



LS RESEARCH, LLC

Wireless Product Development

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

ENGINEERING TEST REPORT # 313052 A

LSR Job #: C-1704

Compliance Testing of:

TiWi-BLE/TiWi-R2

Test Date(s):

12-20-12, 4-27-13, 4-30-13, 5-1-13, 5-2-13, 5-6-13

Prepared For:

LS Research
W66 N220 Commerce Court
Cedarburg, WI 53012

This Test Report is issued under the Authority of:

Khairul Aidi Zainal, Senior EMC Engineer

Signature: 

Date: 6/26/2013

Test Report Reviewed by:

Adam Alger, EMC Engineer

Signature: 

Date: 6-25-13

Report by:

Khairul Aidi Zainal, Senior EMC Engineer

Signature: 

Date: 5/28/13

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Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

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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

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1.0 Summary of Test Report

The purpose of these tests is to request a Class II permissive change to FCC ID: TFB-TIWI1-01 and IC: 5969A-TIWI101, to add an antenna.

The TiWi-BLE/TiWi-R2 was tested and MEETS the following DTS requirements:

Rule	Description	Procedure	Compliant	Note
FCC: 15.247(a)(1) IC: RSS-210 A8.1(a)	Emission Bandwidth 20dB & 99%	ANSI C63.4-2003 ANSI C63.10-2009	Yes	2
FCC: 15.247(b) IC: RSS-210 A8.4	Maximum Output Power	ANSI C63.4-2003 ANSI C63.10-2009	Yes	2
FCC: 15.247(d) IC: RSS-210 A8.5	Radiated Emissions at Band-edge	ANSI C63.4-2003 ANSI C63.10-2009	Yes	1
FCC: 15.247(d) IC: RSS-210 A8.5	Radiated Harmonics	ANSI C63.4-2003 ANSI C63.10-2009	Yes	1
FCC: 15.247(d) IC: RSS-210 A8.5	Radiated Emissions	ANSI C63.4-2003 ANSI C63.10-2009	Yes	1
FCC: 15.109 IC: RSS-GEN	Receiver radiated Emissions	ANSI C63.4-2003 ANSI C63.10-2009	Yes	1

Note 1: Tested in three orthogonal positions.

Note 2: RF Conducted measurement at antenna terminal.

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.

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3.0 Client Information

Manufacturer Name:	LS Research
Address:	W66 N220 Commerce Court Cedarburg, WI 53012
Contact Person:	Brian Petted

3.1 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

Product Name:	TiWi-BLE/TiWi-R2
Model Number:	TiWi-BLE and TiWi-R2
Serial Number:	RF Conducted: 3-016212, 3-030099; Radiated: 3-030099,3-030098
FCC ID	TFB-TIWI1-01
IC Number	5969A-TIWI101

3.2 Product Description

The TiWi-BLE/TiWi-R2 module is a multi-standard module with support for WLAN (802.11 b/g/n), Bluetooth V2.1 and Bluetooth 4.0.

BLE

Frequency Range (MHz)	2402-2480MHz
RF Power In Watts (conducted)	Max: 10.12 mW; Min: 9.57 mW
Max Conducted Output Power (dBm)	10.05
Occupied Bandwidth 99%	1.345 MHz
Type of Modulation	GFSK
Emission Designator	945KF1D
Transmitter Spurious (worst case) at 3 meters	48.7 dB μ V/m at 4880 MHz
Stepped (Y/N)	N
Step Value	N/A
Frequency Tolerance %,Hz, ppm	Better than 100 ppm
Antenna: Detachable / Non-detachable	detachable
Antenna: Type	Ground coupled dipole antenna
Antenna Gain (Peak)	3.0 dBi
FCC Rule Part	Title 47 Part 15.247
Industry Canada Rule Part	RSS-210 Issue 8 2010
Modular Filing	Yes
RF Exposure Type	Mobile
Receiver Spurious (worst case) at 3 meters	40.0 dB μ V/m at 115.4 MHz

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WLAN

Frequency Range (MHz)	2412-2462MHz
RF Power In Watts (conducted)	WL1: Max 0.092683; Min 0.07585 WL2: Max 0.020277; Min 0.01667
Max Conducted Output Power (dBm)	WL1: 19.67 WL2: 13.07
Transmitter Spurious (worst case) at 3 meters	47.6 dB μ V/m at 4924 MHz
Stepped (Y/N)	N
Step Value	N/A
Frequency Tolerance %,Hz, ppm	Better than 100 ppm
Antenna: Detachable / Non-detachable	detachable
Antenna: Type	Ground coupled dipole
Antenna Gain (Peak)	3.0 dBi
FCC Rule Part	Title 47 Part 15.247
Industry Canada Rule Part	RSS-210 Issue 8 2010
Modular Filing	Yes
RF Exposure Type	Mobile
Receiver Spurious (worst case) at 3 meters	40.0 dB μ V/m at 115.4 MHz

3.3 Modifications Incorporated In the EUT for Compliance Purposes

None

3.4 Deviations & Exclusions from Test Specifications

To compare output power measurements to originally reported output power data the previous methods of measurement were utilized as a direct comparison of values.

4.0 Conditions of Test

Environmental:

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

Mains Voltage:

3.3VDC from bench supply

5.0 Additional Information

The EUT was programmed from a laptop computer with LSR's proprietary control program. Once programmed the radio was powered from a bench supply at 3.3VDC.

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6.0 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. For average measurements above 1000MHz the video bandwidth is set at 10Hz.

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

7.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247 (2011) and Industry Canada RSS-210, Issue 8 (2010)

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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Appendix A – Test Equipment



Date: 25-Apr-2013 Type Test: Radiated measurements Job #: C-1704
 Prepared By: Aidi Customer: Arritsu Quote #: 313052

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960 156	100MHz - 1GHz Analog Signal Generator	Agilent	N5181A	MY 49060062	6/30/2012	6/30/2013	Active Calibration
2	EE 960 158	RF Resolocator	Agilent	N8039A	MY 48520110	6/29/2012	6/29/2013	Active Calibration
3	EE 960 157	3Hz - 13.2GHz Spectrum Analyzer	Agilent	E4445A	MY 48250225	6/29/2012	6/29/2013	Active Calibration
4	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	5/16/2012	5/16/2013	Active Calibration
5	EE 960 160	0.9-21GHz LNA	Mini-Circuits	ZVA-213K-S+	977711030	9/17/2012	9/17/2013	Active Calibration
6	AA 960005	Biconical Antenna	EMCO	93110B	9801-2280	6/26/2012	6/26/2013	Active Calibration
7	AA 960004	Log Periodic Antenna	EMCO	93146	9512-4276	9/17/2012	9/17/2013	Active Calibration
8	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	1/29/2013	1/29/2014	Active Calibration
9	AA 960144	Phaselink	Gore	EK0010010720	5800373	6/19/2011	6/19/2013	Active Calibration
10	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration
11	EE 960146	Skd. Gain Horn Ant. w/preamp	Adv. Micro / EMCO	WLA622-4 / 3160-09	123001	9/26/2012	9/26/2013	Active Calibration
12	EE 960147	Pre-Amp	Adv. Micro	WLA612	123101	2/12/2013	2/12/2014	Active Calibration
13	OC 000221C	Spectrum Analyzer	HP	E4407B	US39160256	6/5/2012	6/5/2013	Active Calibration

Project Engineer: [Signature] Quality Assurance: Peter Finken



Date: 13-Aug-2012 Type Test: Conducted measurements Job #: C-1520
 Prepared By: Adam Customer: LSR Quote #: 312182

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Phaselink	Gore	EK0010010720	5800373	6/19/2011	6/19/2013	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	5/9/2012	5/9/2013	Active Calibration

Project Engineer: [Signature] Quality Assurance: [Signature]

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Appendix B – Test Data

B.1 – RF Conducted Measurements

Manufacturer	LS Research
Date	8-23-12, 12-20-12
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Test Voltage	3.3 VDC
Test Location	LS Research, LLC – Bench Measurements
Rule Part	15.247
Measurement Procedure	Measurement of Digital Transmission Systems Operating under Section 15.247 March 23, 2005 (please refer to section 3.4 of this report)
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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Summary of Output Power Measurements Compared to Original Reported Measurements using original measurement method:

Mode	Channel	Frequency (MHz)	Original Reported Power (dBm) ^{Note 1}	Measured Power (dBm)
WLAN 1Mbps	1	2412	19.54	19.39
	6	2437	19.67	19.42
	11	2462	18.80	18.76
WLAN MCS7	1	2412	13.07	12.97
	6	2437	12.66	12.45
	11	2462	12.22	12.21
BLE	0	2402	9.81	9.64
	20	2442	9.86	9.66
	39	2480	10.05	9.54

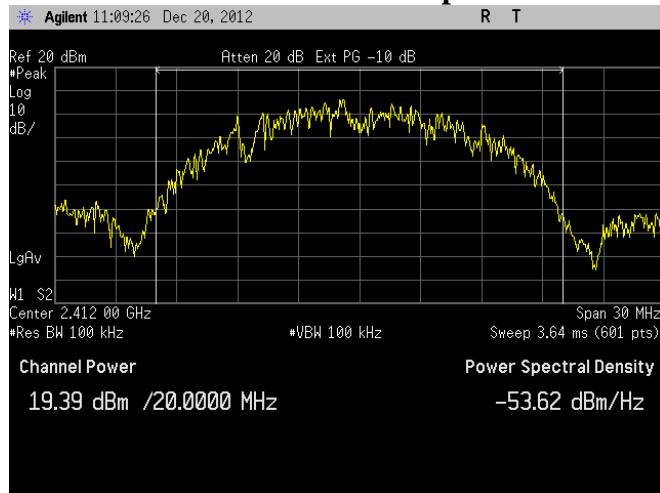
Notes:

1. From report TR 310117 (2010) and TR 311258 (2012) of same FCC / IC ID.

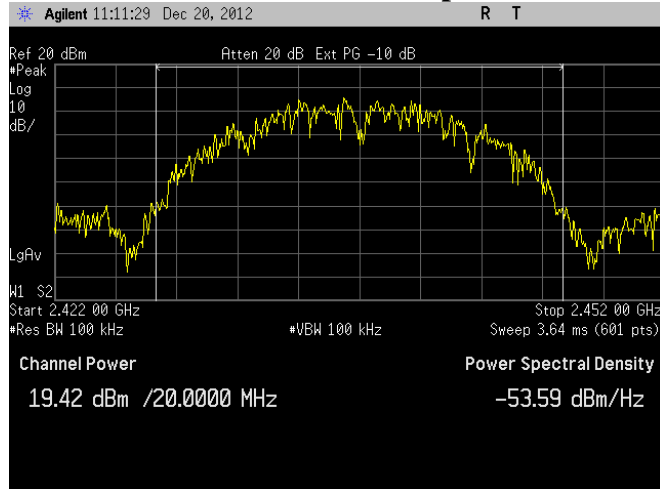
Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Output Power measured with original measurement methods:

Channel 1 – 1 Mbps

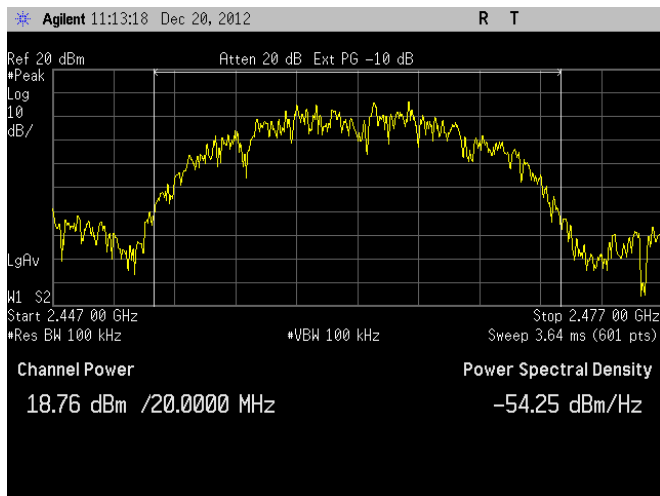


Channel 6 – 1 Mbps

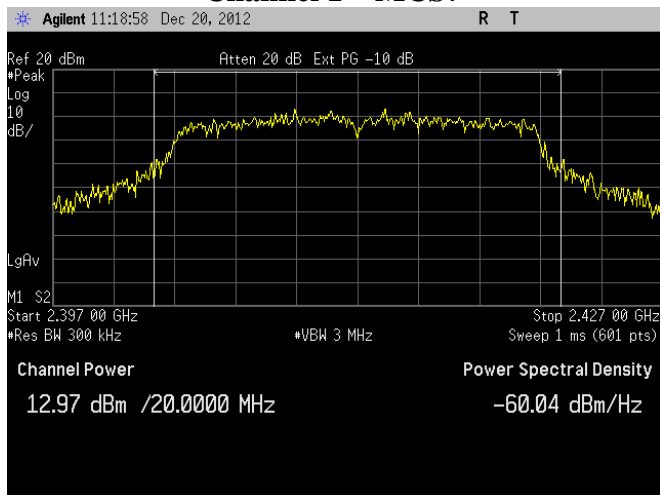


Channel 11 – 1 Mbps

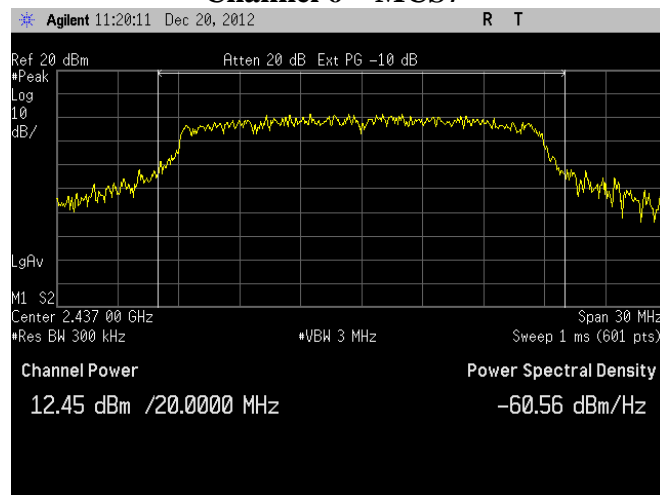
Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
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Channel 1 – MCS7

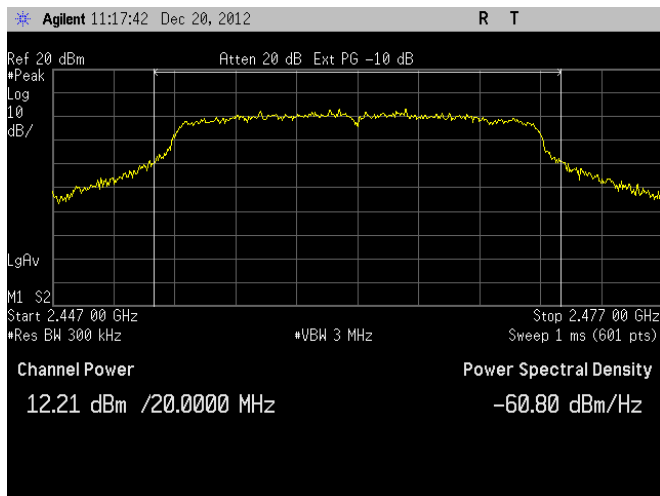


Channel 6 – MCS7

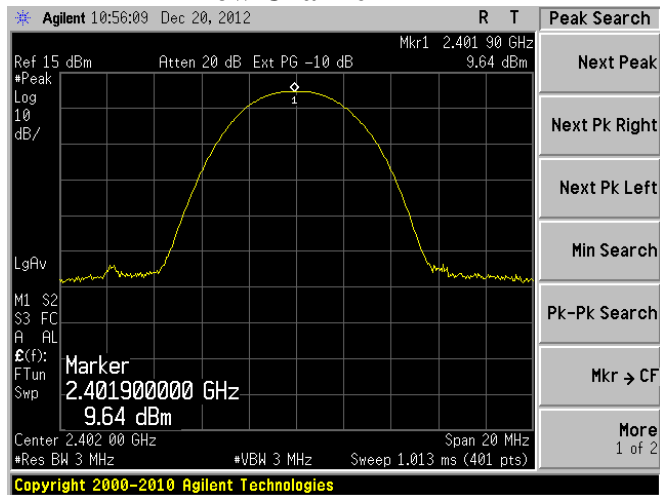


Channel 11 – MCS7

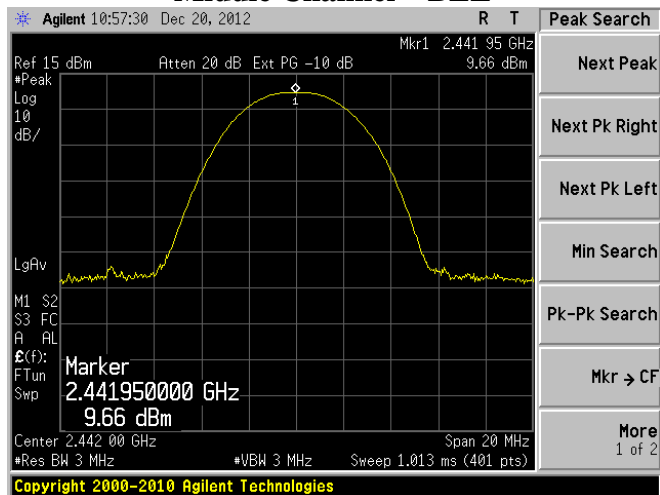
Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
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Low Channel – BLE

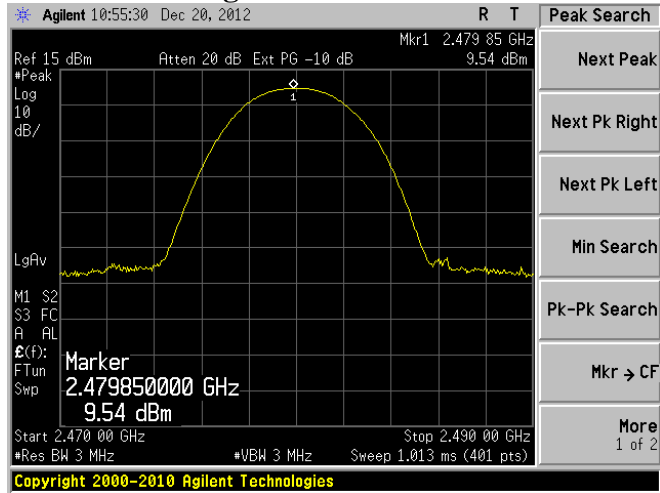


Middle Channel – BLE



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High Channel – BLE



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B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.247(d) / 15.205 / 15.209 / IC: RSS-210 A8.2 (b) / RSS-210 Section 2.2, 2.6, 2.7			
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 – 2009 FCC KDB 558074 D01 DTS Meas Guidance v03r01			
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	3 meters : 30 - 4000 MHz 1 meter: 4 - 26 GHz			
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: 18-25GHz
Measurement Detectors	30-1000MHz Peak Detector RBW: 120 kHz VBW: 300 kHz		1 - 26 GHz: Peak Detector RBW : 1MHz VBW: 3MHz (Peak Measurement) VBW: 10Hz (Average Measurement)	
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 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	<p>Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)</p> <p><u>Generic example of reported data at 200 MHz:</u> Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBμV/m).</p>			

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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)

B.2.1 – Radiated Harmonics in Restricted Bands above 1 GHz

Manufacturer	LS Research
Date	April 30 th to May 6 th 2013
Operator	Aidi Zainal, Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Test Voltage	3.3 VDC
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber
Rule Part	15.247 / 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009 FCC KDB 558074 D01 DTS Meas Guidance v03
Test Distance	3 meter (1-4 GHz) 1 meter (4-10 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	RBW 1MHz; Peak (VBW 3MHz); Average (VBW 10Hz)
Additional Notes	1) Tested in the worst case of continuous transmit GFSK (BLE) and 1 Mbps (WLAN) modulated mode for radiated harmonics in restricted bands in low, mid, and high channels with EUT Antenna in three orthogonal positions with all channels at maximum power.

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Tables:

A. WLAN Transmit Harmonics in Restricted bands

Channel 1 (2412 MHz) Harmonics:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Avg Reading (dBμV/m)	Avg Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4824	1.00	203	57.3	53.0	63.5	10.5	Horizontal	Flat
7236	1.04	49	55.0	45.9	63.5	17.6	Horizontal	Vertical
12060	Note 1							
14472	1.00	271	61.8	54.3	63.5	9.2	Horizontal	Side
19296	1.00	68	58.1	56.0	63.5	7.5	Horizontal	Side

Channel 6 (2437 MHz) Harmonics:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Avg Reading (dBμV/m)	Avg Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4884	1.14	25	59.5	56.2	63.5	7.3	Horizontal	Flat
7326	1.07	228	54.9	45.1	63.5	18.4	Horizontal	Flat
12210	Note 1							
19536	1.00	66	56.1	52.6	74.0	21.4	Horizontal	Side

Channel 11 (2462 MHz) Harmonics:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Avg Reading (dBμV/m)	Avg Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation
4924	1.04	323	59.5	57.1	63.5	6.4	Horizontal	Side
7386	Note 1							
12310	Note 1							
19696	1.03	68	55.7	52.8	74.0	21.2	Horizontal	Side
22158	Note 1							

Notes:

1. Emission buried within system noise floor.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.

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B. Bluetooth (BLE Mode) Radiated Harmonics in restricted bands

Lowest Channel (2402 MHz) Harmonics:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB μ V/m)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4804	1.06	218	59.8	57.8	63.5	5.7	Horizontal	Side
12010	Note 1							
19216	1.00	172	57.6	52.2	74.0	21.8	Vertical	Vertical

Middle Channel (2440 MHz) Harmonics:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB μ V/m)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4880	1.00	331	60.2	58.2	63.5	5.3	Horizontal	Side
7320	1.05	231	57.8	52.9	63.5	10.6	Horizontal	Flat
12200	Note 1							
19520	1.00	37	58.4	54.1	63.5	9.4	Horizontal	Vertical

Highest Channel (2480 MHz) Harmonics:

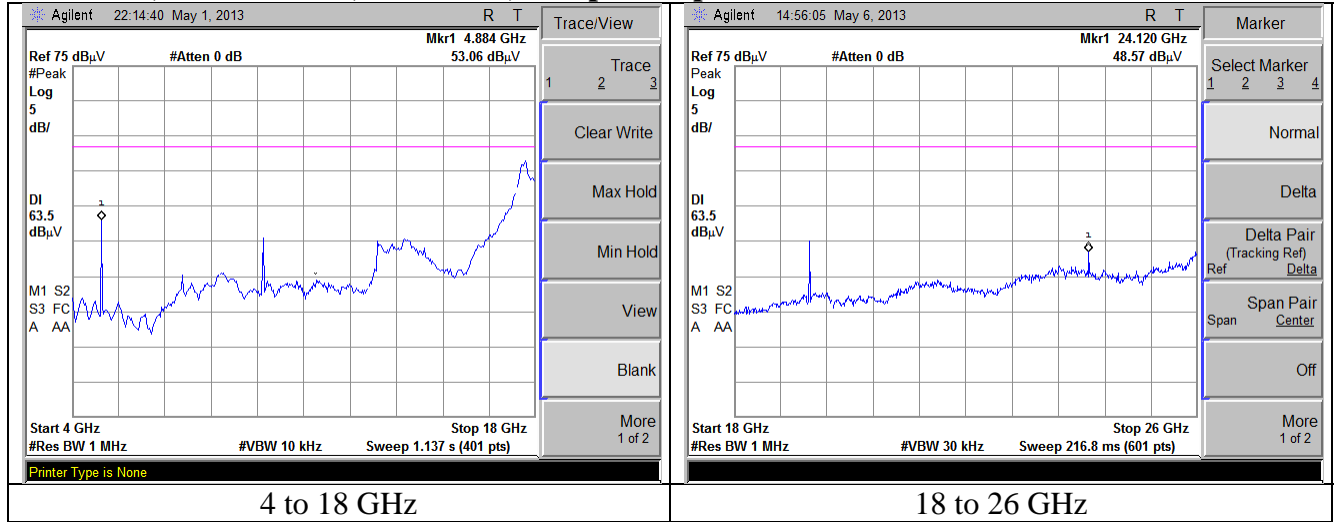
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dB μ V/m)	Avg Reading (dB μ V/m)	Avg Limit (dB μ V/m)	Margin (dB)	Antenna Polarity	EUT orientation
4133	1.08	241	59.0	55.5	63.5	8.0	Horizontal	Side
4960	1.00	73	58.7	55.1	63.5	8.4	Horizontal	Side
7440	1.05	228	58.9	52.0	63.5	11.5	Horizontal	Flat
12400	1.00	25	55.0	45.1	63.5	18.4	Horizontal	Flat
19840	1.00	36.3	57.2	52.1	63.5	11.4	Horizontal	Side
22320	Note 1							

Notes:

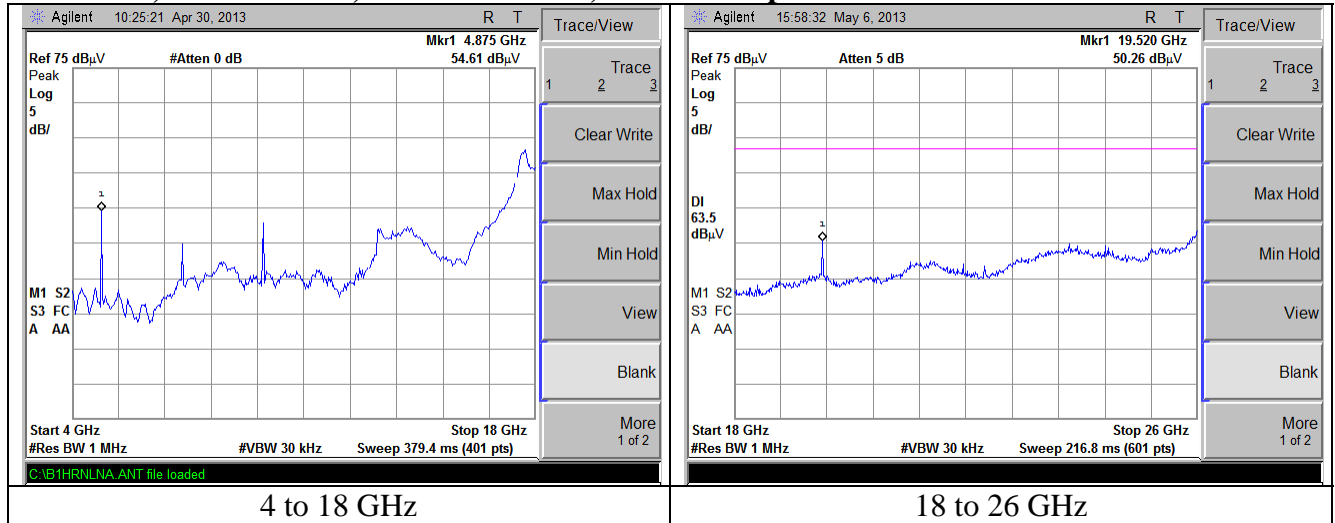
1. Emission buried within system noise floor.
2. Measurements above 4 GHz were made at 1 meters of separation from the EUT. The limits were adjusted to reflect this measurement distance.

Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Plots:
WLAN Transmit Harmonics in Restricted bands
4-26 GHz, Vertical EUT, Channel 6, 1Mbps max power



Bluetooth Radiated Harmonics in restricted bands
4-26 GHz, Vertical EUT, Middle Channel, GFSK max power



Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

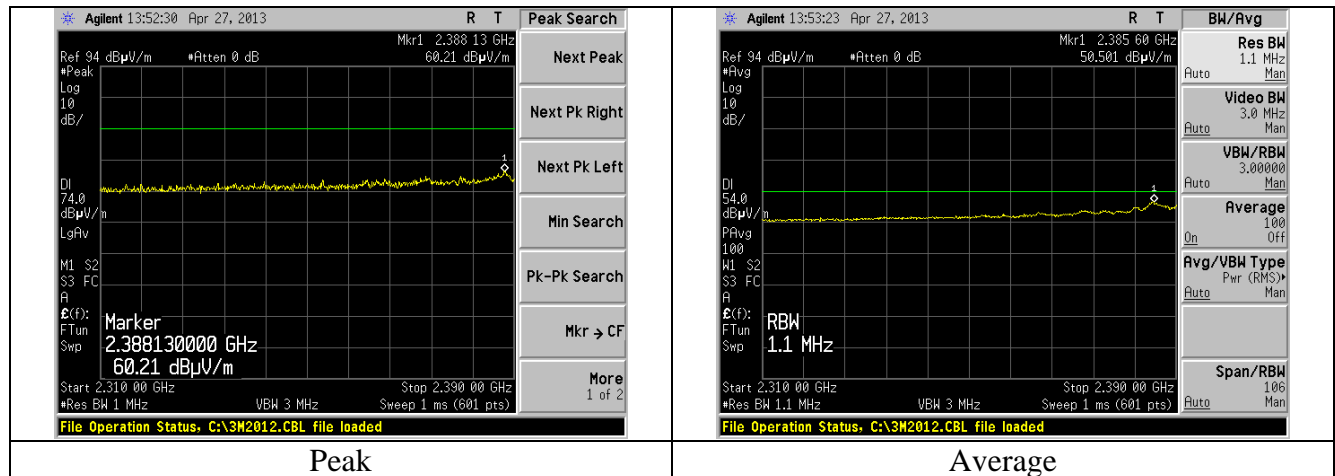
B2.2 - Radiated Band-edge into restricted bands

Manufacturer	LS Research
Date	April 27 th to May 2 nd 2013
Operator	Khairul Aidi Zainal, Peter Feilen
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Test Voltage	3.3 VDC
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber
Rule Part	15.247 / 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2003 ANSI C63.10 - 2009 FCC KDB 558074 D01 DTS Meas Guidance v02 section 10.2
Test Distance	3 meter
EUT Placement	80 cm height non-conductive table
Detectors	Peak and RMS RBW 1MHz; VBW 3MHz;
Additional Notes	1) Tested in continuous transmit modulated mode in low and high channels with EUT Antenna in three orthogonal positions.

WLAN Mode:

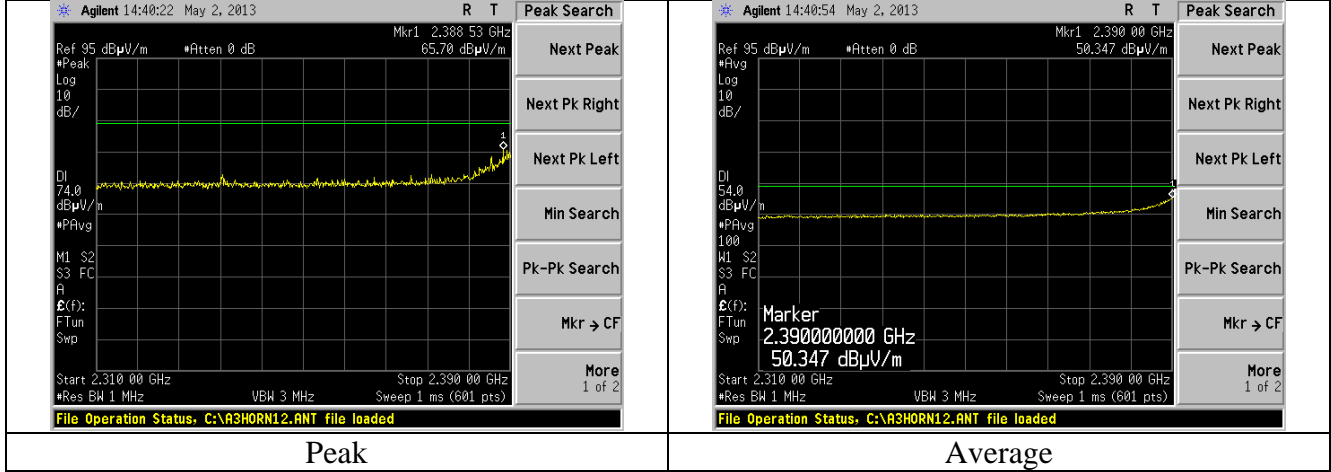
Lower Band-edge into restricted band (2310 MHz to 2390 MHz)

1 MBPS



Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

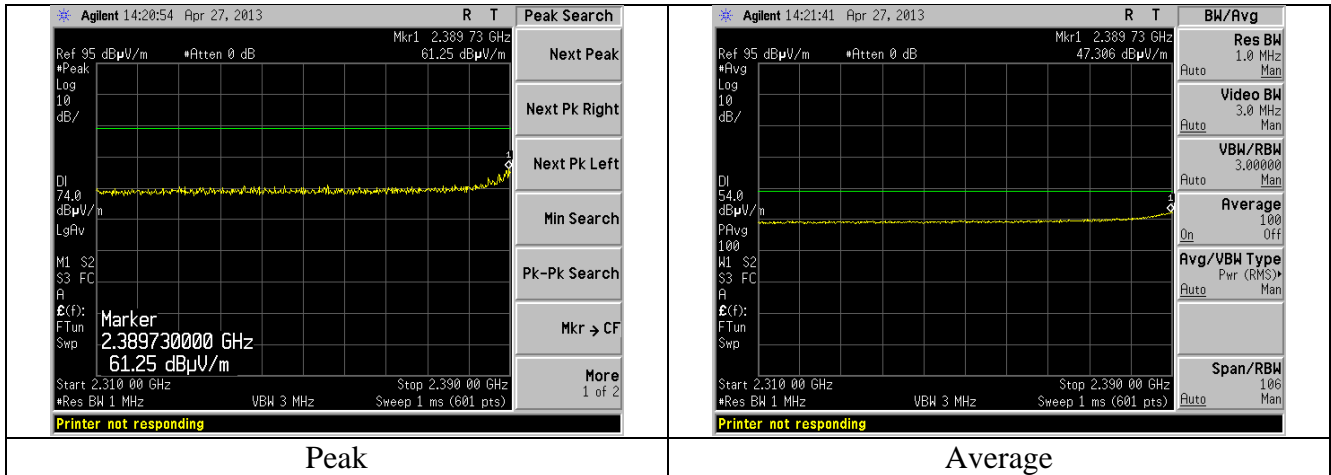
54 MBPS



Peak

Average

MCS7



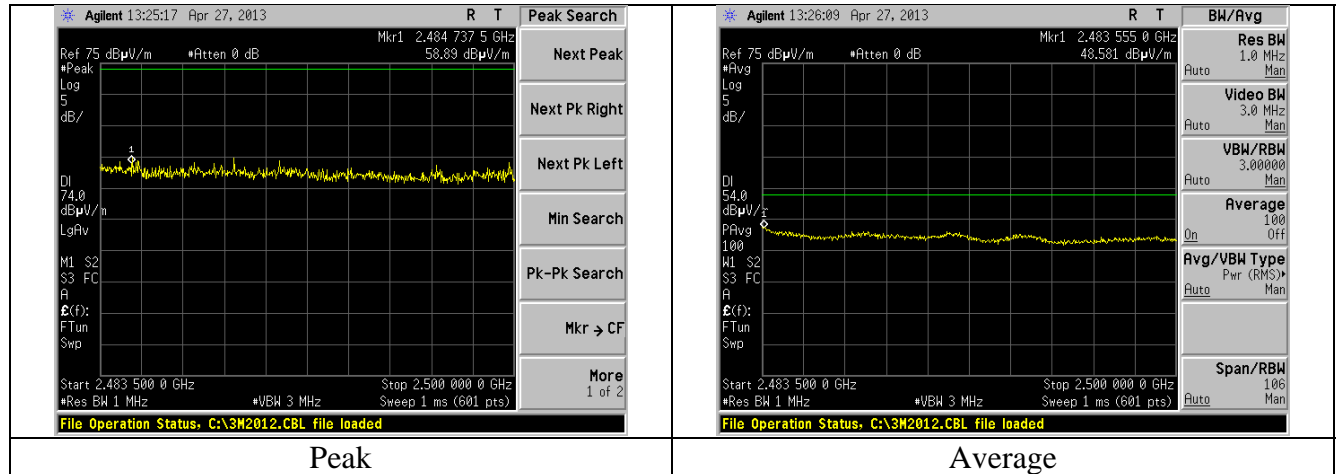
Peak

Average

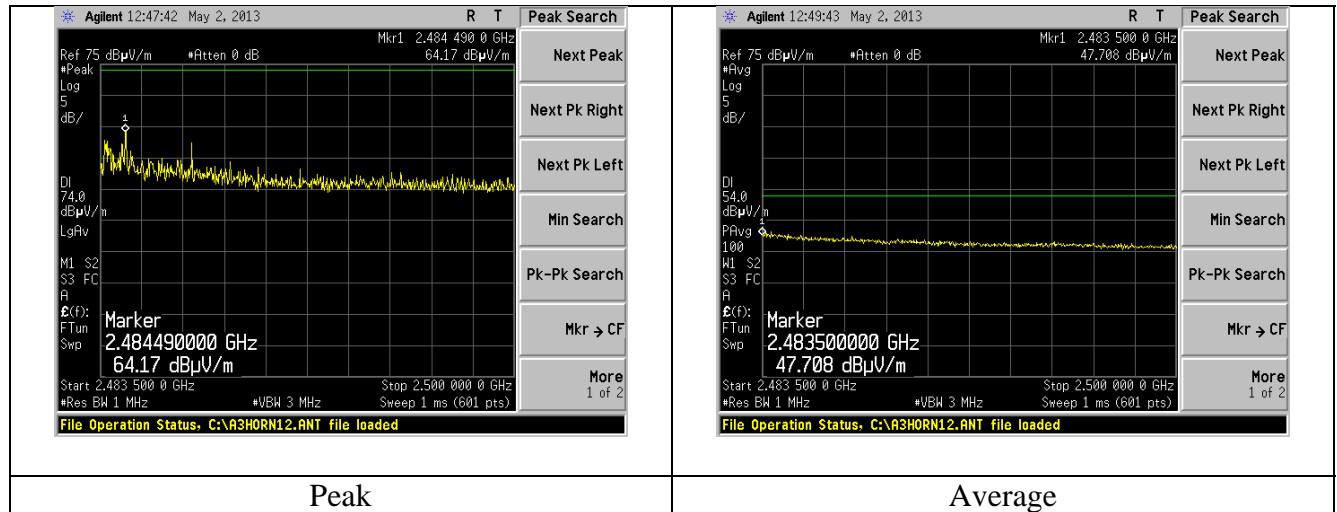
Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Upper Band-edge into restricted band (2483.5 MHz to 2500 MHz)

1 MBPS



54 MBPS



Prepared For: LS Research

Report: TR 313052 A

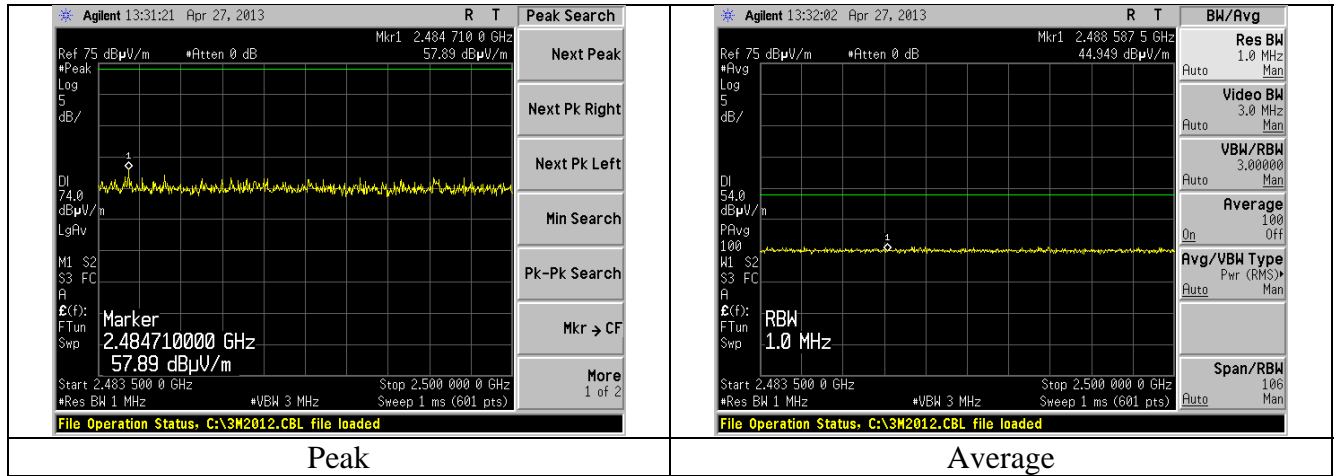
LSR: C-1704

Name: TiWi-BLE/TiWi-R2

Model: TiWi-BLE & TiWi-R2

Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

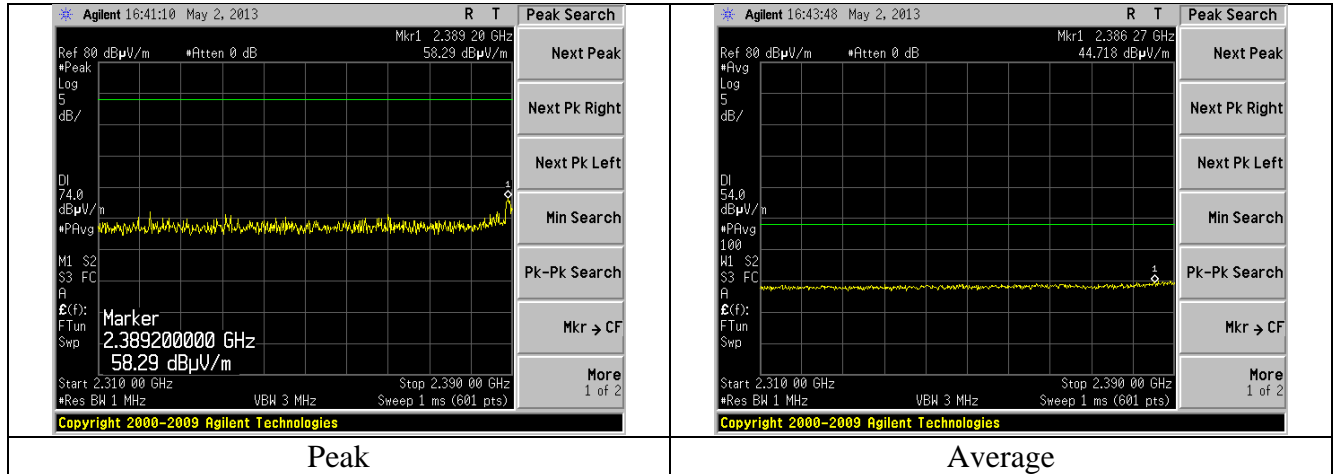
MCS7



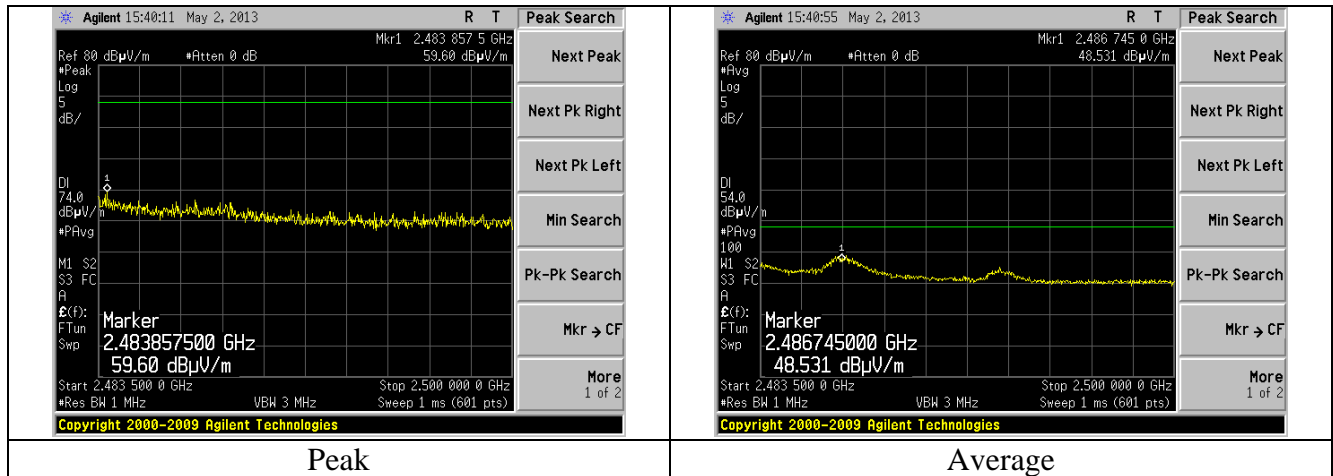
Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Bluetooth (BLE Mode)

Radiated Lower Band-edge into restricted bands (2310 MHz to 2390 MHz)



Radiated Upper Band-edge into restricted bands



Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

B.2.3 – Receive Mode Radiated Emissions

Manufacturer	LS Research
Date	April 30 th to May 6 th 2013
Operator	Mike Hintzke, Peter Feilen.
Temperature	20 - 25° C
Humidity	30 – 60%
Test Voltage	3.3 VDC
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber
Test Distance	3 meter (30 MHz to 4 GHz) 1 meter (4 GHz to 26 GHz)
EUT Placement	80 cm height non-conductive table
Measurements	Final
Detectors	Peak, Quasi-Peak, Average
Additional Notes	1) Emissions 30-4000MHz tested in receive mode on low, mid, high channels in three orientations. No significant difference noted in emissions from mode or channel selection. Worst case reported. 2) Emissions 4-26 GHz tested in Bluetooth BLE receive and WLAN receive on low, mid, high channels in three orientations and reported in separate tables/plots.

30-1000MHz

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
114.8	1.66	258	26.8	43.0	16.2	H	V
115.4	1.00	236	40.0	43.0	3.0	V	V
114.6	1.00	0	39.4	43.0	3.6	V	S
114.5	1.00	219	36.6	43.0	6.4	V	F
126.5	1.00	0	33.8	43.0	9.2	V	F
298.6	1.00	226	31.6	46.0	14.4	H	V
325.9	1.42	185	33.8	46.0	12.2	V	V
298.3	1.00	217	34.8	46.0	11.2	H	S
299.2	1.00	248	37.4	46.0	8.6	H	F
298.2	1.00	290	35.3	46.0	10.7	V	F

Notes:

1. Emissions seen in this range were not a function of EUT mode, channel or power level; likely related to the power supply.
2. H: Horizontal; V: Vertical; S: Side.

Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Bluetooth Receive Mode 4-26 GHz

Frequency (GHz)	Height (m)	Azimuth (degree)	Peak Reading (dB μ V/m)	Average Reading (dB μ V/m)	Peak Limit (dB μ V/m)	Peak Margin (dB)	Average Limit (dB μ V/m)	Average Margin (dB)	Antenna Polarity	EUT orientation	Notes
1.795	1.00	0	38.4	27.2	74.0	35.6	54.0	26.8	H	V	1
2.435	1.00	0	36.0	29.9	74.0	38.0	54.0	24.2	H	V	1
3.830	1.00	0	45.8	35.6	74.0	28.2	54.0	18.4	H	V	1

Notes:

1. Measurement of system noise floor
2. H: Horizontal; V: Vertical; S: Side.

WLAN Receive Mode Emissions 4-26 GHz

Frequency (GHz)	Height (m)	Azimuth (degree)	Peak Reading (dB μ V/m)	Average Reading (dB μ V/m)	Peak Limit (dB μ V/m)	Peak Margin (dB)	Average Limit (dB μ V/m)	Average Margin (dB)	Antenna Polarity	EUT orientation
1.795	1.00	0	38.4	27.2	74.0	35.6	54.0	26.8	H	V
2.435	1.00	0	36	29.9	74.0	38.0	54.0	24.2	H	V
3.830	1.00	0	45.8	35.6	74.0	28.2	54.0	18.4	H	V
9.748	1.00	210	56.9	51.7	83.5	26.6	63.5	11.8	H	V
9.748	1.31	179	55.8	49.2	83.5	27.7	63.5	14.3	V	V
9.748	1.18	2	54.8	50.0	83.5	28.7	63.5	13.5	V	S
9.748	1.00	190	55.1	48.9	83.5	28.4	63.5	14.7	H	S
9.748	1.00	39	54.5	49.3	83.5	29.1	63.5	14.2	H	F
9.748	1.00	96	54.5	49.5	83.5	29.0	63.5	14.0	V	F
9.648	1.00	192	55.9	51.6	83.5	27.6	63.5	11.9	H	V
9.848	1.00	19	56.8	51.8	83.5	26.7	63.5	11.7	H	V
19.696	1.00	66	53.7	49.0	83.5	29.8	63.5	14.5	V	V
19.696	1.00	92	53.3	48.6	83.5	30.2	63.5	14.9	H	V
19.696	1.00	272	55.8	52.8	83.5	27.7	63.5	10.7	H	S
19.696	1.03	243	54.1	48.3	83.5	29.4	63.5	15.2	V	S
19.696	1.02	13	53.9	49.5	83.5	29.6	63.5	14.0	V	F
19.696	1.00	216	54.0	50.1	83.5	29.5	63.5	13.4	H	F
19.536	1.00	273	56.8	53.0	83.5	26.7	63.5	10.5	H	S
19.296	1.00	73	56.1	53.3	83.5	27.4	63.5	10.3	H	S

Prepared For: LS Research

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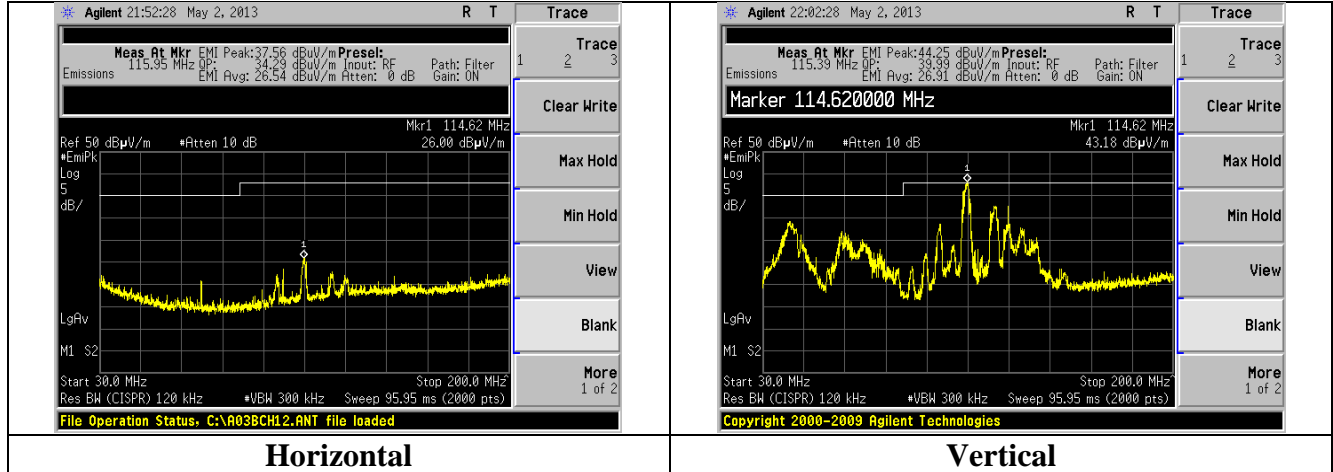
Name: TiWi-BLE/TiWi-R2

Model: TiWi-BLE & TiWi-R2

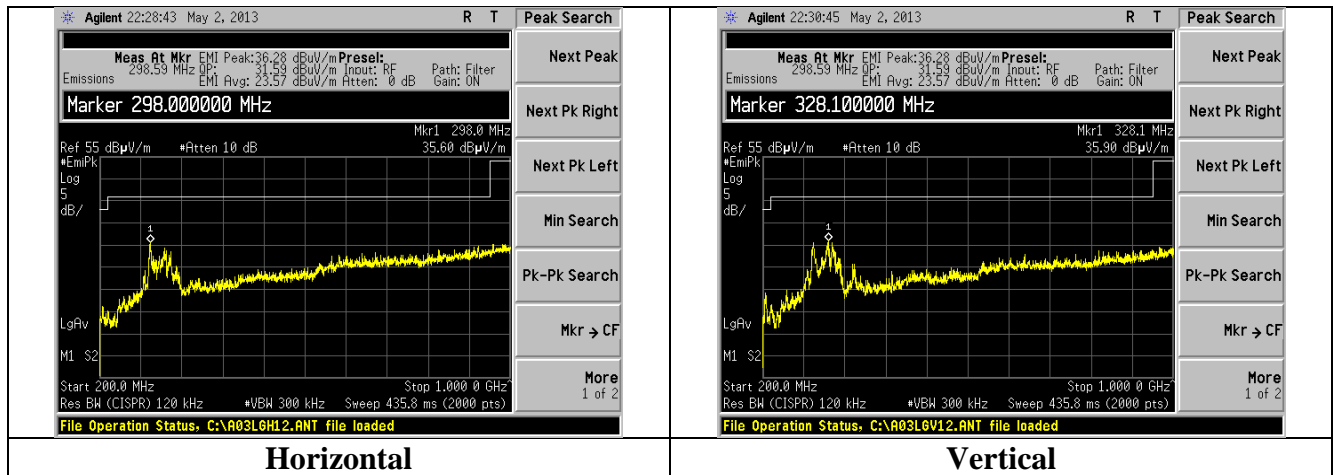
Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Plots:

30 MHz to 200 MHz



200 MHz to 1000 MHz



Prepared For: LS Research

Report: TR 313052 A

LSR: C-1704

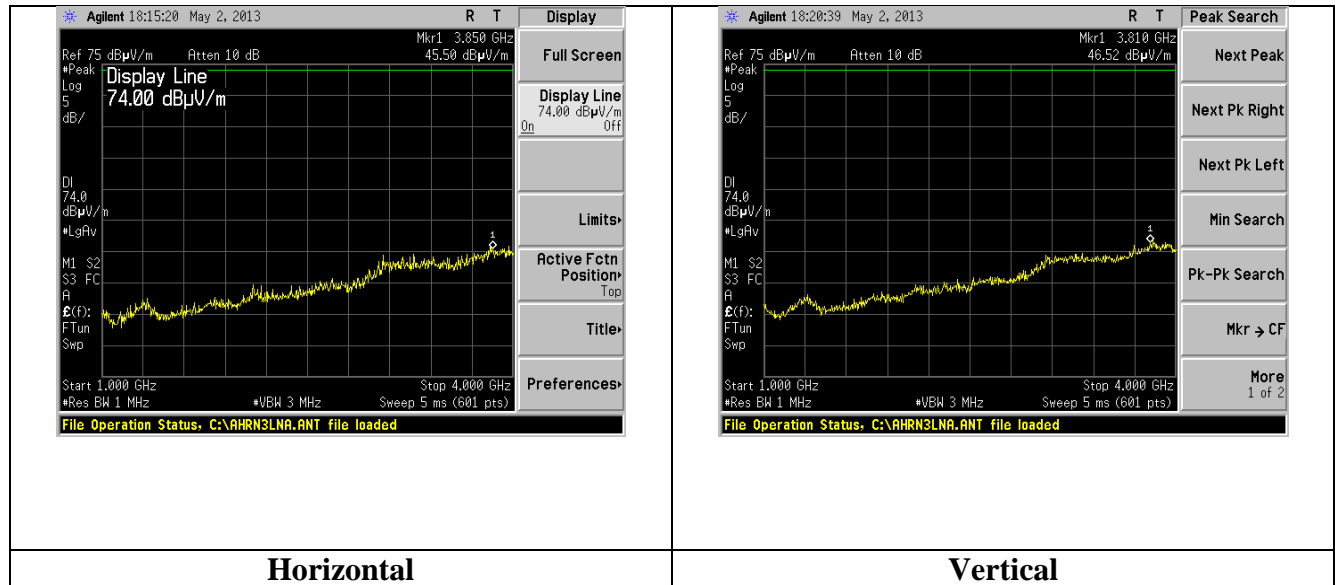
Name: TiWi-BLE/TiWi-R2

Model: TiWi-BLE & TiWi-R2

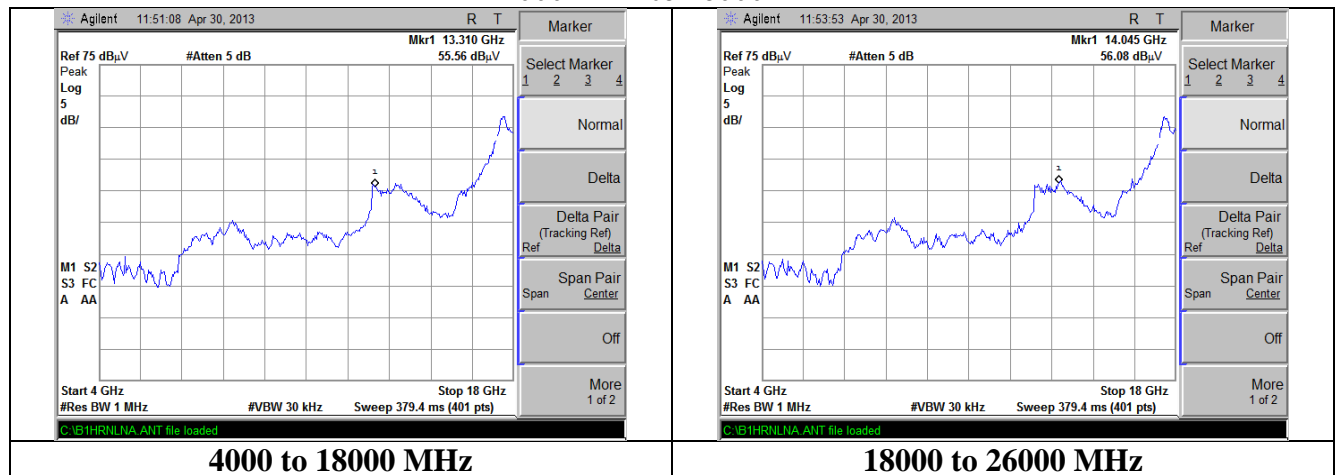
Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Bluetooth Receive Mode 1-26 GHz

1000 MHz to 4000 MHz



4000 MHz to 26000 MHz

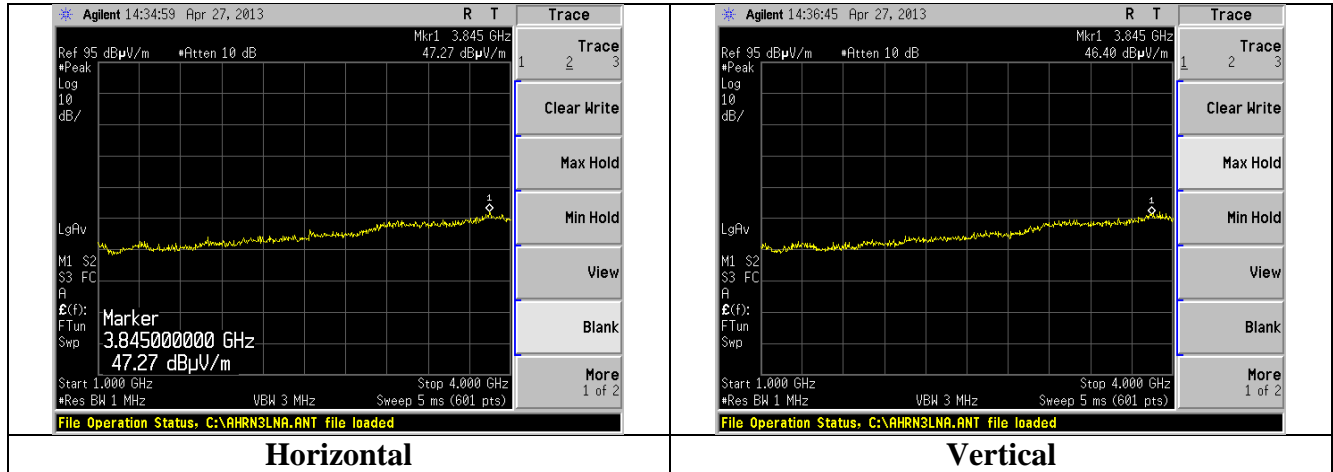


Prepared For: LS Research
 Report: TR 313052 A
 LSR: C-1704

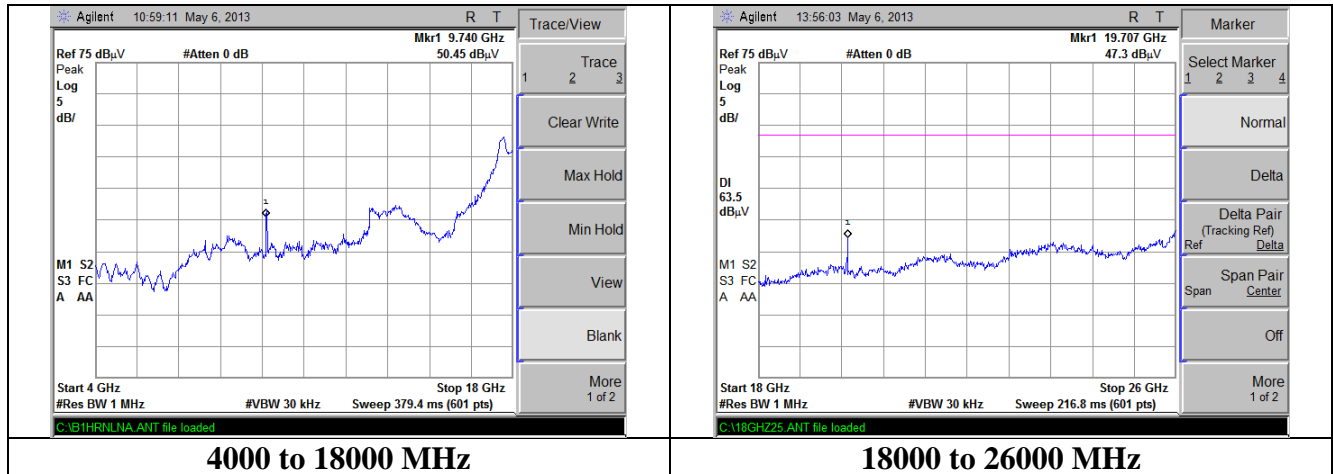
Name: TiWi-BLE/TiWi-R2
 Model: TiWi-BLE & TiWi-R2
 Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

WLAN Receive Mode 1-26 GHz

1000 MHz to 4000 MHz



4000 MHz to 26000 MHz



Prepared For: LS Research

Report: TR 313052 A

LSR: C-1704

Name: TiWi-BLE/TiWi-R2

Model: TiWi-BLE & TiWi-R2

Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Appendix C - Uncertainty Summary

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	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Radiated Emissions	10-Meter OATS, Biconical Antenna	4.32 dB
Radiated Emissions	10-Meter OATS, Log Periodic Antenna	3.63 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64° / 2.88 %RH

Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2013	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 Meas Guidance v02	2012	DTS Meas Guidance
FCC KDB 558074 D01 DTS Meas Guidance v03	2013	DTS Meas Guidance

Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

Appendix E – MPE Calculations

BLE

RF Technical Information:

Type of Evaluation (check one)	<input type="checkbox"/>	SAR Evaluation: Device Used in the Vicinity of the Human Head
	<input type="checkbox"/>	SAR Evaluation: Body-worn Device
	<input checked="" type="checkbox"/>	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
 RF Value: 0.005417 V/m A/m mW/cm²
 Measured Computed Calculated

WLAN

RF Technical Information:

Type of Evaluation (check one)	<input type="checkbox"/>	SAR Evaluation: Device Used in the Vicinity of the Human Head
	<input type="checkbox"/>	SAR Evaluation: Body-worn Device
	<input checked="" type="checkbox"/>	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
 RF Value: 0.54794 V/m A/m mW/cm²
 Measured Computed Calculated

Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098

END OF REPORT

Date	Version	Comments	Person
6/25/13	1	First Revision	Aidi Zainal
6-25-13	1	Reviewed	Adam A

Prepared For: LS Research	Name: TiWi-BLE/TiWi-R2
Report: TR 313052 A	Model: TiWi-BLE & TiWi-R2
LSR: C-1704	Serial: RF Conducted: 3-016212, 3-016181 ; Radiated: 3-030099,3-030098