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

RF Exposure Compliance of:
TiWi-C-W

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

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

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

Signature: Date: 3-26-15

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Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413 B	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 2.1

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LS Research, LLC in Review

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



TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

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

A2LA Certificate Number: 1255.01



Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948

FCC Registration Number: 90756



Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1

File Number: IC 3088-A

On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1

File Number: IC 3088



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 Conformance Summary

The EUT was found to MEET the MPE threshold for FCC §2.1091(mobile) using methods of FCC KDB 447498 D01 General RF Exposure Guidance v05r02 as a standalone device.

2.0 Equipment Under Test (EUT) Information

The following information has been supplied by the applicant.

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

2.1 Product Description

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

Chip Antenna:

Johanson Part # 2450AT18A100 (Peak Gain 0.5 dBi)

U.FL Antenna port utilizes the following antenna options:

LSR 2.4 GHz Dipole Antenna (Gain +2 dBi)

LSR 2.4 GHz FlexPIFA 2 dBi Antenna w/U.FL Cable

2.2 Additional Information

1. Programmed for continuous transmit or receive on low (2412 MHz), middle (2437 MHz), and high channel (2462 MHz) using programming board (DLP-TXRX-0 V2.3) and USB cable connected to laptop with TiWi-C-W RF Eval Tool Version 1.2.0.0

Continuous transmit modulated mode at all WLAN modes / data rates is available via test tool as well as selecting antenna 1 or antenna 2.

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

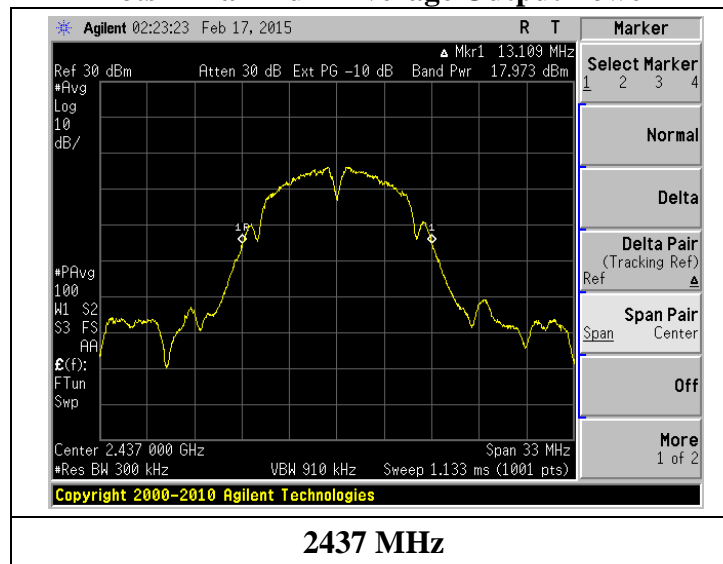
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3.0 RF Conducted Measurement Data

Table
4-layer – Antenna 1 (worst case output power)

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

Plots – Maximum Average Output Power



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4.0 MPE Calculation

2.4 GHz

Type: RF Evaluation

Evaluated Against: General Population/Uncontrolled Exposure

Duty Cycle: 100 %

Document Used for Evaluation: KDB 447498 / OET 65

Measurement Distance: 20 cm

Power Density Limit: 1 mW/cm²

Calculated Value:

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: 17.99 (dBm)

Maximum peak output power at antenna input terminal: 62.922 (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/cm²)

Power density at prediction frequency: 0.019839 (mW/cm²)

5.0 Industry Canada Low Power Exemption

RSS 102 Issue 5 Section 2.5 states that all transmitters that meet the output power requirements as stated in section 2.5.1 and 2.5.2 of RSS 102 are exempt from routine SAR and RF exposure evaluation.

Output Power Evaluation.

Evaluation Frequency = 2437MHz

Device Operation separation distance: **>20cm**

Maximum Effective Isotropic Radiated Power (dBm) = 17.988 dBm + 2.0 dBi = 19.988 dBm

Maximum Effective Isotropic Radiated Power (mW) = $\log^{-1}(\text{EIRP (dBm)}/10) = 99.72 \text{ mW}$

Section 2.5.2 general public use limit at for devices operating greater than 20cm:

Frequency	Limit	Limit @ f
300 MHz to 6 GHz	$1.31 \times 10^{-2} f^{0.6834} \text{ W}$ ($f = \text{MHz}$)	2.703 W

Conclusion:

Since the maximum effective radiated power (EIRP) is less than the applicable section limit, the Product is exempt from SAR/RF Evaluation

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END OF REPORT

Date	Version	Comments	Person
2-23-15	V1	Final	Adam A
3-26-15	V1a	Corrected Output Power and Calculations	Adam A

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