

## **Certification Test Report**

**FCC ID: VSF23545**  
**IC: 7980A-23545**

**FCC Rule Part: 15.247**  
**IC Radio Standards Specification: RSS-210**

**ACS Report Number: 13-2127.W04.2B**

**Responsible Party: Juniper Systems, Inc.**  
**Model: TiWi-R2**

**Test Begin Date: September 4, 2013**  
**Test End Date: September 24, 2013**

**Report Issue Date: November 13, 2013**



FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER AT-1533

This report must not be used by the client to claim product certification, approval, or endorsement by ACCLASS, ANSI, or any agency of the Federal Government.

**Project Manager:**

A handwritten signature in black ink, appearing to read "Thierry Jean-Charles".

**Thierry Jean-Charles**  
**EMC Engineer**  
**Advanced Compliance Solutions, Inc.**

**Reviewed by:**

A handwritten signature in black ink, appearing to read "Kirby Munroe".

**Kirby Munroe**  
**Director, Wireless Certifications**  
**Advanced Compliance Solutions, Inc.**

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**This report contains 15 pages**

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## 1 GENERAL

### 1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-210 for a class II permissive change.

The purpose of the Class II Permissive Change is to add a new antenna type and co-location with the model PH8-P when integrated in the model Archer2 (Project Pulaski) host configuration. The class II permissive change only applies to the 2.4 GHz band (802.11b/g/n).

### 1.2 Manufacturer Information

Juniper Systems, Inc.  
1132 W 1700 N  
Logan, UT 84321

### 1.3 Product Description

The model TiWi-R2 is an 802.11b/g/n 1x1 with Bluetooth 2.1 wireless transceiver module. The test report documents compliance when the unit is integrated in model Archer2 host system consisting of a handheld personal data terminal. The EUT may be co-located with a GSM/GPRS/UMTS/HSPA module in the Archer2 host configuration.

#### Technical Details

Mode of Operation:	WLAN 802.11 b/g/n
Frequency Range:	2412 MHz – 2462 MHz
Number of Channels:	11
Channel Separation:	5 MHz
Transmit Data Rates:	802.11b: 1, 2, 5.5, and 11Mb/s 802.11g: 6, 9, 12, 18, 24, 36, 48, and 54 Mb/s 802.11n: 6.5, 13, 19, 26, 39, 52, 58.5, 65 Mb/s
Modulations:	802.11b DSSS/CCK, 802.11g/n OFDM
Antenna Type/Gain:	Printed Inverted-F Antenna, - 3.0 dBi

Model Number: TiWi-R2

Test Sample Serial Number(s): N/A

Test Sample Condition: The samples were in good conditions with no observable physical damages.

Table 1.3-1: Co-located radios

Model	FCC ID	IC	Manufacturer or Responsible Party	Radio Type	Frequency Range (MHz)
TiWi-R2	VSF23545	7980A-23545	Juniper Systems, Inc.	Bluetooth 2.1	2402 - 2480
PH8-P	VSF23795	7980A-23795	Juniper Systems, Inc.	GSM/GPRS/UMTS/HSPA Module	824.2 - 848.8 826.4 – 846.6 1850.2 – 1909.8 1852.4 – 1907.6

**Note: There is no co-transmission for the 802.11b/g/n and Bluetooth 2.1 radios.**

#### 1.4 Test Methodology and Considerations

The EUT was tested for radiated emissions for the 802.11bgn radio when integrated in the model Archer2 (Pulaski) host configuration.

The radiated emissions evaluations were conducted up to the 10<sup>th</sup> harmonic. Preliminary measurements were collected for the EUT set in three orthogonal orientations. The measurements reported herein correspond to the orientation leading to the highest emissions relative to the limits.

Table 1.4-1: 802.11bgn Radio Test Configuration

Mode of Operation	Frequency (MHz)	Channel	Power Table Settings	Data Rate (Mbps)
802.11b	2412	1	26	1
	2437	6	26	
	2462	11	26	
802.11g	2412	1	22	6
	2437	6	27	
	2462	11	22	
802.11n	2412	1	22	6.5 (MCS0)
	2437	6	27	
	2462	11	22	

The EUT was also evaluated for inter-modulation products when transmitting at the same time with co-located GSM/GPRS/UMTS/HSPA module. All inter-modulation products were found compliant to the limits of FCC Section 15.209 and Industry Canada RSS-GEN.

## **2 TEST FACILITIES**

### **2.1 Location**

The radiated and conducted emissions test sites are located at the following address:

Advanced Compliance Solutions, Inc.  
3998 FAU Blvd, Suite 310  
Boca Raton, Florida 33431  
Phone: (561) 961-5585  
Fax: (561) 961-5587  
[www.acstestlab.com](http://www.acstestlab.com)

FCC Test Firm Registration #: 475089  
Industry Canada Lab Code: 4175C

### **2.2 Laboratory Accreditations/Recognitions/Certifications**

ACS is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ACLASS program and has been issued certificate number AT-1533 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

**2.3 Radiated & Conducted Emissions Test Site Description**

**2.3.1 Semi-Anechoic Chamber Test Site**

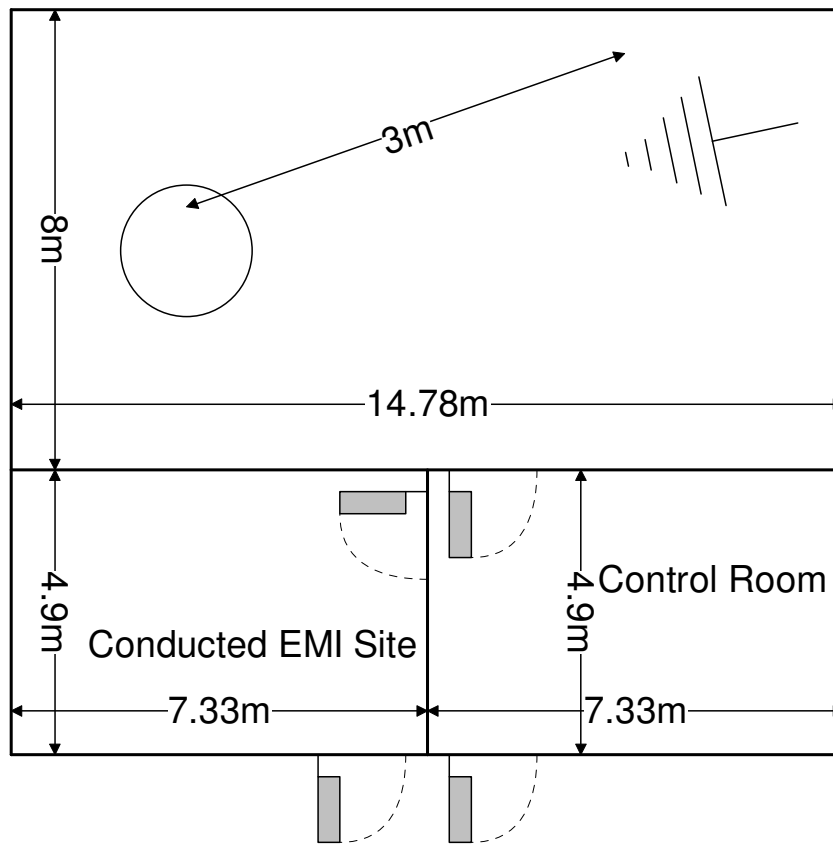
The EMC radiated test facility consists of an RF-shielded enclosure. The interior dimensions of the indoor semi-anechoic chamber are approximately 48 feet (14.6 m) long by 36 feet (10.8 m) wide by 24 feet (7.3 m) high and consist of rigid, 1/8 inch (0.32 cm) steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. 8-foot RF absorbing cones are installed on 4 walls and the ceiling. The steel-clad ground plane is covered with vinyl floor.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flushed with the chamber floor which it is connected to, around its circumference, with a continuous metallic loaded spring. An EMCO Model 1050 Multi-device Controller controls the turntable position.

A pneumatic motor is used to control antenna polarizations and height relative to the ground. The height information is displayed on the control unit EMCO Model 1050.

The control room is an RF shielded enclosure attached to the semi-anechoic chamber with two bulkhead panels for connecting RF, and control cables. The dimension of the room is 7.3 m x 4.9 m x 3 m high and the entrance doors of both control and conducted rooms are 3 feet (0.91 m) by 7 feet (2.13 m).

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

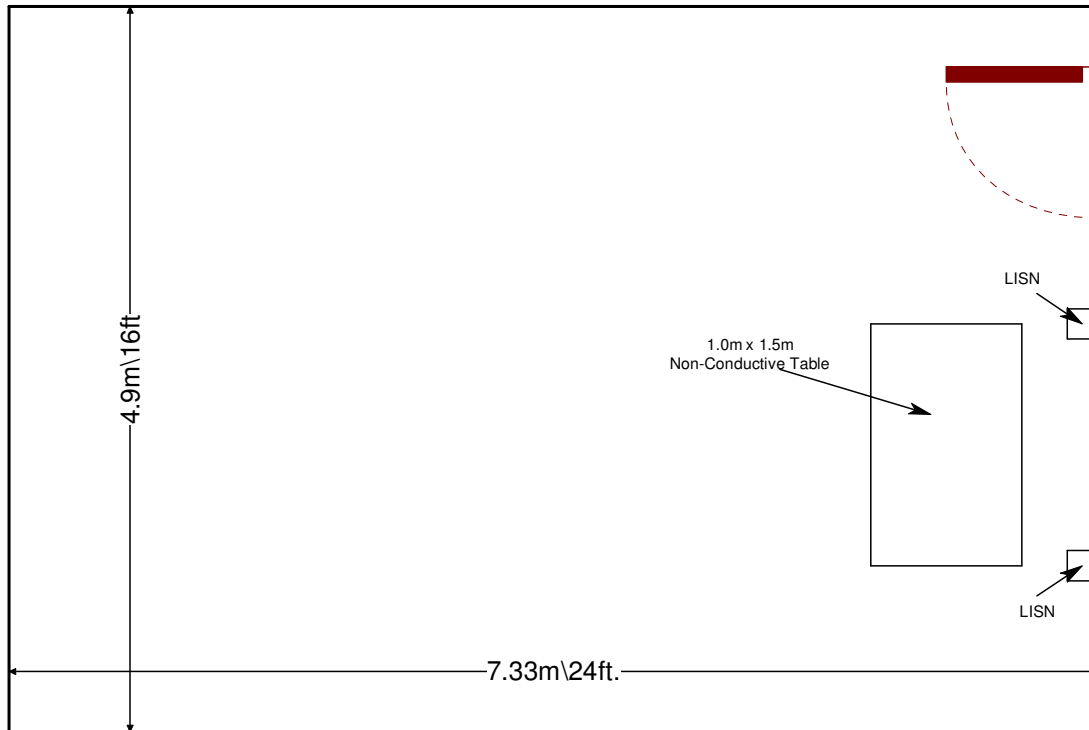


**Figure 2.3.1-1: Semi-Anechoic Chamber Test Site**

**2.3.2 Conducted Emissions Test Site Description**

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m<sup>3</sup>. As per ANSI C63.4 2003 requirements, the data were taken using two LISNs; a Solar Model 8028-50 50 Ω/50 μH and an EMCO Model 3825, which are installed as shown in Photograph 3. For 220 V, 50 Hz, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/220 V EDGAR variable frequency generator, Model 1001B, to filter conducted noise from the generator.

A diagram of the room is shown below in figure 2.3.2-1:



**Figure 2.3.2-1: AC Mains Conducted EMI Site**

### **3 APPLICABLE STANDARD REFERENCES**

The following standards were used:

- ❖ ANSI C63.4-2003: Method of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the 9 kHz to 40 GHz.
- ❖ ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices.
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2013.
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2013
- ❖ KDB Publication No. 558074 D01 DTS Meas Guidance v03r01 – Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247, April 9, 2013.
- ❖ Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 8 December 2010.
- ❖ Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 3, December 2010.



#### 4 LIST OF TEST EQUIPMENT

The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

**Table 4-1: Test Equipment**

AssetID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
523	Agilent	E7405	Spectrum Analyzers	MY45103293	1/8/2013	1/8/2015
524	Chase	CBL6111	Antennas	1138	1/7/2013	1/7/2015
2006	EMCO	3115	Antennas	2573	4/24/2013	4/24/2015
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	12/31/2012	12/31/2013
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	1/1/2013	1/1/2014
2044	QMI	N/A	Cables	2044	12/31/2012	12/31/2013
2076	Hewlett Packard	HP5061-5458	Cables	2076	12/29/2012	12/29/2013
2070	Mini Circuits	VHF-8400+	Filter	2070	12/31/2012	12/31/2013
2072	Mini Circuits	VHF-3100+	Filter	30737	12/31/2012	12/31/2013
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/29/2012	12/29/2013
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/20/2012	12/20/2013
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR

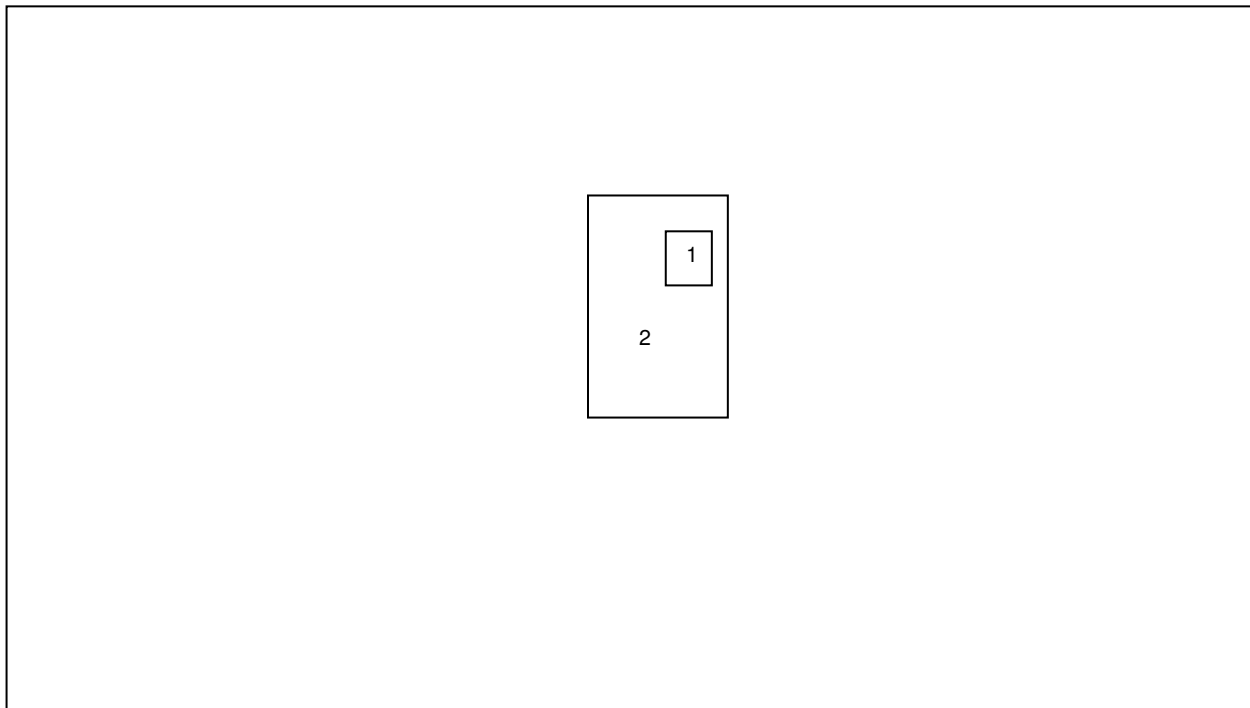
**NCR=No Calibration Required**

5 SUPPORT EQUIPMENT

Table 5-1: EUT and Support Equipment

Item #	Type Device	Manufacturer or Responsible Party	Model/Part #	Serial #
1	EUT	Juniper Systems	TiWi-R2	N/A
2	Host	Juniper Systems	Archer2	AR2X444

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM



## **7 SUMMARY OF TESTS**

Along with the tabular data shown below, plots were taken of all signals deemed important enough to document.

### **7.1 Antenna Requirement – FCC: Section 15.203**

The EUT uses a printed Inverted-F antenna provided by the host PCB. The antenna is not detachable but is etched on the host PCB, thereby meeting the requirements of FCC 15.203.

### **7.2 Band-Edge Compliance and Spurious Emissions-FCC 15.247(d) IC: RSS-210 A8.5**

#### **7.2.1 Radiated Spurious Emissions - FCC 15.205, 15.209; IC: RSS-210 2.2, RSS-Gen 7.2.2, 7.2.5**

##### **7.2.1.1 Measurement Procedure**

Radiated emissions tests were made over the frequency range of 30 MHz to 26 GHz, 10 times the highest fundamental frequency.

The EUT was rotated through 360° and the receive antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. For frequencies below 1000MHz, quasi-peak measurements were made using a resolution bandwidth RBW of 120 kHz and a video bandwidth VBW of 300 kHz. For frequencies above 1000 MHz, peak measurements are made with RBW of 1 MHz and VBW of 3 MHz. Average measurements are performed in the linear scale using VBW of 30 Hz over a 5 second sweep.

##### **7.2.1.2 Measurement Results**

Radiated band-edge and spurious emissions found in the band of 30MHz to 26 GHz are reported in the tables below.

**Table 7.2.1-1: Radiated Spurious Emissions Tabulated Data – 802.11b**

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
<b>Low Channel (2412 MHz)</b>										
2390	64.32	54.66	H	-8.65	55.67	46.01	74.0	54.0	18.3	8.0
2390	63.37	52.20	V	-8.65	54.72	43.55	74.0	54.0	19.3	10.4
4824	49.92	43.85	H	-0.83	49.09	43.02	74.0	54.0	24.9	11.0
4824	49.07	40.70	V	-0.83	48.24	39.87	74.0	54.0	25.8	14.1
12060	45.40	32.83	H	11.32	56.72	44.15	83.5	63.5	26.8	19.4
12060	44.84	32.89	V	11.32	56.16	44.21	83.5	63.5	27.3	19.3
14472	43.41	31.05	H	18.11	61.52	49.16	83.5	63.5	22.0	14.3
14472	43.86	32.12	V	18.11	61.97	50.23	83.5	63.5	21.5	13.3
19296	42.37	29.53	V	9.29	51.66	38.82	83.5	63.5	31.8	24.7
<b>Middle Channel ( 2437 MHz)</b>										
4874	49.23	41.92	H	-0.68	48.55	41.24	74.0	54.0	25.5	12.8
4874	47.67	38.18	V	-0.68	46.99	37.50	74.0	54.0	27.0	16.5
12185	44.40	31.31	H	11.24	55.64	42.55	83.5	63.5	27.9	21.0
12185	44.77	31.44	V	11.24	56.01	42.68	83.5	63.5	27.5	20.8
19496	42.99	29.47	V	9.42	52.41	38.89	83.5	63.5	31.1	24.6
<b>High Channel (2462 MHz)</b>										
2483.5	66.43	55.31	H	-8.26	58.17	47.05	74.0	54.0	15.8	7.0
2483.5	63.29	51.03	V	-8.26	55.03	42.77	74.0	54.0	19.0	11.2
4924	48.11	39.11	H	-0.53	47.58	38.58	74.0	54.0	26.4	15.4
4924	47.96	37.51	V	-0.53	47.43	36.98	74.0	54.0	26.6	17.0
12310	43.96	30.91	H	11.16	55.12	42.07	83.5	63.5	28.4	21.4
12310	44.47	31.55	V	11.16	55.63	42.71	83.5	63.5	27.9	20.8
19696	41.61	29.09	V	10.28	51.89	39.37	83.5	63.5	31.6	24.1

**Notes:**

- All emissions above 19.696 GHz were attenuated below the limits and the noise floor of the measurement equipment.
- Emissions above 10 GHz were measured at a distance of 1m. The limits are corrected using a distance correction factor of  $20 \cdot \log(3/1) = 9.5$  dB.

**Table 7.2.1-2: Radiated Spurious Emissions Tabulated Data – 802.11g**

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
<b>Low Channel (2412 MHz)</b>										
2390	80.44	58.60	H	-8.65	71.79	49.95	74.0	54.0	2.2	4.0
2390	78.21	56.50	V	-8.65	69.56	47.85	74.0	54.0	4.4	6.1
12060	45.05	32.18	H	11.32	56.37	43.50	83.5	63.5	27.1	20.0
12060	44.47	32.09	V	11.32	55.79	43.41	83.5	63.5	27.7	20.1
19296	42.92	29.26	V	9.29	52.21	38.55	83.5	63.5	31.3	25.0
<b>Middle Channel ( 2437 MHz)</b>										
12185	44.35	31.43	H	11.24	55.59	42.67	83.5	63.5	27.9	20.8
12185	45.04	31.75	V	11.24	56.28	42.99	83.5	63.5	27.2	20.5
19496	41.65	29.29	V	9.42	51.07	38.71	83.5	63.5	32.4	24.8
<b>High Channel (2462 MHz)</b>										
2483.5	78.67	55.16	H	-8.26	70.41	46.90	74.0	54.0	3.6	7.1
2483.5	76.59	52.81	V	-8.26	68.33	44.55	74.0	54.0	5.7	9.5
12310	43.92	31.10	H	11.16	55.08	42.26	83.5	63.5	28.4	21.2
12310	44.22	31.70	V	11.16	55.38	42.86	83.5	63.5	28.1	20.6
19696	41.78	29.05	V	10.28	52.06	39.33	83.5	63.5	31.4	24.2

**Notes:**

- All emissions above 19.696 GHz were attenuated below the limits and the noise floor of the measurement equipment.
- Emissions above 10 GHz were measured at a distance of 1m. The limits are corrected using a distance correction factor of  $20 \cdot \log(3/1) = 9.5$  dB.

**Table 7.2.1-3: Radiated Spurious Emissions Tabulated Data – 802.11n**

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
<b>Low Channel ( 2412 MHz)</b>										
2390	81.28	60.36	H	-8.65	72.63	51.71	74.0	54.0	1.4	2.3
2390	79.62	58.60	V	-8.65	70.97	49.95	74.0	54.0	3.0	4.0
12060	44.71	32.53	H	11.32	56.03	43.85	83.5	63.5	27.5	19.7
12060	44.49	32.24	V	11.32	55.81	43.56	83.5	63.5	27.7	19.9
19296	42.00	29.19	V	9.29	51.29	38.48	83.5	63.5	32.2	25.0
<b>Middle Channel ( 2437 MHz)</b>										
12185	43.78	31.34	H	11.24	55.02	42.58	83.5	63.5	28.5	20.9
12185	43.81	31.49	V	11.24	55.05	42.73	83.5	63.5	28.5	20.8
<b>High Channel (2462 MHz)</b>										
2483.5	81.14	56.23	H	-8.26	72.88	47.97	74.0	54.0	1.1	6.0
2483.5	76.96	52.22	V	-8.26	68.70	43.96	74.0	54.0	5.3	10.0
12310	44.25	31.08	H	11.16	55.41	42.24	83.5	63.5	28.1	21.3
12310	44.15	31.46	V	11.16	55.31	42.62	83.5	63.5	28.2	20.9

**Notes:**

- All emissions above 12.31 GHz were attenuated below the limits and the noise floor of the measurement equipment.
- Emissions above 10 GHz were measured at a distance of 1m. The limits are corrected using a distance correction factor of  $20 \cdot \log(3/1) = 9.5$  dB.

**7.2.1.3 Sample Calculation:**

$$R_C = R_U + CF_T$$

Where:

$CF_T$	=	Total Correction Factor (AF+CA+AG)-DC (Average Measurements Only)
$R_U$	=	Uncorrected Reading
$R_C$	=	Corrected Level
AF	=	Antenna Factor
CA	=	Cable Attenuation
AG	=	Amplifier Gain
DC	=	Duty Cycle Correction Factor

**Example Calculation: Peak**

Corrected Level:  $64.32 + (-8.65) = 55.67 \text{ dB}\mu\text{V/m}$

Margin:  $74 \text{ dB}\mu\text{V/m} - 55.67 \text{ dB}\mu\text{V/m} = 18.3 \text{ dB}$

**Example Calculation: Average**

Corrected Level:  $54.66 + (-8.65) = 46.01 \text{ dB}\mu\text{V/m}$

Margin:  $54 \text{ dB}\mu\text{V/m} - 46.01 \text{ dB}\mu\text{V/m} = 8.0 \text{ dB}$

**8 CONCLUSION**

In the opinion of ACS, Inc., the TiWi-R2 meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210 for the test procedures documented in the test report.

**END REPORT**