



**LS RESEARCH LLC**

Wireless Product Development

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TESTING CERT #1255.01

**TEST REPORT # 311362 A**  
**LSR Job #: C-1371**

Compliance Testing of:

TiWi5

Test Date(s):

January 18<sup>th</sup> to April 25<sup>th</sup> 2012

Prepared For:

Attention: Matthew Meiller  
LS Research, LLC  
W66 N220 Commerce Ct.  
Cedarburg, WI  
53012

This Test Report is issued under the Authority of:  
Khairul Aidi Zainal, Senior EMC Engineer

Signature:

Date: 5-15-12

Test Report Reviewed by:  
Shane Rismeyer, EMC Engineer

Signature:

Date: 5-15-12

Project Engineer:  
Khairul Aidi Zainal, Senior EMC Engineer.

Signature:

Date: 5-15-12

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## TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION .....	4
1.1 - Scope.....	4
1.2 – Normative References .....	4
1.3 - LS Research, LLC Test Facility .....	5
1.4 – Location of Testing.....	5
1.5 – Test Equipment Utilized .....	5
EXHIBIT 2. PERFORMANCE ASSESSMENT .....	6
2.1 – Client Information .....	6
2.2 - Equipment Under Test (EUT) Information .....	6
2.3 - Associated Antenna Description .....	6
2.4 - EUT'S Technical Specifications .....	7
2.5 - Product Description.....	8
EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS .....	9
3.1 - Climate Test Conditions.....	9
3.2 - Applicability & Summary Of EMC Emission Test Results .....	9
3.3 - Modifications Incorporated In The EUT For Compliance Purposes .....	9
3.4 - Deviations & Exclusions From Test Specifications .....	9
EXHIBIT 4. DECLARATION OF CONFORMITY .....	10
EXHIBIT 5. RADIATED EMISSIONS TEST.....	11
5.1 - Test Setup.....	11
5.2 - Test Procedure .....	11
5.3 - Test Equipment Utilized .....	12
5.4 - Test Results .....	12
5.5 - Calculation of Radiated Emissions Limits and reported data.....	13
5.6 - Radiated Emissions Test Data Chart.....	14
5.7 – Screen Captures.....	22
EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE .....	28
6.1 Test Setup.....	28
6.2 Test Procedure .....	28
6.3 Test Equipment Utilized .....	28
6.4 Test Results .....	28
EXHIBIT 7. OCCUPIED BANDWIDTH .....	32
7.1 - Limits.....	32

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

7.2 - Method of Measurements .....	32
7.3 - Test Data .....	32
7.4 – Screen Captures .....	34
EXHIBIT 8. BAND EDGE MEASUREMENTS .....	35
8.1 - Method of Measurements .....	35
8.2. Band edge captures .....	36
8.2.2.2 WLAN .....	40
EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b) .....	45
9.1 - Method of Measurements .....	45
9.2 - Test Data .....	45
9.3 – Screen Captures .....	48
EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d) .....	53
10.1 - Limits .....	53
10.2 – Conducted Harmonic And Spurious RF Measurements .....	53
Measurement procedure used was FCC OET KDB 558074 D01 section 5.4 .....	53
10.3 - Test Data .....	54
EXHIBIT 11. POWER SPECTRAL DENSITIES: 15.247(e) .....	58
11.1     Limits .....	58
Measurement procedure used was FCC OET KDB 558074 D01 section 5.3.1 .....	58
11.2     Test Data .....	58
11.3     Screen Captures – Power Spectral Density .....	61
EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS .....	66
EXHIBIT 13. MPE CALCULATIONS .....	67
13.1 2400 to 2483.5 MHz Band .....	67
13.2 5725 to 5850 MHz Band .....	68
APPENDIX A – Test Equipment List .....	69
APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO .....	70
APPENDIX C - Uncertainty Statement .....	71

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 1. INTRODUCTION

### 1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 RSS GEN issue 3 and RSS 210 issue 8 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	FCC KDB 558074 D01 DTS Measurement Guidance v01
Environmental Classification:	Commercial, Industrial or Business Residential

### 1.2 - Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2012	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Measurement Guidance v01	2012	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## **1.3 - LS Research, LLC Test Facility**

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) as conforming to 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. Accreditation status can be verified at A2LA's web site: [www.a2la2.net](http://www.a2la2.net).

## **1.4 – Location of Testing**

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

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

List of Facilities Located at LS Research, LLC:

Compact Chamber  
Semi-Anechoic Chamber  
Open Area Test Site (OATS)

## **1.5 – Test Equipment Utilized**

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1 - Client Information

Manufacturer Name:	LS Research, LLC
Address:	W66 N220 Commerce Ct. Cedarburg, WI 53012
Contact Name:	Matt Meiller

### 2.2 - Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	TiWi5
Model Number:	TiWi5
Serial Number:	Conducted Measurements: SN051201 Radiated Measurements: SN361116, SN081201, SN051205, SN011201

### 2.3 - Associated Antenna Description

There are two types antenna associated with the EUT:

1. A dual-band sleeve dipole antenna with a peak gain of 2.0 dBi in the 2.4GHz and 5.0GHz band.
2. A Johanson Technology dual-band ceramic chip antenna with a peak gain of 1.0dBi in the 2.4GHz and -1.5 dBi in the 5GHz band.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	2402MHz – 2480MHz (BLE) 2412MHz – 2462MHz (WLAN) 5745MHz – 5825 MHz (WLAN 5.8GHz)
RF Power in Watts (Conducted measurement)	
Minimum:	2.4GHz WLAN: 0.0575 5.8GHz WLAN: 0.0339 Bluetooth LE: 0.0085
Maximum:	2.4GHz WLAN: 0.1585 5.8GHz WLAN: 0.1148 Bluetooth LE: 0.0089
Max Conducted Output Power (in dBm)	2.4GHz WLAN: 22.0 5.8GHz WLAN: 20.6 Bluetooth LE: 9.5
Field Strength at 3 meters (Maximum)	Not Applicable
Occupied Bandwidth (99% BW)	2.4GHz WLAN: 17.6 MHz 5.8GHz WLAN: 17.8 MHz Bluetooth LE: 1.04 MHz
Type of Modulation	GFSK,OFDM,DSSS
Occupied Bandwidth (6% BW)	WLAN: 17.6 MHz Bluetooth LE: 679kHz
Transmitter Spurious (worst case) at 3 meters	51.26 dB $\mu$ V/m at 14472 MHz
Stepped (Y/N)	N
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100 ppm
Transceiver Model # (if applicable)	WL1273L
Antenna Information	
Detachable/non-detachable	Non-detachable and detachable
Type	Dual band Sleeve Dipole and Ceramic Chip antenna
Gain (From data sheet)	Dipole: 2.4GHz and 5.8GHz: 2.0dBi Chip antenna: 2.4GHz: 1.0dBi 5.8GHz: -1.5dBi
EUT will be operated under FCC Rule Part(s)	Title 47 part 15.247
EUT will be operated under RSS Rule Part(s)	RSS 210
Modular Filing	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
Portable or Mobile?	Mobile

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

**RF Technical Information:**

Type of Evaluation (check one)	SAR Evaluation: Device Used in the Vicinity of the Human Head
	SAR Evaluation: Body-worn Device
	X RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits:  General Public Use  Controlled Use

Duty Cycle used in evaluation: 100 %

Standard used for evaluation: OET 65

Measurement Distance: 20 cm

2400 to 2483.5 MHz Band

RF Value: 0.4997  V/m  A/m  W/m<sup>2</sup>  
 Measured  Computed  Calculated

5745 to 5850 MHz Band

RF Value: 0.3620  V/m  A/m  W/m<sup>2</sup>  
 Measured  Computed  Calculated

## **2.5 - Product Description**

The TIWI5 module is a multi-standard module with support for WLAN (802.11 a/b/g/n), Bluetooth 2.1+EDR and Bluetooth 4.0 (LE).

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

### 3.1 - Climate Test Conditions

Temperature:	70 -71° F
Humidity:	32-42%
Pressure:	728-741mmHg

### 3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247 (a)(1) IC : RSS 210 A8.1 (a)	20 dB Bandwidth	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(2) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	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

The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices (RSS GEN and RSS 210 of IC) and the associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.

### 3.3 - Modifications Incorporated In The EUT For Compliance Purposes

None       Yes (explain below)

### 3.4 - Deviations & Exclusions From Test Specifications

None       Yes (explain below)

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 4. DECLARATION OF CONFORMITY

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

*Note: 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.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 5. RADIATED EMISSIONS TEST

### 5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in continuous transmit mode for final testing using power as provided by a bench DC power supply. The unit has the capability to operate on 3 channels, controllable via instructions on:

1. Trioscope for WLAN mode
2. Proprietary LS Research Bluetooth programming tool for Bluetooth LE mode.

The applicable limits apply at a 3 meter distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels to comply with FCC Part 15.31(m).

### 5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 25000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 18 GHz while a standard gain horn antenna was used in the 18 GHz to 25 GHz range. The maximum radiated RF emissions between 30MHz to 4 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities. Between 4GHz to 25GHz, the sense antenna was raised and lowered between 1 and 1.8 meters in height.

The EUT was positioned in 3 orthogonal orientations.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### **5.3 - Test Equipment Utilized**

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at a calibration laboratory accredited to ISO 17025, and are traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz).

### **5.4 - Test Results**

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 8 (2010), Annex 8 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## **5.5 - Calculation of Radiated Emissions Limits and reported data.**

### **Reported data:**

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

**Reported Measurement data = Raw receiver measurement (dB $\mu$ V/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).**

### **Generic example of reported data at 200 MHz:**

**Reported Measurement data = 18.2 (raw receiver measurement ) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dB $\mu$ V/m).**

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

Frequency (MHz)	3 m Limit $\mu$ V/m	3 m Limit (dB $\mu$ V/m)	1 m Limit (dB $\mu$ V/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-40,000	500	54.0	63.5

Sample conversion of field strength ( $\mu$ V/m to dB $\mu$ V/m):  
dB $\mu$ V/m = 20 log<sub>10</sub> (100) = 40 dB $\mu$ V/m (from 30-88 MHz)

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 5.6 - Radiated Emissions Test Data Chart

Manufacturer:	LS Research LLC				
Date(s) of Test:	January 18 <sup>th</sup> to April 25 <sup>th</sup> 2012				
Project Engineer(s):	Khairul Aidi Zainal				
Test Engineer(s):	Khairul Aidi Zainal, Peter Feilen, Mike Hintzke and Shane Rismeyer				
Voltage:	3.6 VDC				
Operation Mode:	continuous transmit, modulated				
Environmental Conditions in the Lab:	Temperature: 70° F Relative Humidity: 32%				
EUT Power:	Single Phase 120VAC			3 Phase ____VAC	
	Battery			X	Other: Bench DC Supply
EUT Placement:	X	80cm non-conductive pedestal		10cm Spacers	
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS	
Measurements:	Pre-Compliance			Preliminary	X Final
Detectors Used:	X	Peak		X Quasi-Peak	X Average

Emissions that are present but not a function of the transmitter:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Quasi Peak Reading (dB $\mu$ V/m)	Average Reading (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity
374.6	1.00	154.9	29.16	23.31	16.13	46.0	22.7	V
166.4	1.37	113.6	34.58	25.21	15.67	43.0	17.8	H
160.0	1.00	131.7	33.44	31.25	29.37	43.0	11.8	V
55.3	1.00	111.1	36.51	33.32	26.04	40.0	6.7	V
67.7	1.00	121.3	33.3	29.87	22.9	40.0	10.1	V

Notes:

1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## RADIATED EMISSIONS DATA CHART (continued)

### 5.6.1 Chip antenna

#### 5.6.1.1 Bluetooth LE

The following table depicts the level of radiated emissions of channel 2402 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4804	1.00	44	60.5	58.1	63.5	5.4	Vertical	Vertical
12010	1.00	314	58.5	45.3	63.5	18.2	Horizontal	Vertical
19216	1.00	304	57.2	44.9	63.5	18.6	Vertical	Vertical

The following table depicts the level of significant radiated emissions of channel 2440 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1.08	162	67.5	54.0	63.5	9.5	Horizontal	Vertical
7320	1.00	32	58.0	51.8	63.5	11.7	Horizontal	Vertical
12200	1.00	312	66.2	52.1	63.5	11.4	Horizontal	Vertical
19520	1.00	28	56.9	43.0	63.5	20.6	Horizontal	Side

The following table depicts the level of significant radiated emissions of channel 2480 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.00	37	70.9	56.6	63.5	6.9	Vertical	Flat
7440	1.04	35	58.7	47.3	63.5	16.2	Horizontal	Vertical
12400	1.07	326	67.7	52.7	63.5	10.8	Vertical	Flat
19840	1.00	36	54.0	41.1	63.5	22.4	Horizontal	Side
22320	1.00	327	50.6	37.9	63.5	25.6	Vertical	Vertical

**Notes:**

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 5.6.1.2 2.4GHz WLAN

The following table depicts the level of radiated emissions of channel 2412 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4824	1.00	84.4	58.6	55.2	63.5	8.3	Horizontal	Flat
12060	1.08	4.5	55.7	49.2	63.5	14.3	Vertical	Side
14472	1.00	29.2	64.1	60.8	63.5	2.7	Vertical	Side
19296	1.00	293	52.6	44.4	63.5	19.1	Vertical	Vertical

The following table depicts the level of significant radiated emissions of channel 2437 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4884	1.01	72	57.4	55.0	63.5	8.5	Vertical	Side
7326	1.00	13	51.6	42.5	63.5	21.0	Vertical	Vertical
12210	1.00	341	60.6	54.5	63.5	9.0	Vertical	Vertical
19536	1.00	70	55.4	47.6	63.5	15.9	Vertical	Vertical

The following table depicts the level of significant radiated emissions of channel 2462 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4924	1.00	85	56.9	54.3	63.5	9.2	Vertical	Side
7386	1.03	22	52.4	43.6	63.5	19.9	Vertical	Vertical
12310	1.00	352	57.8	51.0	63.5	12.5	Vertical	Vertical
19696	1.00	70	52.8	44.8	63.5	18.7	Vertical	Vertical
22158	1.00	335	52.4	41.6	63.5	21.9	Vertical	Vertical

*Notes:*

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 5.6.1.3 5.7GHz WLAN

The following table depicts the level of radiated emissions of channel 5745 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11490	1	138	61.1	57.5	63.5	6.1	Vertical	Flat
22980	1	290	55.7	48.6	63.5	14.9	Vertical	Side

The following table depicts the level of significant radiated emissions of channel 5785 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11570	1	138.5	61.0	57.7	63.5	5.8	Vertical	Flat

The following table depicts the level of significant radiated emissions of channel 5825 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11650	1	135.8	60.2	56.5	63.5	7.0	Vertical	Flat

**Notes:**

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 5.6.2 Dipole antenna

### 5.6.2.1 Bluetooth LE

The following table depicts the level of radiated emissions of channel 2402 MHz in the restricted band:

Dipole Bent:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4804	1.03	242	60.0	43.7	63.5	19.8	Vertical	Flat
12010	1.18	0	57.0	48.8	63.5	14.7	Vertical	Vertical

Dipole Straight:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4804	1.03	226	58.5	41.2	63.5	22.3	Vertical	Vertical
12010	1	320	55.5	39.0	63.5	24.6	Horizontal	Side

The following table depicts the level of significant radiated emissions of channel 2440 MHz in the restricted band:

Dipole Bent:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1	271	59.1	41.3	63.5	22.2	Vertical	Side
7320	1.05	140	56.9	43.9	63.5	19.6	Vertical	Flat
12200	1.19	4	61.3	47.3	63.5	16.2	Vertical	Vertical

Dipole Straight:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1	188	62.7	42.3	63.5	21.2	Horizontal	Side
7320	1	121	56.3	46.7	63.5	16.8	Horizontal	Side
12200	1	351	64.1	48.3	63.5	15.2	Horizontal	Flat

Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

The following table depicts the level of significant radiated emissions of channel 2480 MHz in the restricted band:

Dipole Bent:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1.23	264	55.0	38.8	63.5	24.7	Vertical	Side
7440	1	245	53.1	38.2	63.5	25.4	Horizontal	Flat
12400	1.1	22	58.2	40.4	63.5	23.1	Horizontal	Side

Dipole Straight:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4960	1	223	60.8	40.5	63.5	23.1	Vertical	Vertical
7440	1	140	54.4	38.4	63.5	25.1	Horizontal	Flat
12400	1.17	23	56.4	40.1	63.5	23.4	Vertical	Vertical

### 5.6.2.2 2.4GHz WLAN

The following table depicts the level of radiated emissions of channel 2412 MHz in the restricted band:

FREQ (MHz)	ANT	EUT	HEIGHT (cm)	AZIMUTH (°)	PEAK (dB $\mu$ V/m)	AVG (dB $\mu$ V/m)	LIMIT (dB $\mu$ V/m)	MARGIN (dB)
14472.0	H	SB	109.0	337	63.1	59.6	63.5	3.9
4824.0	V	VS	109.8	32	55.9	50.0	63.5	13.5
12060.0	H	VB	100.0	325	61.9	55.9	63.5	7.6
19296.0	H	SB	102.2	301	57.1	49.5	63.5	14.0

The following table depicts the level of significant radiated emissions of channel 2437 MHz in the restricted band:

FREQ (MHz)	ANT	EUT	HEIGHT (cm)	AZIMUTH (°)	PEAK (dB $\mu$ V/m)	AVG (dB $\mu$ V/m)	LIMIT (dB $\mu$ V/m)	MARGIN (dB)
4884.0	V	VS	129.3	75	53.2	49.5	63.5	14.0
7326.0	H	SB	102.5	312	52.7	43.3	63.5	20.2
12210.0	H	VB	100.0	324	62.5	59.1	63.5	4.4
19536.0	H	SB	103.3	280	58.4	50.7	63.5	12.8

Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, SB: Side with dipole bent, VB:Vertical with dipole bent, VS:Vertical with dipole straight .
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

The following table depicts the level of significant radiated emissions of channel 2462 MHz in the restricted band:

FREQ (MHz)	ANT	EUT	HEIGHT (cm)	AZIMUTH (°)	PEAK (dB $\mu$ V/m)	AVG (dB $\mu$ V/m)	LIMIT (dB $\mu$ V/m)	MARGIN (dB)
7386.0	H	SS	101.9	334	53.9	48.1	63.5	15.4
4924.0	V	VS	113.5	28	56.6	54.1	63.5	9.5
12310.0	H	VB	100.0	319	62.9	59.5	63.5	4.1
19696.0	H	SB	103.8	291	57.7	52.1	63.5	11.4
22158.0	H	VB	100.6	64	57.5	46.8	63.5	16.7

### 5.6.2.3 5.7GHz WLAN

The following table depicts the level of radiated emissions of channel 5745 MHz in the restricted band:

Dipole Bent:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11490	1.00	95.6	60.5	57.7	63.5	5.8	Horizontal	Vertical
22980	1.02	338	59.1	54.7	63.5	8.9	Vertical	Vertical

Dipole Straight:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11490	1.00	93.4	60.1	57.0	63.5	6.5	Horizontal	Vertical
22980	1.00	334	58.9	54.3	63.5	9.2	Vertical	Vertical

Notes:

1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, SB: Side with dipole bent, VB:Vertical with dipole bent, VS:Vertical with dipole straight .
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

The following table depicts the level of significant radiated emissions of channel 5785 MHz in the restricted band:

Dipole Bent:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11570	1.00	97.3	60.2	57.0	63.5	6.5	Horizontal	Vertical

Dipole Straight:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11570	1.00	97.3	60.5	57.3	63.5	6.2	Horizontal	Vertical

The following table depicts the level of significant radiated emissions of channel 5825 MHz in the restricted band:

Dipole Bent:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11650	1.00	96.8	59.2	56.4	63.5	7.1	Horizontal	Vertical

Dipole Straight:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB $\mu$ V/m)	Avg Reading (dB $\mu$ V/m)	Avg Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
11650	1.00	97.7	59.4	56.1	63.5	7.4	Horizontal	Vertical

Notes:

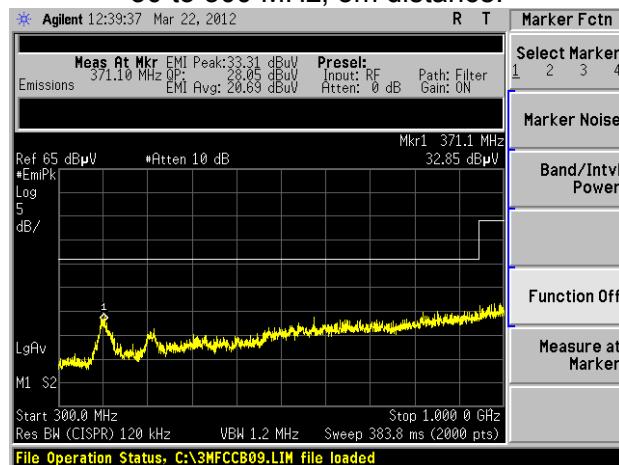
1. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.
2. H: Horizontal, V: Vertical, S: Side, F: Flat.
3. Refer to exhibit 5.5 on explanation of how data is reported.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

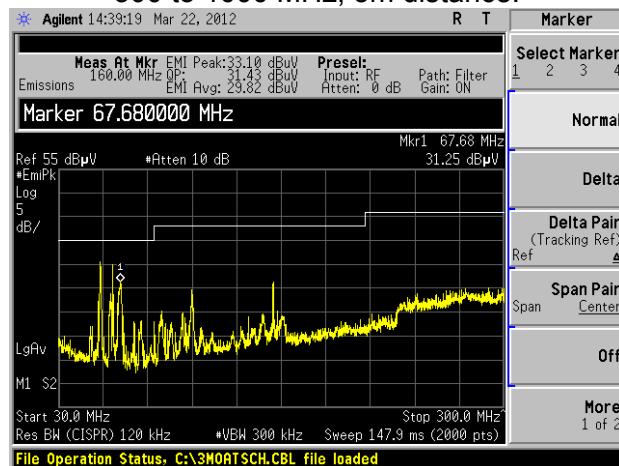
## 5.7 – Screen Captures.

The screen captures below are those using the Peak detector of the analyzer. In addition, the screen captures presented are those which were deemed to be an appropriate representation of the spectrum scan.

30 to 300 MHz, 3m distance.

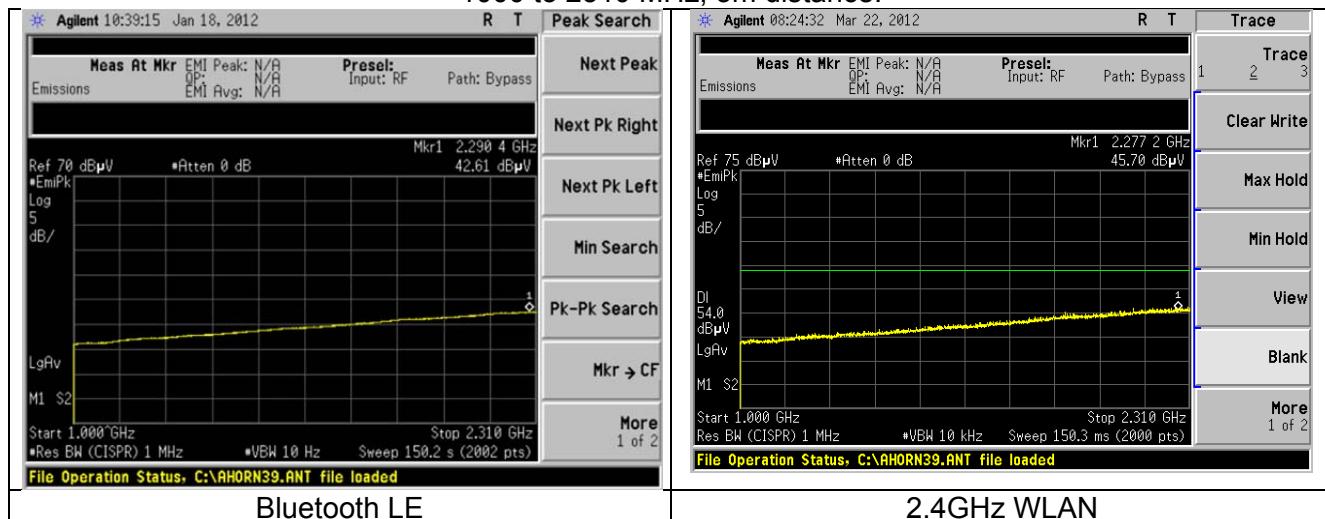


300 to 1000 MHz, 3m distance.

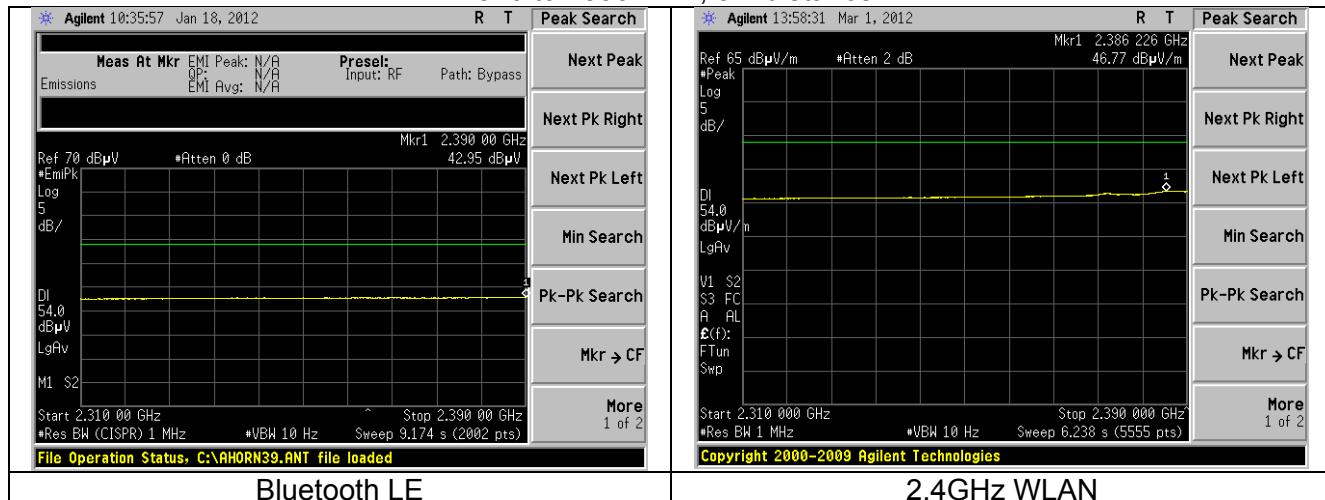


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 1000 to 2310 MHz, 3m distance.



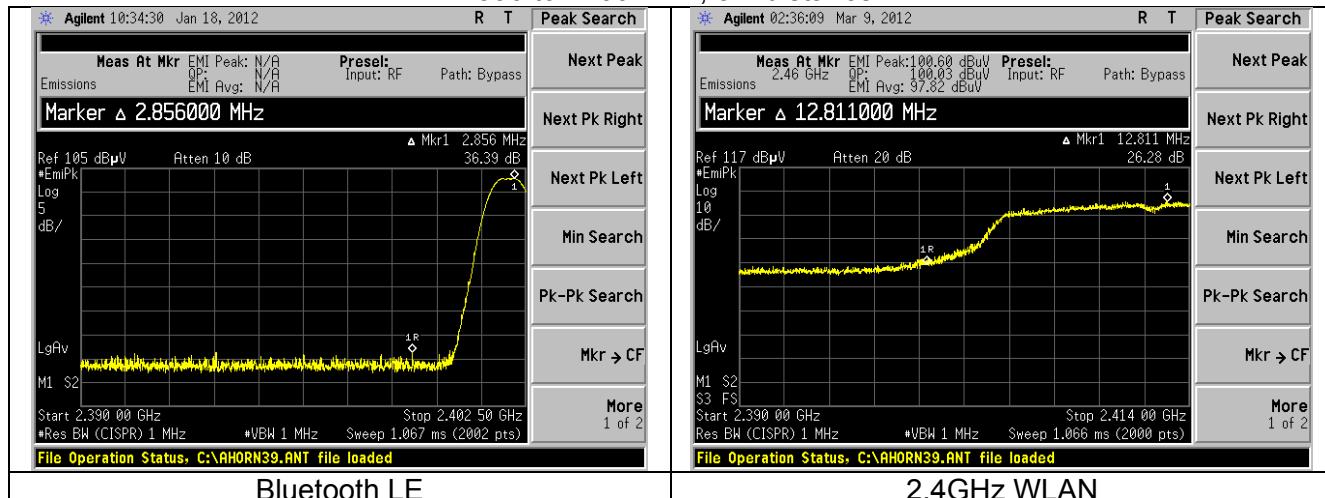
### 2310 to 2390 MHz, 3m distance.



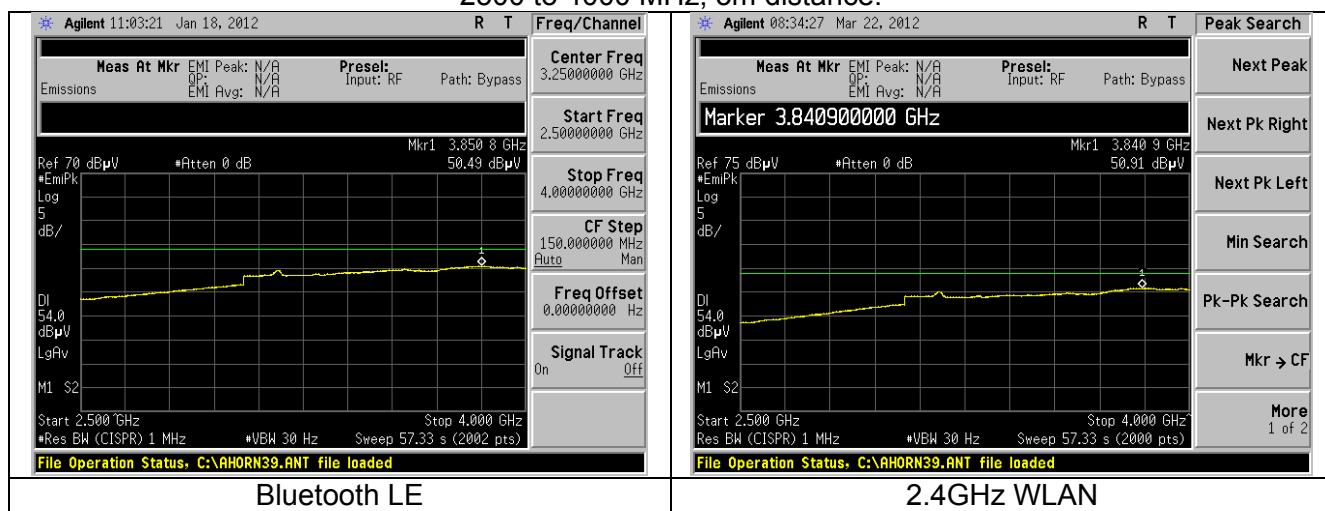
Note: The range 2483.5 to 2500 MHz is in section 8 of this report (Band-edges).

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 2390 to 2400 MHz, 3m distance.

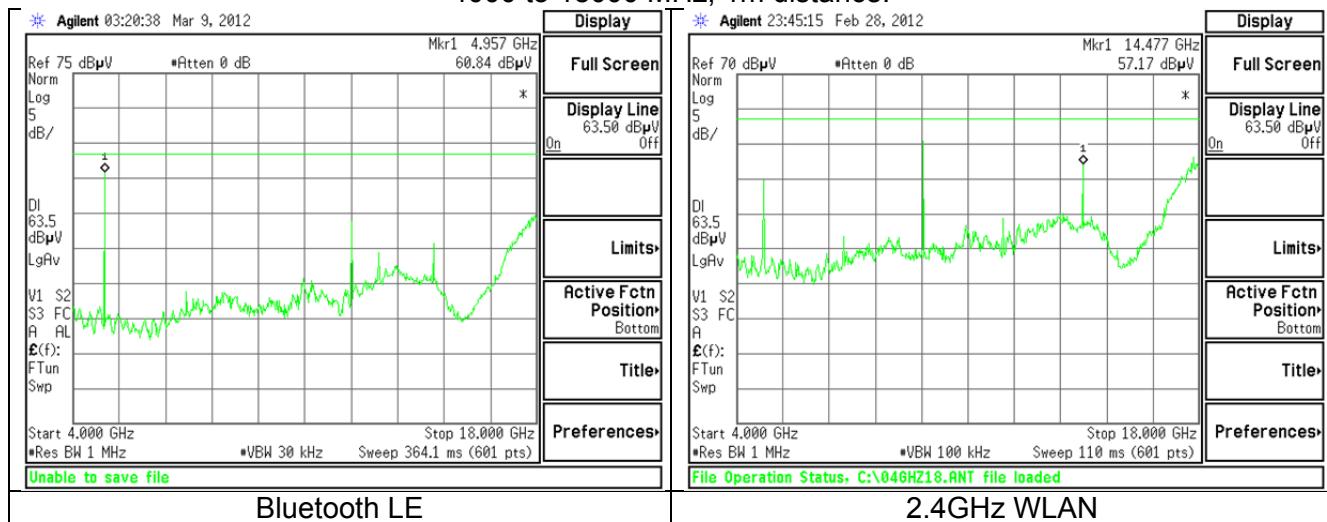


### 2500 to 4000 MHz, 3m distance.

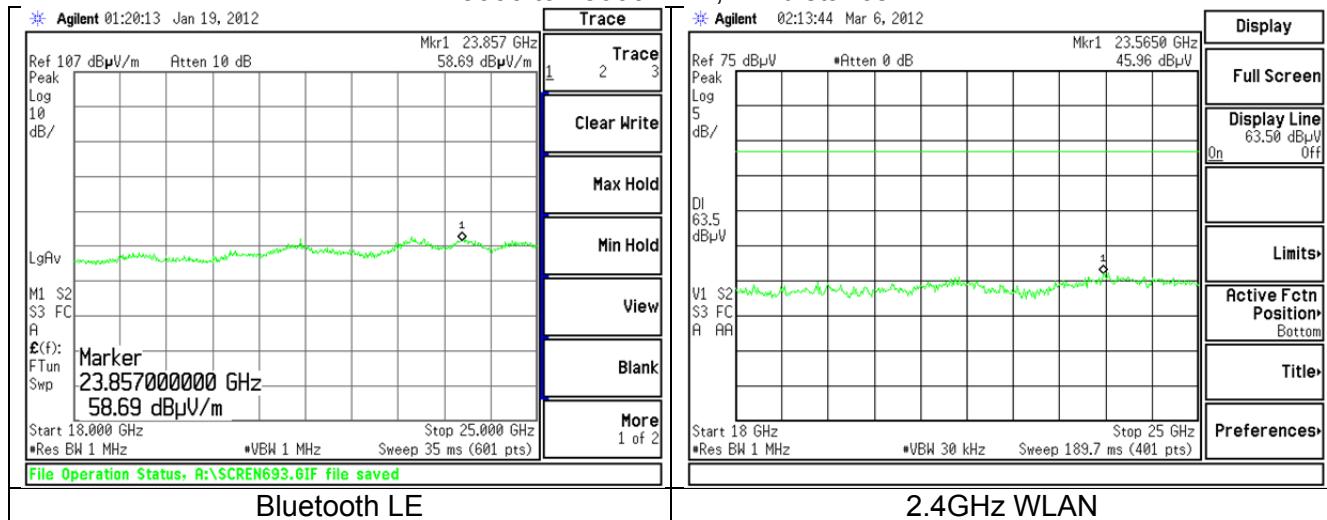


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 4000 to 18000 MHz, 1m distance.



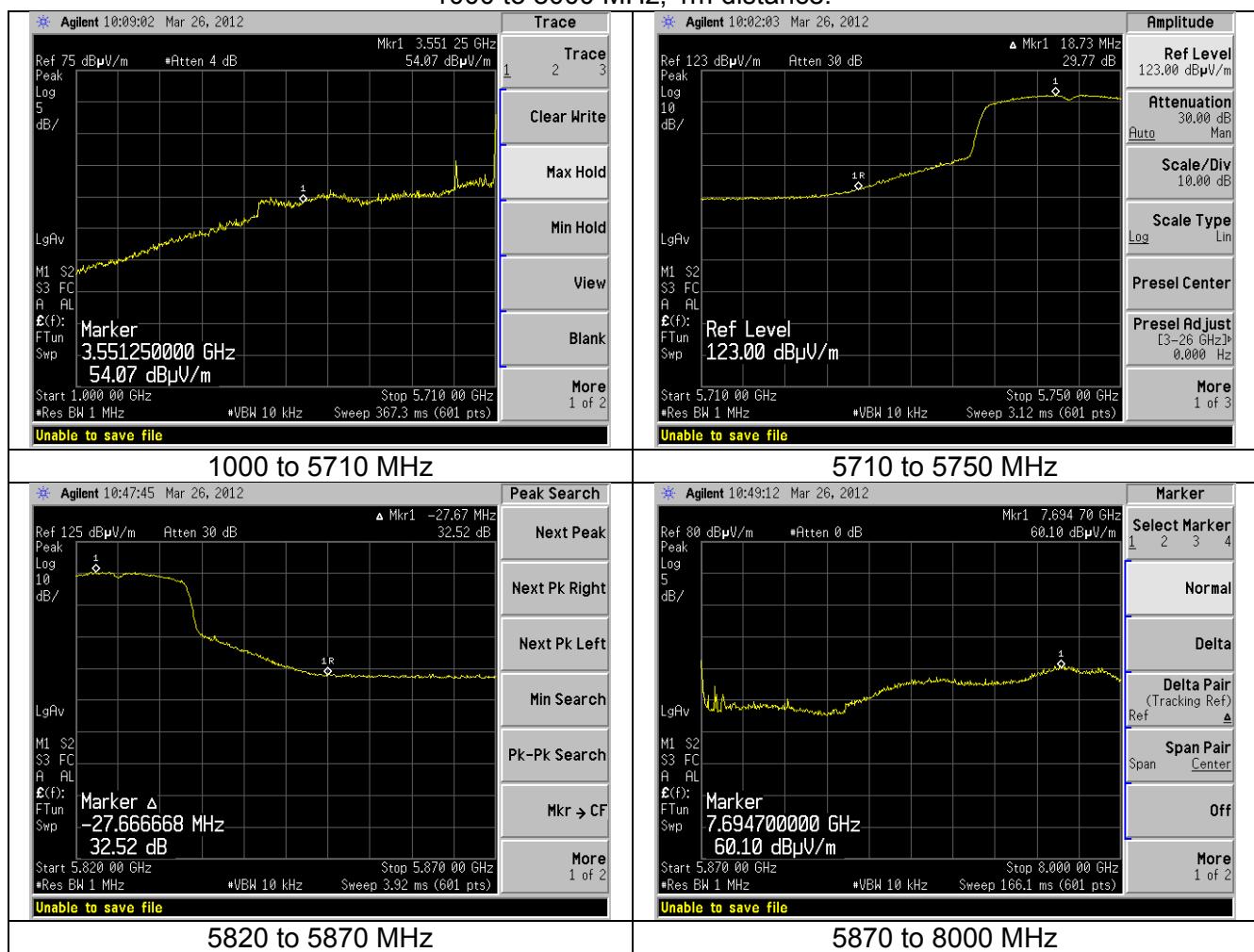
### 18000 to 25000 MHz, 1m distance.



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

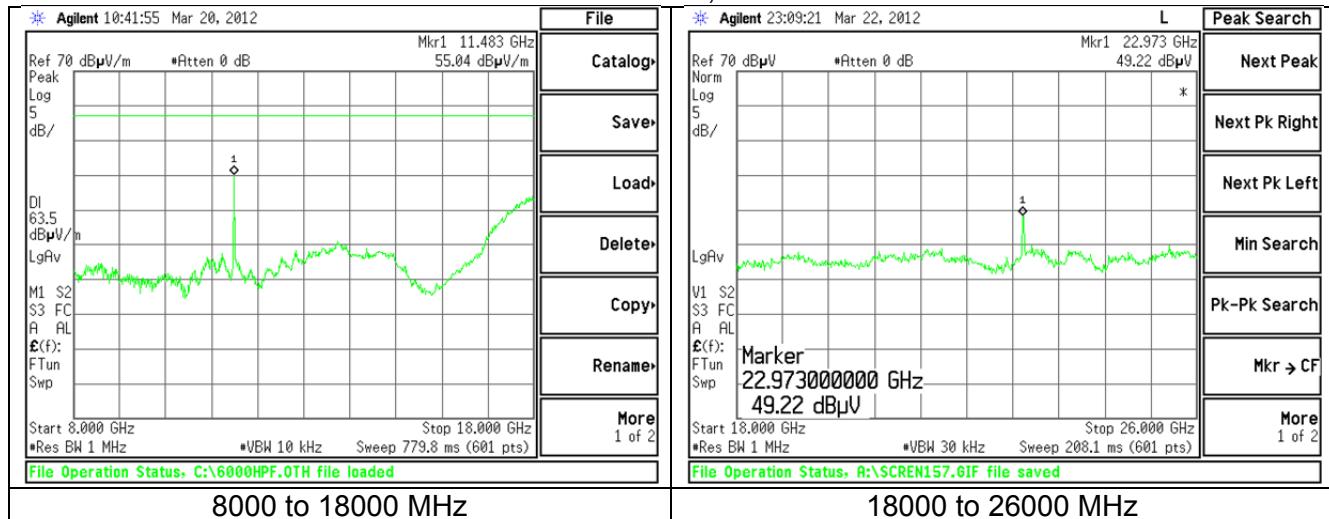
The screen captures below are for the 5.7 GHz WLAN

1000 to 8000 MHz, 1m distance.



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 8000 to 26000 MHz, 1m distance.



### 26000 to 40000 MHz, 1m distance.



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

### 6.1 Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT was connected to a USB port of a generic laptop and set to transmit. The Generic laptop power supply was then plugged into a  $50\Omega$  (ohm), 50/250  $\mu$ H Line Impedance Stabilization Network (LISN). The AC power supply of 120V was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter, and then to EMI receiver System. The EMCO LISN used has the ability to terminate the unused port with a  $50\Omega$  (ohm) load when switched to either L1 (line) or L2 (neutral).

### 6.2 Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

**This test was performed on the EUT while it was powered using an off-the-shelf wall AC to DC power supply.**

### 6.3 Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter were performed at an IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. All cables are calibrated and checked periodically for conformance. The emissions are measured on the EMI System, which has automatic correction for all factors stored in memory and allows direct readings to be taken.

### 6.4 Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 and RSS GEN 7.2.2 for Conducted Emissions for an Intentional Radiator. See the Data Charts and Graphs for more details of the test results.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 6.5 FCC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dB $\mu$ V)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW $\geq$ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	

\* The limit decreases linearly with the logarithm of the frequency in this range.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 6.6

## CONDUCTED EMISSIONS TEST DATA CHART

Frequency Range inspected: 150 KHz to 30 MHz

Manufacturer:	LS Research			
Date(s) of Test:	April 25 <sup>th</sup> 2012			
Project Engineer:	Khairul Aidi Zainal			
Test Engineer:	Mike Hintzke			
Voltage:	120 VAC			
Operation Mode:	Continuous transmit, modulated			
Environmental Conditions in the Lab:	Temperature: 71°F Relative Humidity: 40%			
Test Location:	X	AC Mains Test area		Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane		10cm Spacers
	X	80cm above Ground Plane		Other:
Measurements:		Pre-Compliance	Preliminary	X Final
Detectors Used:	Peak	X	Quasi-Peak	X Average

Frequency (MHz)	Line	Quasi-Peak			Average		
		Q-Peak Reading (dB $\mu$ V)	Q-Peak Limit (dB $\mu$ V)	Quasi-Peak Margin (dB)	Average Reading (dB $\mu$ V)	Average Limit (dB $\mu$ V)	Average Margin (dB)
0.150	L1	35.2	66.0	30.8	5.2	56.0	50.8
0.302	L1	32.2	60.2	28.0	10.7	50.2	39.5
1.106	L1	27.2	56.0	28.8	-2.7	46.0	48.7
0.150	L2	34.6	66.0	31.4	4.9	56.0	51.1
0.416	L2	20.0	57.5	37.5	-7.0	47.5	54.5
0.295	L2	30.0	60.4	30.4	0.6	50.4	49.8
1.025	L2	27.6	56.0	28.4	-2.4	46.0	48.4
0.618	L2	22.1	56.0	33.9	17.7	46.0	28.3

**Notes:**

- 1) The emissions listed are characteristic of the power supply used, and did not change by the EUT.

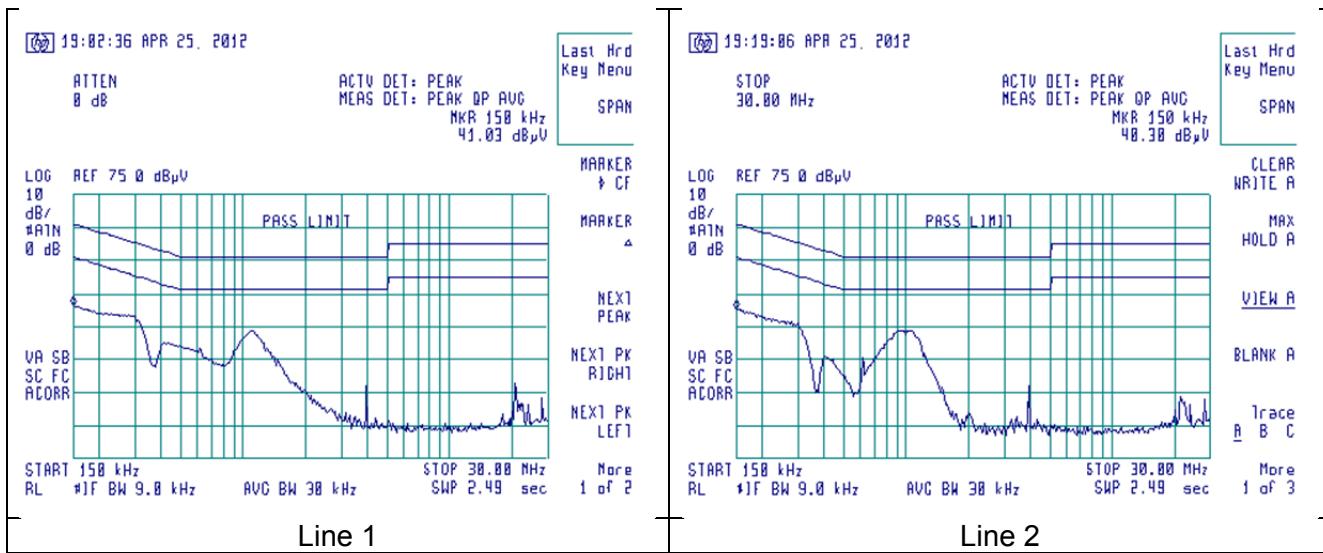
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 6.7 Test Setup Photo(s) – Conducted Emissions Test



## 6.8 Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 7. OCCUPIED BANDWIDTH

Test Engineer(s): Adam Alger and Khairul Aidi Zainal

### **7.1 - Limits**

For a DTS system operating in the 2400 to 2483.5 MHz and 5725 to 5850 MHz band, the 6dB emission bandwidth limit is 500 kHz.

### **7.2 - Method of Measurements**

Industry Canada (IC RSS GEN 4.6.1) also requires the measurement of the 99% bandwidth in addition to the 6dB emission bandwidth. For this portion of the tests, 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 thereby 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. A bandwidth measurement function that is built into the spectrum analyzer was used to measure the 99 % bandwidth while the 6dB bandwidth was measured using **FCC OET KDB 558074 section 5.1**.

### **7.3 - Test Data**

#### 7.3.1 Bluetooth LE

Data Rate	Channel	Frequency (MHz)	EBW 6 dB (MHz)	EBW 26dB (MHz)	EBW 99% (MHz)
1 Mbps	0	2402	0.679	N/A	1.035
	19	2440	0.678	N/A	1.031
	39	2480	0.679	N/A	1.032

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

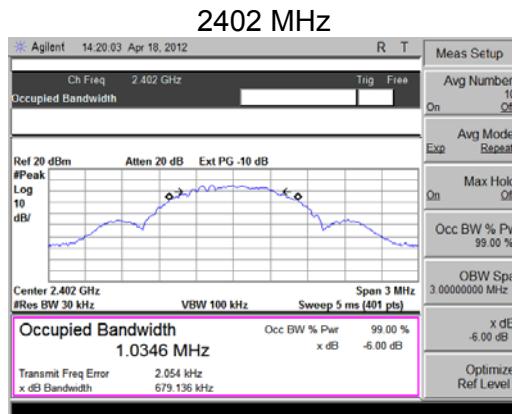
### 7.3.2 WLAN

Data Rate	Channel	Frequency (MHz)	EBW 6 dB (MHz)	EBW 26dB (MHz)	EBW 99% (MHz)
1 Mbps 802.11 b	1	2412	9.1	16.1	13.9
	6	2437	9.1	16.1	13.9
	11	2462	9.1	16.1	13.9
11 MBPS 802.11 b	1	2412	10.3	16.6	14.4
	6	2437	10.2	16.9	14.4
	11	2462	9.8	16.8	14.4
54 MBPS 802.11g	1	2412	16.4	18.0	16.4
	6	2437	16.4	18.0	16.4
	11	2462	16.4	18.0	16.4
MCS7 802.11n HT20	1	2412	17.4	19.1	17.6
	6	2437	17.6	19.0	17.6
	11	2462	17.5	19.3	17.5
6 MBPS 802.11a	149	5745	16.2	19.6	17.2
	157	5785	16.1	20.0	17.3
	165	5825	16.2	20.1	17.4
12 MBPS 802.11a	149	5745	16.2	20.1	16.9
	157	5785	16.3	19.9	16.9
	165	5825	16.2	20.2	16.9
24 MBPS 802.11a	149	5745	16.3	19.0	16.7
	157	5785	16.2	19.9	16.9
	165	5825	16.2	20.6	16.8
MCS7 802.11n HT20	149	5745	17.2	20.0	17.8
	157	5785	17.5	19.9	17.8
	165	5825	17.5	19.7	17.8

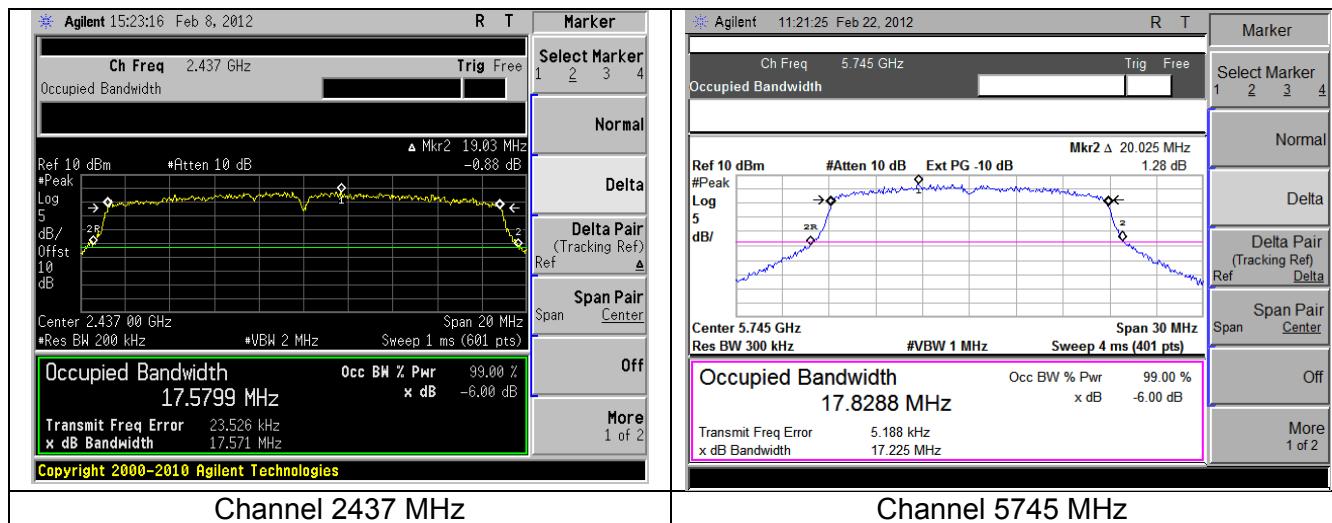
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 7.4 – Screen Captures

### 7.4.1 Bluetooth LE



### 7.4.2 WLAN



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 8. BAND EDGE MEASUREMENTS

Test Engineer(s): Adam Alger, Khairul Aidi Zainal,

### **8.1 - Method of Measurements**

FCC 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in RSS GEN and also to the limits in the applicable annex. The EUT was operated in continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

The Band-edge measurements were performed conducted and radiated. The measurement of band-edge was performed to satisfy FCC 15.247(d).

Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz.

**Measurement procedure used was FCC OET KDB 558074 D01 section 5.4**

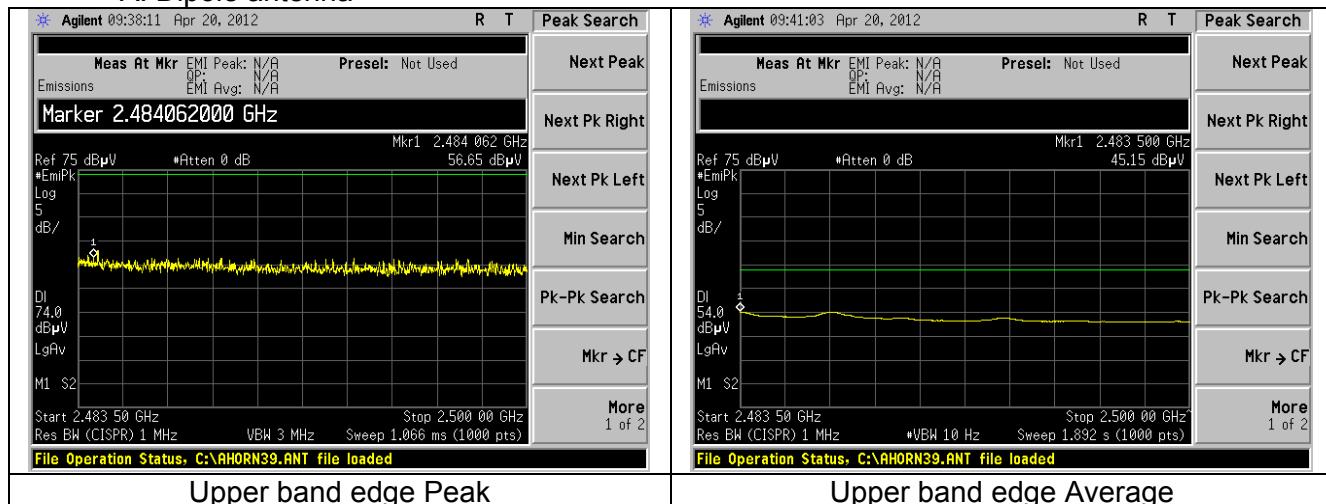
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 8.2. Band edge captures.

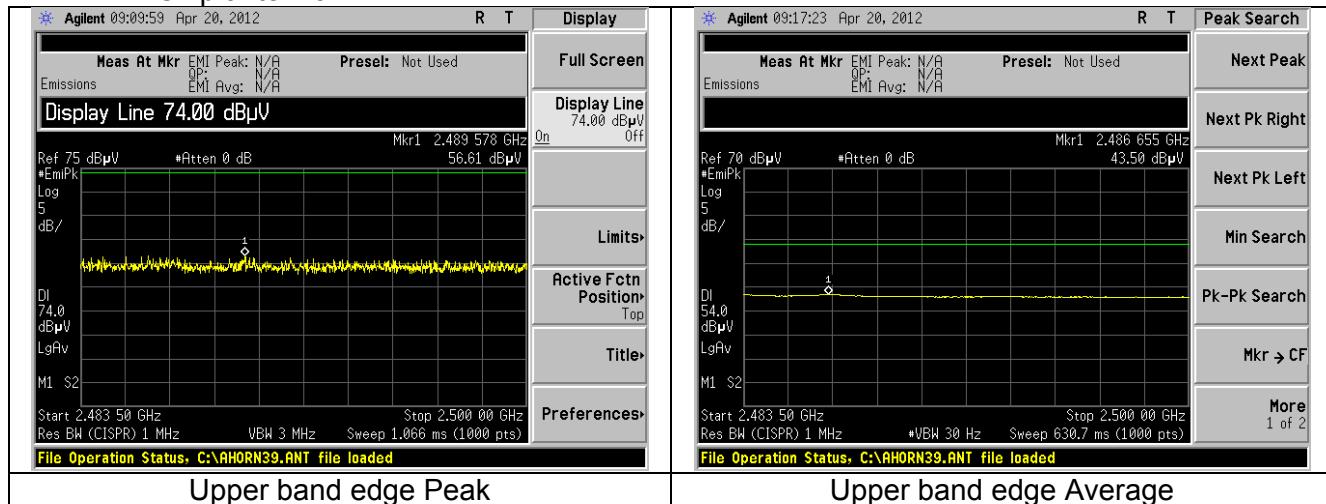
### 8.2.1 Radiated Band-edge in Restricted Band:

#### 8.2.1.1 Bluetooth LE

##### A. Dipole antenna



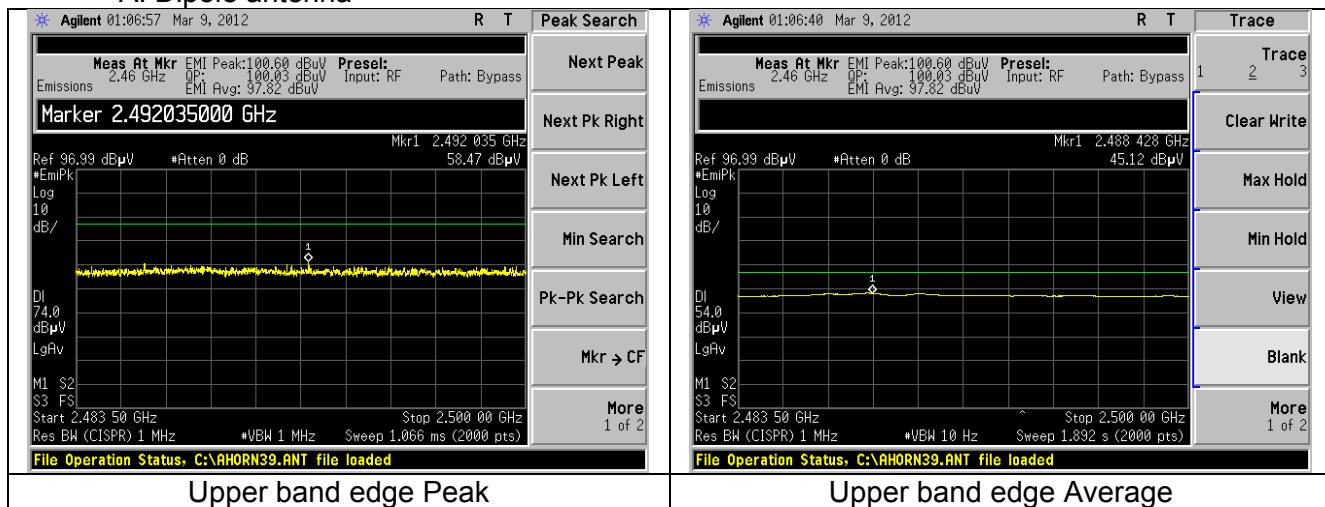
##### B. Chip antenna



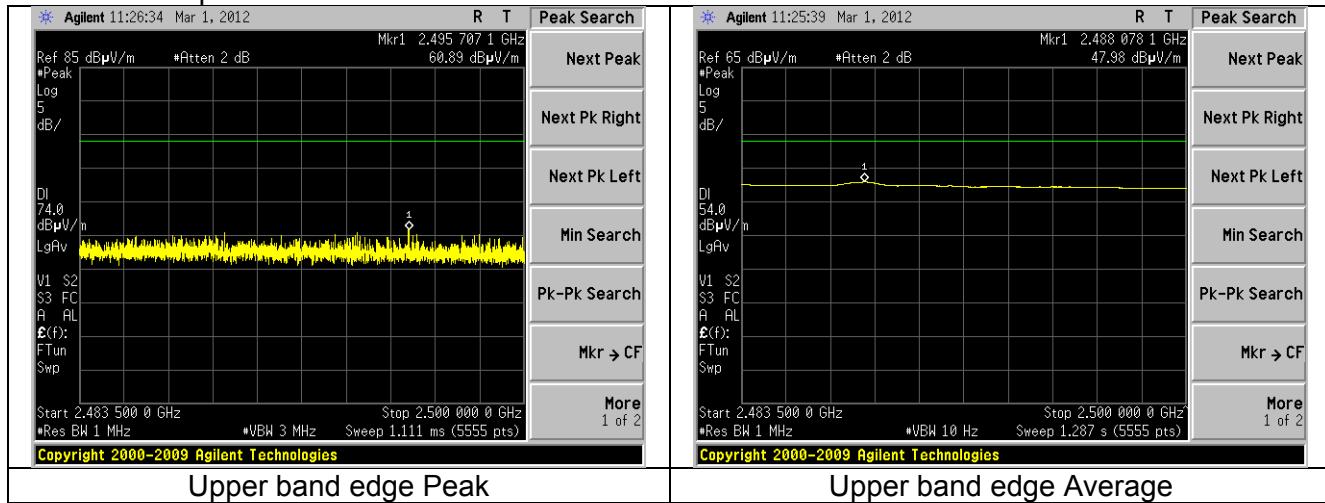
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 8.2.1.2 WLAN 1MBPS

### A. Dipole antenna



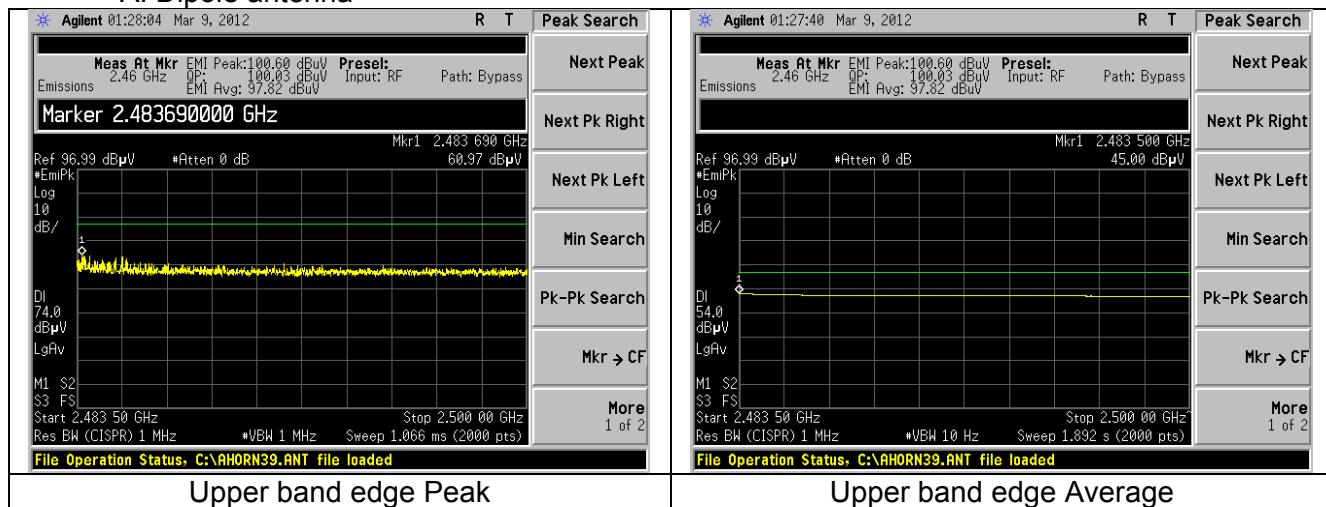
### B. Chip antenna



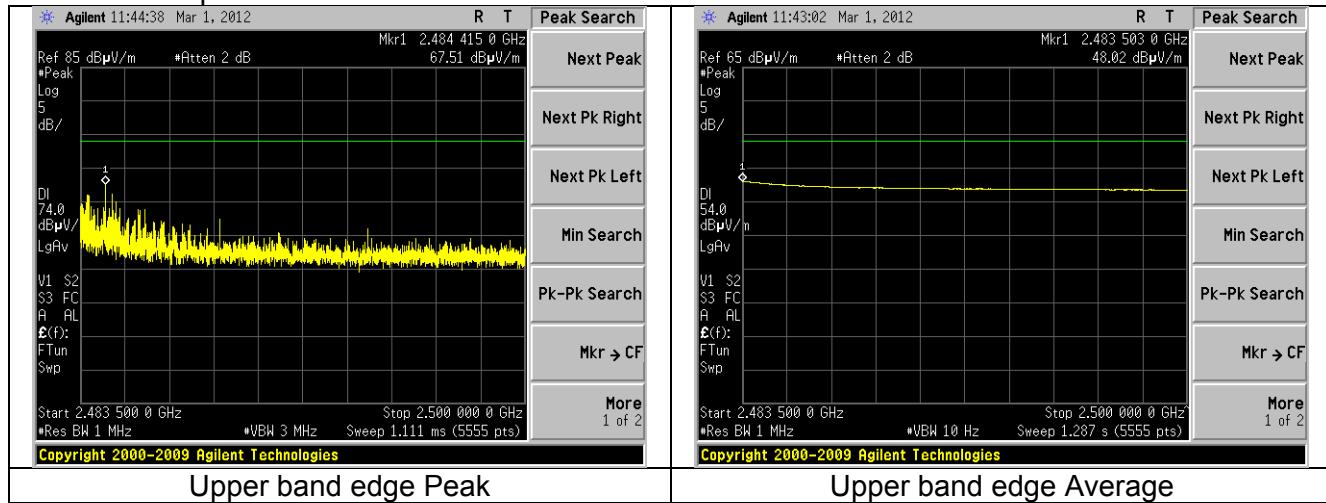
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 8.2.1.3 WLAN 54MBPS

#### A. Dipole antenna



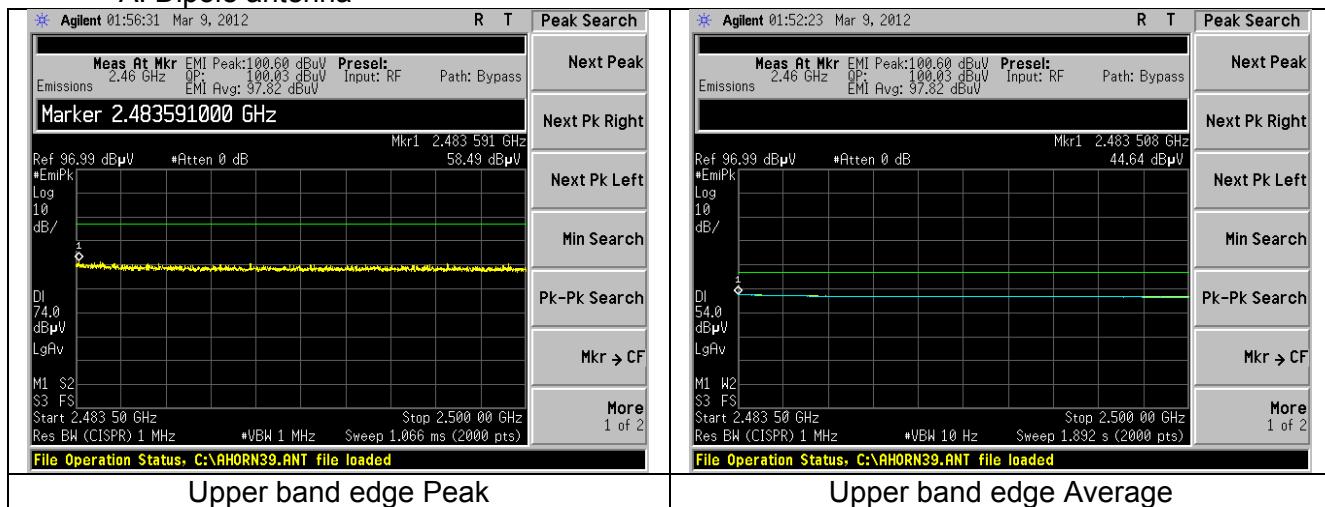
#### B. Chip antenna



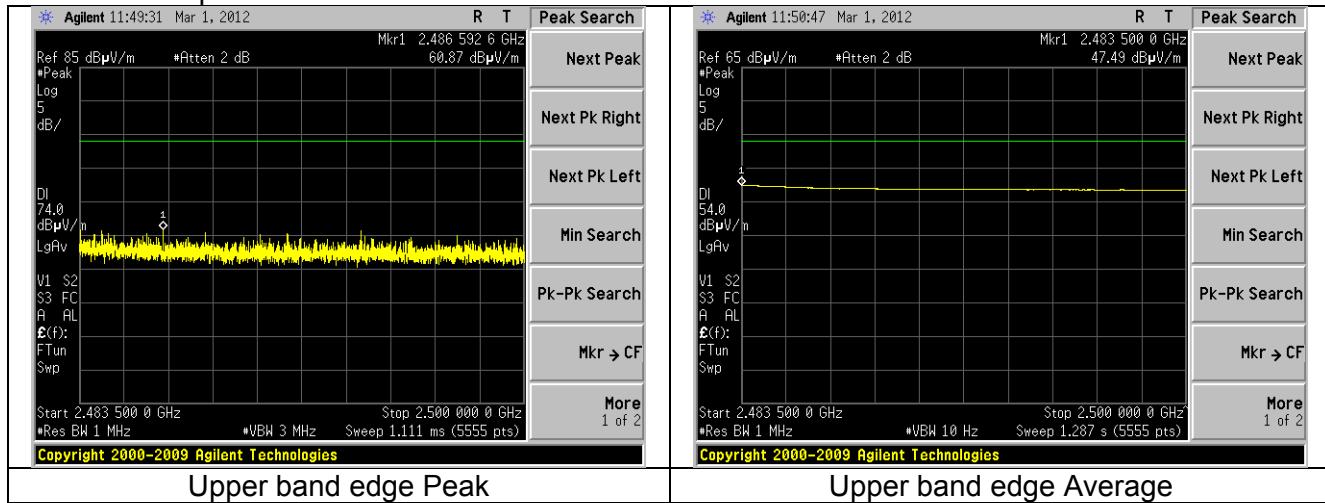
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 8.2.1.3 WLAN MCS7

#### A. Dipole antenna



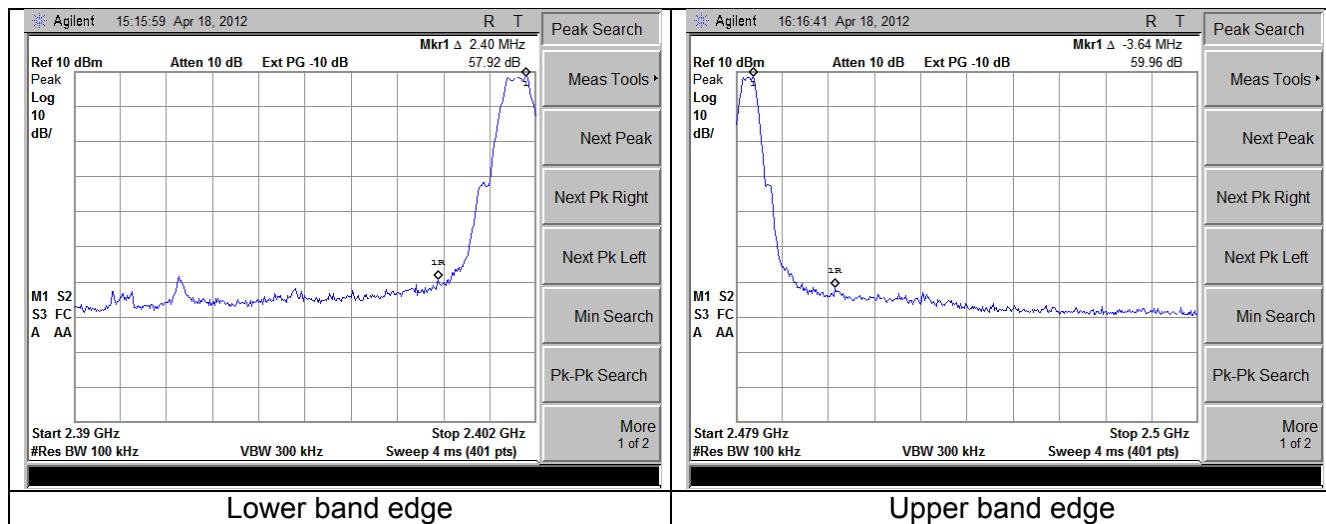
#### B. Chip antenna



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

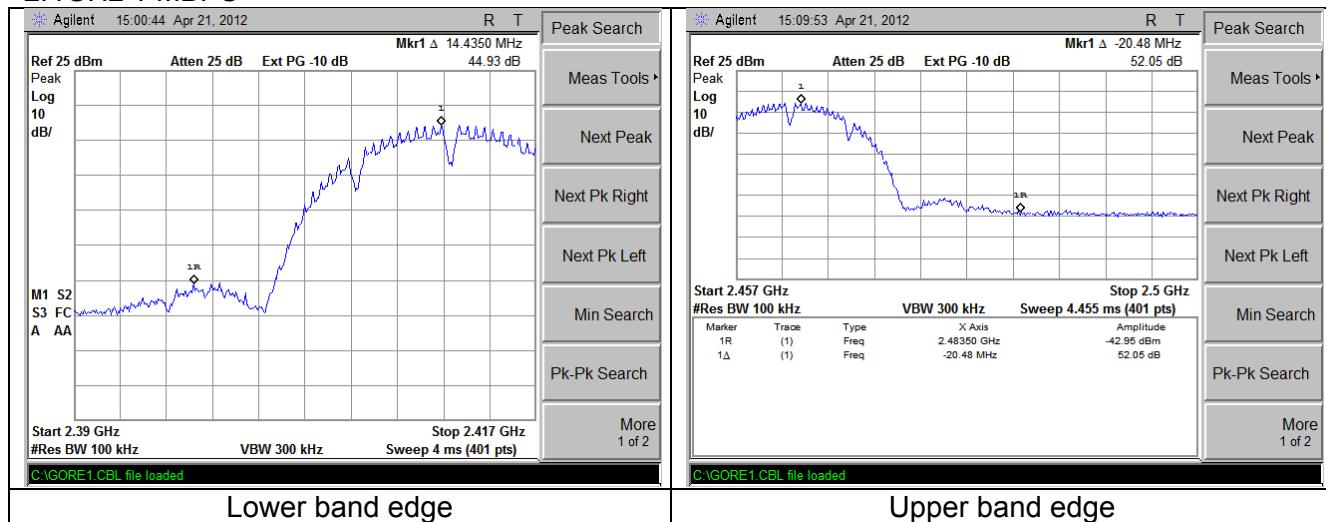
## 8.2.2 Conducted Band-edge:

### 8.2.2.1 Bluetooth LE



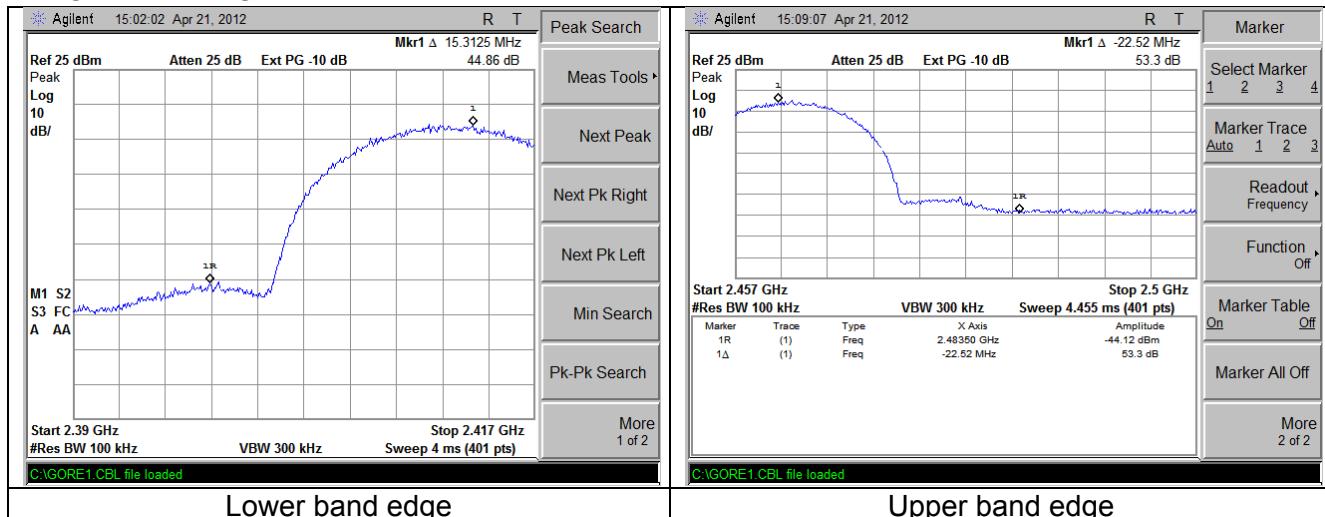
### 8.2.2.2 WLAN

#### 2.4GHz 1 MBPS

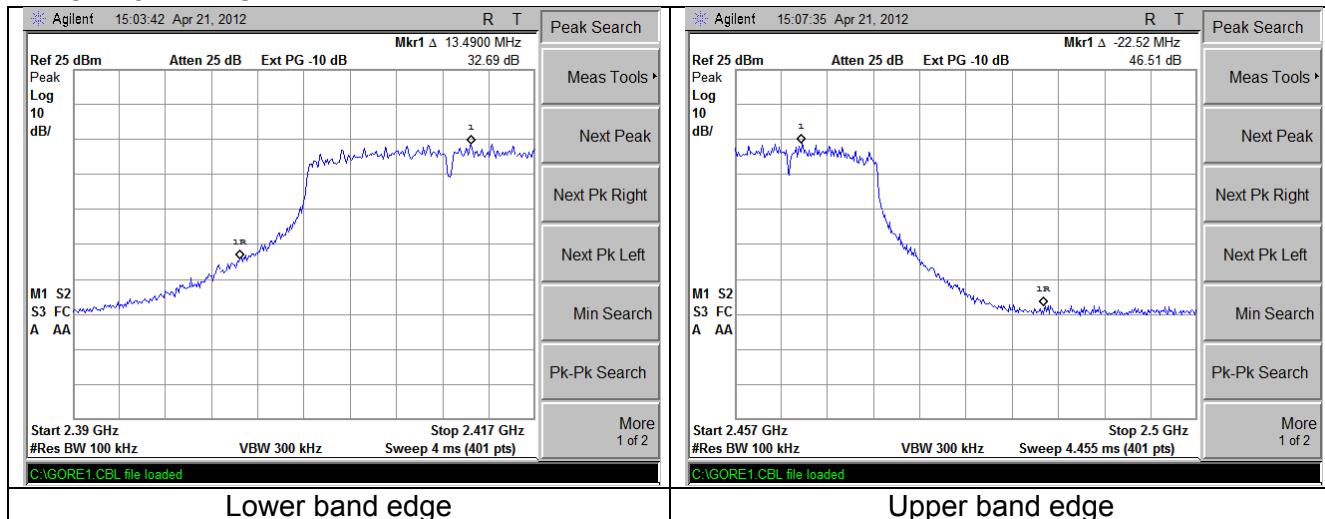


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 2.4GHz 11 MBPS

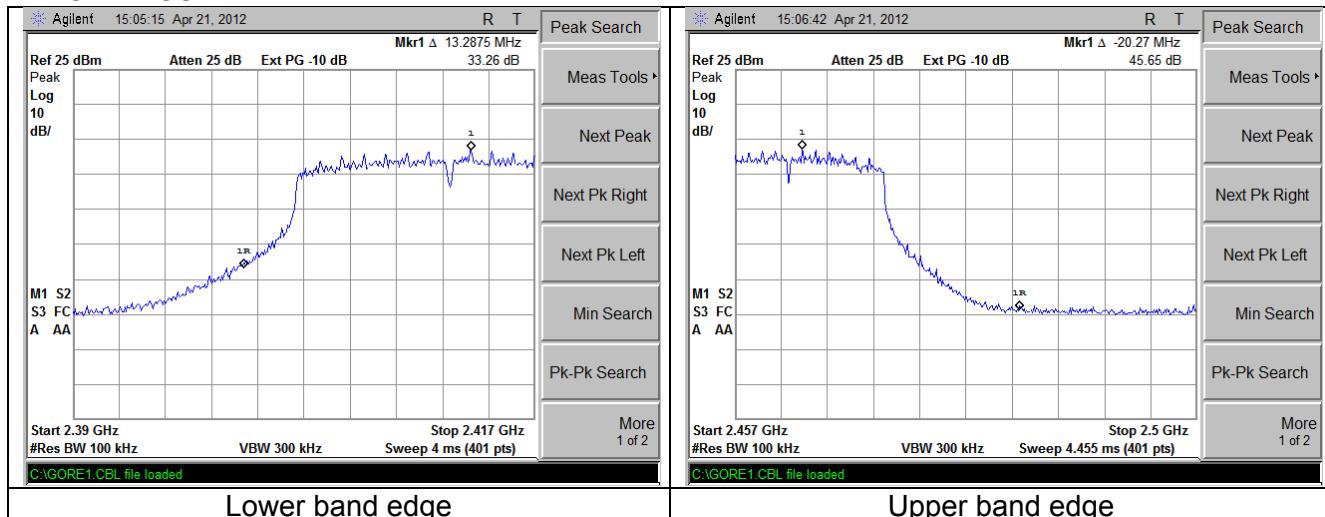


## 2.4GHz 54 MBPS

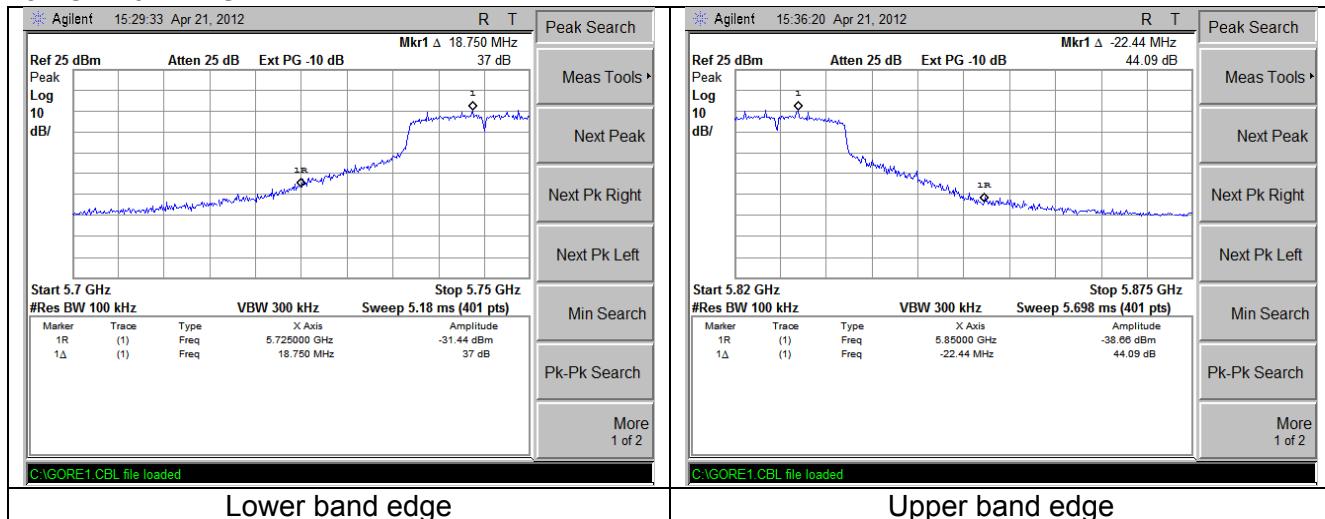


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 2.4GHz MCS7

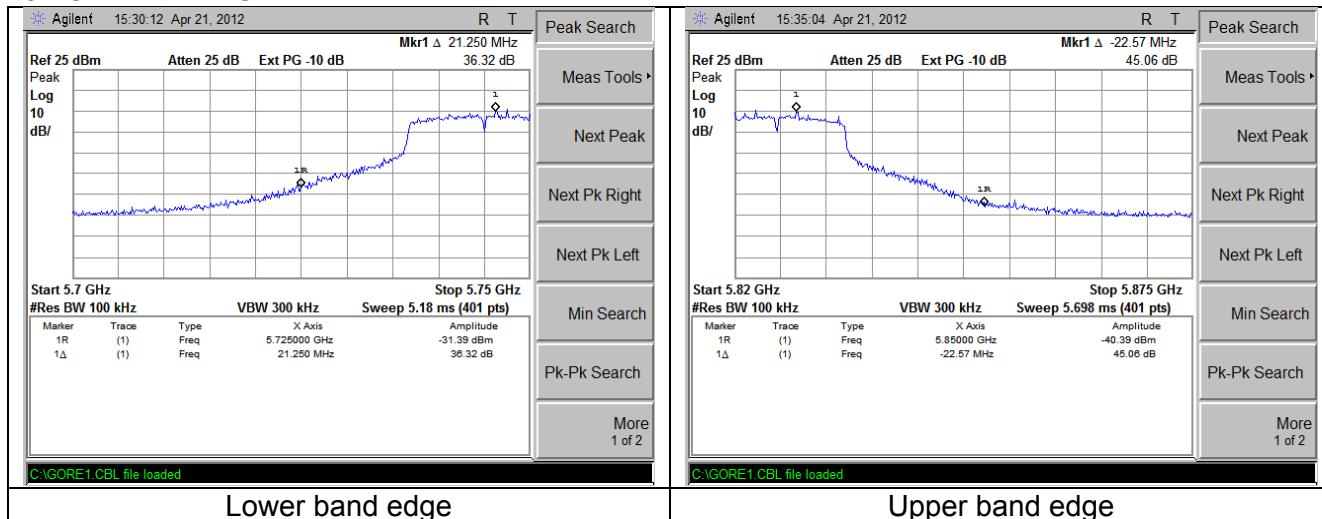


## 5.7GHz 6 MBPS

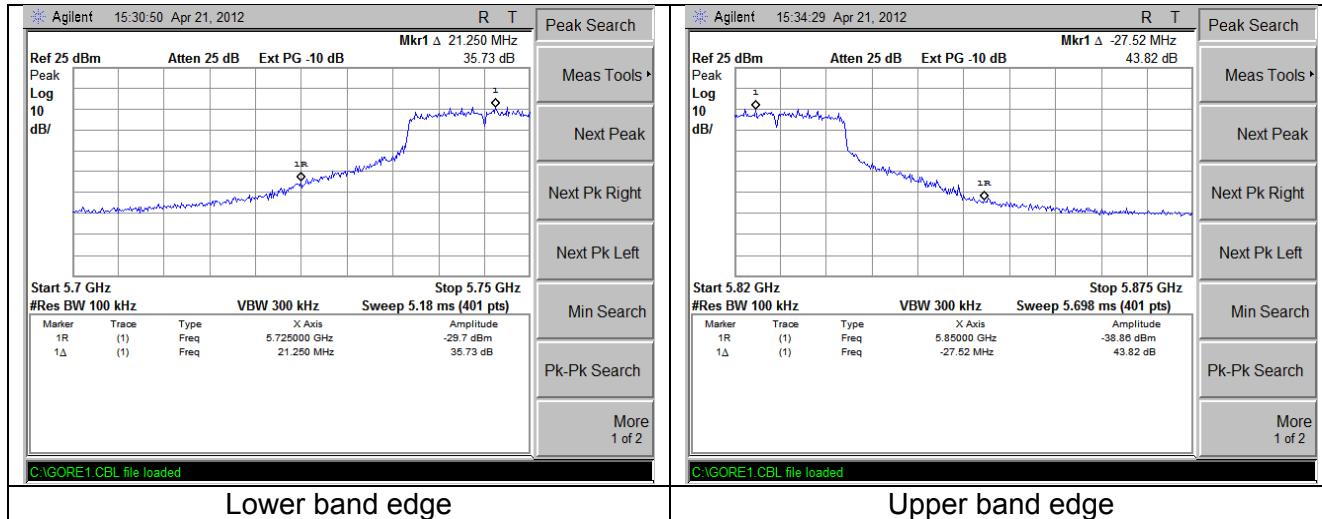


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 5.7GHz 12 MBPS

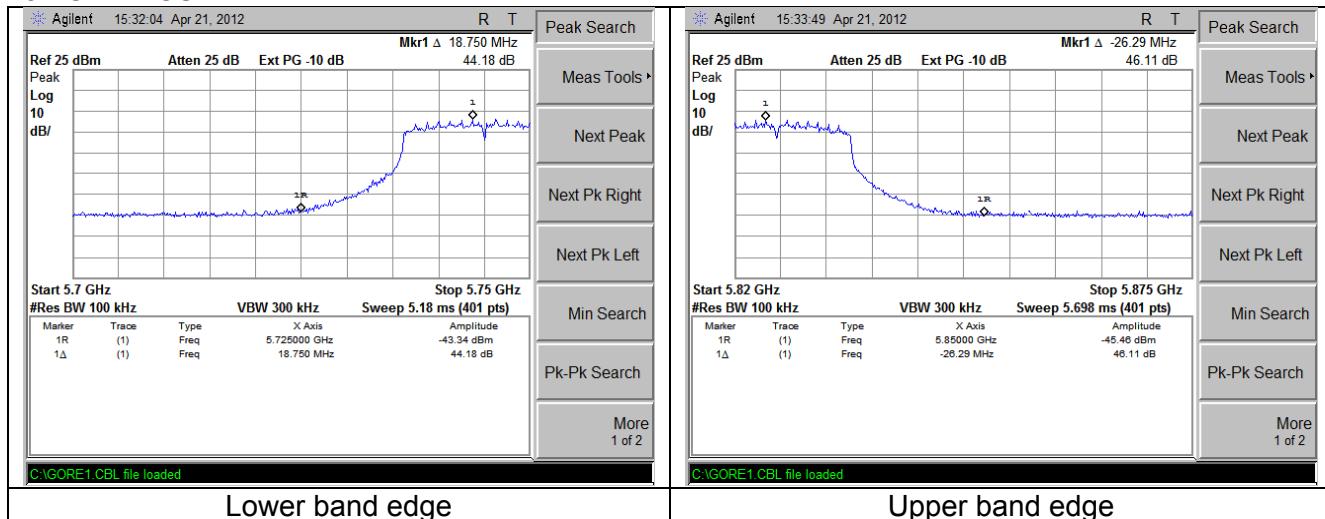


## 5.7GHz 24 MBPS



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 5.7GHz MCS7



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 9. POWER OUTPUT (CONDUCTED): 15.247(b)

Test Engineer(s): Adam Alger and Khairul Aidi Zainal

### **9.1 - Method of Measurements**

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for 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 unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with the appropriate resolution bandwidth, with measurements from a peak detector presented in the chart below.

**Measurement procedure used was FCC OET KDB 558074 D01 section 5.2.1**

### **9.2 - Test Data**

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

**Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).**

**Generic example of reported data at 2440 MHz:**

**Reported Measurement data = 8.55 (raw receiver measurement in dBm ) + 0.85 (cable factor in dB) = 9.4 (dBm).**

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 9.2.1 Bluetooth LE

Data Rate	Channel	Frequency (MHz)	Power (dBm)	Power Limit (dBm)	Power Margin (dB)
1 Mbps	0	2402	9.5	30	20.5
	19	2440	9.4	30	20.6
	39	2480	9.3	30	20.7

### 9.2.2 2.4GHz WLAN

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
1 Mbps	1	2412	20.8	30	9.2
	6	2437	20.8	30	9.2
	11	2462	20.8	30	9.2

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
11 Mbps	1	2412	22.0	30	8.0
	6	2437	22.0	30	8.0
	11	2462	22.0	30	8.0

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
54 Mbps	1	2412	19.5	30	10.5
	6	2437	19.5	30	10.5
	11	2462	19.5	30	10.5

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
MCS7	1	2412	17.6	30	12.4
	6	2437	17.6	30	12.4
	11	2462	17.6	30	12.4

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 9.2.3 5.7GHz WLAN

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
6 Mbps	149	5745	20.6	30	9.4
	157	5785	20.2	30	9.8
	165	5825	20.4	30	9.6

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
12 Mbps	149	5745	20.6	30	9.4
	157	5785	20.3	30	9.7
	165	5825	20.5	30	9.5

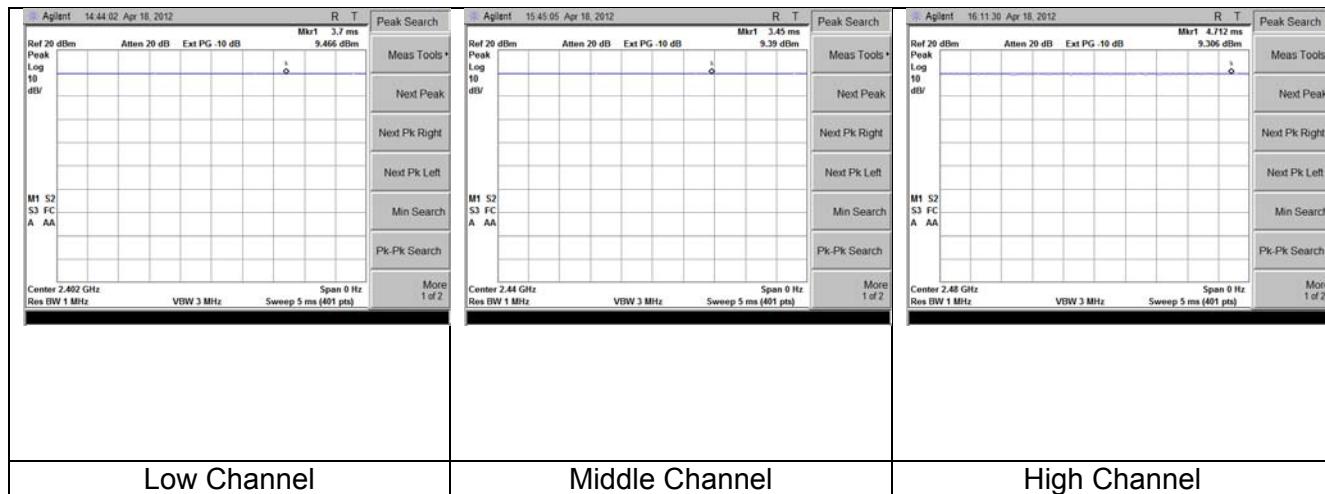
Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
24 Mbps	149	5745	20.5	30	9.6
	157	5785	20.0	30	10.0
	165	5825	20.2	30	9.8

Data Rate	Channel	Frequency (MHz)	Power *PK2 (dBm)	Power Limit (dBm)	Power Margin (dB)
MCS7	149	5745	16.0	30	14.0
	157	5785	15.3	30	14.7
	165	5825	15.8	30	14.2

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

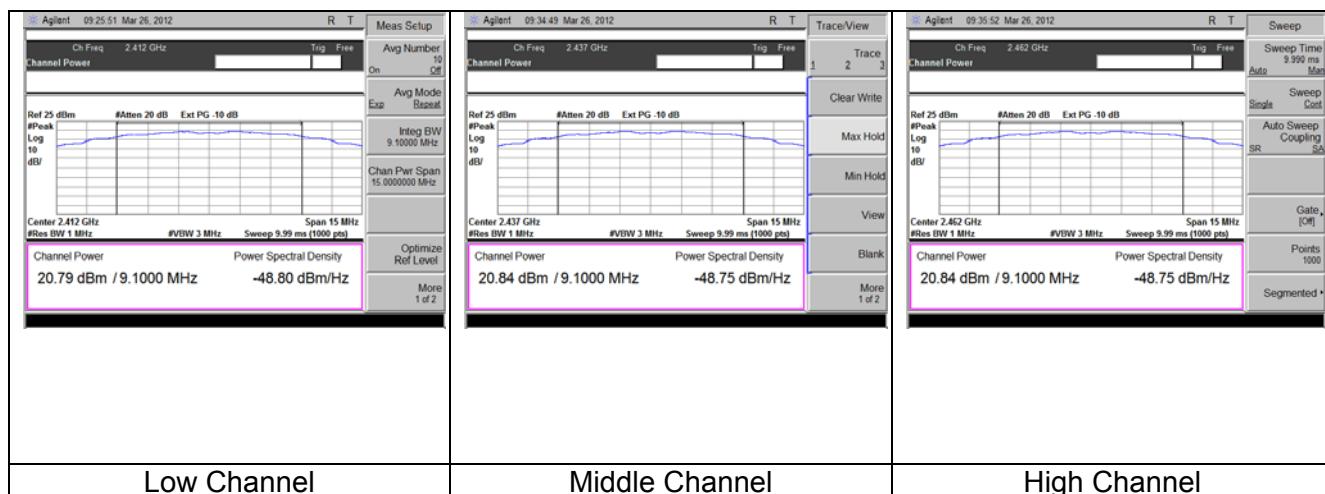
## 9.3 - Screen Captures.

### 9.3.1 Bluetooth LE



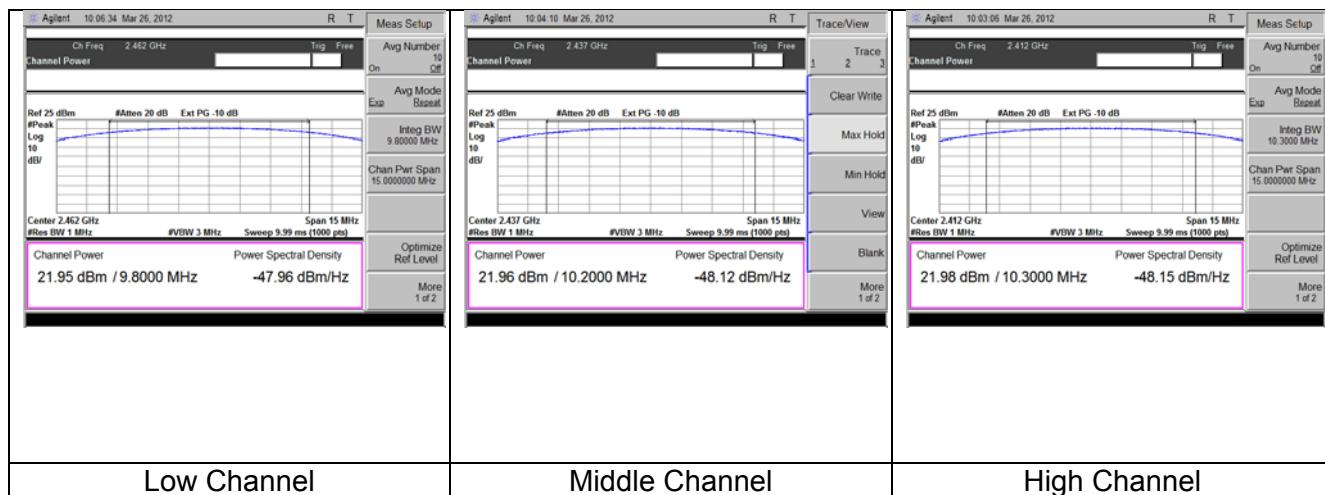
### 9.3.2 2.4GHz WLAN

#### 9.3.2.1 1MBPS

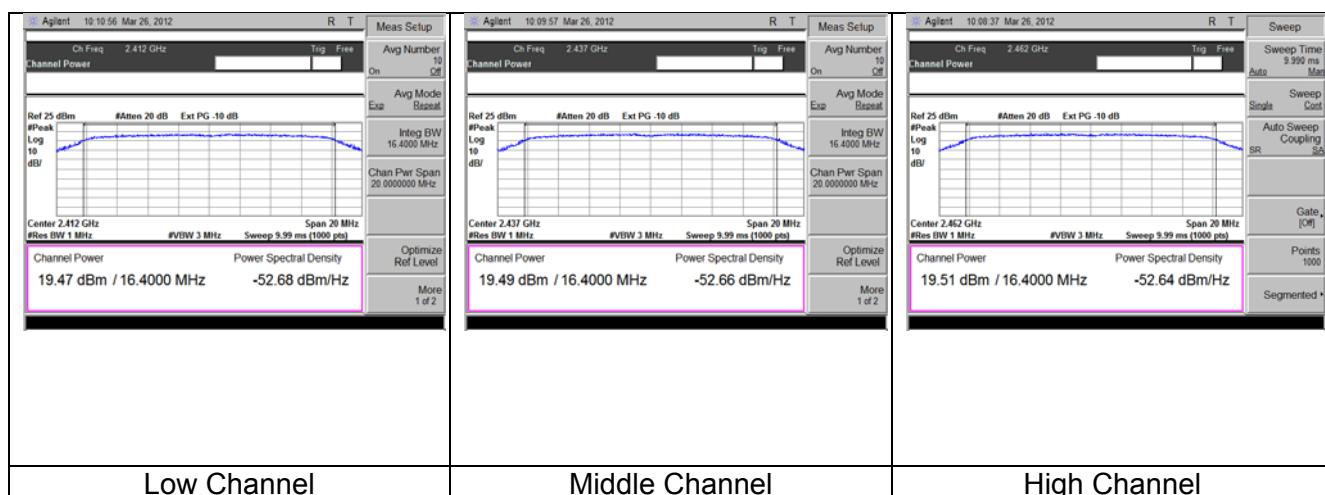


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 9.3.2.2 11MBPS

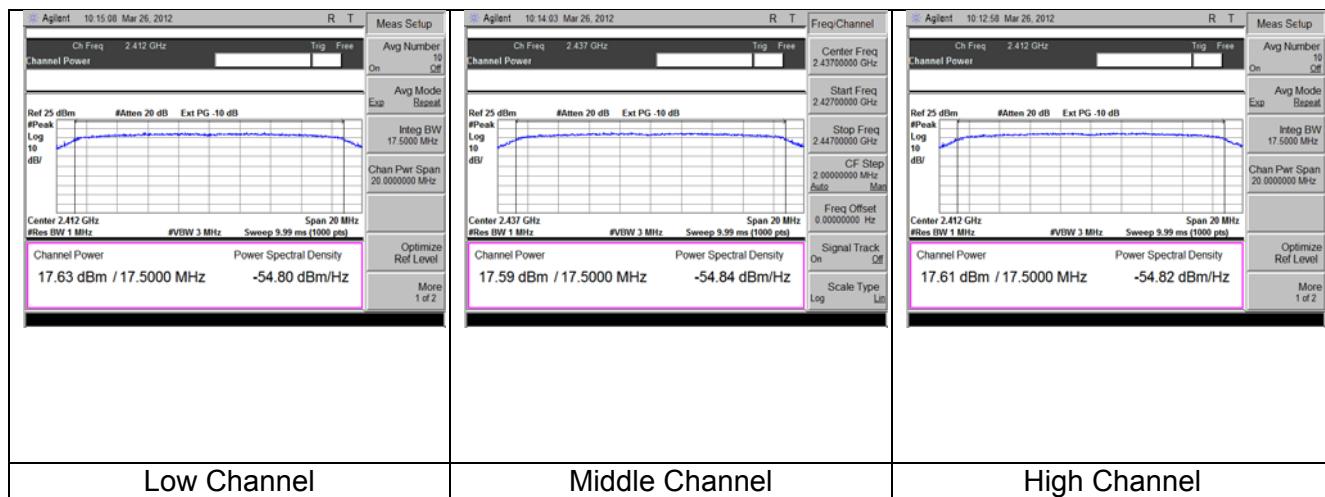


### 9.3.2.3 54MBPS



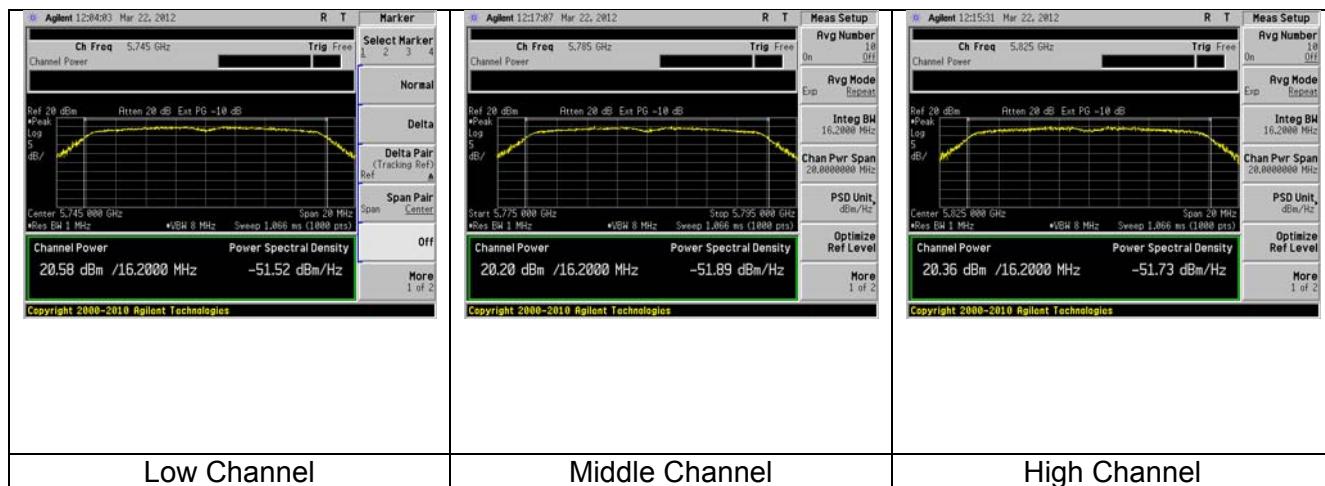
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 9.3.2.4 MCS7



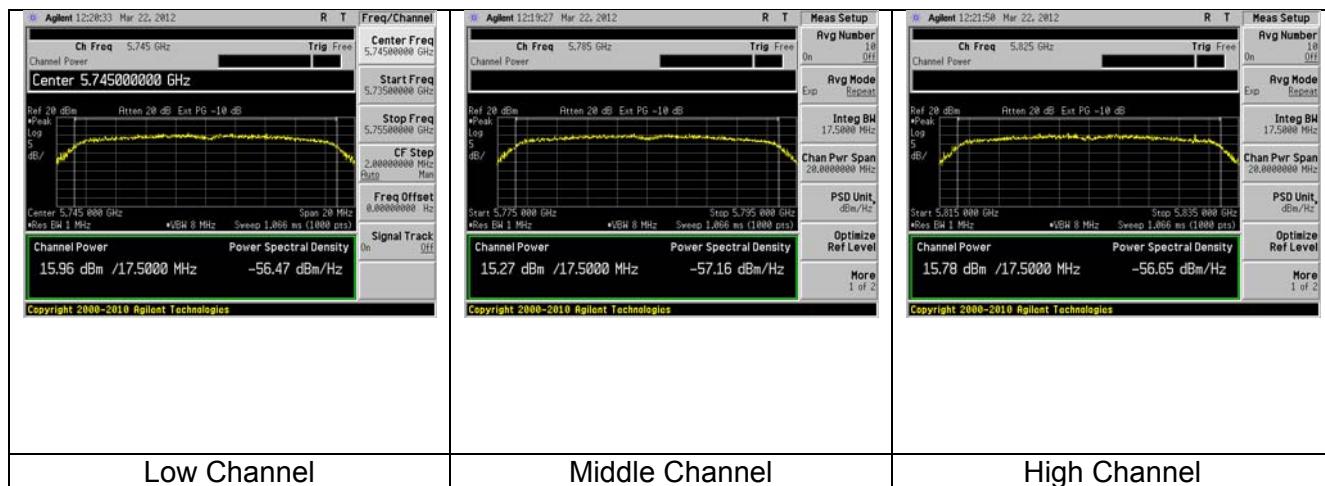
### 9.3.3 5.7GHz WLAN

#### 9.3.3.1 6MBPS

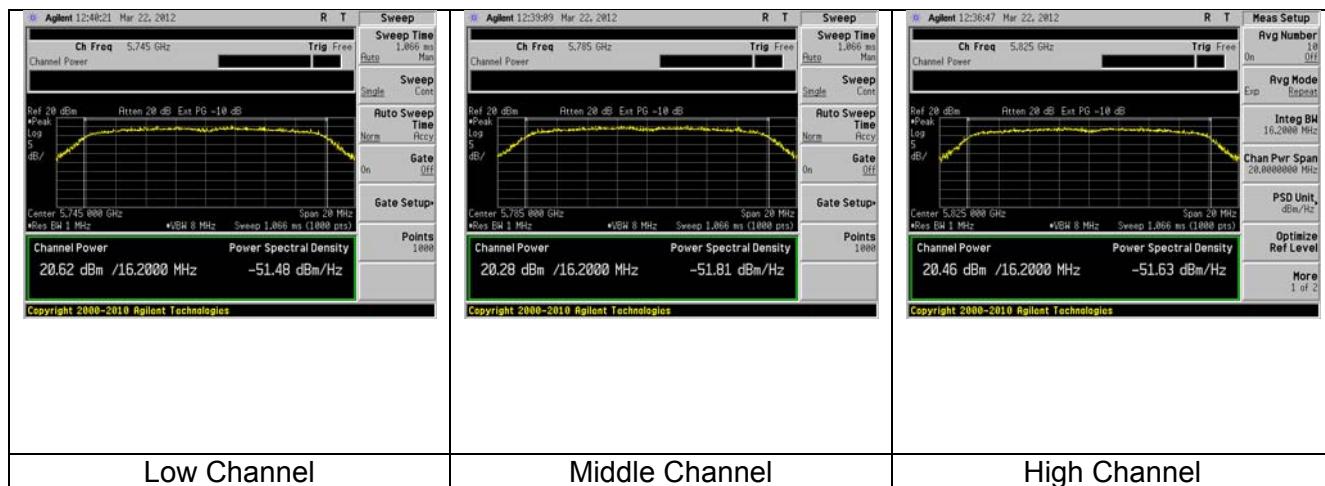


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 9.3.3.2 12MBPS

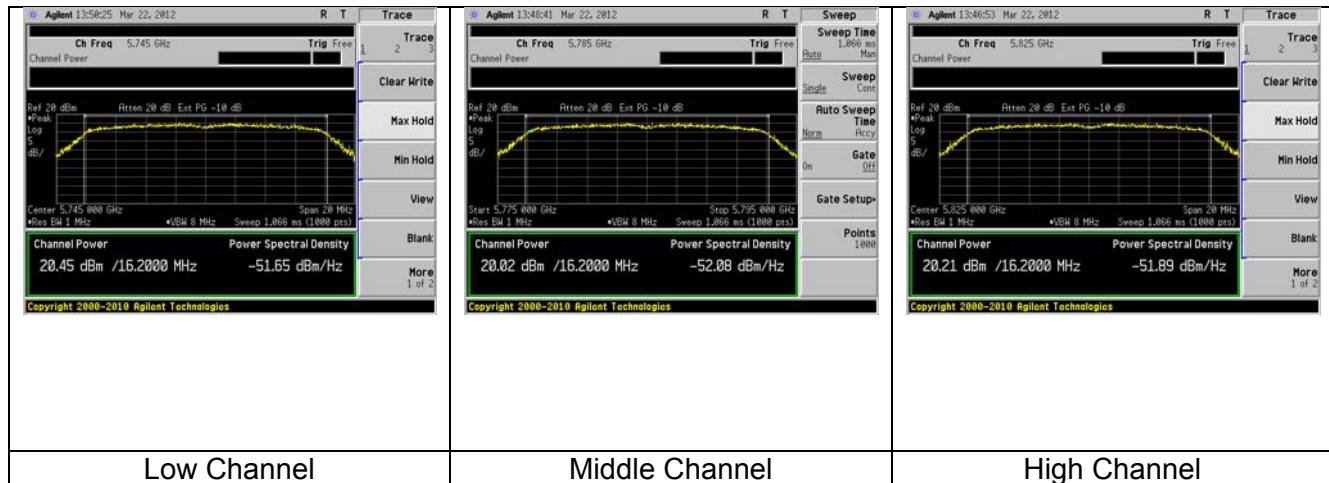


### 9.3.3.3 24MBPS



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 9.3.3.4 MCS7



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS: 15.247(d)

Test Engineer(s): Adam Alger and Khairul Aidi Zainal

### **10.1 - Limits**

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

### **10.2 - Conducted Harmonic And Spurious RF Measurements**

FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

**Measurement procedure used was FCC OET KDB 558074 D01 section 5.4**

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

**Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).**

**Generic example of reported data at 2440 MHz:**

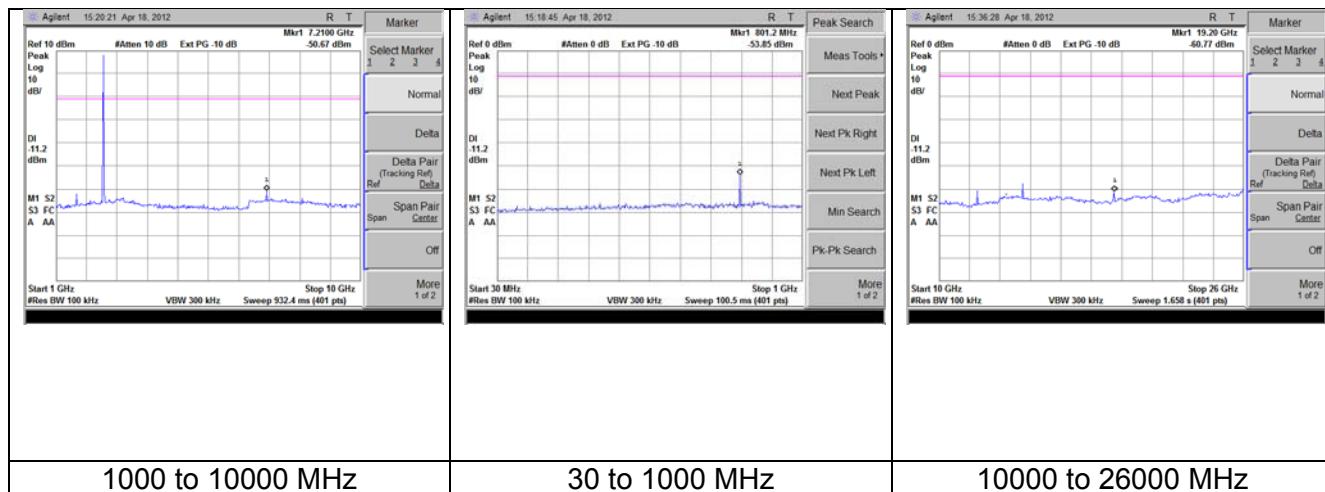
**Reported Measurement data = 8.55 (raw receiver measurement in dBm ) + 0.85 (cable factor in dB) = 9.4 (dBm).**

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## 10.3 - Test Data

The data presented below are samples selected from the various data rates and channels tested.

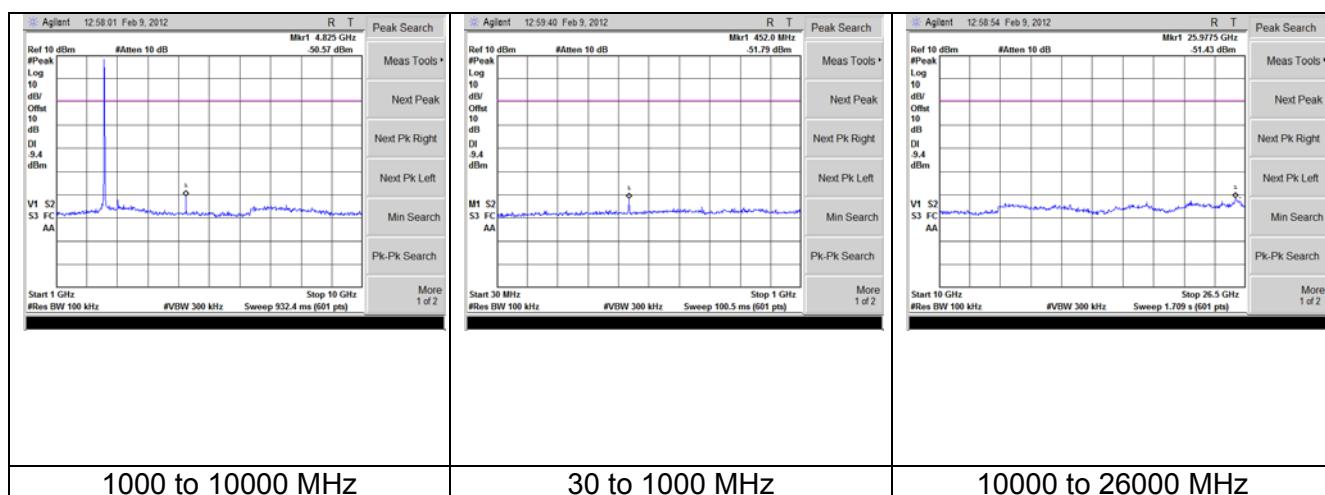
### 10.3.1 Bluetooth LE



Note: Range scan of Low Channel

### 10.3.2 2.4GHz WLAN

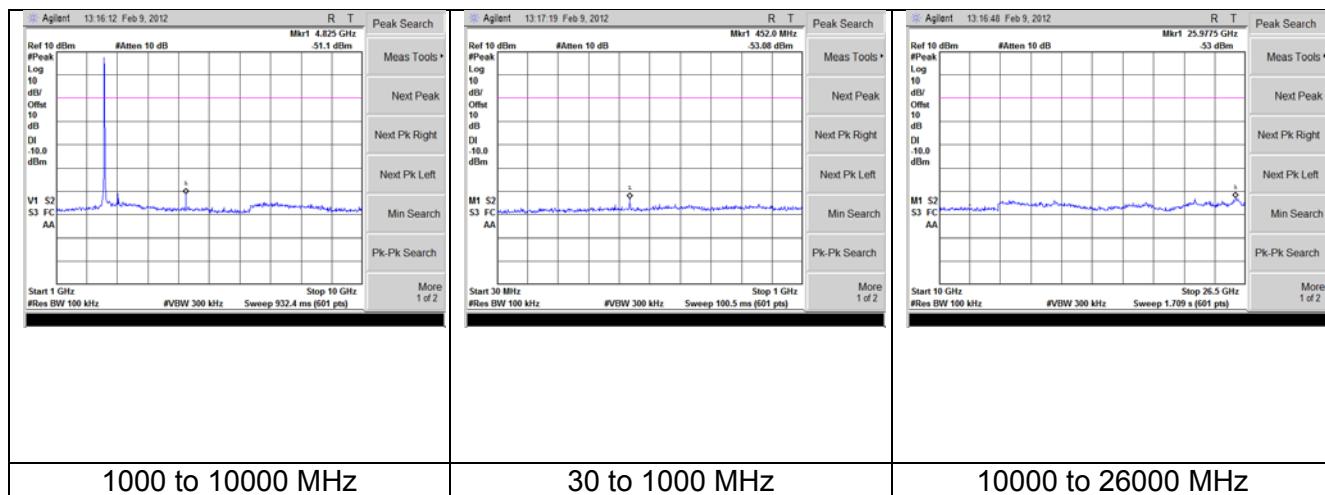
#### 10.3.2.1 1MBPS



Note: Range scan of Low Channel

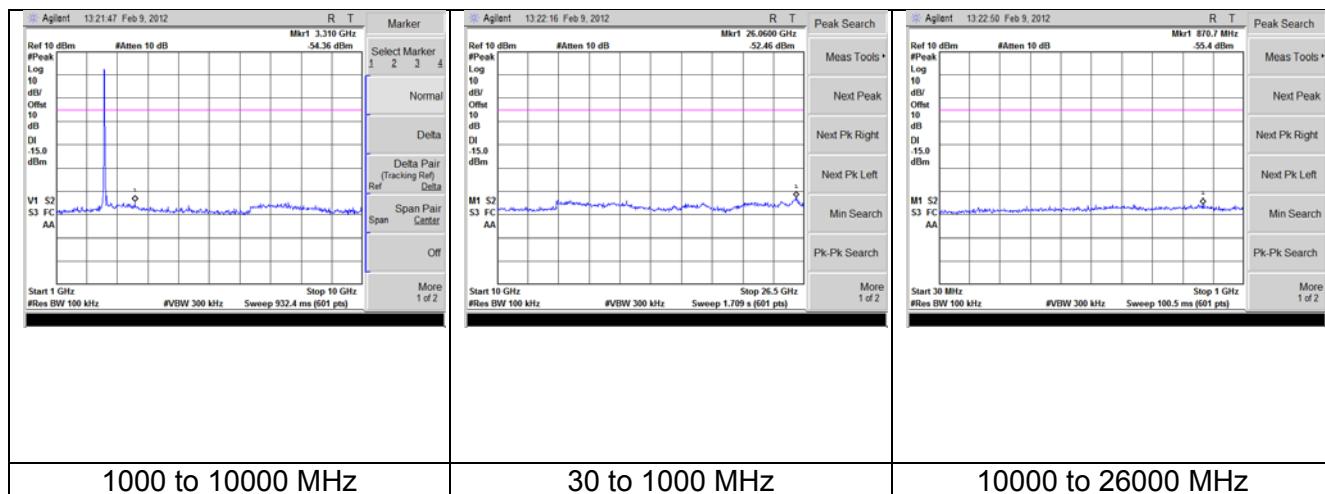
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 10.3.2.2 11MBPS



Note: Range scan of Low Channel

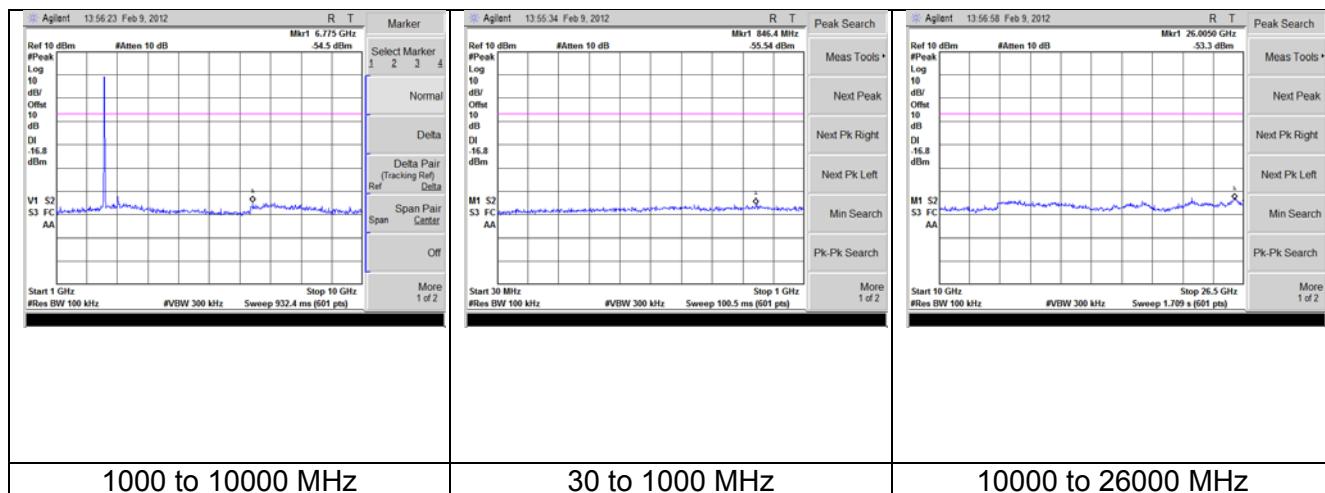
### 10.3.2.3 54MBPS



Note: Range scan of Low Channel

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

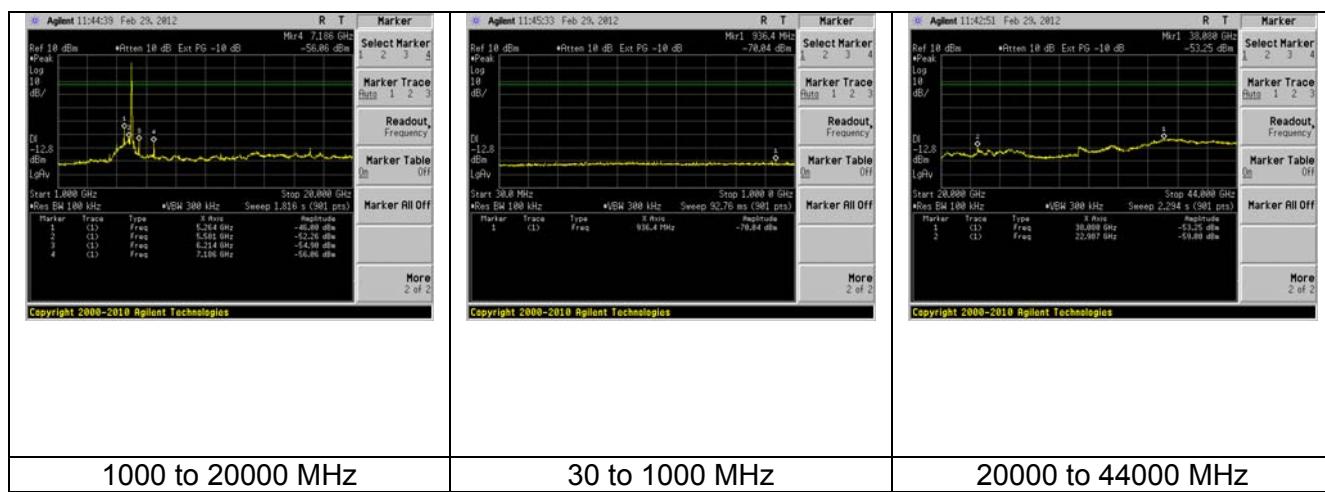
### 10.3.2.4 MCS7



Note: Range scan of Low Channel

### 10.3.3 5.7GHz WLAN

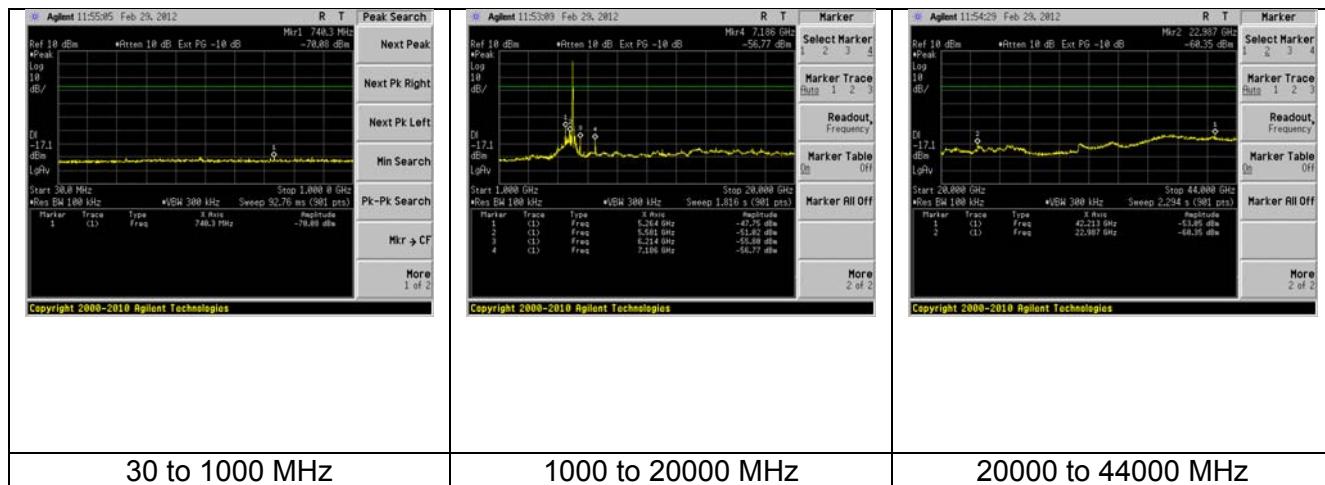
#### 10.3.3.1 6MBPS



Note: Range scan of Low Channel

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 10.3.3.2 MCS7



Note: Range scan of Low Channel

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 11. POWER SPECTRAL DENSITIES: 15.247(e)

### **11.1 Limits**

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The peak output frequency for each representative frequency was scanned, with a narrow bandwidth, and reduced sweep, and a power density measurement was performed.

**Measurement procedure used was FCC OET KDB 558074 D01 section 5.3.1**

The data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

**Reported Measurement data = Raw receiver measurement (dBm) + Cable factor (dB) + Miscellaneous factors when applicable (dB).**

**Generic example of reported data at 2440 MHz:**

**Reported Measurement data = 8.55 (raw receiver measurement in dBm ) + 0.85 (cable factor in dB) = 9.4 (dBm).**

### **11.2 Test Data**

Per FCC OET KDB 558074 D01, the power level in a 100kHz bandwidth was scaled to an equivalent value in kHz by applying a bandwidth correction factor (BWCF)

$$\text{BWCF} = 10\log(3\text{kHz}/100\text{kHz}) = -15.2\text{dB}$$

#### 11.2.1 Bluetooth LE

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
1 Mbps	0	2402	8.8	-6.4	8	14.4
	19	2440	8.8	-6.5	8	14.5
	39	2480	8.7	-6.5	8	14.5

Sample calculation:

$$\text{PKPSD (2440MHz)} = 8.8\text{dBm (100kHz)} - 15.2\text{dB} = -6.5\text{dBm (3kHz)}$$

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 11.2.2 2.4GHz WLAN

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
1 Mbps	1	2412	9.5	-5.7	8	13.7
	6	2437	9.2	-6.0	8	14.0
	11	2462	9.1	-6.1	8	14.1

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
11 Mbps	1	2412	9.0	-6.2	8	14.2
	6	2437	9.3	-5.9	8	13.9
	11	2462	9.1	-6.1	8	14.1

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
54 Mbps	1	2412	3.5	-11.7	8	19.7
	6	2437	3.4	-11.8	8	19.8
	11	2462	3.4	-11.8	8	19.8

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD 3kHz Limit (dBm)	PKPSD Margin (dB)
MCS7	1	2412	1.7	-13.5	8	21.5
	6	2437	1.5	-13.7	8	21.7
	11	2462	1.8	-13.4	8	21.4

Sample calculation:

PKPSD (2437MHz/MCS7) = 1.5dBm (100kHz) -15.2dB = -13.7dBm (3kHz)

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 11.2.3 5.7GHz WLAN

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
6 Mbps	149	5745	7.2	-8.0	8	16.0
	157	5785	6.2	-9.0	8	17.0
	165	5825	7.3	-7.9	8	15.9

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
12 Mbps	149	5745	7.5	-7.7	8	15.7
	157	5785	6.8	-8.4	8	16.4
	165	5825	6.6	-8.6	8	16.6

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
24 Mbps	149	5745	7.2	-8.0	8	16.0
	157	5785	6.9	-8.3	8	16.3
	165	5825	7.1	-8.1	8	16.1

Data Rate	Channel	Frequency (MHz)	*PKPSD 100 kHz (dBm)	*PKPSD 3 kHz (dBm)	PKPSD Limit (dBm)	PKPSD Margin (dB)
MCS7	149	5745	2.6	-12.6	8	20.6
	157	5785	2.2	-13.0	8	21.0
	165	5825	2.2	-13.0	8	21.0

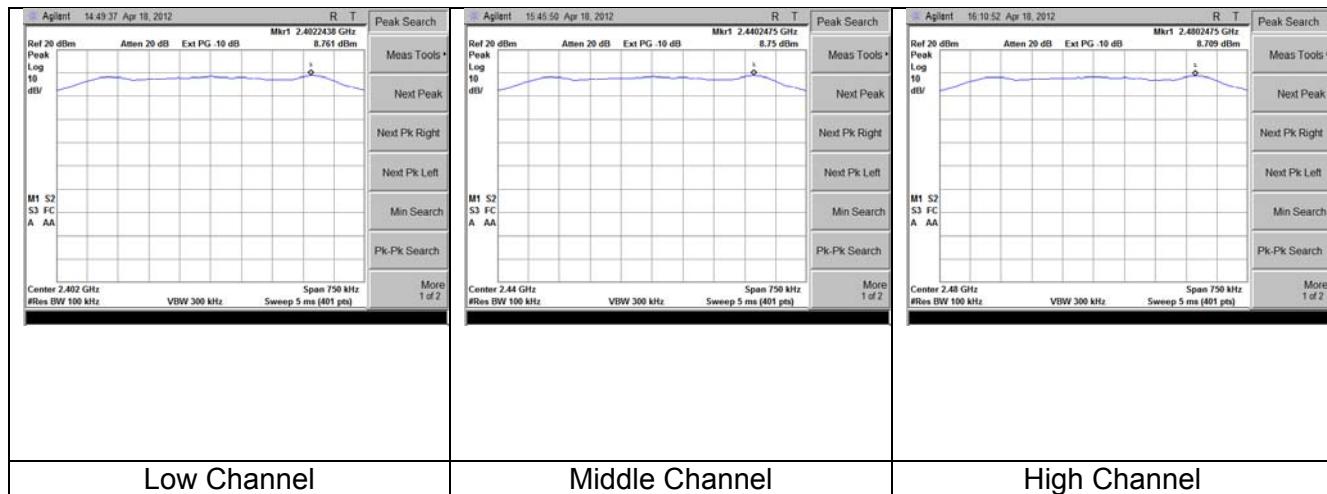
Sample calculation:

PKPSD (5785MHz/MCS7) = 2.2dBm (100kHz) -15.2dB = -13.0dBm (3kHz)

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

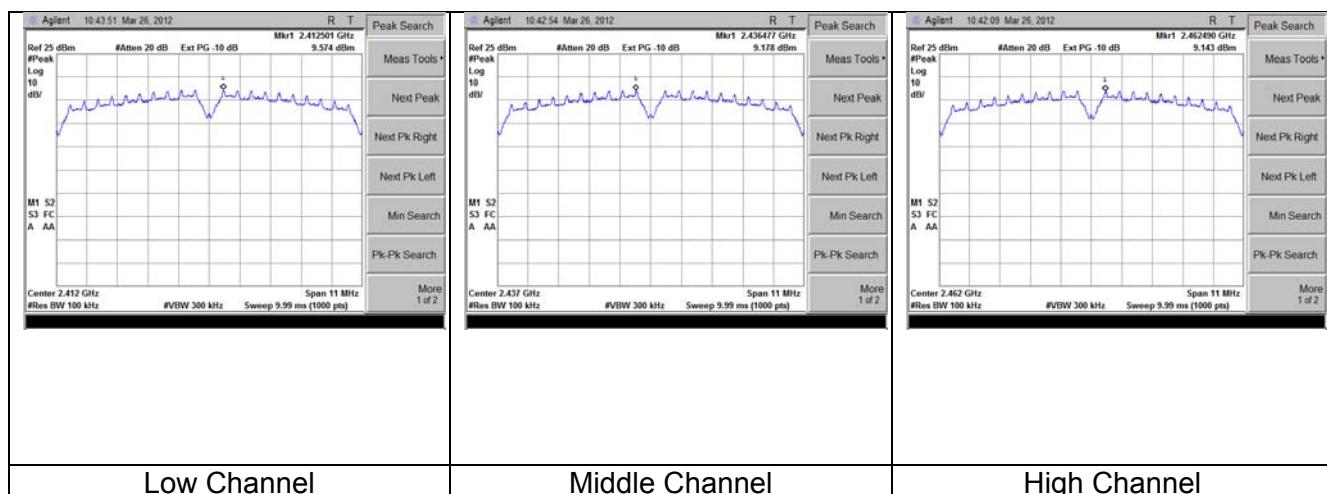
## 11.3 Screen Captures – Power Spectral Density

### 11.3.1 Bluetooth LE



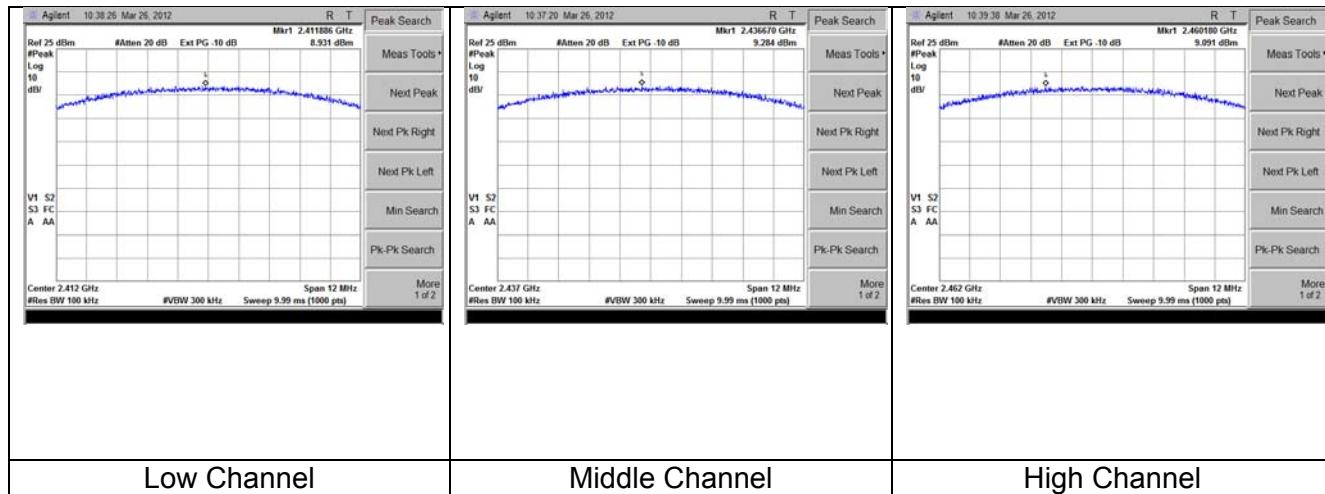
### 11.3.2 2.4GHz WLAN

#### 11.3.2.1 1MBPS

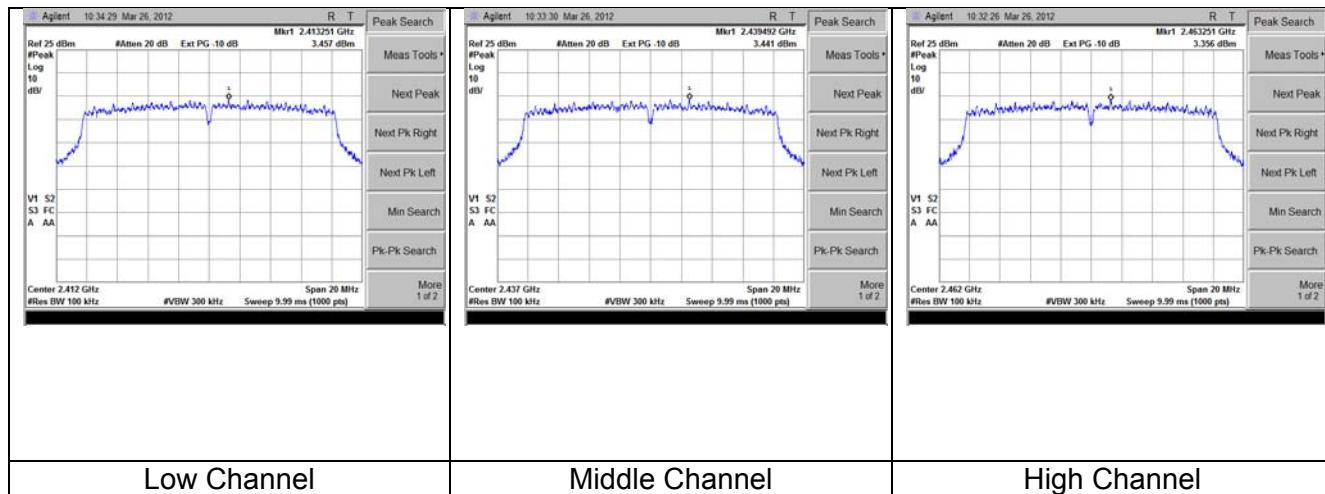


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 11.3.2.2 11MBPS

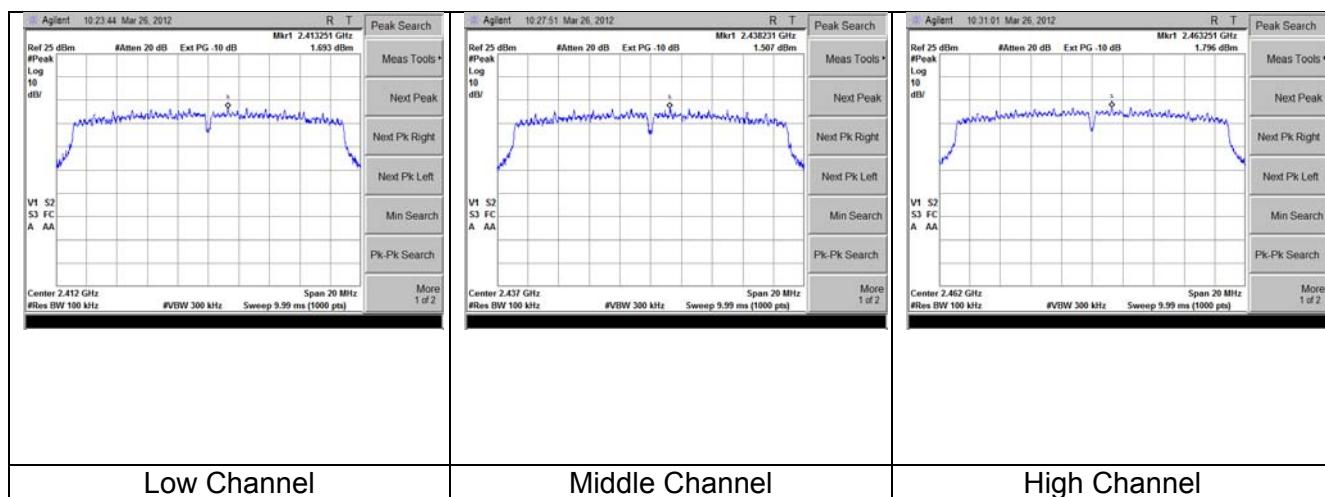


### 11.3.2.3 54MBPS



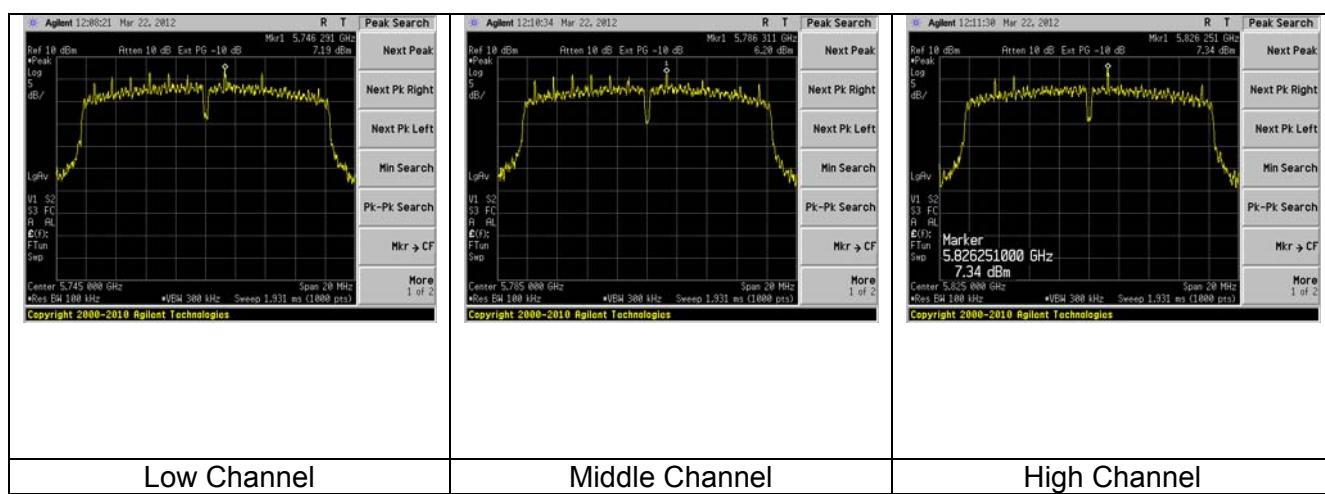
Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 11.3.2.4 MCS7



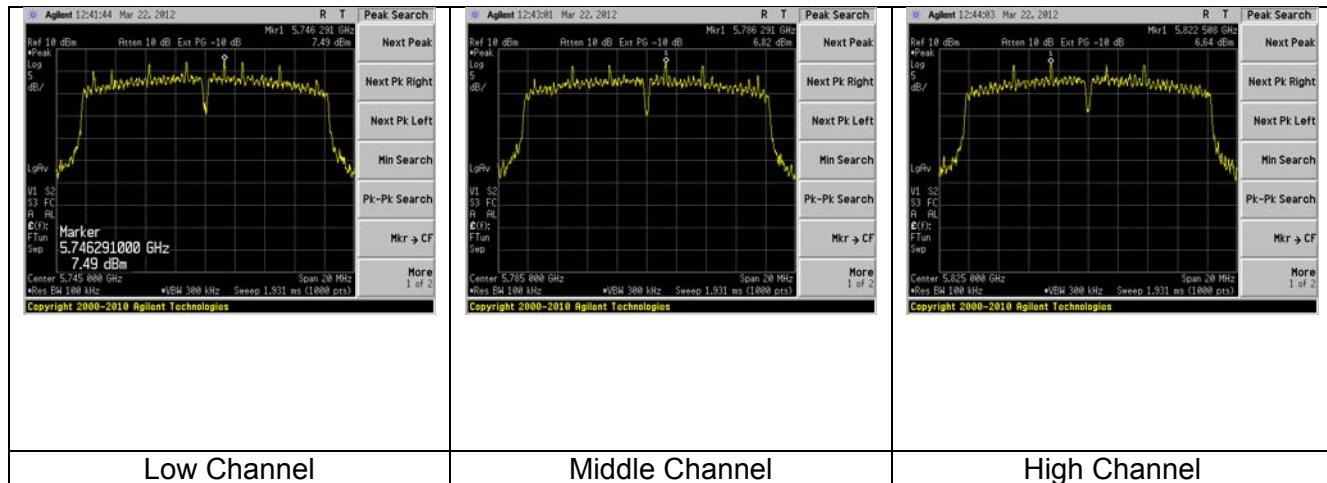
### 11.3.3 5.7GHz WLAN

#### 11.3.3.1 6MBPS

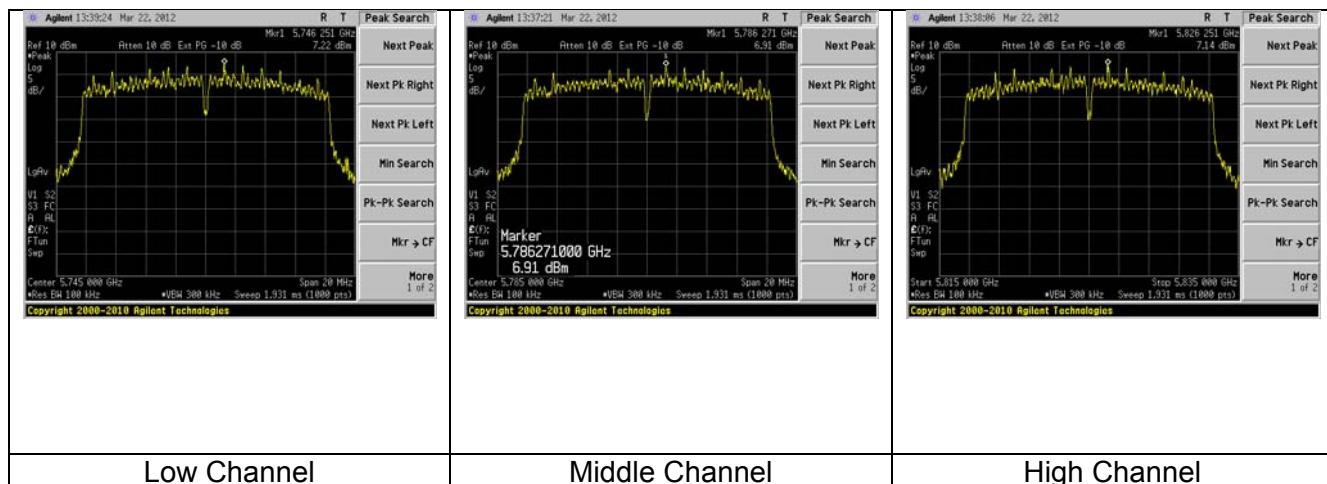


Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 11.3.3.2 12MBPS

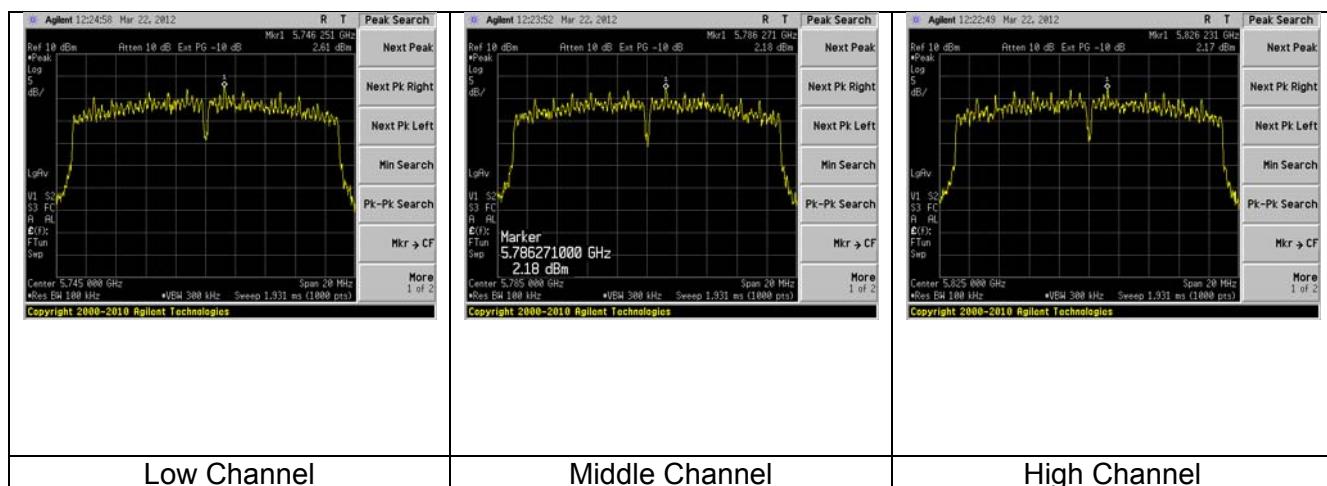


### 11.3.3.3 24MBPS



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

### 11.3.3.4 MCS7



Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

Test Engineer(s): Khairul Aidi Zainal

The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied  $\pm 15\%$  from the nominal.

### BLUETOOTH

	3.06 VDC		3.60 VDC		4.14 VDC		FREQ.DRIFT (Hz)	Pout DRIFT (dBm)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)		
LOW CHANNEL	9.4	2402000459	9.4	2402000479	9.4	2402000479	20	0.0
MID CHANNEL	9.4	2440000560	9.4	2440000560	9.4	2440000539	21	0.0
HIGH CHANNEL	9.2	2480000580	9.2	2480000560	9.2	2480000539	41	0.1

### WLAN 2.4 GHZ

	3.06 VDC		3.60 VDC		4.14 VDC		FREQ.DRIFT (Hz)	Pout DRIFT (dBm)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)		
LOW CHANNEL	6.1	2412000969	6.4	2412000990	6.2	2412000990	21	0.3
MID CHANNEL	6.6	2437000920	6.7	2437000940	6.6	2437000960	40	0.1
HIGH CHANNEL	6.5	2462000939	6.6	2462000960	6.7	2462000960	21	0.3

### WLAN 5.7 GHZ

	3.06 VDC		3.60 VDC		4.14 VDC		FREQ.DRIFT (Hz)	Pout DRIFT (dBm)
	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)	POWER (dBm)	FREQUENCY (Hz)		
LOW CHANNEL	3.8	5745002200	4.0	5745002300	4.0	5745002340	140	0.3
MID CHANNEL	2.7	5785002280	3.0	5785002360	3.2	5785002280	80	0.5
HIGH CHANNEL	2.1	5825002160	2.4	5825002220	2.6	5825002320	160	0.4

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## EXHIBIT 13. MPE CALCULATIONS

The following MPE calculations are based on a measured conducted RF power of 22dBm at 2437MHz and 20.6dBm at 5745MHz as presented to the antenna. The gain of this antenna, based on the data sheet is 2.0dBi.

### 13.1 2400 to 2483.5 MHz Band

#### Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal: 22.00 (dBm)

Maximum peak output power at antenna input terminal: 158.489 (mW)

Antenna gain(typical): 2 (dBi)

Maximum antenna gain: 1.585 (numeric)

Prediction distance: 20 (cm)

Prediction frequency: 2437 (MHz)

MPE limit for uncontrolled exposure at prediction frequency: 1 (mW/cm<sup>2</sup>)

Power density at prediction frequency: 0.049972 (mW/cm<sup>2</sup>)

Maximum allowable antenna gain: 15.0 (dBi)

Margin of Compliance at 20 cm = 13.0 dB

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## **13.2 5725 to 5850 MHz Band**

### **Prediction of MPE limit at a given distance**

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal: 20.60 (dBm)

Maximum peak output power at antenna input terminal: 114.815 (mW)

Antenna gain(typical): 2 (dBi)

Maximum antenna gain: 1.585 (numeric)

Prediction distance: 20 (cm)

Prediction frequency: 5745 (MHz)

MPE limit for uncontrolled exposure at prediction frequency: 1 (mW/cm<sup>2</sup>)

Power density at prediction frequency: 0.036202 (mW/cm<sup>2</sup>)

Maximum allowable antenna gain: 16.4 (dBi)

Margin of Compliance at 20 cm = 14.4 dB

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## APPENDIX A - Test Equipment List



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

Date: 20-Dec-2011

Type Test: Radiated Measurements

Job #: C-1371

Prepared By: Aidi

Customer: LSR

Quote #: 311362

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	U845300564	4/25/2011	4/25/2012	Active Calibration
2	EE 960147	Pre-Amp	Adv. Micro	WLA 612	123101	1/4/2011	1/4/2012	Active Calibration
3	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro	WLA 622-4	123001	1/13/2011	1/13/2012	Active Calibration
4	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY 40290225	6/6/2011	6/6/2012	Active Calibration
5	EE 960158	RF Preselector	Agilent	N8039A	MY 46520110	6/12/2011	6/12/2012	Active Calibration
6	EE 960161	26.5-40GHz LNA	Ducommun Techn	ALN-33144030	110317-01	10/4/2011	10/4/2012	Active Calibration
7	AA 960144	Phaseflex	Gore	EK0010010720	5800373	6/12/2011	6/12/2012	Active Calibration
8	AA 960005	Bi-conical Antenna	EMCO	93110B	9601-2200	6/10/2011	6/10/2012	Active Calibration
9	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	1/15/2011	1/15/2012	Active Calibration
10	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/4/2011	1/4/2012	Active Calibration
11	AA 960137	Double Ridge Horn Antenna	EMCO	3160-10	69259	10/4/2011	10/4/2012	Active Calibration
12	AA 960160	UNIFLEX Cable	Micro-Coax	UFC142A-0-0720-20121652-001		10/4/2011	10/4/2012	Active Calibration

Project Engineer: Aidi

Quality Assurance: PEIER



Wireless Product Development  
Equipment Calibration

Date: 20-Dec-2011

Type Test: Conducted measurements

Job #: C-1371

Prepared By: Aidi

Customer: LSR

Quote #: 311362

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960143	Phaseflex	Gore	EK0010010480	5546519	6/12/2011	6/12/2012	Active Calibration
2	CC 000221C	Spectrum Analyzer	HP	E4478B	U839160256	5/4/2011	5/4/2012	Active Calibration
3	EE 960073	Spectrum Analyzer	Agilent	E4446A	U845300564	4/25/2011	4/25/2012	Active Calibration
4	AA 960144	Phaseflex	Gore	EK0010010720	5800373	6/12/2011	6/12/2012	Active Calibration

Project Engineer: Aidi

Quality Assurance: ADAMALGER



Wireless Product Development  
Equipment Calibration

Date: 20-Dec-2011

Type Test: AC mains

Job #: C-1371

Prepared By: Aidi

Customer: LSR

Quote #: 311362

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960013	EMI Receiver	HP	0546A System	3617A00320;3448A	11/22/2011	11/22/2012	Active Calibration
2	EE 960014	EMI Receiver-filter section	HP	05460A	3448A00296	11/22/2011	11/22/2012	Active Calibration
3	AA 960072	Transient Limiter	HP	11947A	3107A02515	11/22/2011	11/22/2012	Active Calibration
4	AA 960075	USN	EMCO	38102NM	9612-1710	9/19/2011	9/19/2012	Active Calibration

Project Engineer: Aidi

Quality Assurance: Mike Hintzle

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## **APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO**

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2012		
RSS GEN	2010		
RSS 210	2010		

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371

## APPENDIX C - Uncertainty Statement

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

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.24 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.8 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.18 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.92 dB
Conducted Emissions	Shielded Room/EMCO LISN	1.60 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	1.128 Volts/Meter
Conducted Immunity	3 Volts level	1.0 V

	PARAMETER	LSR ± Uncertainty
1	Radio Frequency, from F0	±1.3x10 <sup>-7</sup>
2	Total RF conducted Power	±1.38 dB
3	RF conducted power density	±1.38 dB
4	Conducted spurious emissions	±1.38 dB
5	Radiated emissions	±4.87 dB
6	Temperature	±0.64° C
7	Humidity	±2.9 %
8	DC voltage	±0.03 %
9	Low frequency voltage	±0.1 %

Prepared For: LS Research	Model #: TiWi5	Report #: 311362A
EUT: TiWi5	Serial #: Conducted: SN 051201 Radiated: SN051205, SN011201, SN081201, SN361116	LSR Job #: C-1371