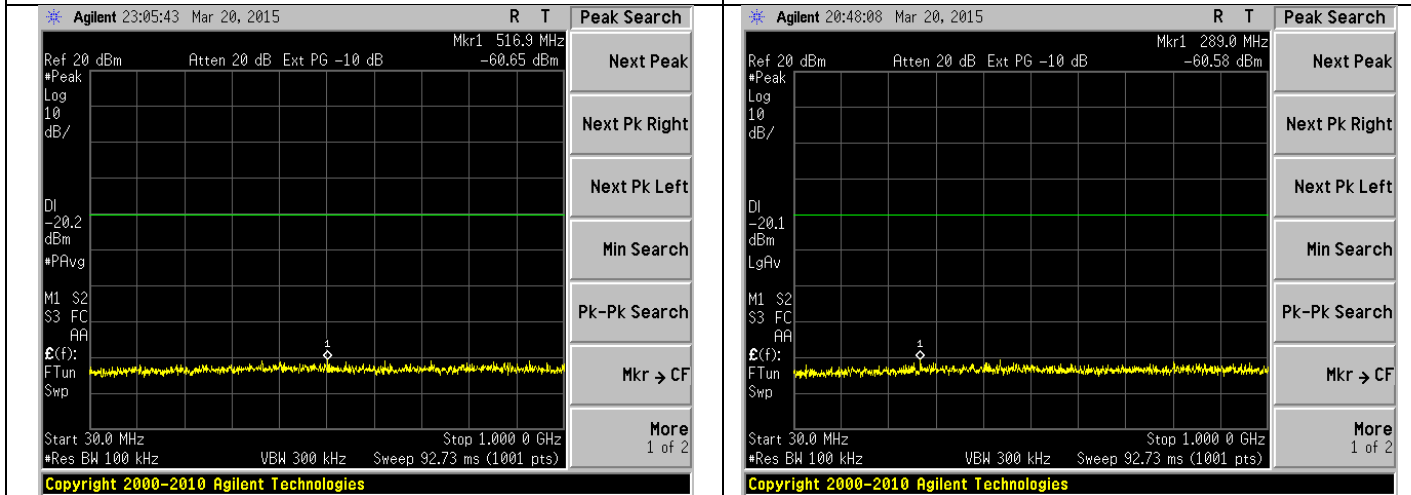
Ant 1 - Low Channel 30-1000 MHz

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

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

B.1.6 – RF Conducted – Frequency Stability

Manufacturer	LSR
Date	2-16, 3-19, 3-20 2015
Operator	Adam A
Temp. / R.H.	20 - 25° 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		FREQ DRIFT (Hz)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (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		FREQ DRIFT (Hz)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (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		FREQ DRIFT (Hz)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (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		FREQ DRIFT (Hz)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (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

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.247 / 15.205 / 15.209 IC: RSS-210 A8 / RSS-210 Section 2.2			
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 – 2009 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: 30-300 MHz	Log Periodic Dipole Array: 300-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	Standard Gain Horn: 18-26GHz
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: At least 300 kHz		1 - 40 GHz: RBW : 1MHz VBW: At least 3 (MHz) Peak 10 Hz Average	
Description of Measurement	<p>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.</p> <p>2) The EUT is placed on a non-conductive pedestal <u>made of expanded polyethylene foam</u> centered on a turn-table in the test location with the antenna at the test distance from the EUT</p> <p>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.</p>			
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 ($\mu\text{V/m}$)	3 m Limit ($\text{dB}\mu\text{V/m}$)	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)

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

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 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009 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	<ol style="list-style-type: none"> 1) Tested in the worst case of continuous transmit modulated mode based on conducted measurements with EUT rotated in three orientations. 2) EUT maximized in azimuth and antenna height with maximum results reported. 3) 4-layer and 2-layer boards tested. 4) U.FL antenna port terminated with matching 50 ohm termination tested. 5) Antenna 1 and Antenna 2 tested.

Example Calculation:

FCC 15.209 Average Limit @ 3 meter (dB μ V/m) – Average Reading (dB μ V/m) = Margin

FCC 15.209 Peak Limit @ 3 meter (dB μ V/m) – Peak Reading (dB μ V/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 (dB μ V/m)	Average Limit (dB μ V/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 (dB μ V/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

Prepared For: LSR

Name: TiWi-C-W

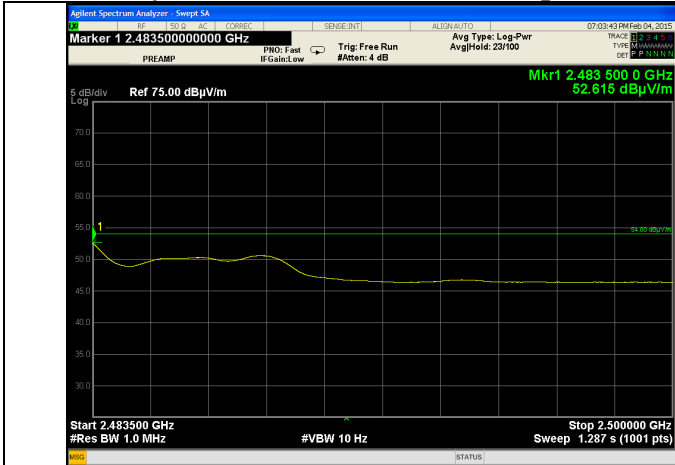
Report: TR 314413

Model: TiWi-C-W

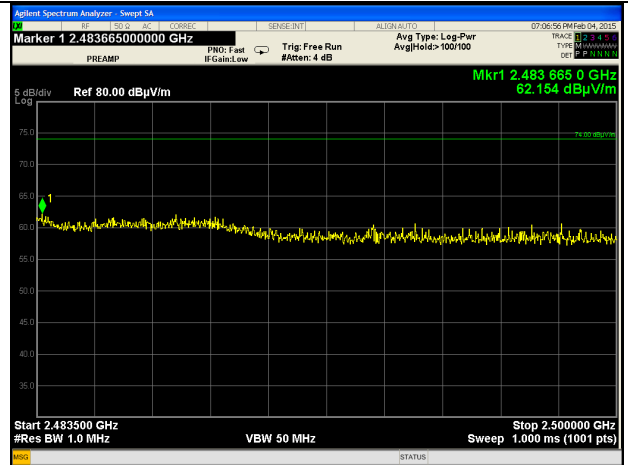
LSR: C-2114

Serial: See Section 3.1

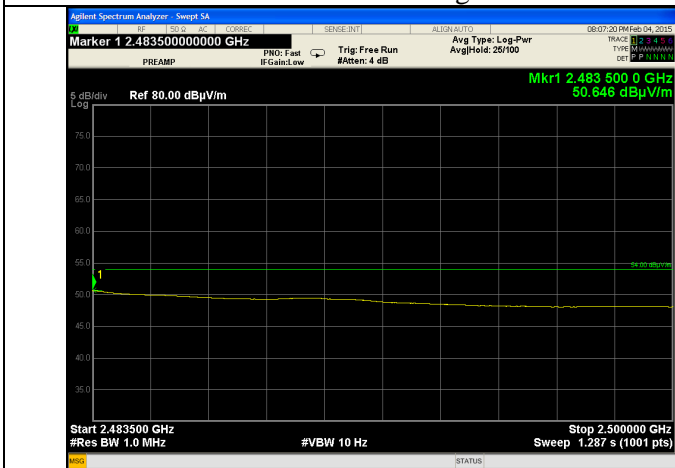
4-layer board – Antenna 1 – Chip Antenna



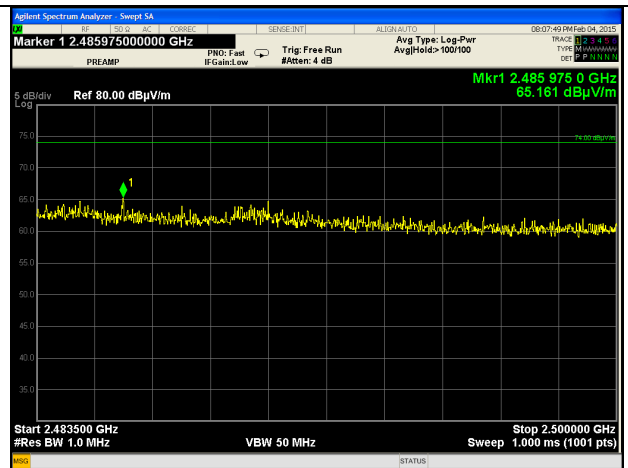
802.11b – Average



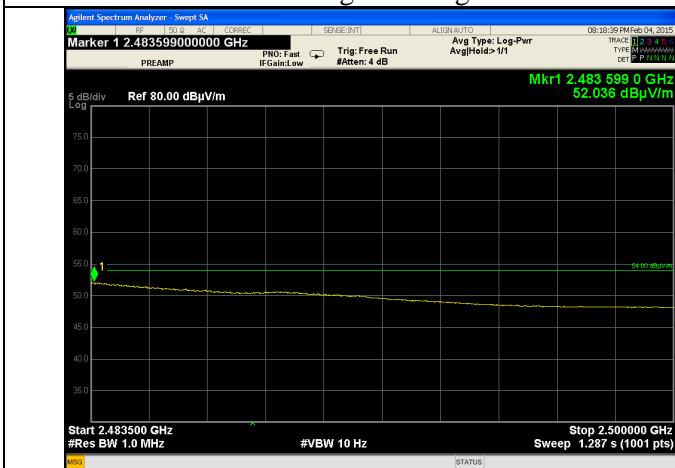
802.11b – Peak



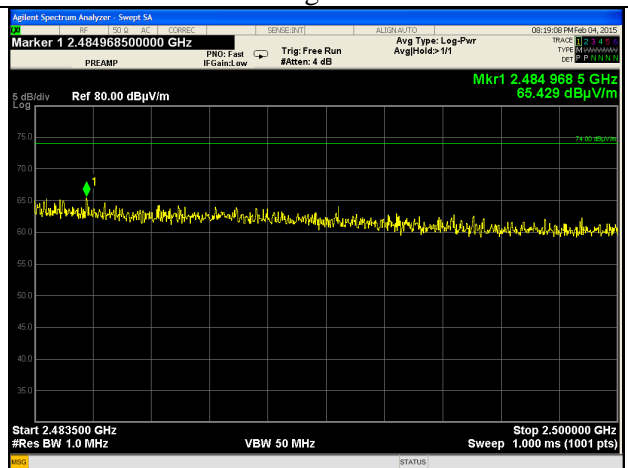
802.11g – Average



802.11g – Peak



802.11n – Average



802.11n – Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

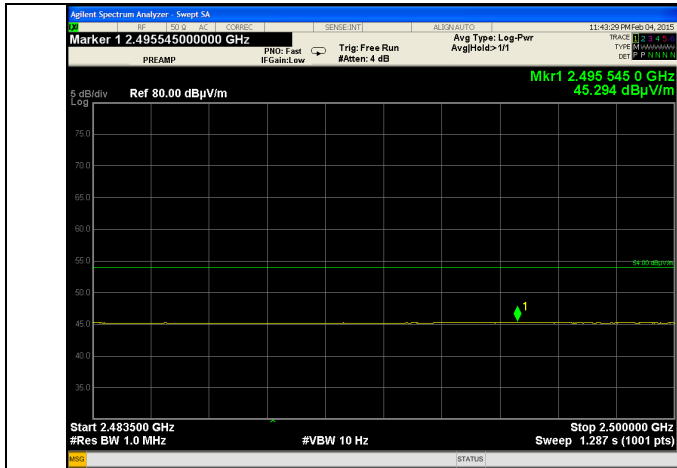
Upper Band-Edge Restricted Band - High Channel
4-layer board – Antenna 1 – u.fl port with termination
802.11b (worst case mode)

Average

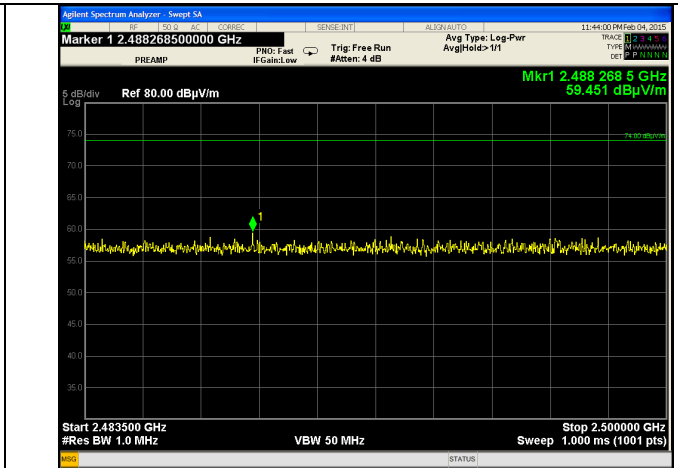
Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.495545	45.294	54	8.7

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

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

**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

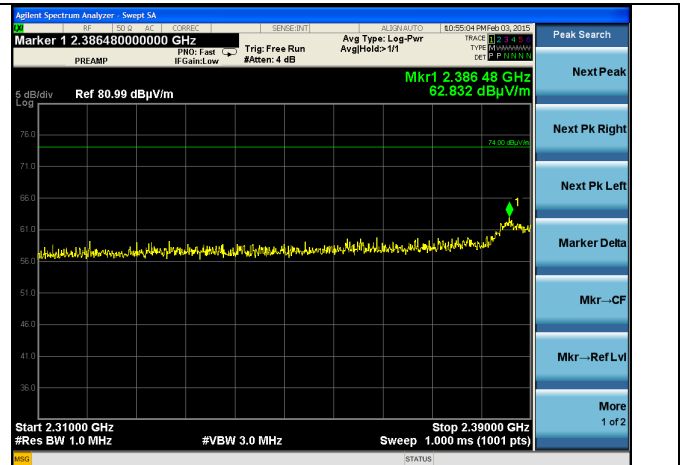
Peak

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

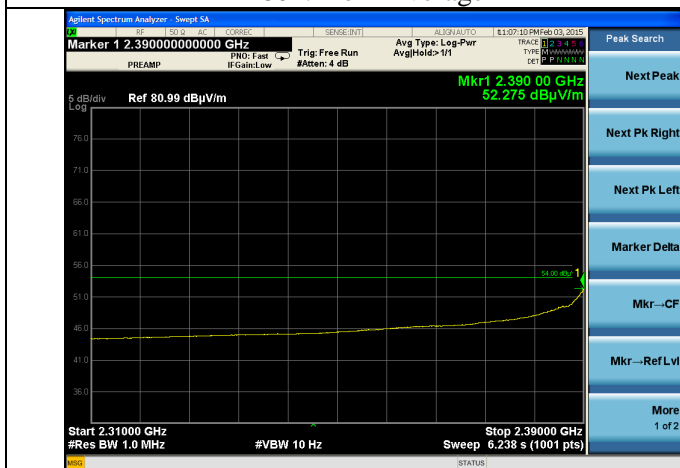
4-layer board – Antenna 1 – Chip Antenna



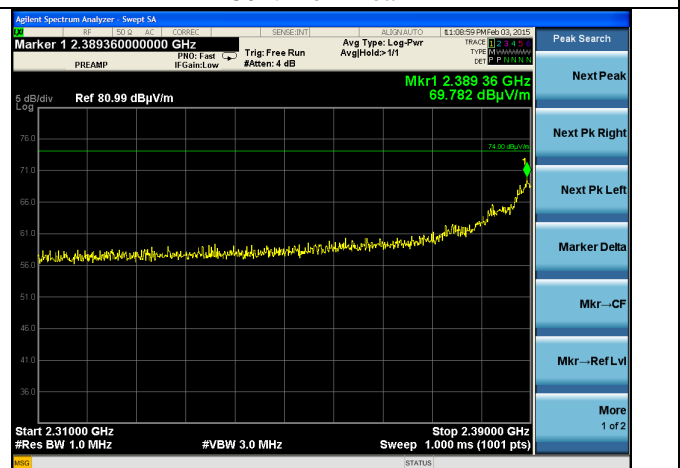
802.11b – Average



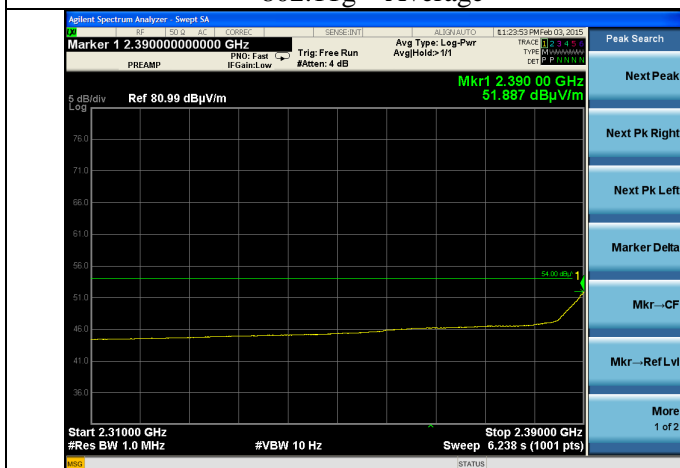
802.11b – Peak



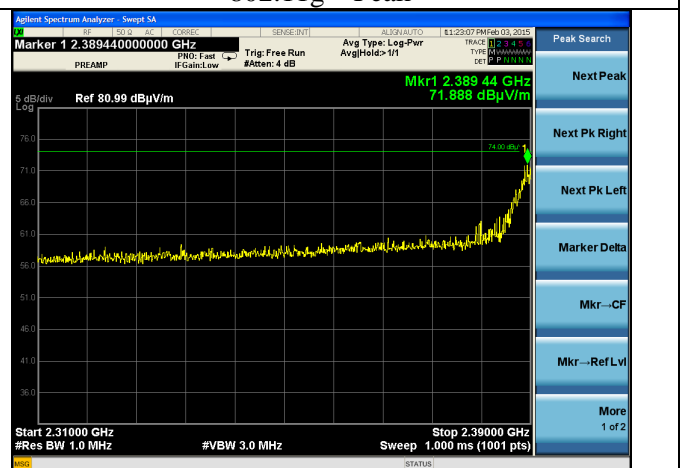
802.11g – Average



802.11g – Peak



802.11n – Average



802.11n – Peak

Prepared For: LSR
Report: TR 314413
LSR: C-2114

Name: TiWi-C-W
Model: TiWi-C-W
Serial: See Section 3.1

**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

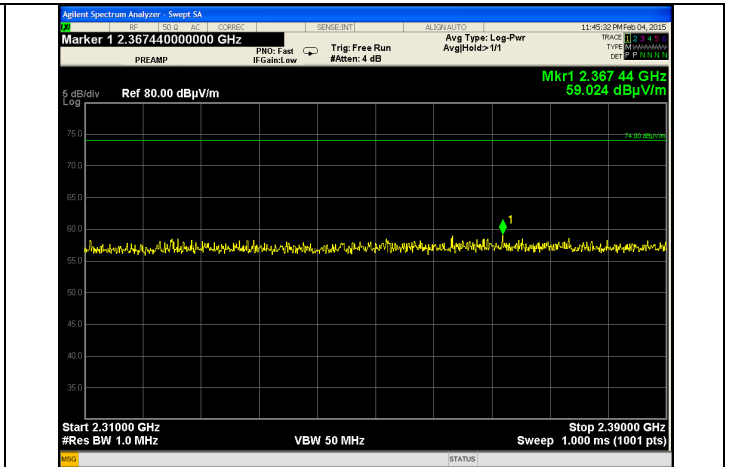
Peak

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

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

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