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Test Report: 103365-1TRFWL

Applicant: RLW Inc.
2029 Cato Ave
State College, PA
16801

Apparatus: wSIM

FCC ID: V5NRLW88844422

In Accordance With: FCC Part 15 Subpart C, 15.247
FHSS System and Digitally Modulated Radiators
902-928MHz, 2400 - 2483.5 MHz, 5725-5850MHz

Tested By: Nemko Canada Inc.
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Authorized By:

Heng Lin, EMC/Wireless Specialist

Date: May 20, 2008

Total Number of Pages: 26

Report Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart C. Radiated tests were conducted in accordance with ANSI C63.4-2003. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

The assessment summary is as follows:

Apparatus Assessed: wSIM

Specification: FCC Part 15 Subpart C, 15.247

Compliance Status: Complies

Exclusions: None

Non-compliances: None

Report Release History: Original Release

Author: Jason Nixon, Wireless/Telecom Specialist

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025.

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Section 1 : Equipment Under Test

1.1 Product Identification

The Equipment Under Test was identified as follows:

wSIM (M/N: RLW000651-3)

1.2 Samples Submitted for Assessment

The following samples of the apparatus have been submitted for type assessment:

Sample No.	Description	Serial No.
9	wSIM	0B-6F

The first samples were received on: March 10, 2008

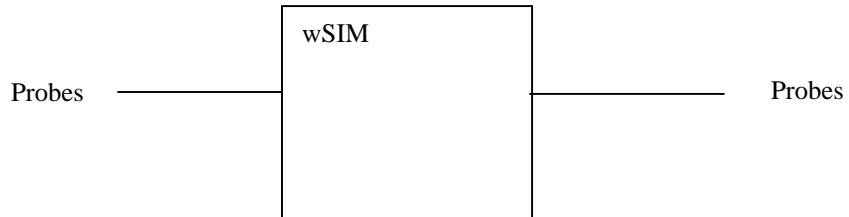
1.3 Theory of Operation

The EUT is a wireless sensor interface module (wSIM), which uses IEEE 802.15.4 protocol to provide a mesh network to monitor remote sensors located in harsh industrial environments.

1.4 Technical Specifications of the EUT

Operating Frequency:	2405-2480MHz
Peak Output Power:	17mW (12.3dBm)
Emission Designator	G1D
Modulation:	OQPSK
Antenna Data:	Integral 2dBi
Power Source:	3VDC provided by battery

1.5 Block Diagram of the EUT



Section 2 : Test Conditions

2.1 Specifications

The apparatus was assessed against the following specifications:

FCC Part 15 Subpart C, 15.247

FHSS System and Digitally Modulated Radiators
902-928MHz, 2400 - 2483.5 MHz, 5725-5850MHz

2.2 Deviations From Laboratory Test Procedures

No deviations were made from laboratory test procedures.

2.3 Test Environment

All tests were performed under the following environmental conditions:

Temperature range	:	15 – 30 °C
Humidity range	:	20 - 75 %
Pressure range	:	86 - 106 kPa
Power supply range	:	+/- 5% of rated voltages

2.4 Test Equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Next Cal.
3m EMI Test Chamber	TDK	SAC-3	FA002047	May 19/08
Bilog	Sunol	JB3	FA002108	Jan. 21/09
Flush Mount Turntable	Sunol	FM2022	FA002082	NCR
Controller	Sunol	SC104V	FA002060	NCR
Mast	Sunol	TLT2	FA002061	NCR
Receiver/Spectrum Analyzer	Rohde & Schwarz	ESU 26	FA002043	Dec. 07/08
50 Coax cable	HUBER + SUHNER	None	FA002015	Sept. 19/08
50 Coax cable	HUBER + SUHNER	None	FA002074	July 03/08
Horn Antenna #2	EMCO	3115	FA000825	Jan. 15/09
Spectrum Analyzer	Rohde & Schwarz	FSP	FA001920	Mar. 19/08
18.0 – 40.0GHz Horn Antenna	EMCO	3116	FA001847	May 9/08
1.0 – 18.0 GHz Amplifier	Endwave	JCA118-503	FA002091	Oct 3/08
18.0 – 26.0 GHz Amplifier	NARDA	BBS-1826N612	FA001550	COU
Notch Filter	Microwave Circuits	2400-2483MHz	FA001940	COU

COU – Calibrate on Use

NCR – No Calibration Required

2.5 Measurement Uncertainty

Nemko Canada measurement uncertainty has been calculated using guidance of UKAS LAB 34:2003 and TIA-603-B Nov 7, 2002. All calculations have been performed to provide a confidence level of 95% and can be found in Nemko Canada document MU-003.

Section 3 : Observations

3.1 Modifications Performed During Assessment

No modifications were performed during assessment.

3.2 Record Of Technical Judgements

No technical judgements were made during the assessment.

3.3 EUT Parameters Affecting Compliance

The user of the apparatus could not alter parameters that would affect compliance.

3.4 Test Deleted

No Tests were deleted from this assessment.

3.5 Additional Observations

There were no additional observations made during this assessment.

Section 4 : Results Summary

This section contains the following:

FCC Part 15 Subpart C : Test Results

The column headed 'Required' indicates whether the associated clauses were invoked for the apparatus under test. The following abbreviations are used:

N No : not applicable / not relevant.

Y Yes : Mandatory i.e. the apparatus shall conform to these tests.

N/T Not Tested, mandatory but not assessed. (See section 3.4 Test deleted)

The results contained in this section are representative of the operation of the apparatus as originally submitted.

4.1 FCC Part 15 Subpart C : Test Results

Part 15	Test Description	Required	Result
15.31(e)	Variation of power supply	N	
15.207(a)	Powerline Conducted Emissions	N	
15.209(a)	Radiated Emissions within Restricted Bands	Y	PASS
15.247(a)(1)	Frequency hopping systems	N	
15.247(a)(2)	Systems using digital modulation techniques	Y	PASS
15.247(b)(1)	Maximum peak output power of Frequency hopping systems operating in the 2400-2483.5 MHz band and 5725-5850 MHz band	N	
15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902-928 MHz band	N	
15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands	Y	PASS
15.247(b)(4)	Maximum peak output power	Y	PASS
15.247(c)(1)	Fixed point-to-point Operation with directional antenna gains greater than 6 dBi	N	
15.247(c)(2)	Transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams	N	
15.247(d)	Radiated Emissions Not in Restricted Bands	Y	PASS
15.247(e)	Power Spectral Density for Digitally Modulated Devices	Y	PASS
15.247(f)	Time of Occupancy for Hybrid Systems	N	

Notes:

Appendix A : Test Results

Clause 15.209(a) Radiated Emissions within Restricted Bands

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvoltsmeter)	Measurement Distance (meters)
0.009-0.490	2400/F (kHz)	300
0.490-1.705	24000/F (kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Conditions:

Sample Number:	9	Temperature (°C):	23
Date:	March 15, 2008	Humidity (%):	21
Modification State:	0	Tester:	Jason Nixon
		Laboratory:	3m Chamber

Test Results:

See Attached Table for Results

Additional Observations:

The Spectrum was searched from 30MHz to 25GHz.

These results apply to emissions found in the Restricted bands defined in FCC Part 15 Subpart C, 15.205.

All measurements were performed at 3m using a Peak detector with 1MHz RBW/3MHz VBW.

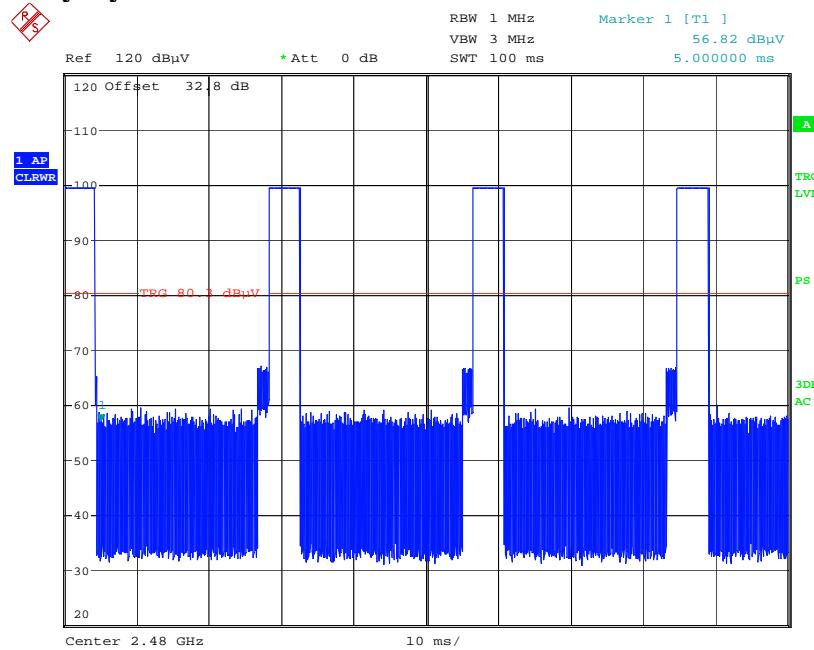
Frequency (MHz)	Antenna	Polarity	RCVD Signal (dBuV)	Ant. Factor (dB)	Amp. Gain / Cable Loss (dB)	Duty Cycle Corr.	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	
1	4810	Horn2	V	72.67	32.7	-49.2	-12.5	56.17	74	17.83	Peak
							43.67	54	10.33	Average	
2	4810	Horn2	H	68.33	32.7	-49.2	-12.5	51.83	74	22.17	Peak
							39.33	54	14.67	Average	
3	4910	Horn2	V	66.69	32.7	-38.3	-12.5	61.09	74	12.91	Peak
							48.59	54	5.41	Average	
4	4910	Horn2	H	59.65	32.7	-38.3	-12.5	54.05	74	19.95	Peak
							41.55	54	12.45	Average	
5	7365	Horn2	V	64.40	36.0	-34.4	-12.5	66.00	74	8.00	Peak
							53.50	54	0.50	Average	
6	7365	Horn2	H	58.01	36.0	-34.4	-12.5	59.61	74	14.39	Peak
							47.11	54	6.89	Average	
7	4960	Horn2	V	65.18	32.7	-38.3	-12.5	59.58	74	14.42	Peak
							47.08	54	6.92	Average	
8	4960	Horn2	H	58.54	32.7	-38.3	-12.5	52.94	74	21.06	Peak
							40.44	54	13.56	Average	
9	7440	Horn2	V	64.43	36.0	-34.7	-12.5	65.73	74	8.27	Peak
							53.23	54	0.77	Average	
10	7440	Horn2	H	56.67	36.0	-34.7	-12.5	57.97	74	16.03	Peak
							45.47	54	8.53	Average	

Calculation:

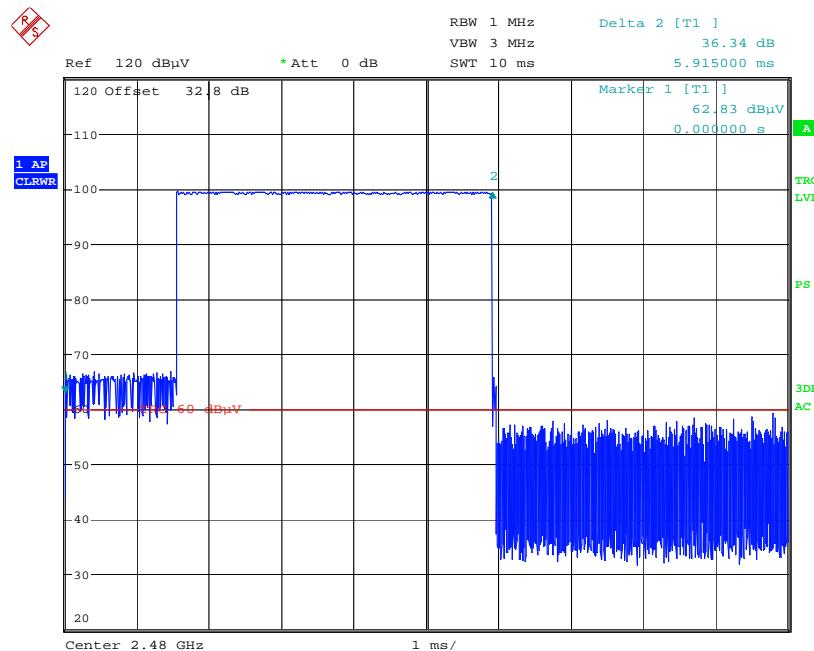
Peak emission = RCVD Signal + Ant. Factor + Amp. Gain/Cable Loss

Average emission = RCVD Signal + Ant. Factor + Amp. Gain/Cable Loss + duty cycle corr.

Duty Cycle:

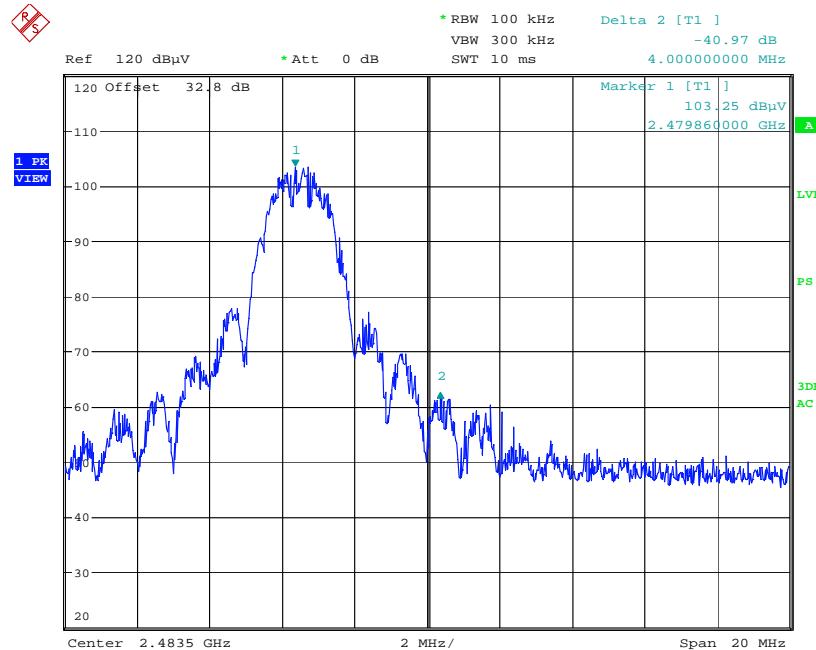


Date: 15.MAR.2008 18:23:26



Date: 15.MAR.2008 18:24:18

Duty cycle correction = $20\log((5.915\text{ms} \times 4)/100\text{ms}) = -12.5\text{dB}$

**Delta Marker Measurement for 2.4835MHz Band Edge
Vertical Polarization**

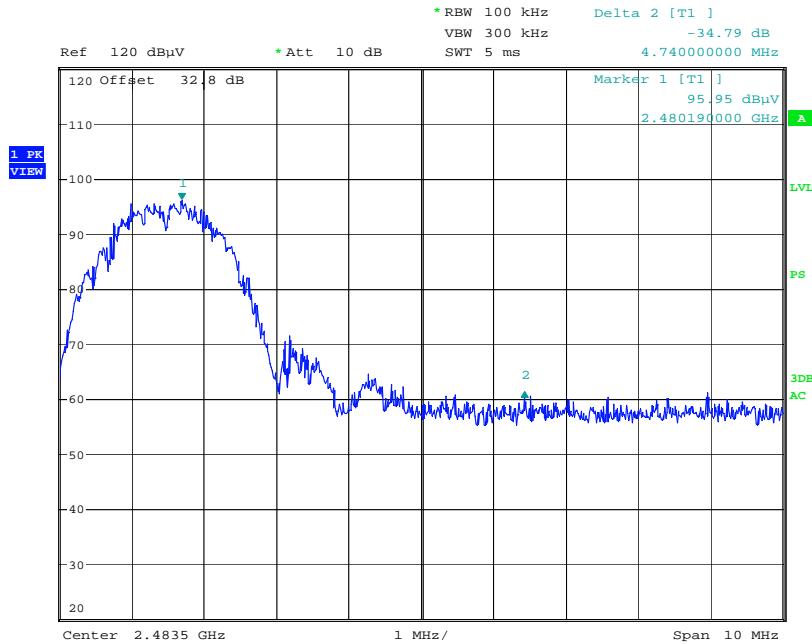
Date: 15.MAR.2008 18:18:02

Note: This plot includes the cable loss and antenna factor (32.8dB)

Measured Field Strength for High Channel in 1MHz RBW = 107.43dB μ V/m

Delta Marker = 40.97dB

Therefore, Peak Field Strength = 107.43dB μ V/m - 40.97dB = 66.46dB μ V/mLimit = 74dB μ V/mAverage Field Strength = 66.46dB μ V/m - 12.5dB(Duty Cycle) = 53.96dB μ V/mLimit = 54dB μ V/m

Horizontal Polarization

Date: 17.MAR.2008 16:08:30

Note: This plot includes the cable loss and antenna factor (32.8dB)

Measured Field Strength for High Channel in 1MHz RBW = 100.16dB μ V/m

Delta Marker = 34.79dB

Therefore, Peak Field Strength = 100.16dB μ V/m - 34.79dB = 65.37dB μ V/mLimit = 74dB μ V/mAverage Field Strength = 65.37dB μ V/m - 12.5dB(Duty Cycle) = 52.87dB μ V/mLimit = 54dB μ V/m

Clause 15.247(a)(2) Systems using digital modulation techniques

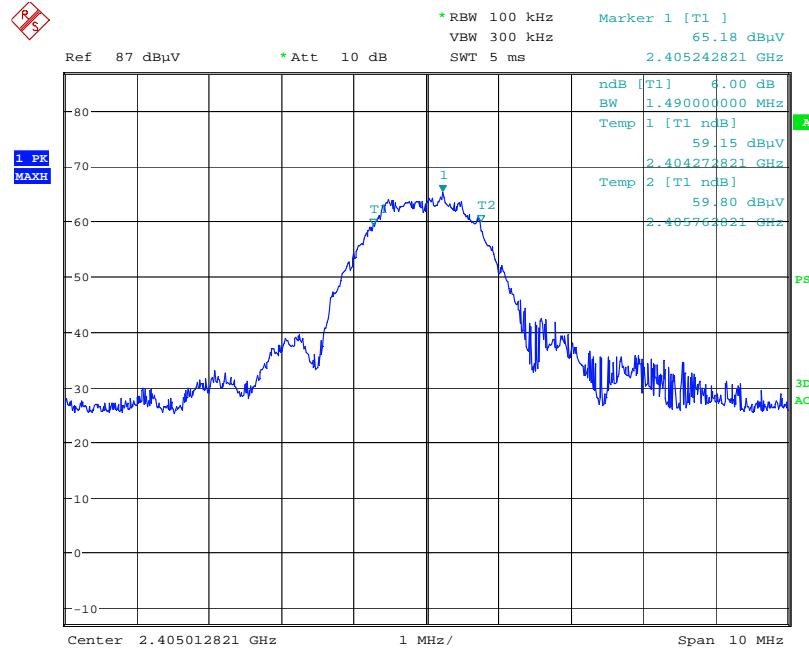
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

Test Conditions:

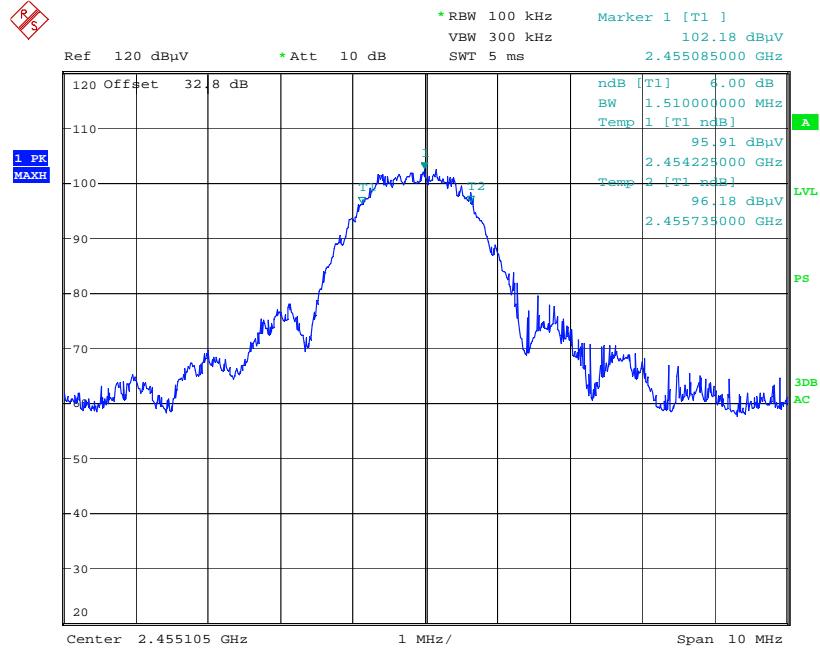
Sample Number:	9	Temperature (°C):	23
Date:	March 13, 2008	Humidity (%):	18
Modification State:	0	Tester:	Jason Nixon
		Laboratory:	3m Chamber

Test Results:**6dB Bandwidth:**

Frequency	6dB Bandwidth
2405MHz	1.49MHz
2455MHz	1.51MHz
2480MHz	1.41MHz

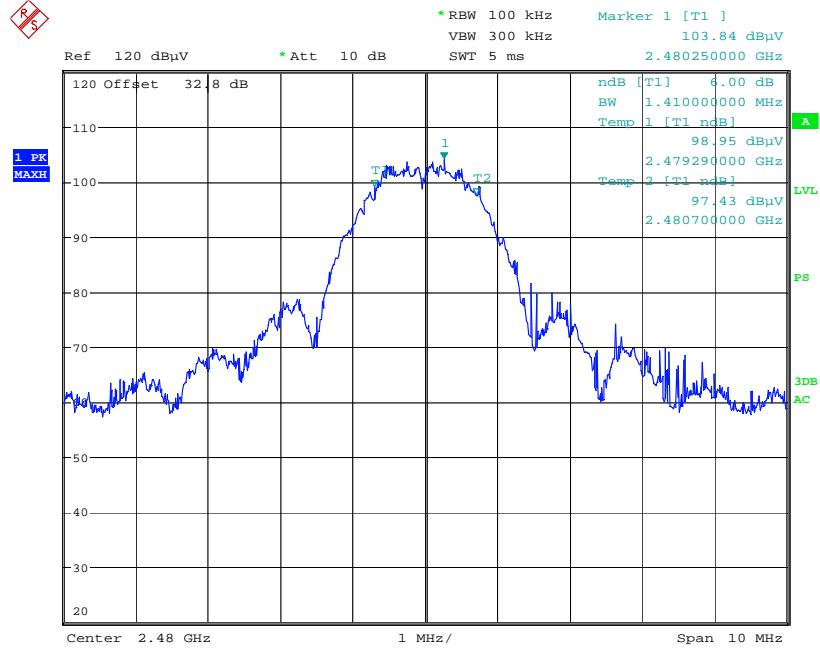
Low Channel

Mid Channel



Date: 13.MAR.2008 12:57:01

High Channel



Date: 13.MAR.2008 13:20:08

Clause 15.247(b)(3) Maximum peak output power of systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Conditions:

Sample Number:	9	Temperature (°C):	23
Date:	March 13, 2008	Humidity (%):	18
Modification State:	0	Tester:	Jason Nixon

Laboratory:	3m Chamber
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Test Results:**Radiated Output Power:**

Ch.	Freq.	Pol V/H	Rx dBuV	Cable loss dB	Ant Factor dB/m	F.S. dBuV/m
low	2405MHz	V	76.71	4.5	28.3	109.51
	2405MHz	H	71.95	4.5	28.3	104.75
mid	2455MHz	V	74.40	4.5	28.3	107.20
	2455MHz	H	69.19	4.5	28.3	101.99
hi	2480MHz	V	74.63	4.5	28.3	107.43
	2480MHz	H	67.36	4.5	28.3	100.16

Measured value (V/m) = $10^{(FS/20)}$ /1000000 = 0.2989V/m

Antenna Gain (numeric) = $10^{(Ag/10)}$ = 1.58

$$\text{Output Power (W)} = \frac{E^2 R^2}{30G} = 0.017W$$

E = Measured Value (V/m)

R = Measurement distance

G = Antenna Gain (numeric)

Additional Observations:

All Measurements were performed at 3m using a Peak Detector with 2MHz RBW/5MHz VBW. The EUT was tested with fresh new batteries.

Clause 15.247(b)(4) Maximum peak output power

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Conditions:

Sample Number:	9	Temperature (°C):	23
Date:	March 13, 2008	Humidity (%):	18
Modification State:	0	Tester:	Jason Nixon

Laboratory: 3m Chamber**Test Results:****Maximum EIRP**

Measured output power = 12.3dBm

Maximum output power = 12.3dBm + 2dBi = 14.3dBm EIRP

Clause 15.247(d) Radiated Emissions Not in Restricted Bands

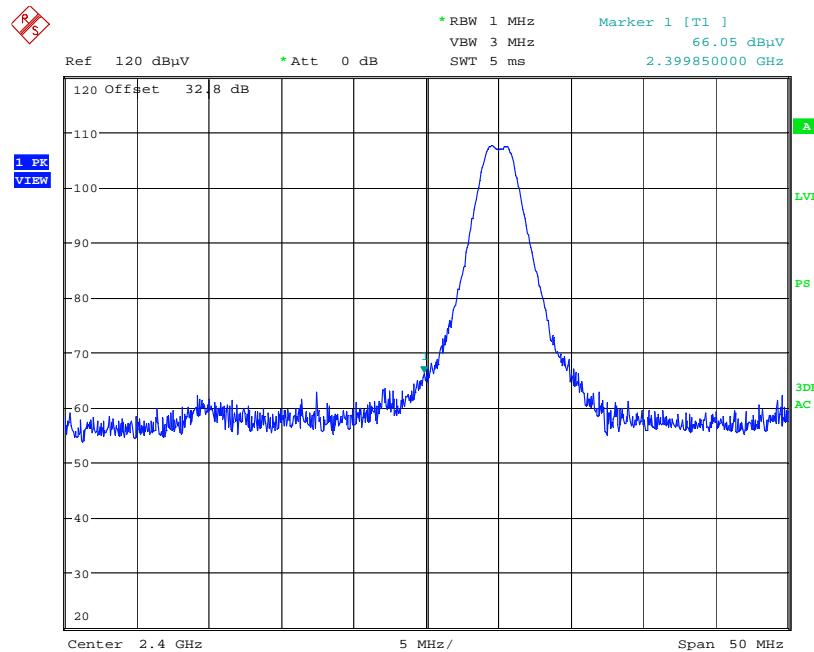
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Conditions:

Sample Number:	9	Temperature (°C):	23
Date:	March 15, 2008	Humidity (%):	21
Modification State:	0	Tester:	Jason Nixon

Laboratory: 3m Chamber |**Test Results:**

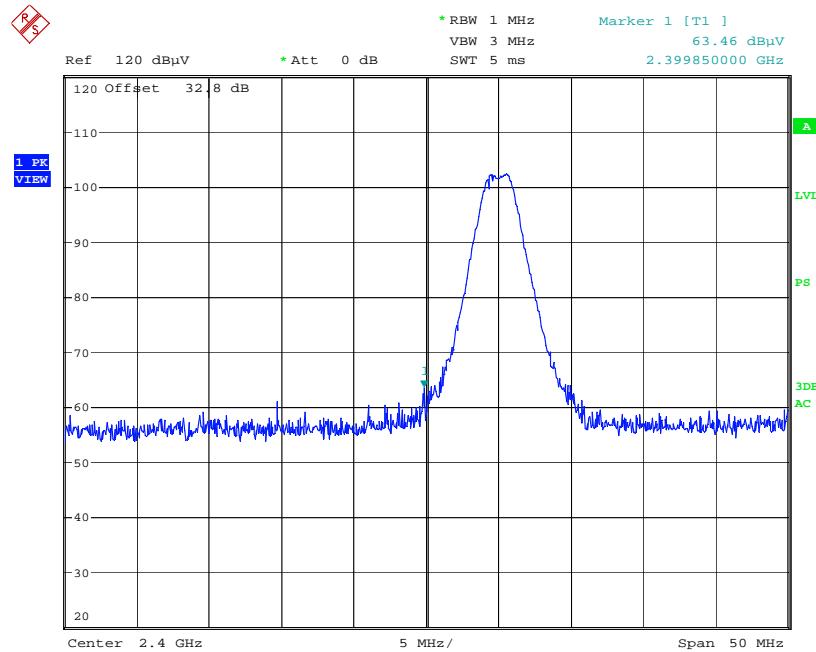
See Attached Table and Plots.

**Lower Band Edge:
Vertical Polarization**

Date: 15.MAR.2008 19:15:16

Note: This plot includes cable loss and antenna factor (32.8dB)

Peak Level = 66.05dB μ V/m at 3mLimit = 74dB μ V/mAverage Level = 66.05dB μ V/m - 12.5dB = 53.55dB μ V/mLimit = 54dB μ V/m

Horizontal Polarization

Date: 15.MAR.2008 19:17:57

Note: This plot includes cable loss and antenna factor (32.8dB)

Peak Level = 63.46dB μ V/m at 3mLimit = 74dB μ V/mAverage Level = 63.46dB μ V/m - 12.5dB = 50.96dB μ V/mLimit = 54dB μ V/m

Freq. (MHz)	Ant	Pol. V/H	RCVD Signal (dB μ V)	Ant. Factor (dB)	Cable Loss (dB)	Amp. Gain (dB)	Level (dB μ V)	Limit (dB μ V)	Margin (dB)
Low Ch.									
2405	Horn2	V	73.12	28.3	4.5	N/A	105.92	—	—
2405	Horn2	H	67.26	28.3	4.5	N/A	100.06	—	—
7215	Horn2	V	55.82	36.0	8.2	-42.6	57.42	85.92	28.5
7215	Horn2	H	48.38	36.0	8.2	-42.6	49.98	80.06	30.08
9620	Horn2	V	45.43	38.0	9.3	-43.3	49.43	85.92	36.49
Mid Ch.									
2455	Horn2	V	69.18	28.3	4.5	N/A	101.98	—	—
2455	Horn2	H	63.59	28.3	4.5	N/A	96.39	—	—
9820	Horn2	V	43.96	38.0	9.3	-43.3	47.96	81.98	34.02
High Ch.									
2480	Horn2	V	70.84	28.3	4.5	N/A	103.64	—	—
2480	Horn2	H	62.45	28.3	4.5	N/A	95.25	—	—
9920	Horn2	V	42.37	38.0	9.3	-43.3	46.37	83.64	37.27

Note 1: Antenna Legend: BC = Biconical, BL = Bilog, LP = Log-Periodic, Horn = Horn, ED = EMCO Dipole

Additional Observations:

Measurements were performed at 3m using a Peak Detector with 100kHz RBW/ 300kHz VBW. Limit is equal to the fundamental field strength – 20dB.

The spectrum was searched from 30MHz to 25GHz. The EUT was tested using a fresh new battery.

Clause 15.247(e) Power Spectral Density for Digitally Modulated Devices

For digitally modulated 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Conditions:

Sample Number:	9	Temperature (°C):	23
Date:	March 15, 2008	Humidity (%):	21
Modification State:	0	Tester:	Jason Nixon
		Laboratory:	3m Chamber

Test Results:**Radiated Power Spectral Density Power:**

Ch.	Freq.	Pol V/H	Rx dBuV	Cable loss dB	Ant Factor dB/m	F.S. dBuV/m	PSD Conducted dBm
low	2405MHz	V	63.53	4.5	28.3	96.33	-0.88
	2405MHz	H	59.46	4.5	28.3	92.26	-4.96
mid	2455MHz	V	63.15	4.5	28.3	95.95	-1.27
	2455MHz	H	58.01	4.5	28.3	90.81	-6.41
hi	2480MHz	V	62.83	4.5	28.3	95.63	-1.59
	2480MHz	H	56.25	4.5	28.3	89.05	-8.17

Example Calculation:

$$FS=96.33 \text{ dBuV/m}$$

$$\text{Measured value (V/m)} = 10^{(FS/20)} / 1000000 = 0.06554 \text{ V/m}$$

$$\text{Antenna Gain (numeric)} = 10^{(Ag/10)} = 1.58$$

$$\text{Output Power (W)} = \frac{E^2 R^2}{30G} = 0.000816 \text{ W} = -0.88 \text{ dBm}$$

E = Measured Value (V/m)

R = Measurement distance

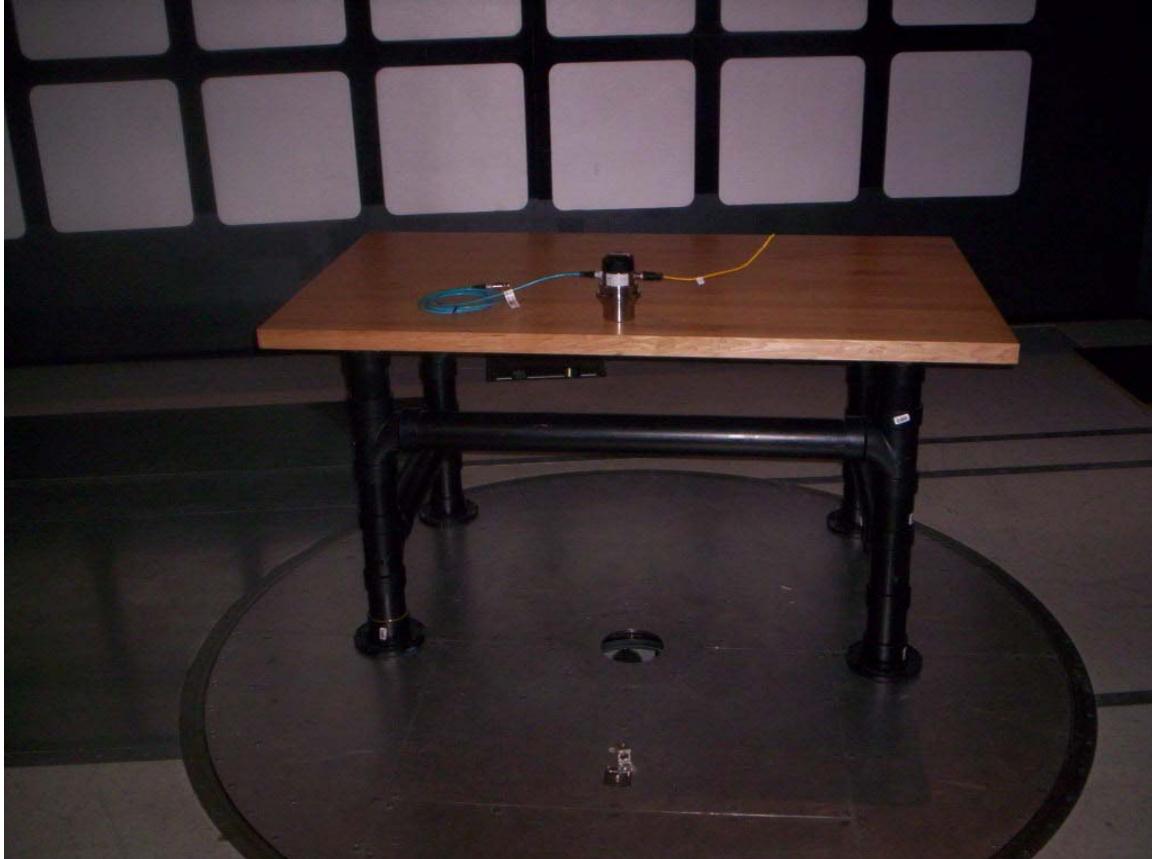
G = Antenna Gain (numeric)

Additional Observations:

All Measurements were performed at 3m using a Peak Detector with 3kHzRBW/10kHz VBW, the span was set to 1.5MHz and the sweep time was set to 500seconds. The EUT was tested with fresh new batteries.

Appendix B : Setup Photographs

Spurious Emissions Setup:



Appendix C : Block Diagram of Test Setups**Test Site For Radiated Emissions**