

Certification Test Report

FCC ID: VSF23545
IC: 7980A-23545

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

ACS Report Number: 14-2073.W04.2A

Applicant: Juniper Systems, Inc.
Model(s): TiWi-R2

Test Begin Date: July 23, 2014
Test End Date: October 15, 2014

Report Issue Date: October 22, 2014



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.

Reviewed by:

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

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

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This report contains 16 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 for a permissive change.

The purpose of the permissive change is to add new host configuration as well as co-location with the model PH8-P when integrated in the model Allegro2 host configuration.

1.2 Applicant 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 within the handheld personal data terminal model Allegro2 which offers provision for co-location with a GSM/GPRS/UMTS/HSPA transceiver module.

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
Modulations: 802.11b DSSS/CCK, 802.11g/n OFDM
TX 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
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 equipment was provided in good condition without any physical damage.

The EUT is integrated within a composite system which includes multiple radios. The list of the radios featured in the host model Allegro2 are provided below.

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+EDR	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 Allegro2 host configuration.

The radiated emissions evaluations were conducted up to the 10th 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: 802.11 b/g/n 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.

The EUT was also evaluated for unintentional emissions in the Allegro2 host configuration. Compliance to the unintentional emission requirements is documented in a separate test report.

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

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:

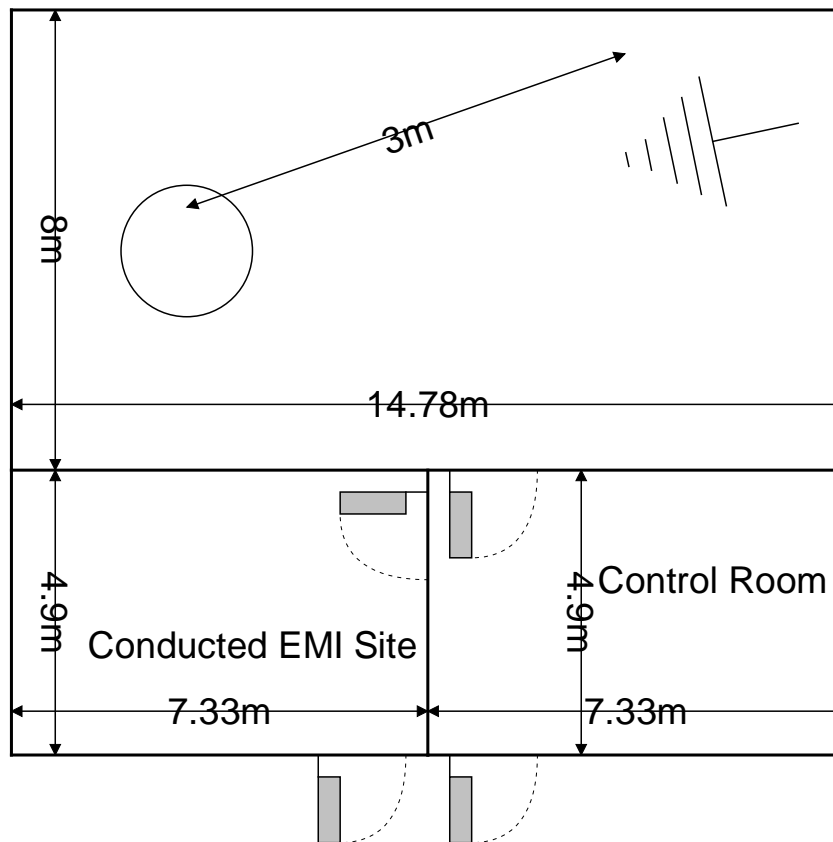


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are $7.3 \times 4.9 \times 3 \text{ m}^3$. As per ANSI C63.4 2003 requirements, the data were taken using two LISNs; a Solar Model 8028-50 $50 \Omega/50 \mu\text{H}$ 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:

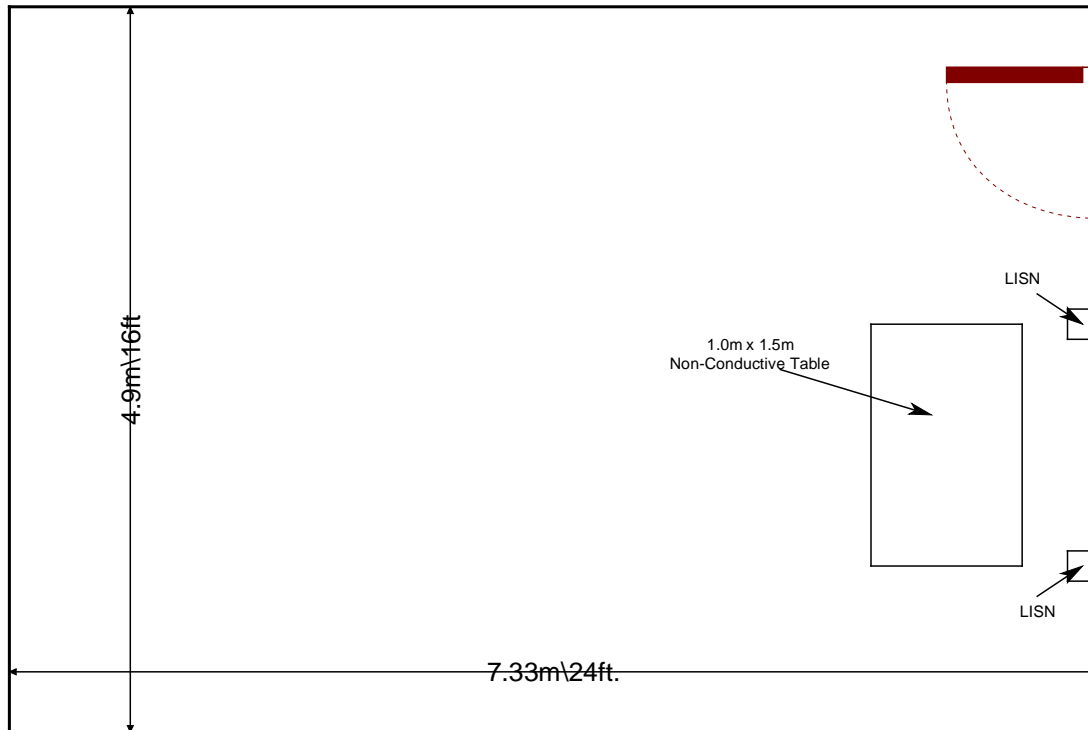


Figure 2.3.2-1: AC Mains Conducted EMI Site

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, 2014.
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2014
- ❖ KDB Publication No. 558074 D01 DTS Meas Guidance v03r02 – Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under 15.247, June 5, 2014.
- ❖ 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
2002	EMCO	3108	Antennas	2147	11/22/2013	11/22/2015
2004	EMCO	3146	Antennas	1385	11/22/2013	11/22/2015
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	12/31/2013	12/31/2014
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	2/27/2014	2/27/2015
2044	QMI	N/A	Cables	2044	12/31/2013	12/31/2014
2076	Hewlett Packard	HP5061-5458	Cables	2076	12/31/2013	12/31/2014
2070	Mini Circuits	VHF-8400+	Filter	2070	1/1/2014	1/1/2015
2072	Mini Circuits	VHF-3100+	Filter	30737	1/1/2014	1/1/2015
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/31/2013	12/31/2014
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/16/2013	12/16/2014
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	Host	Juniper Systems	Allegro2	AG2B018
2	Power Supply	PhiHong	PSAA20R120	30205765A1
3	Mouse	Dell	M-UARDEL7	LZ9290C07NR
4	Laptop	Dell	PP18L	770wy91
5	Power Supply	Dell	HA90PE1-00	0U66800F-47890-91F-B2UJ-A01

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power	1.48m	No	Host to Power Supply
B	USB	1.8m	No	Host to Mouse
C	Extension Cord	1.85m	No	Power Supply to AC Mains
D	Power	1.82m	No	Power Supply to Laptop
E	Serial	10m	No	Host to Laptop
F	USB	10m	No	Host to Laptop
G	Power	0.9m	No	Power Supply to AC Mains

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

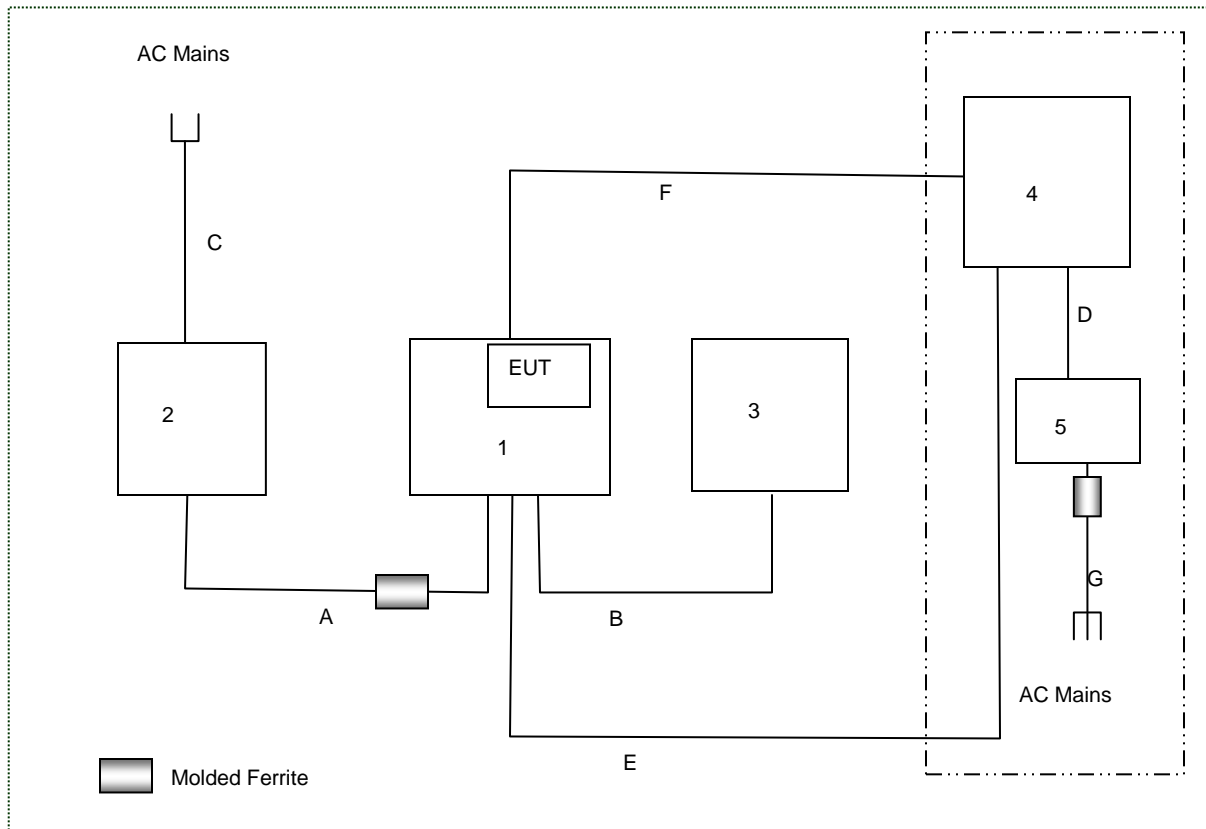


Figure 6-1: Radiated Emission Setup

Note: The equipment enclosed within the dotted box was set outside of the test environment during the evaluation.

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 model TiWi-R2 uses a printed inverted-F antenna provided by the host PCB. The antenna cannot be removed without permanently damaging the unit, thus meeting the requirements of FCC section 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 into Restricted Frequency Bands - 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. Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

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 restricted frequency bands of 30MHz to 26 GHz are reported in the tables below.

Table 7.2.1.2-1: Radiated Emissions Independent of the Transmitter

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
3792.5	47.88	36.87	H	-1.89	45.99	34.98	74.0	54.0	28.0	19.0
3816.25	49.07	40.93	H	-1.81	47.26	39.12	74.0	54.0	26.7	14.9
3840.175	51.24	44.30	H	-1.73	49.51	42.57	74.0	54.0	24.5	11.4
3840.175	49.51	42.77	V	-1.73	47.78	41.04	74.0	54.0	26.2	13.0
3888.15	47.00	35.29	H	-1.57	45.43	33.72	74.0	54.0	28.6	20.3

Note: The emissions reported above were observed to be independent of the transmitter mode of operation.

Table 7.2.1.2-2: 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
Low Channel = 2412 MHz										
2390	66.62	59.29	H	-8.00	58.62	51.29	74.0	54.0	15.4	2.7
2390	63.48	54.84	V	-8.00	55.48	46.84	74.0	54.0	18.5	7.2
4824	46.92	37.12	H	-0.21	46.71	36.91	74.0	54.0	27.3	17.1
4824	46.95	37.35	V	-0.21	46.74	37.14	74.0	54.0	27.3	16.9
12060	44.91	32.44	H	12.79	57.70	45.23	83.5	63.5	25.8	18.3
12060	44.81	31.82	V	12.79	57.60	44.61	83.5	63.5	25.9	18.9
19296	41.63	29.51	H	11.01	52.64	40.52	83.5	63.5	30.9	23.0
Middle Channel = 2437MHz										
4874	45.64	34.65	H	-0.06	45.58	34.59	74.0	54.0	28.4	19.4
4874	47.60	38.72	V	-0.06	47.54	38.66	74.0	54.0	26.5	15.3
7311	47.03	33.99	H	5.54	52.57	39.53	74.0	54.0	21.4	14.5
7311	46.32	33.30	V	5.54	51.86	38.84	74.0	54.0	22.1	15.2
12185	44.48	31.88	H	12.97	57.45	44.85	83.5	63.5	26.0	18.6
12185	43.73	31.31	V	12.97	56.70	44.28	83.5	63.5	26.8	19.2
19496	41.32	28.78	H	11.19	52.51	39.97	83.5	63.5	31.0	23.5
19496	41.42	28.63	V	11.19	52.61	39.82	83.5	63.5	30.9	23.7
High Channel = 2462MHz										
2483.5	64.28	52.63	H	-7.61	56.67	45.02	74.0	54.0	17.3	9.0
2483.5	59.08	47.82	V	-7.61	51.47	40.21	74.0	54.0	22.5	13.8
4924	46.53	36.10	H	0.09	46.62	36.19	74.0	54.0	27.4	17.8
4924	46.12	36.03	V	0.09	46.21	36.12	74.0	54.0	27.8	17.9
7386	43.03	30.80	H	5.81	48.84	36.61	74.0	54.0	25.2	17.4
12310	44.12	30.81	H	13.15	57.27	43.96	83.5	63.5	26.2	19.5
19696	41.26	29.20	H	12.20	53.46	41.40	83.5	63.5	30.0	22.1
19696	41.16	29.23	V	12.20	53.36	41.43	83.5	63.5	30.1	22.1

Notes:

- All emissions above 19.7 GHz were attenuated below the limits and the noise floor of the measurement equipment.
- The emissions above 10 GHz were measured at 1m distance. The limits are corrected using a distance correction factor of $20 \cdot \log(3/1) = 9.5$ dB.

Table 7.2.1.2-3: 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
Low Channel = 2412 MHz										
2390	80.78	60.42	H	-8.00	72.78	52.42	74.0	54.0	1.2	1.6
2390	75.77	56.02	V	-8.00	67.77	48.02	74.0	54.0	6.2	6.0
19296	41.83	29.01	V	11.01	52.84	40.02	83.5	63.5	30.7	23.5
Middle Channel = 2437MHz										
19496	41.58	29.43	V	11.19	52.77	40.62	83.5	63.5	30.7	22.9
High Channel = 2462MHz										
2483.5	79.95	56.86	H	-7.61	72.34	49.25	74.0	54.0	1.7	4.7
2483.5	70.12	49.94	V	-7.61	62.51	42.33	74.0	54.0	11.5	11.7
19696	41.55	29.41	H	12.20	53.75	41.61	83.5	63.5	29.7	21.9
19696	41.13	29.27	V	12.20	53.33	41.47	83.5	63.5	30.2	22.0

Notes:

- All emissions above 19.7 GHz were attenuated below the limits and the noise floor of the measurement equipment.
- The emissions above 10 GHz were measured at 1m distance. The limits are corrected using a distance correction factor of $20 \cdot \log(3/1) = 9.5$ dB.

Table 7.2.1.2-4: Radiated Spurious Emissions Tabulated Data - 802.11n 20 MHz

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
Low Channel = 2412 MHz										
2390	81.51	58.92	H	-8.00	73.51	50.92	74.0	54.0	0.5	3.1
2390	78.43	57.17	V	-8.00	70.43	49.17	74.0	54.0	3.6	4.8
4824	46.60	33.45	H	-0.21	46.39	33.24	74.0	54.0	27.6	20.8
4824	50.71	36.86	V	-0.21	50.50	36.65	74.0	54.0	23.5	17.4
12060	44.77	31.27	H	12.79	57.56	44.06	83.5	63.5	25.9	19.4
Middle Channel = 2437MHz										
4874	46.60	33.28	H	-0.06	46.54	33.22	74.0	54.0	27.5	20.8
4874	51.10	37.32	V	-0.06	51.04	37.26	74.0	54.0	23.0	16.7
12185	44.48	31.21	H	12.97	57.45	44.18	83.5	63.5	26.0	19.3
12185	44.44	30.87	V	12.97	57.41	43.84	83.5	63.5	26.1	19.7
19496	42.04	29.43	V	11.19	53.23	40.62	83.5	63.5	30.3	22.9
High Channel = 2462MHz										
2483.5	80.66	54.57	H	-7.61	73.05	46.96	74.0	54.0	0.9	7.0
2483.5	77.94	53.62	V	-7.61	70.33	46.01	74.0	54.0	3.7	8.0
4924	45.61	33.35	H	0.09	45.70	33.44	74.0	54.0	28.3	20.6
4924	48.20	36.10	V	0.09	48.29	36.19	74.0	54.0	25.7	17.8
7386	47.15	33.99	H	5.81	52.96	39.80	74.0	54.0	21.0	14.2
12310	43.72	31.02	H	13.15	56.87	44.17	83.5	63.5	26.6	19.3

Notes:

- All emissions above 19.5 GHz were attenuated below the limits and the noise floor of the measurement equipment.
- The emissions above 10 GHz were measured at 1m distance. 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: $66.62 + (-8.00) = 58.62$ dB μ V/m

Margin: 74 dB μ V/m – 58.62 dB μ V/m = 15.4 dB

Example Calculation: Average

Corrected Level: $59.29 + (-8.00) = 51.29$ dB μ V/m

Margin: 54 dB μ V/m – 51.29 dB μ V/m = 2.7 dB

8 CONCLUSION

In the opinion of ACS, Inc., the model 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