Excellence in Compliance Testing

Certification Test Report

FCC ID: HSW-DNT2400
IC: 4492A-DNT2400

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

ACS Report Number 09-0199-15C

Manufacturer: **RFM / Cirronet Inc.**
Model(s): **DNT2400C, DNT2400P**

Test Begin Date: June 25, 2009
Test End Date: July 14, 2009

Report Issue Date: July 30, 2009

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

This report is not be used to claim certification, approval, or endorsement by NVLAP, NIST or any government agency.

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This report contains 33 pages

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1.0 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.

1.2 Product Description

1.2.1 General

The DNT2400 is a 2.4 GHz frequency hopping transceiver designed for use in Industrial monitoring and control markets. Basic operating parameters of the radio are:

Band of operation:	2409.33 – 2467.11 MHz
Number of hopping channels:	37
Channel spacing	1.444 MHz
Output power (maximum):	18 dBm
Over the air data rates:	38.4 Kbps, 115.2 Kbps, 200 Kbps and 500 Kbps
Modulation format:	Gaussian filtered FSK
Emission Designator:	F1D
Antennas:	9 dBi Omni, Mobile Mark Antennas, Part Number–OD9-2400 6 dBi Patch, Cirronet/RFM custom design, Part Number–PA2400
RF connector:	UFL

Manufacturer Information:
RFM/Cirronet, Inc.
3079 Premiere Parkway, Suite 140
Duluth, GA 30097

Test Sample Serial Number(s):
UNIT#1 Schematic Date of 5282009

Test Sample Condition:
Test samples were provided in good working order with no visible defects.

Detailed photographs of the EUT are filed separately with this filing.

1.2.2 Intended Use

The DNT2400 is intended for use in Industrial monitoring and control markets.

1.3 Test Methodology and Considerations

A test evaluation board was utilized to supply power and program the EUT for test modes. See Section 5.0 – 6.0 for additional details.

The DNT2400C and DNT2400P models are electrically identical and differ only their mounting option. The DNT2400C is designed for reflow soldering and the DNT2400P is designed for socket mounting. To allow use of a test fixture during testing the DNT2400P model was evaluated.

The DNT2400 was tested using multiple data rates, 38.4 Kbps, 115.2 Kbps, 200 Kbps and 500 Kbps. Where applicable, the worst case data from all modes of operation is provided.

2.0 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions
5015 B.U. Bowman Drive
Buford, GA 30518
Phone: (770) 831-8048
Fax: (770) 831-8598

2.2 Laboratory Accreditations/Recognitions/Certifications

The Semi-Anechoic Chamber Test Site, Open Area Test Site (OATS) and Conducted Emissions Site have been fully described, submitted to, and accepted by the FCC, Industry Canada and the Japanese Voluntary Control Council for Interference by information technology equipment. In addition, ACS is compliant to ISO/IEC 17025 as certified by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program. The following certification numbers have been issued in recognition of these accreditations and certifications:

FCC Registration Number: 894540
Industry Canada Lab Code: IC 4175A-1
VCCI Member Number: 1831

- VCCI OATS Registration Number R-1526
- VCCI Conducted Emissions Site Registration Number: C-1608

NVLAP Lab Code: 200612-0

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 20' x 30' x 18' shielded enclosure. The chamber is lined with Toyo Ferrite Grid Absorber, model number FFG-1000. The ferrite tile grid is 101 x 101 x 19mm thick and weighs approximately 550 grams. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber.

The turntable is 150cm in diameter and is located 160cm from the back wall of the chamber. The chamber is grounded via 1 - 8' copper ground rod, installed at the center of the back wall, it is bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is all steel, flush mounted table installed in an all steel frame. The table is remotely operated from inside the control room located 25' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Behind the turntable is a 3' x 6' x 4' deep shielded pit used for support equipment if necessary. The pit is equipped with 1 - 4" PVC chases from the turntable to the pit that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit.

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3-1 below:

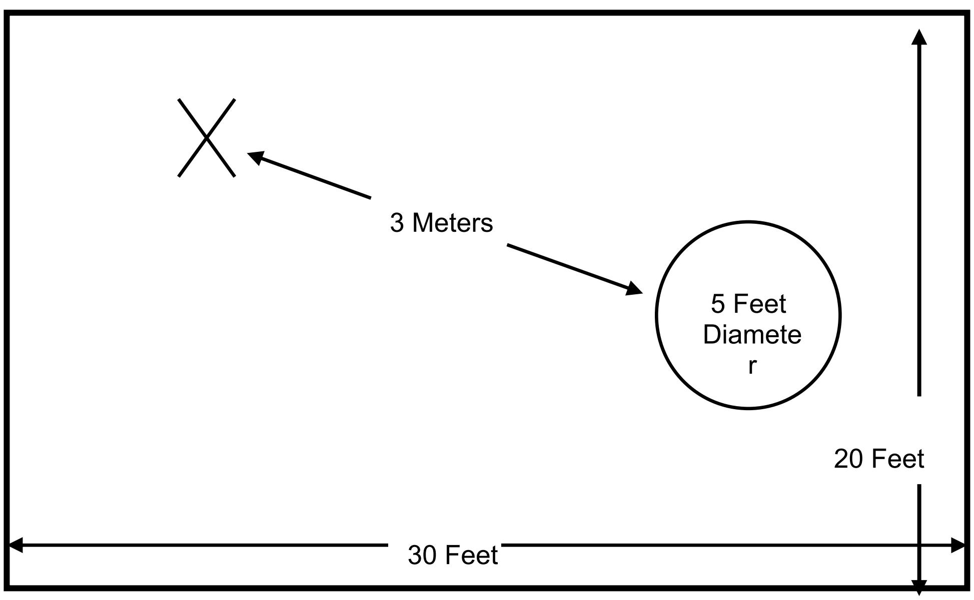

Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Open Area Tests Site (OATS)

The open area test site consists of a 40' x 66' concrete pad covered with a perforated electro-plated galvanized sheet metal. The perforations in the sheet metal are 1/8" holes that are staggered every 3/16". The individual sheets are placed to overlap each other by 1/4" and are riveted together to provide a continuous seam. Rivets are spaced every 3" in a 3 x 20 meter perimeter around the antenna mast and EUT area. Rivets in the remaining area are spaced as necessary to properly secure the ground plane and maintain the electrical continuity.

The entire ground plane extends 12' beyond the turntable edge and 16' beyond the antenna mast when set to a 10 meter measurement distance. The ground plane is grounded via 4 - 8' copper ground rods, each installed at a corner of the ground plane and bound to the ground plane using 3/4" stainless steel braided cable.

The turntable is an all aluminum 10' flush mounted table installed in an all aluminum frame. The table is remotely operated from inside the control room located 40' from the range. The turntable is electrically bonded to the surrounding ground plane via steel fingers installed on the edge of the turn table. The steel fingers make constant contact with the ground plane during operation.

Adjacent to the turntable is a 7' x 7' square and 4' deep concrete pit used for support equipment if necessary. The pit is equipped with 5 - 4" PVC chases from the pit to the control room that allow for cabling to the EUT if necessary. The underside of the turntable can be accessed from the pit so cables can be supplied to the EUT from the pit. The pit is covered with 2 sheets of 1/4" diamond style re-enforced steel sheets. The sheets are painted to match the perforated steel ground plane; however the underside edges have been masked off to maintain the electrical continuity of the ground plane. All reflecting objects are located outside of the ellipse defined in ANSI C63.4.

A diagram of the Open Area Test Site is shown in Figure 2.3-2 below:

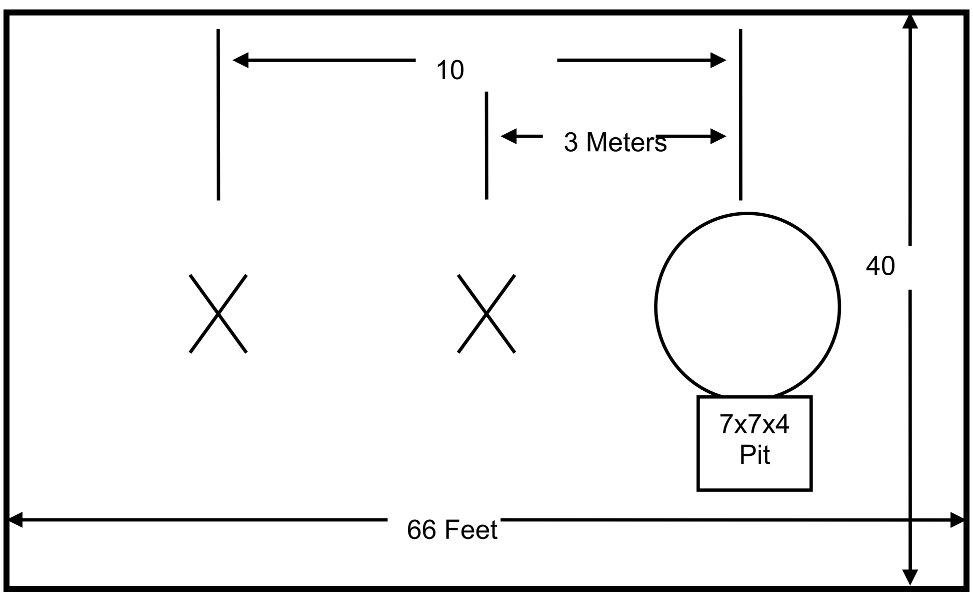

Figure 2.3-2: Open Area Test Site

2.4 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 8' solid aluminum horizontal group reference plane (GRP) bonded every 3" to an 8' X 8' vertical ground plane.

The site is of sufficient size to test table top and floor standing equipment in accordance with section 6.1.4 of ANSI C63.4.

A diagram of the room is shown below in figure 4.1.3-1:

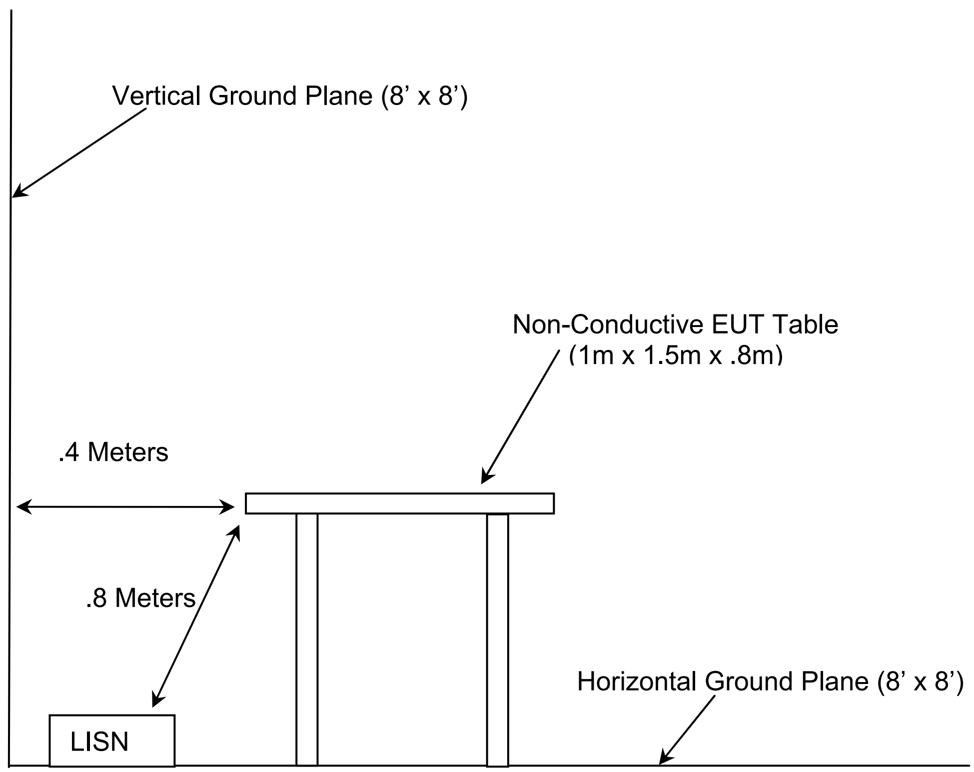

Figure 2.4-1: AC Mains Conducted EMI Site

3.0 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 9KHz to 40GHz
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2009
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2009
- FCC Public Notice DA 00-705 - Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems, March 30, 2000
- Industry Canada Radio Standards Specification: RSS-210 - Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, Issue 7 June 2007
- Industry Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue2, June 2007.

4.0 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

Equipment Calibration Information					
ACS#	**Mfg.**	**Eq. type**	**Model**	**S/N**	**Cal. Due**
1	Rohde & Schwarz	Spectrum Analyzers	ESMI - Display	833771/007	09-19-2009
2	Rohde & Schwarz	Spectrum Analyzers	ESMI-Receiver	839587/003	09-19-2009
22	Agilent	Amplifiers	8449B	3008A00526	10-22-2009
25	Chase	Antennas	CBL6111	1043	08-22-2009
30	Spectrum Technologies	Antennas	DRH-0118	970102	05-08-2010
73	Agilent	Amplifiers	8447D	2727A05624	07-15-2010
152	EMCO	LISN	3825/2	9111-1905	03-25-2010
167	ACS	Cable Set	Chamber EMI Cable Set	167	02-06-2010 (See Note1)
168	Hewlett Packard	Attenuators	11947A	44829	02-10-2010 (See Note2)
283	Rohde & Schwarz	Spectrum Analyzer	FSP40	1000033	09-19-2009
291	Florida RF Labs	Cables	SMRE-200W-12.0-SMRE	None	11-24-2009 (See Note1)
292	Florida RF Labs	Cables	SMR-290AW-480.0-SMR	None	11-24-2009 (See Note1)
324	ACS	Cables	Belden	8214	07-28-2009 (See Note1)
338	Hewlett Packard	Amplifiers	8449B	3008A01111	10-22-2009
340	Aeroflex/Weinschel	Attenuators	AS-20	7136	10-22-2009 (See Note2)
422	Florida RF Labs	Cables	SMS-200AW-72.0-SMR	805	02-05-2010 (See Note1)
432	Microwave Circuits	Filters	H3G020G4	264066	07-17-2010 (See Note1)

Note1: Items characterized on an annual cycle. The date shown indicates the next characterization due date.

Note2: Items verified on an annual cycle. The date shown indicates the next verification due date.

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	9V ITE Power Supply	Globtek, Inc.	GT-21088-0909-W2	02106248/03
2	DNT500 Eval Board	Cirronet	800886 Rev PR3	ACS#6

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

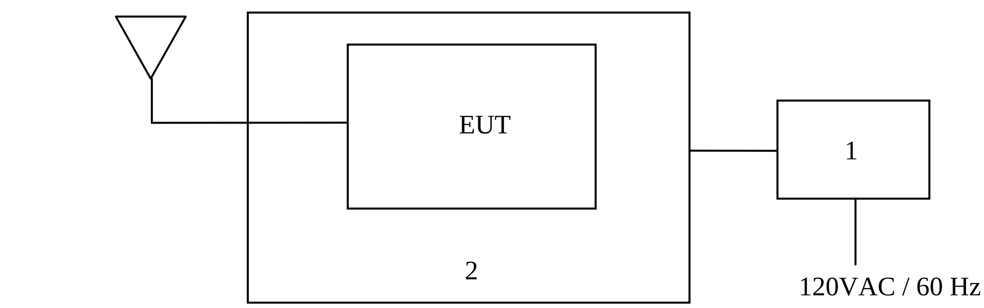

Figure 1: Radiated & AC Power Line Conducted Emissions Setup

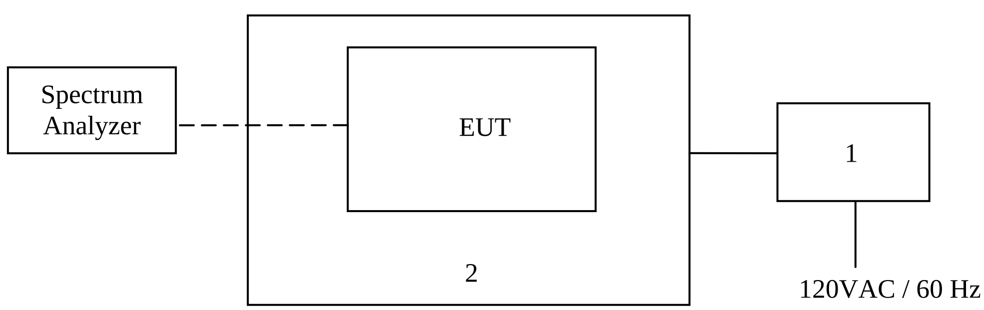

Figure 2: RF Conducted Setup

Figure 6-1: EUT Test Setup

*See Test Setup photographs for additional detail.

7.0 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 DNT2400 utilizes a UFL connecter soldered directly to the PCB board.

7.2 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.2

7.2.1 Test Methodology

ANSI C63.4 sections 6 and 7 were the guiding documents for this evaluation. Conducted emissions were performed from 150kHz to 30MHz with the spectrum analyzer's resolution bandwidth set to 9kHz and the video bandwidth set to 30kHz. The calculation for the conducted emissions is as follows:

Corrected Reading = Analyzer Reading + LISN Loss + Cable Loss
Margin = Applicable Limit - Corrected Reading

7.2.2 Test Results

Results of the test are shown below in Tables 7.2.2-1 to 7.2.2-4 and Figures 7.2.2-1 to 7.2.2-4.

Table 7.2.2-1: Conducted EMI Results – Line 1 – Dipole

Frequency (MHz)	Level (dBuV)	Transducer (dB)	Limit (dBuV)	Margin (dB)	Line	PE	Detector
2.046	33.2	10	56	22.8	L1	FLO	QP
2.148	35.6	10	56	20.4	L1	FLO	QP
2.25	34.9	10	56	21.1	L1	FLO	QP
2.358	31	10	56	25	L1	FLO	QP
2.496	9.2	10	56	46.8	L1	FLO	QP
4.506	28.3	10	56	27.7	L1	FLO	QP
4.608	31.3	10	56	24.7	L1	FLO	QP
4.71	33.3	10	56	22.7	L1	FLO	QP
4.812	33.6	10	56	22.4	L1	FLO	QP
4.914	33.5	10	56	22.5	L1	FLO	QP
2.028	6.7	10	46	39.3	L1	FLO	AVG
2.148	29	10	46	17	L1	FLO	AVG
2.25	28.7	10	46	17.3	L1	FLO	AVG
2.358	25.6	10	46	20.4	L1	FLO	AVG
2.454	23.4	10	46	22.6	L1	FLO	AVG
4.512	13.6	10	46	32.4	L1	FLO	AVG
4.572	11.9	10	46	34.1	L1	FLO	AVG
4.71	31	10	46	15	L1	FLO	AVG
4.812	32.3	10	46	13.7	L1	FLO	AVG
4.914	32	10	46	14	L1	FLO	AVG

Table 7.2.2-2: Conducted EMI Results – Line 2 - Dipole

Frequency (MHz)	Level (dBuV)	Transducer (dB)	Limit (dBuV)	Margin (dB)	Line	PE	Detector
1.944	26.2	10	56	29.8	L2	FLO	QP
1.992	9.8	10	56	46.2	L2	FLO	QP
2.148	33.1	10	56	22.9	L2	FLO	QP
2.25	32.9	10	56	23.1	L2	FLO	QP
2.97	29.5	9.9	56	26.5	L2	FLO	QP
3.786	27.6	9.9	56	28.4	L2	FLO	QP
4.398	27.2	10	56	28.8	L2	FLO	QP
4.506	30.7	10	56	25.3	L2	FLO	QP
4.704	28.2	10	56	27.8	L2	FLO	QP
4.98	11.1	10	56	44.9	L2	FLO	QP
1.968	6.9	10	46	39.1	L2	FLO	AVG
1.974	6.9	10	46	39.1	L2	FLO	AVG
2.118	6.7	10	46	39.3	L2	FLO	AVG
2.256	23.6	10	46	22.4	L2	FLO	AVG
2.964	18.7	9.9	46	27.3	L2	FLO	AVG
3.744	6.8	9.9	46	39.2	L2	FLO	AVG
4.404	28.2	10	46	17.8	L2	FLO	AVG
4.506	29.4	10	46	16.6	L2	FLO	AVG
4.71	26.2	10	46	19.8	L2	FLO	AVG
4.998	7.6	10	46	38.4	L2	FLO	AVG

Table 7.2.2-3: Conducted EMI Results – Line 1 – Patch

Frequency (MHz)	Level (dBuV)	Transducer (dB)	Limit (dBuV)	Margin (dB)	Line	PE	Detector
2.046	32.8	10	56	23.2	L1	FLO	QP
2.148	35.1	10	56	20.9	L1	FLO	QP
2.25	34.4	10	56	21.6	L1	FLO	QP
2.478	9.1	10	56	46.9	L1	FLO	QP
2.97	30.5	9.9	56	25.5	L1	FLO	QP
3.888	29.6	9.9	56	26.4	L1	FLO	QP
4.608	31.4	10	56	24.6	L1	FLO	QP
4.71	33.4	10	56	22.6	L1	FLO	QP
4.812	33.7	10	56	22.3	L1	FLO	QP
4.914	33.5	10	56	22.5	L1	FLO	QP
2.046	27.3	10	46	18.7	L1	FLO	AVG
2.124	6.8	10	46	39.2	L1	FLO	AVG
2.25	28.3	10	46	17.7	L1	FLO	AVG
2.478	6.5	10	46	39.5	L1	FLO	AVG
2.97	26.2	9.9	46	19.8	L1	FLO	AVG
3.888	25.8	9.9	46	20.2	L1	FLO	AVG
4.602	21.4	10	46	24.6	L1	FLO	AVG
4.71	31.3	10	46	14.7	L1	FLO	AVG
4.812	32.3	10	46	13.7	L1	FLO	AVG
4.914	31.9	10	46	14.1	L1	FLO	AVG

Table 7.2.2-4: Conducted EMI Results – Line 2 - Patch

Frequency (MHz)	Level (dBuV)	Transducer (dB)	Limit (dBuV)	Margin (dB)	Line	PE	Detector
2.046	30.4	10	56	25.6	L2	FLO	QP
2.148	33	10	56	23	L2	FLO	QP
2.202	9.4	10	56	46.6	L2	FLO	QP
2.352	29.9	10	56	26.1	L2	FLO	QP
2.97	29.6	9.9	56	26.4	L2	FLO	QP
4.398	26.8	10	56	29.2	L2	FLO	QP
4.608	30.8	10	56	25.2	L2	FLO	QP
4.71	30.3	10	56	25.7	L2	FLO	QP
4.914	29.4	10	56	26.6	L2	FLO	QP
4.956	11	10	56	45	L2	FLO	QP
2.022	6.5	10	46	39.5	L2	FLO	AVG
2.148	25.9	10	46	20.1	L2	FLO	AVG
2.25	25.3	10	46	20.7	L2	FLO	AVG
2.376	6.9	10	46	39.1	L2	FLO	AVG
3	6.5	9.9	46	39.5	L2	FLO	AVG
4.434	12.2	10	46	33.8	L2	FLO	AVG
4.596	12.9	10	46	33.1	L2	FLO	AVG
4.71	26.6	10	46	19.4	L2	FLO	AVG
4.866	6.8	10	46	39.2	L2	FLO	AVG
4.962	7.1	10	46	38.9	L2	FLO	AVG

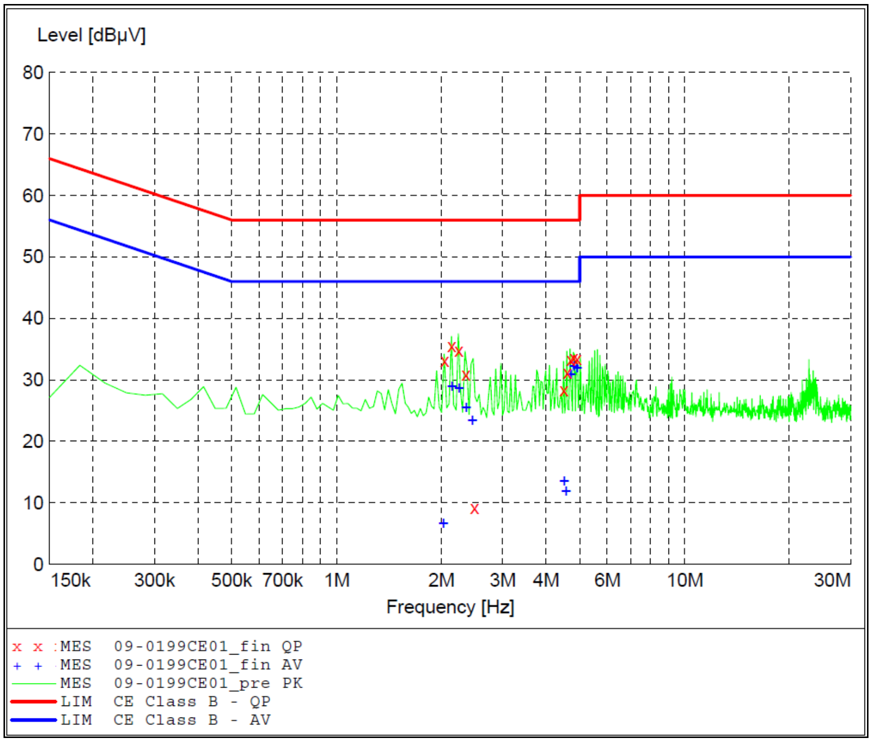

Figure 7.2.2-1: Conducted EMI Results – Line 1 - Dipole

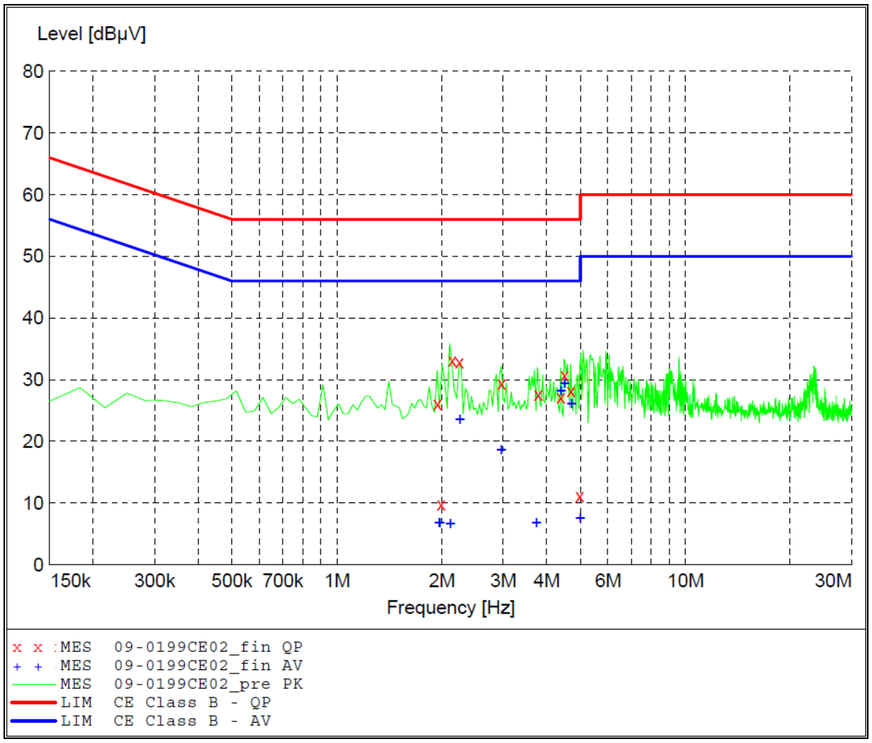

Figure 7.2.2-2: Conducted EMI Results – Line 2 - Dipole

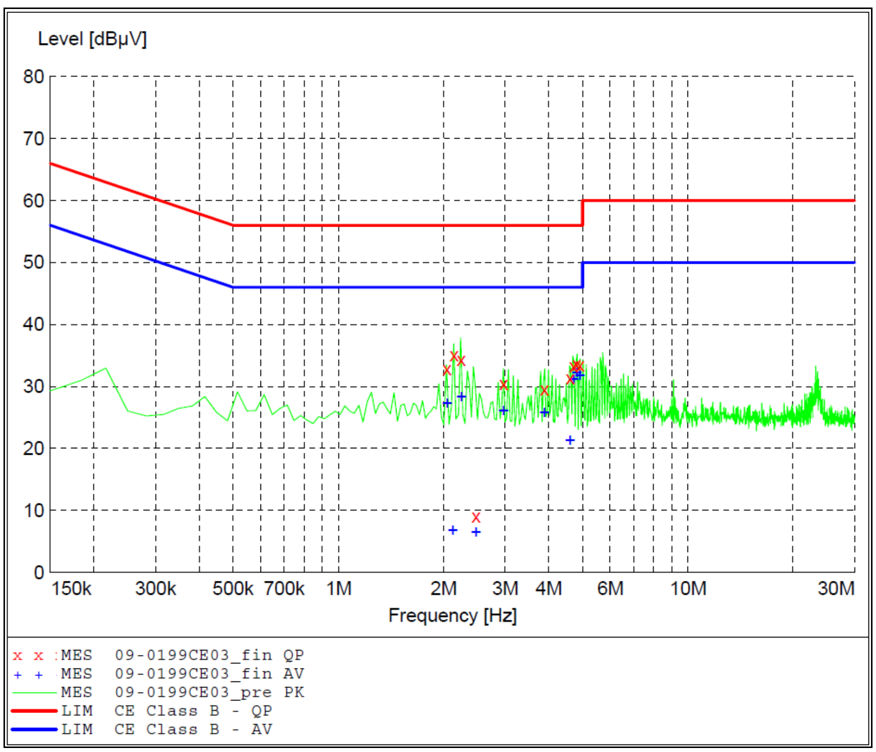

Figure 7.2.2-3: Conducted EMI Results – Line 1 - Patch

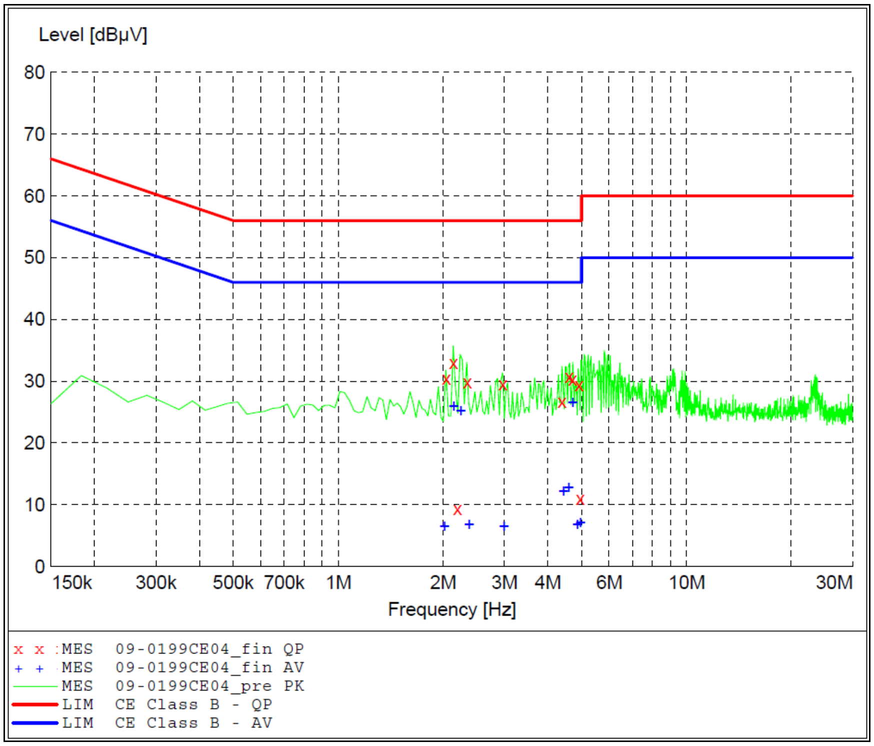

Figure 7.2.2-4: Conducted EMI Results – Line 2 - Patch

7.3 Radiated Emissions – FCC: Section 15.109(Unintentional Radiation) IC: RSS-210 2.6

7.3.1 Test Methodology

Radiated emissions tests were performed over the frequency range of 30MHz to 12.5 GHz. Measurements of the radiated field strength were made at a distance of 3m from the boundary of the equipment under test (EUT) and the receiving antenna. The antenna height was varied from 1m to 4m so that the maximum radiated emissions level would be detected. Radiated measurements above 30MHz and below 1GHz were made with the Spectrum Analyzer's resolution bandwidth set to 120 KHz using a Quasi-peak detector. Above 1GHz, peak and average measurements are taken with the RBW and VBW were set to 1MHz and 3MHz respectively.

The DNT2400 was evaluated with both the 9dBi dipole and 6 dBi patch antenna. Final data was collected using the dipole antenna which represents worst case.

7.3.2 Test Results

Results of the test are given in Table 7.3.2-1 below:

Table 7.3.2-1: Radiated Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
38.688	---------	40.24	V	-12.60	---------	27.64	--------	40.0	---------	12.36
90.302	---------	38.64	V	-15.43	---------	23.21	--------	43.5	---------	20.29
116.106	---------	42.07	V	-12.43	---------	29.64	--------	43.5	---------	13.86
103.193	---------	36.51	V	-13.18	---------	23.33	--------	43.5	---------	20.17
129.008	---------	38.97	V	-12.20	---------	26.77	--------	43.5	---------	16.73
193.515	---------	43.37	H	-15.82	---------	27.55	--------	43.5	---------	15.95
180.611	---------	41.18	V	-14.92	---------	26.26	--------	43.5	---------	17.24

7.4 Peak Output Power - FCC Section 15.247(b)(2) IC: RSS-210 A8.4(1)

7.4.1 Test Methodology (Conducted Method)

The 20dB bandwidth of the EUT was within the resolution bandwidth of spectrum analyzer, therefore the power measurement was made using the spectrum analyzer method. The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The resolution and video bandwidth were set to > 20 dB bandwidth of the emission measured. The device employs >50 channels therefore the power is limited to 1 Watt.

7.4.2 Test Results

Results are shown below in table 7.4.2-1 and the worst case was plotted and shown in figure 7.4.2-1 to 7.4.2-3 below:

Table 7.4.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
2409.33	17.64
2441.11	17.49
2467.11	17.49

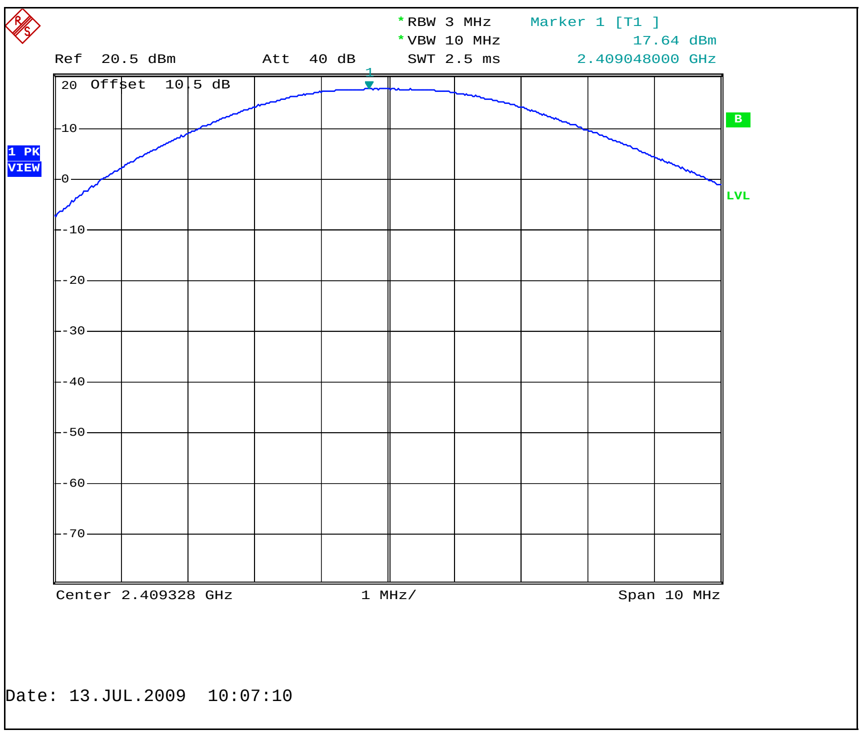

Figure 7.4.2-1: Output power – Low Channel

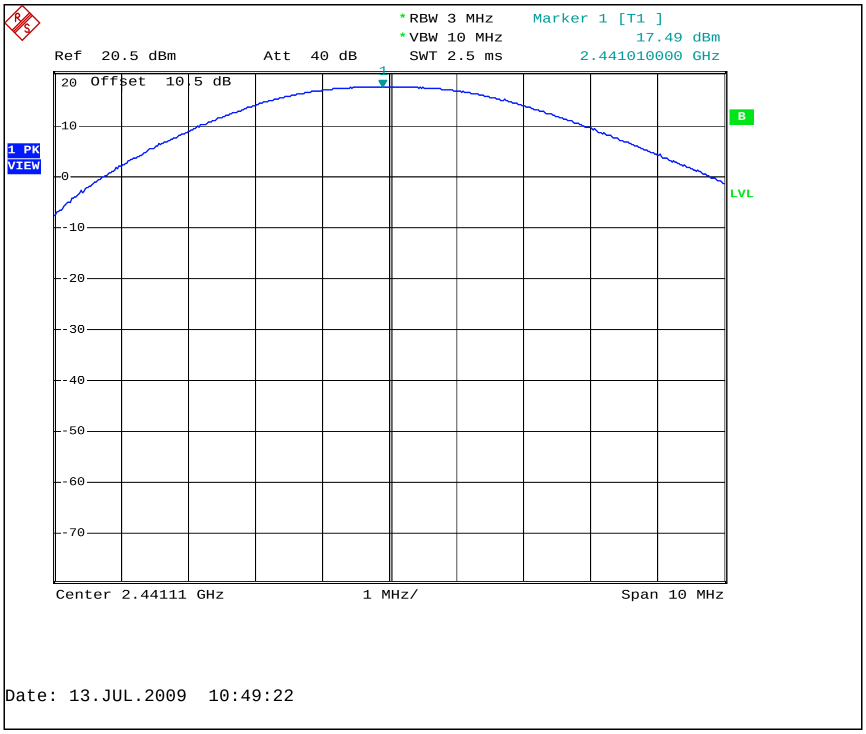

Figure 7.4.2-2: Output power – Mid Channel

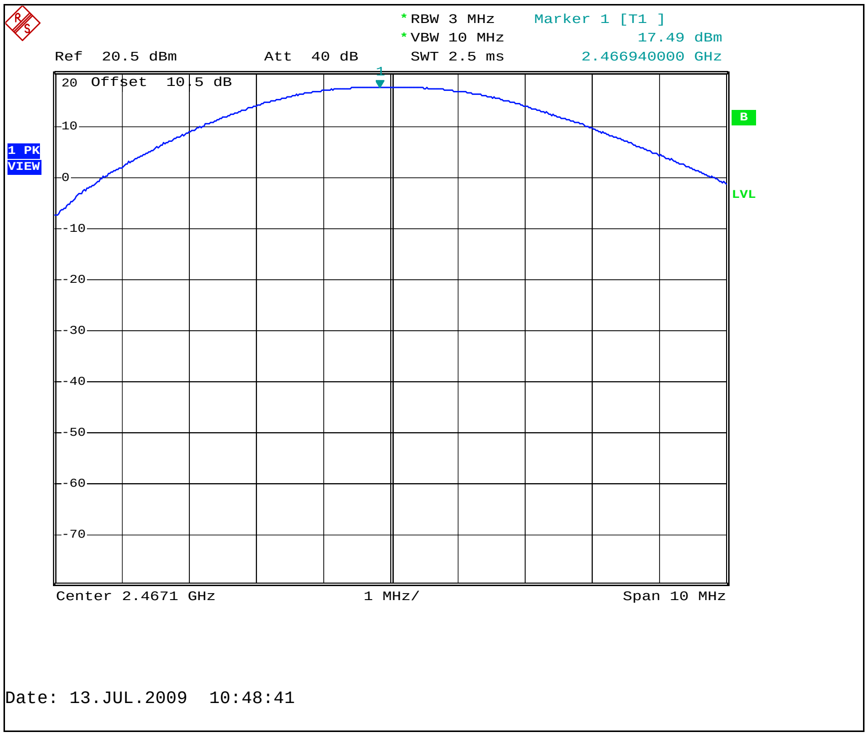

Figure 7.4.2-3: Output power – High Channel

7.5 Channel Usage Requirements

7.5.1 Carrier Frequency Separation – FCC: Section 15.247(a)(1) IC: RSS-210 A8.1(b)

7.5.1.1 Test Methodology

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer was set wide enough to capture two adjacent peaks and the RBW and VBW were set to ≥ 1% of the span.

7.5.1.2 Test Results

The maximum 20dB bandwidth of the hopping channel was measured to be 942 kHz (See figure 7.5.4-1 to 7.5.4-3 below). The adjacent channel separation was measured to be 1.458 MHz. Results are shown in figure 7.5.1-1 below:

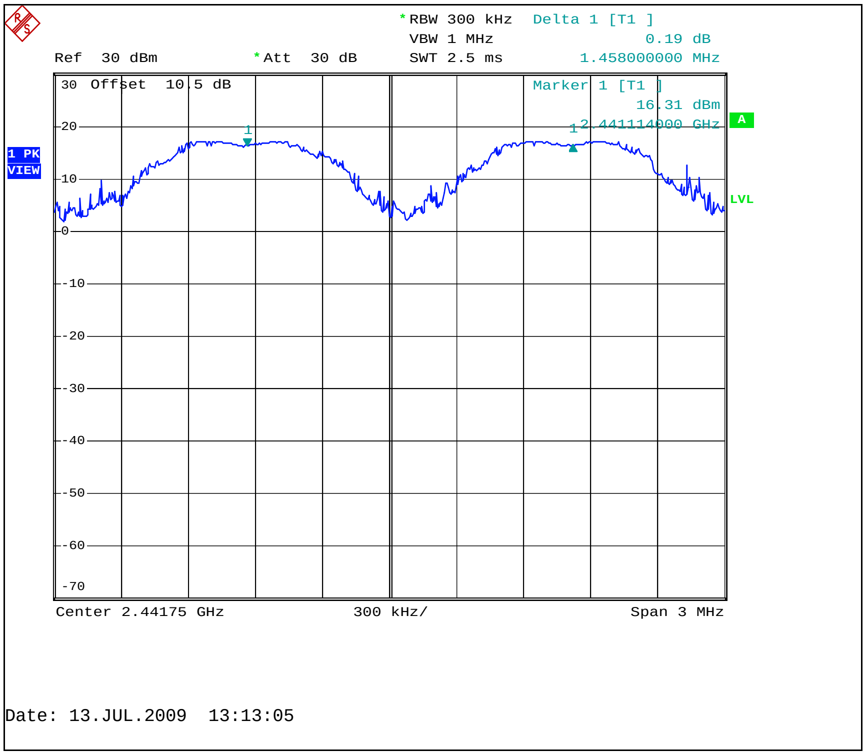

Figure 7.5.1-1: Carrier Frequency Separation

7.5.2 Number of Hopping Channels – FCC: Section 15.247(a)(1)(iii), FCC: Section 15.247(b)(1); IC: RSS-210 A8.1(b), IC: RSS-210 A8.1(d)

The maximum peak conducted output power is less than 0.125W. The device employs 37 hopping channels which is greater than 15 hopping channels as required. Results are shown in Figure 7.5.2-1 below:

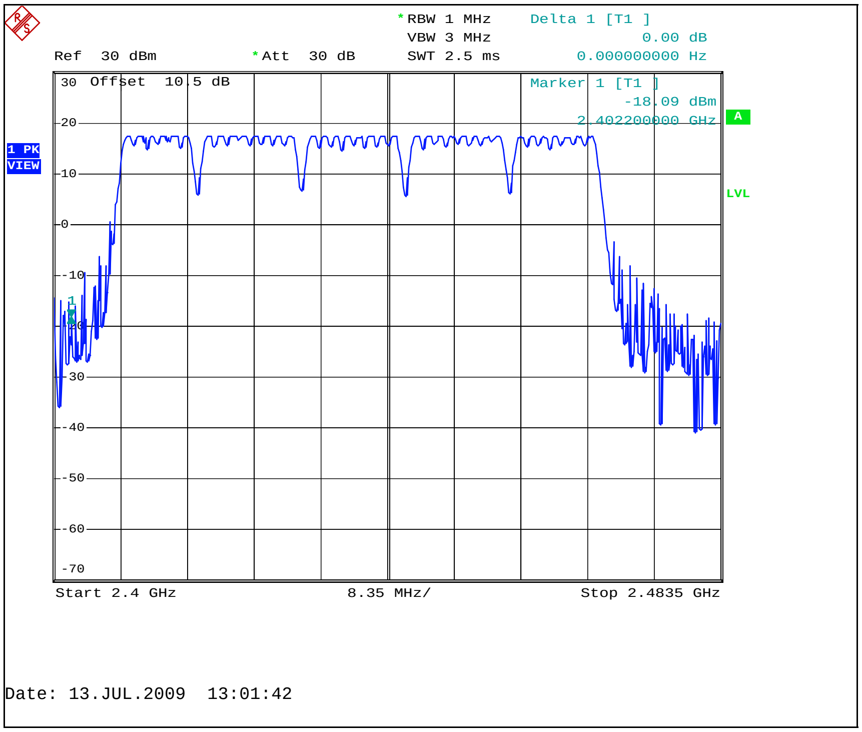

Figure 7.5.2-1: Number of Hopping Channels

7.5.3 Channel Dwell Time – FCC: Section 15.247(a)(1)(i) IC: RSS-210 A8.1(c)

7.5.3.1 Test Methodology

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The hopping channel is centered on the analyzer and the span set to 0 Hz. The RBW was set to 1 MHz and the VBW to 3 MHz. Sweep time was adjusted to capture the burst duration and repetition. The marker –delta function of the analyzer was employed to measure the burst duration and repetition rate.

7.5.3.2 Test Results

For all data rates the channel dwell time is less than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed (0.4*37 = 14.8s). The maximum time of occupancy on any channel in a 14.8 second period is 230ms for the 38.4kbps data rate. A single measured transmission and transmission repetition rate is shown for all data rates in figures 7.5.3-1 to 7.5.3-8 below:

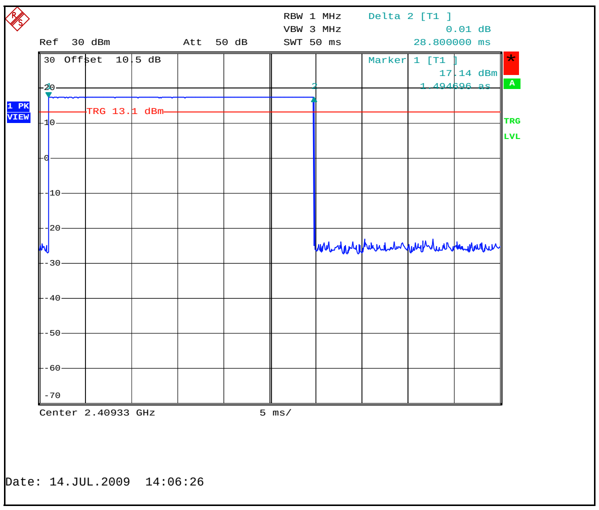

Figure 7.5.3-1: Dwell Time – 38.4 kbps (28.8ms)

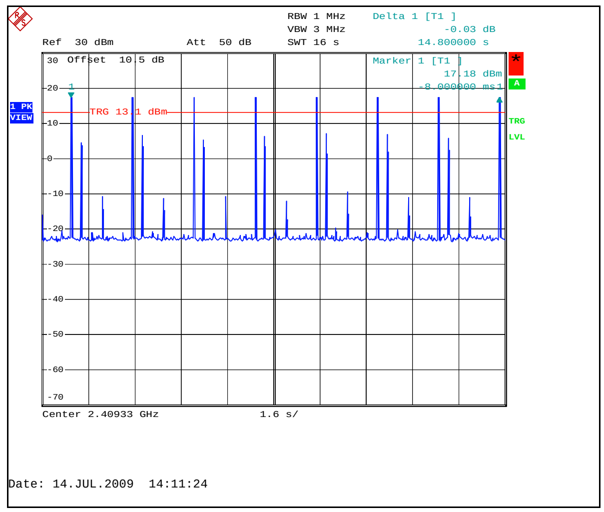

Figure 7.5.3-2: Repetition – 38.4 kbps (8 * 28.8ms = 230.4ms)

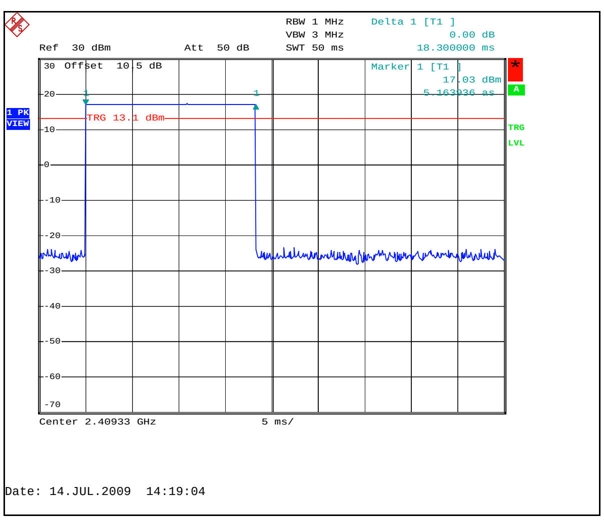

Figure 7.5.3-3: Dwell Time – 115.2 kbps (18.3ms)

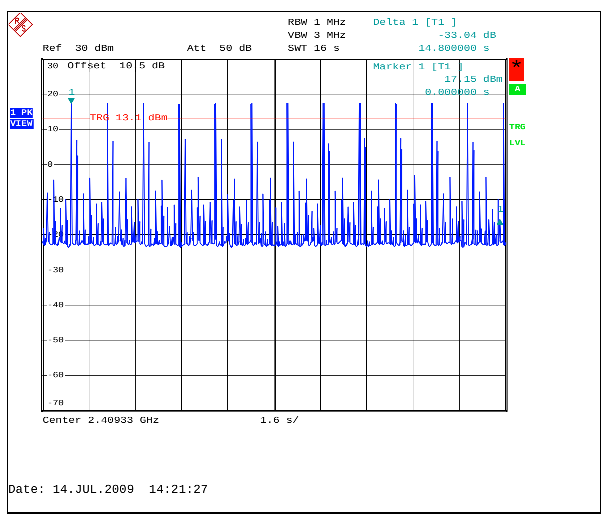

Figure 7.5.3-4: Repetition – 115.2 kbps (12 * 18.3ms = 219.6ms)

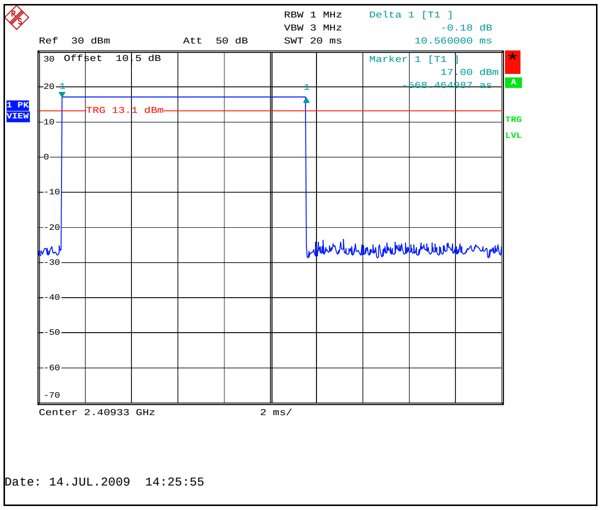

Figure 7.5.3-5: Dwell Time – 200 kbps (10.56ms)

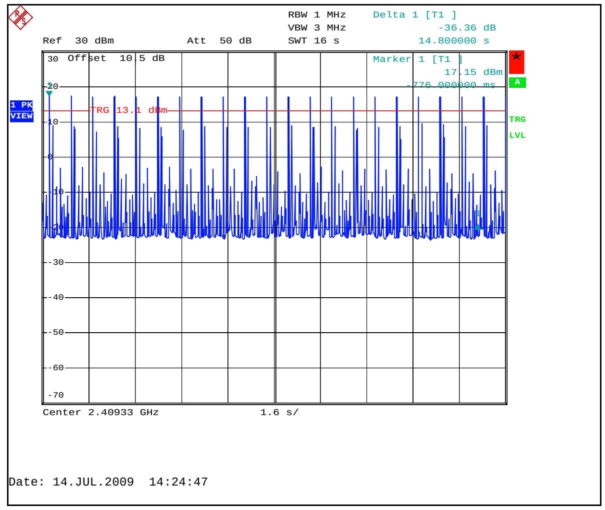

Figure 7.5.3-6: Repetition – 200 kbps (20 * 10.56ms = 211.2ms)

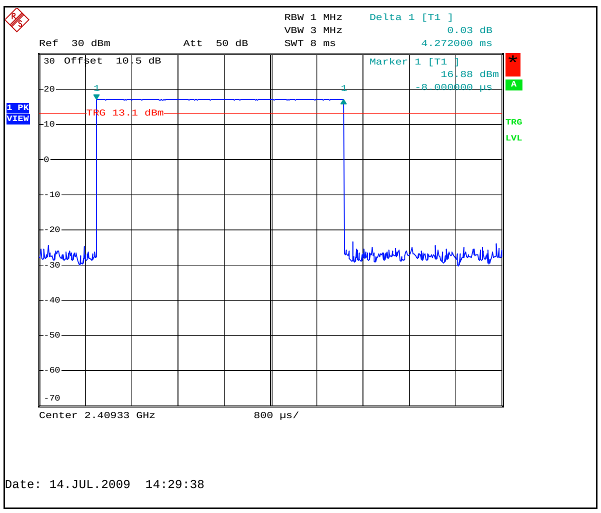

Figure 7.5.3-7: Dwell Time – 500 kbps (4.27ms)

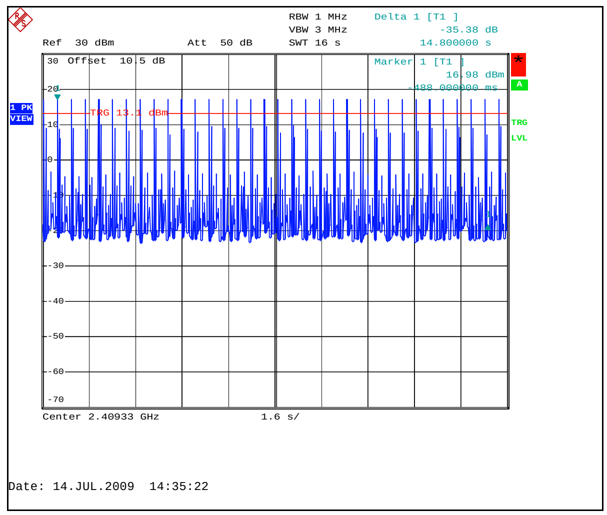

Figure 7.5.3-8: Repetition – 500 kbps (32 * 4.27ms = 136.6ms)

7.5.4 20dB & 99% Bandwidth - FCC: Section 15.247(a)(1) IC: RSS-210 A8.1(b)

7.5.4.1 Test Methodology

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The spectrum analyzer span was set to 2 to 3 times the estimated 20 dB bandwidth of the emission. The RBW was to ≥ 1% of the estimated 20 dB bandwidth. The trace was set to max hold with a peak detector active. The Delta function of the analyzer was utilized to determine the 20 dB bandwidth of the emission. The span and RBW were examined and re-adjusted if necessary to meet the requirements of 2 to 3 times the 20 bandwidth for the span and ≥ 1% of the 20 dB bandwidth for the RBW.

The 99% occupied bandwidth was also measured in accordance to the measurement guidelines provided by Industry Canada (The Measurement of Occupied Bandwidth).

7.5.4.2 Test Results

The maximum 20dB bandwidth was found to be approximately 942 kHz. Results are shown below in Table 7.5.4-1 and Figures 7.5.4-1 through 7.5.4-6.

Table 7.5.4-1

Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)	Date Rate (kbps)
2409.33	92.7	92.1	38.4
2409.33	258	290	115.2
2409.33	622	636	200
2409.33	900	963	500
2441.11	91.8	92.7	38.4
2441.11	253	292	115.2
2441.11	626	644	200
2441.11	942	993	500
2467.11	92.7	91.5	38.4
2467.11	251	295	115.2
2467.11	634	646	200
2467.11	900	990	500

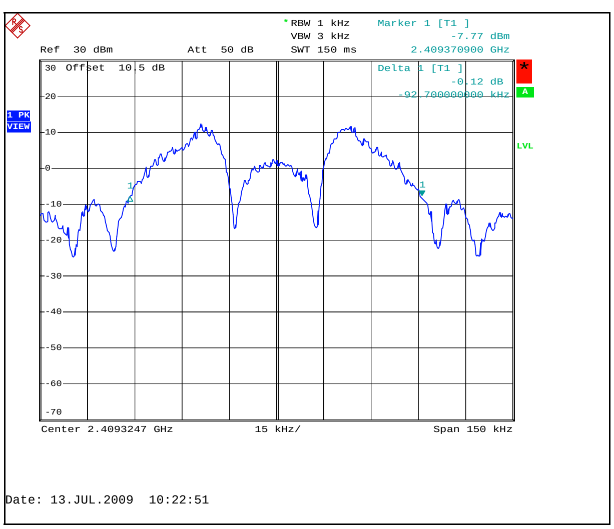

Figure 7.5.4-1: 20dB Bandwidth Low Channel – 38.4 kbps

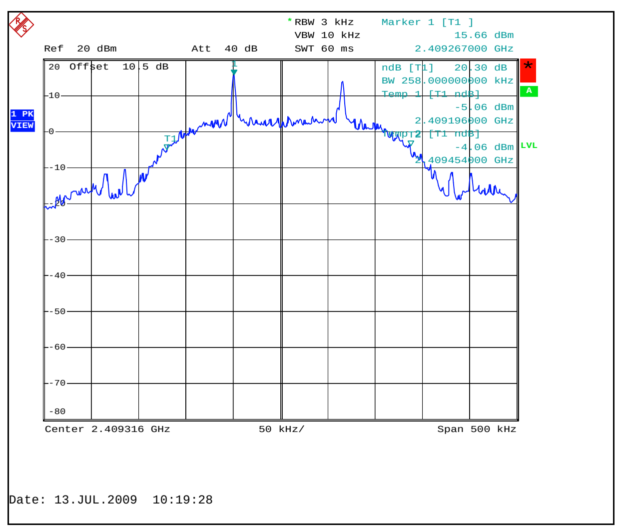

Figure 7.5.4-2: 20dB Bandwidth Low Channel – 115.2 kbps

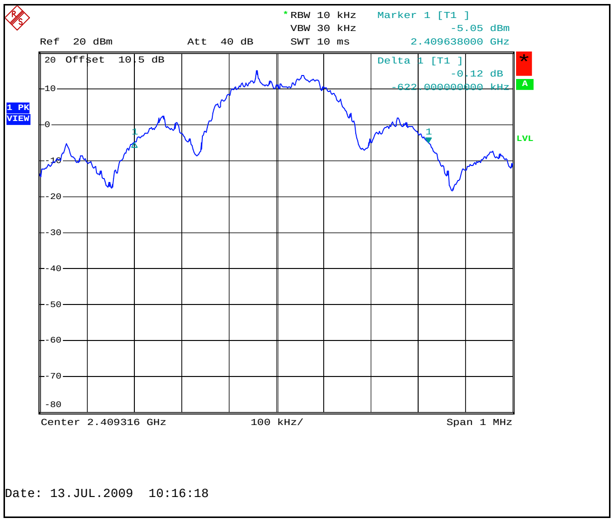

Figure 7.5.4-3: 20dB Bandwidth Low Channel – 200 kbps

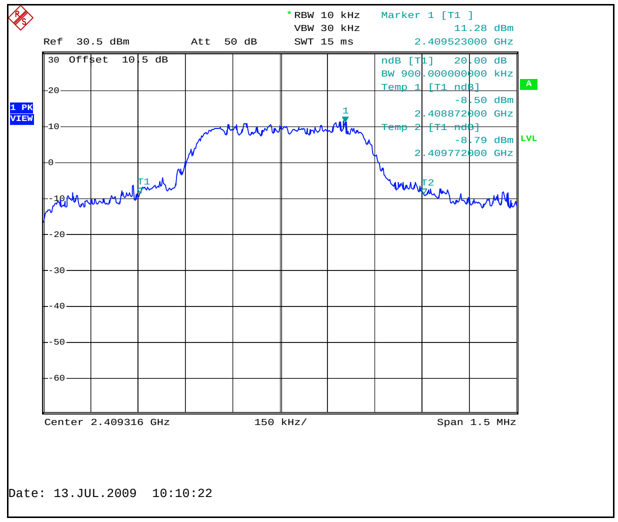

Figure 7.5.4-4: 20dB Bandwidth Low Channel – 500 kbps

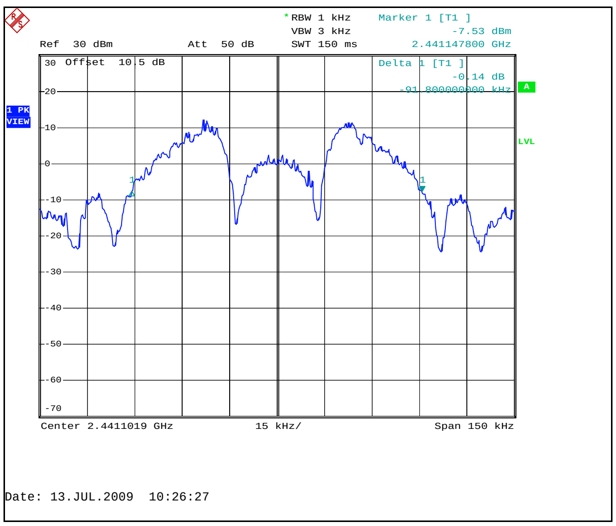

Figure 7.5.4-5: 20dB Bandwidth Mid Channel – 38.4 kbps

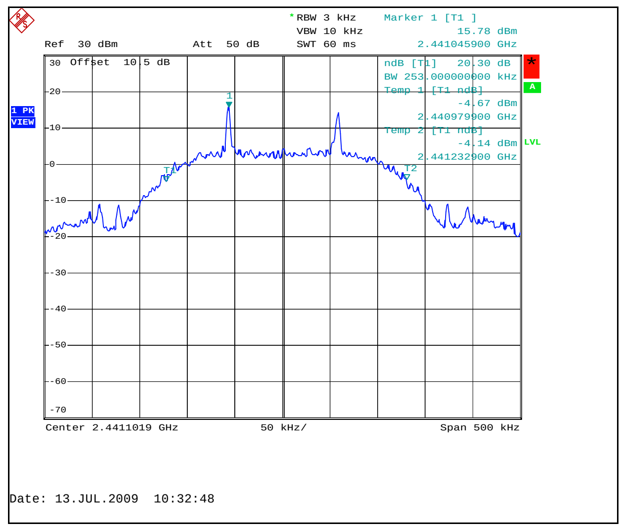

Figure 7.5.4-6: 20dB Bandwidth Mid Channel – 115.2 kbps

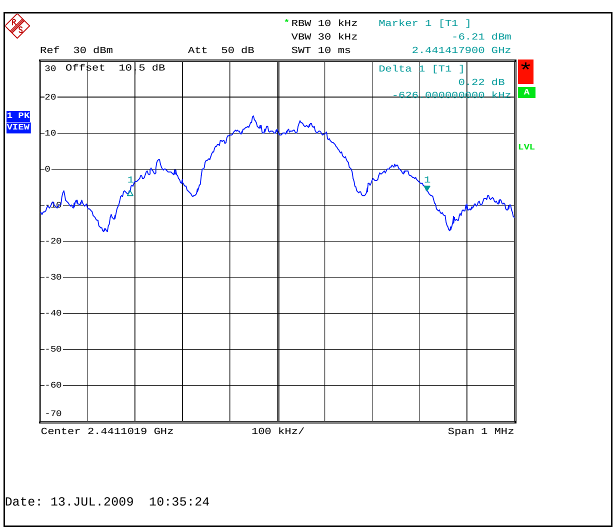

Figure 7.5.4-7: 20dB Bandwidth Mid Channel – 200 kbps

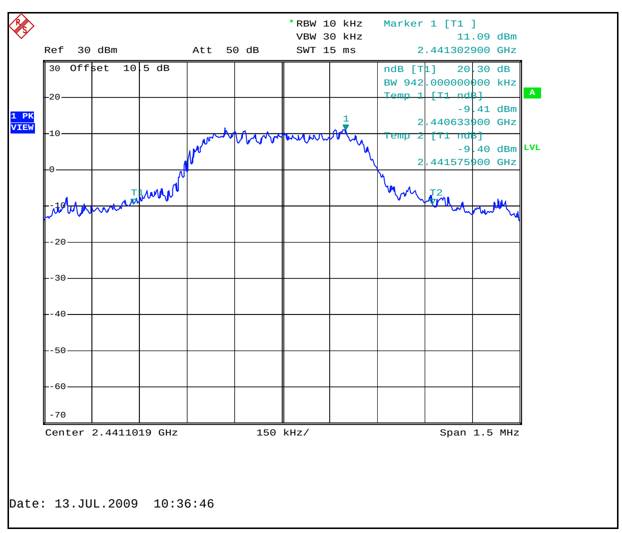

Figure 7.5.4-8: 20dB Bandwidth Mid Channel – 500 kbps

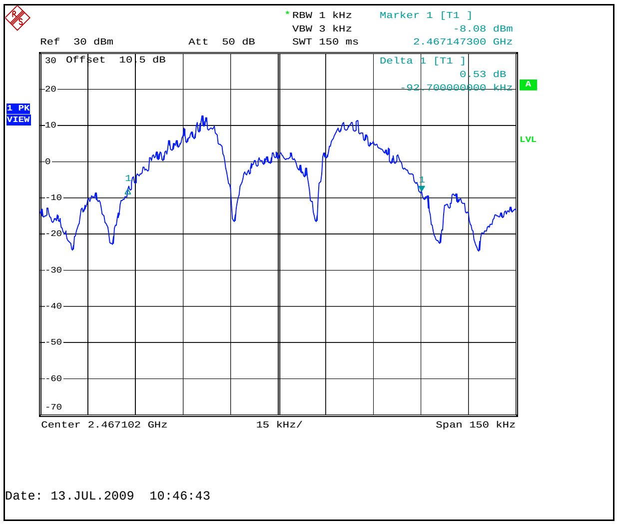

Figure 7.5.4-9: 20dB Bandwidth High Channel – 38.4 kbps

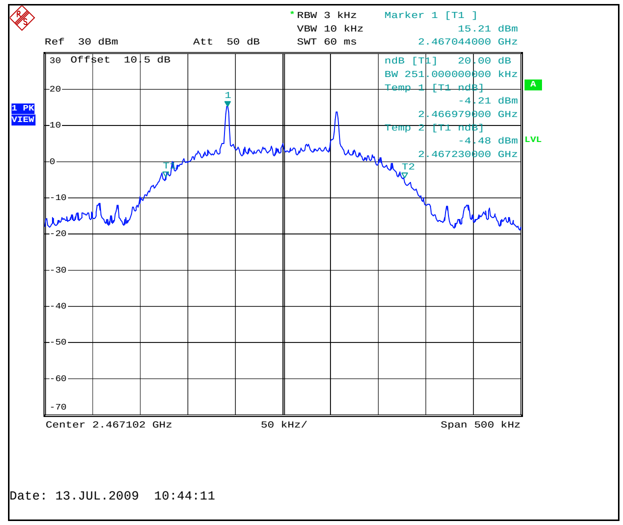

Figure 7.5.4-10: 20dB Bandwidth High Channel – 115.2 kbps

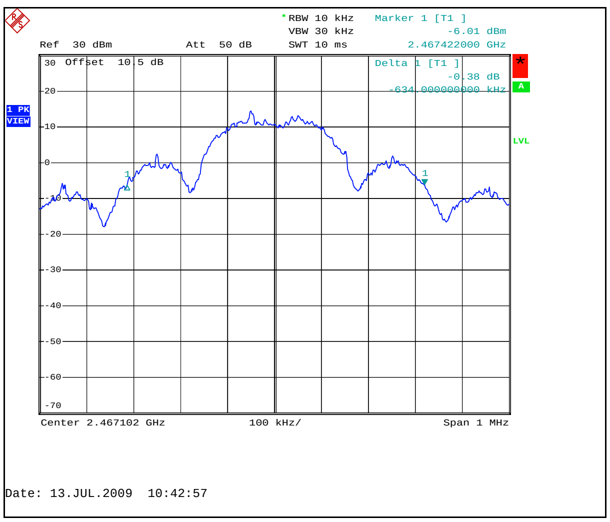

Figure 7.5.4-11: 20dB Bandwidth High Channel – 200 kbps

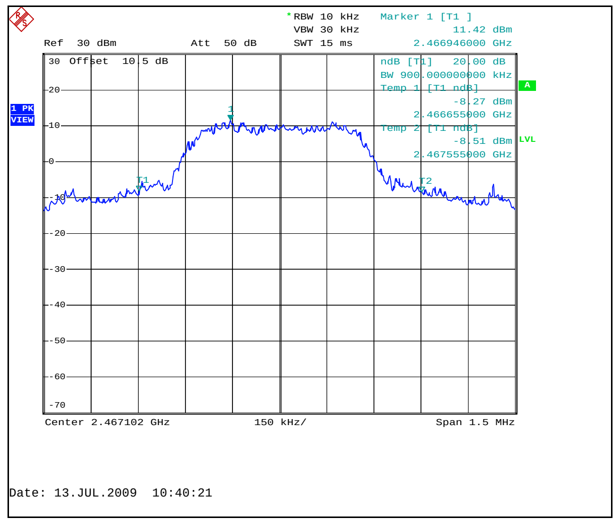

Figure 7.5.4-12: 20dB Bandwidth High Channel – 500 kbps

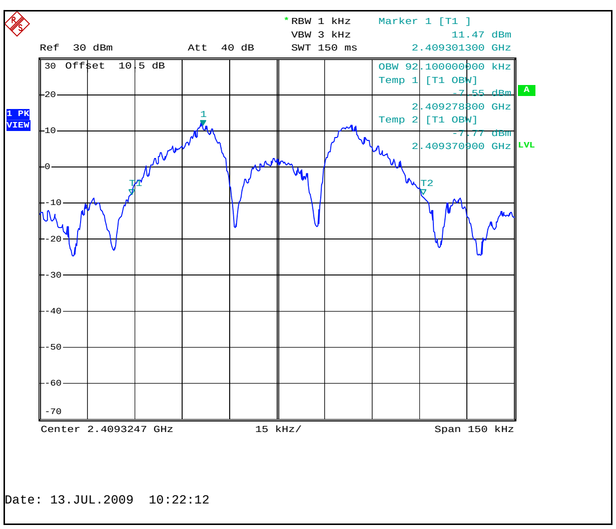

Figure 7.5.4-13: 99% Bandwidth Low Channel – 38.4 kbps

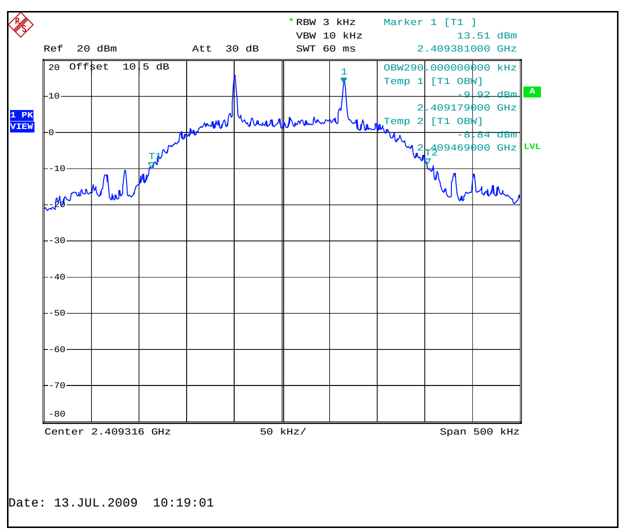

Figure 7.5.4-14: 99% Bandwidth Low Channel – 115.2 kbps

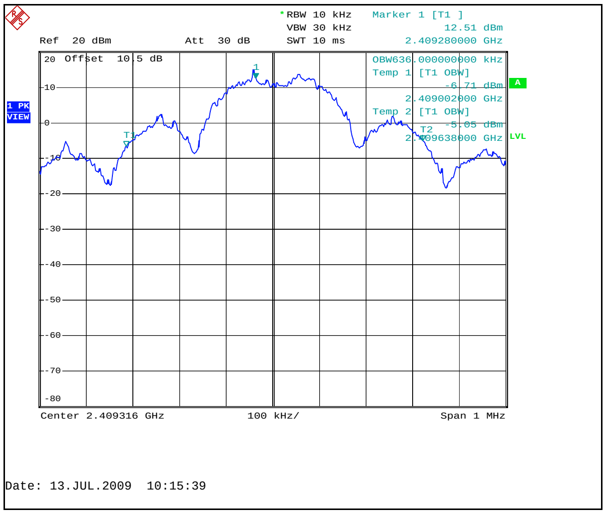

Figure 7.5.4-15: 99% Bandwidth Low Channel – 200 kbps

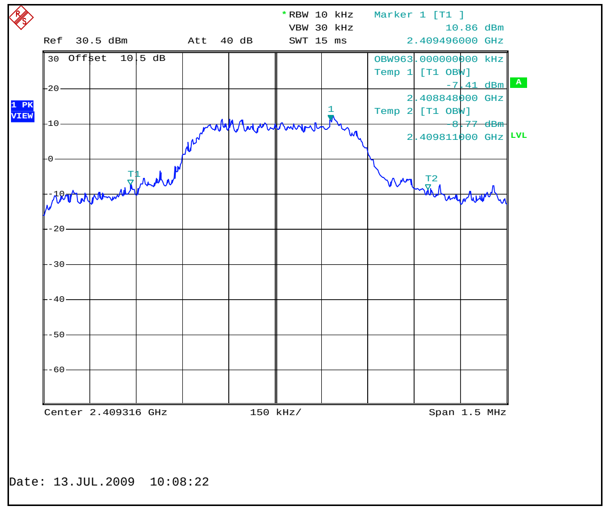

Figure 7.5.4-16: 99% Bandwidth Low Channel – 500 kbps

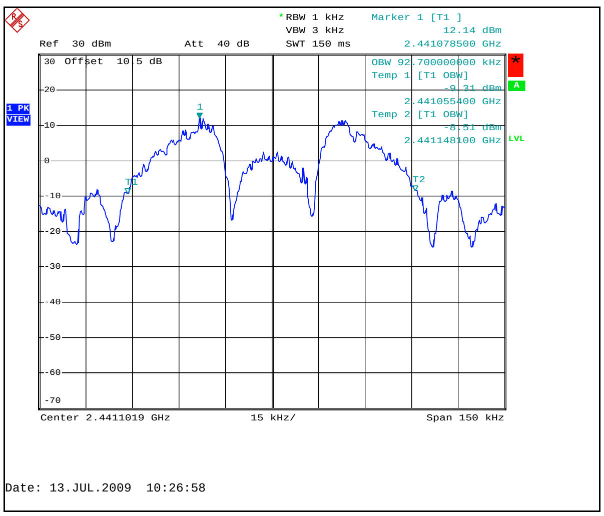

Figure 7.5.4-17: 99% Bandwidth Mid Channel – 38.4 kbps

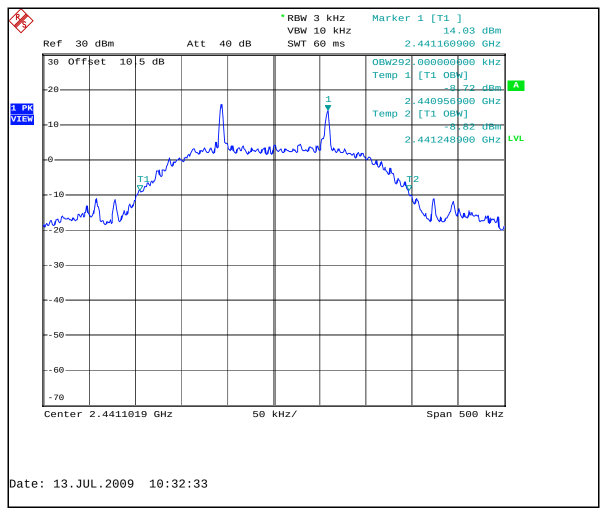

Figure 7.5.4-18: 99% Bandwidth Mid Channel – 115.2 kbps

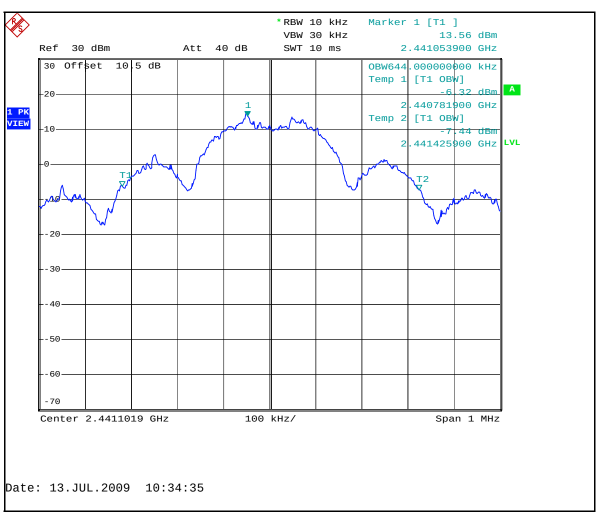

Figure 7.5.4-19: 99% Bandwidth Mid Channel – 200 kbps

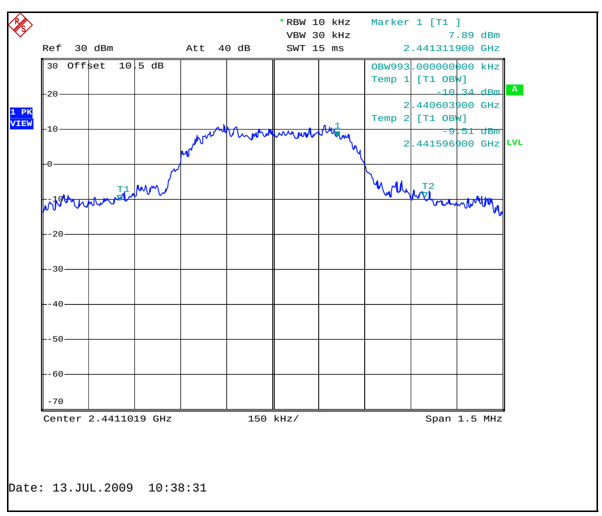

Figure 7.5.4-20: 99% Bandwidth Mid Channel – 500 kbps

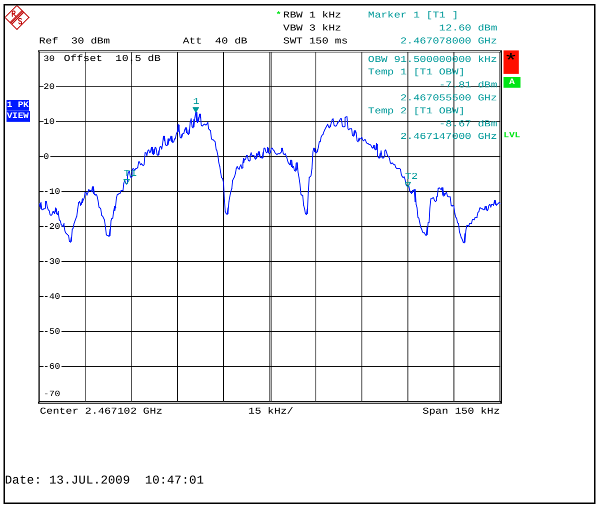

Figure 7.5.4-21: 99% Bandwidth High Channel – 38.4 kbps

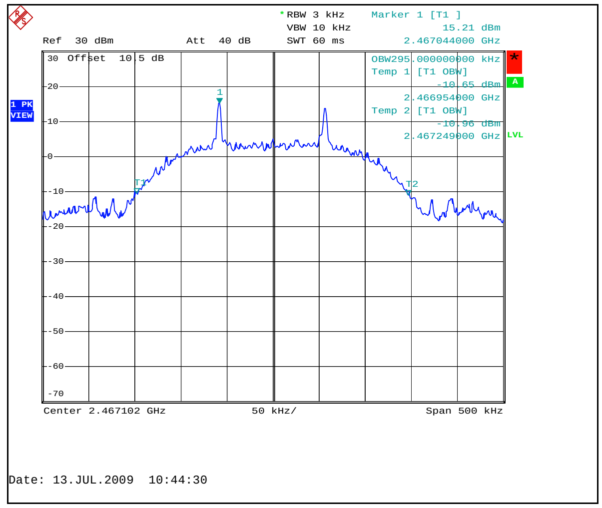

Figure 7.5.4-22: 99% Bandwidth High Channel – 115.2 kbps

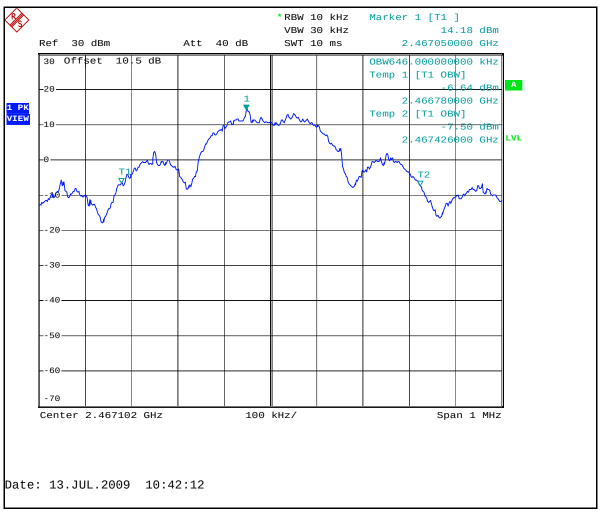

Figure 7.5.4-23: 99% Bandwidth High Channel – 200 kbps

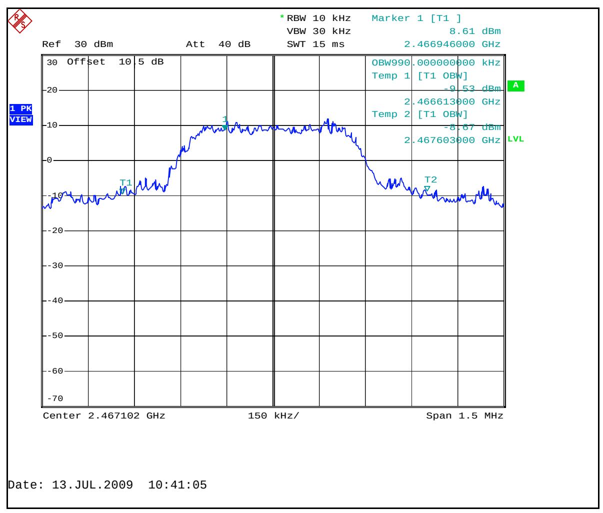

Figure 7.5.4-24: 99% Bandwidth High Channel – 500 kbps

7.6 Band-Edge Compliance and Spurious Emissions - FCC Section 15.247(d) IC: RSS-210 2.6, A8.5

7.6.1 Band-Edge Compliance - FCC Section 15.247(d) IC: RSS-210 2.6, A8.5

7.6.1.1 Test Methodology

The EUT was investigated at the low and high channels of operation to determine band-edge compliance. All antenna types were evaluated. Because the upper band-edge coincides with a restricted band, band-edge compliance for the upper band-edge was determined using the radiated mark-delta method as outlined in FCC DA 00-705. The radiated field strength of the fundamental emission was first determined and then the mark-delta method was used to determine the field strength of the band-edge emissions.

The lower band-edge compliance was determined using the marker-delta method in which the radio frequency power that is produced by the EUT is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of desired power.

For band-edge measurements data was collected with the hopping function disabled and enabled.

Band-edge was evaluated for all data rates in both horizontal and vertical polarizations with worst case data presented below.

Compliance with the average limits in hopping mode for the 9dBi dipole antenna was determined with using absolute measurement at the band-edge and data presented in section 7.6.3.

7.6.1.2 Test Results

Band-edge compliance is displayed in Table 7.6.1.2-1 to 7.6.1.2-4 and Figure 7.6.1.2-1 – 7.6.1.2-10.

Table 7.6.1.2-1: Upper Band-edge – Dipole Antenna

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2467.1	108.30	106.75	H	-4.26	104.04	91.67	47.96	56.08	43.71	74.0	54.0	17.92	10.29
2467.1	125.89	124.34	V	-4.26	121.63	109.26	65.92	55.71	43.34	74.0	54.0	18.29	10.66

Table 7.6.1.2-2: Upper Band-edge (Hopping) – Dipole Antenna

Fundamental Frequency (MHz)	Uncorrected Level (dBuV)	Antenna Polarity (H/V)	Correction Factors (dB)	Fundamental Level (dBuV/m)	Marker-Delta (dB)	Band-Edge Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2467.1	108.30	H	-4.26	104.04	43.30	60.74	74.0	13.26
2467.1	125.89	V	-4.26	121.63	50.09	71.54	74.0	2.46

Note: Compliance with band-edge for average emissions limits is shown in section 7.6.3.

Table 7.6.1.2-3: Upper Band-edge – Patch Antenna

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2467.1	113.96	112.36	H	-4.26	109.70	97.28	63.11	46.59	34.17	74.0	54.0	27.41	19.83
2467.1	116.37	114.90	V	-4.26	112.11	99.82	64.02	48.09	35.80	74.0	54.0	25.91	18.20

Table 7.6.1.2-4: Upper Band-edge (Hopping) – Patch Antenna

Frequency (MHz)	Uncorrected Level (dBuV)		Antenna Polarity	Correction Factors	Fundamental Level (dBuV/m)		Marker-Delta (dB)	Band-Edge Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg		pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2467.1	113.96	112.36	H	-4.26	109.70	97.28	48.80	60.90	48.48	74.0	54.0	13.10	5.52
2467.1	116.37	114.90	V	-4.26	112.11	99.82	48.88	63.23	50.94	74.0	54.0	10.77	3.06

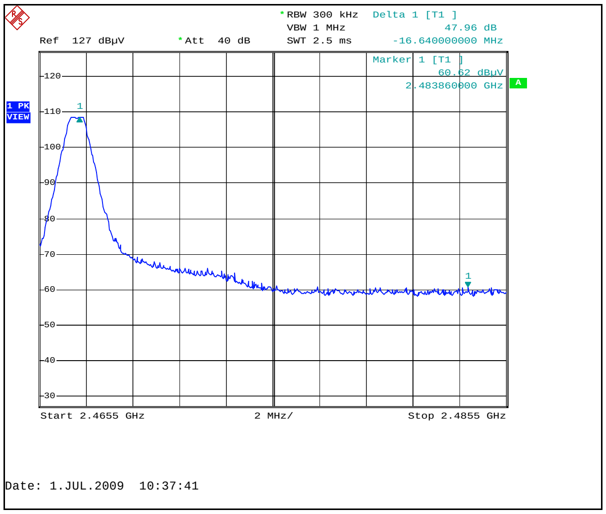

Figure 7.6.1.2-1: Upper Band-edge Hpol – Dipole

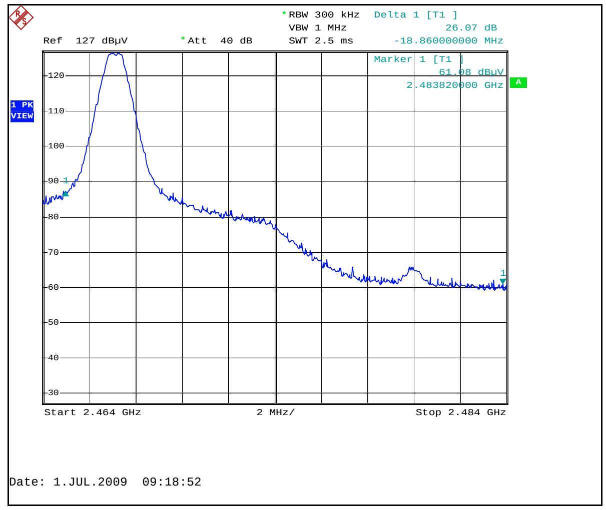

Figure 7.6.1.2-2: Upper Band-edge Vpol – Dipole

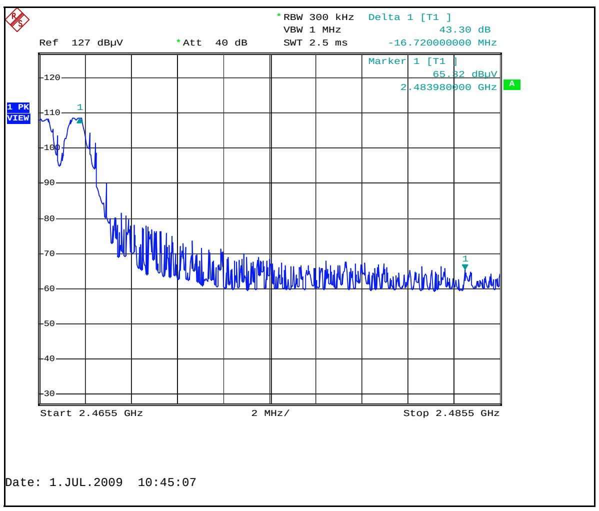

Figure 7.6.1.2-3: Upper Band-edge Hpol (Hopping) – Dipole

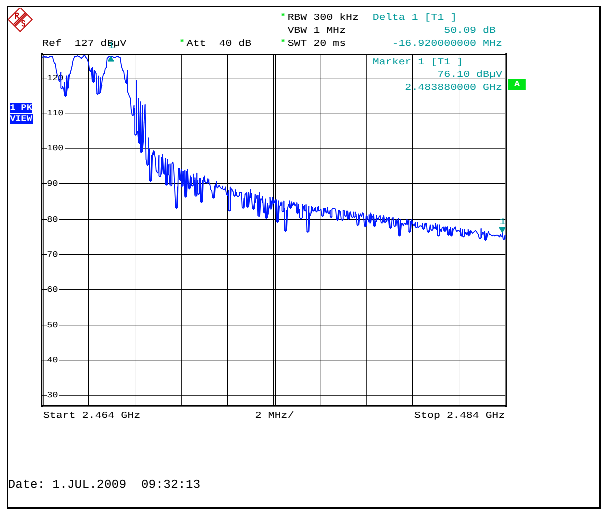

Figure 7.6.1.2-4: Upper Band-edge Vpol (Hopping) – Dipole

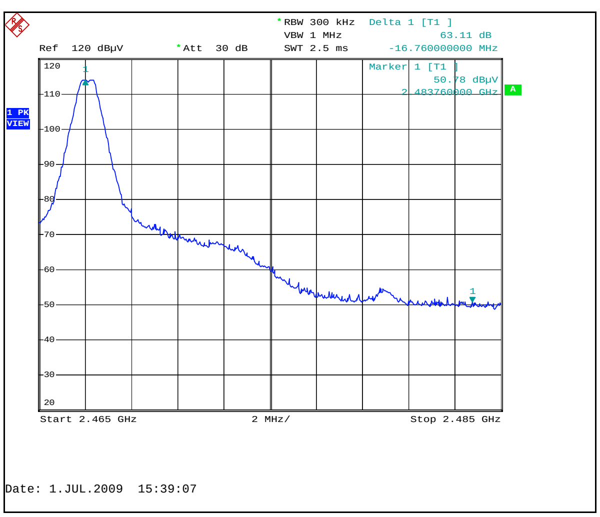

Figure 7.6.1.2-5: Upper Band-edge Hpol – Patch

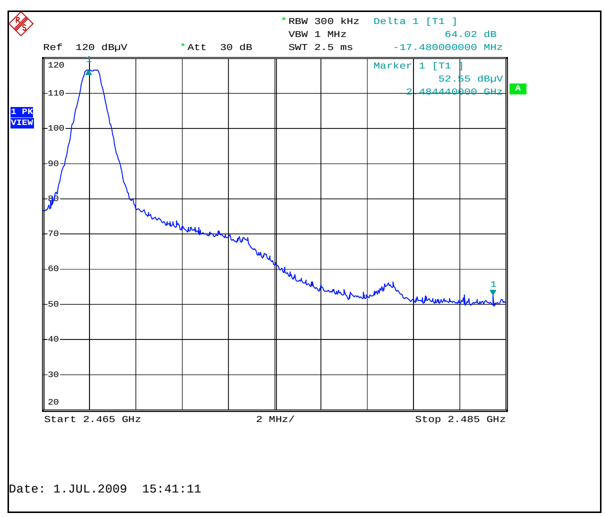

Figure 7.6.1.2-6: Upper Band-edge Vpol – Patch

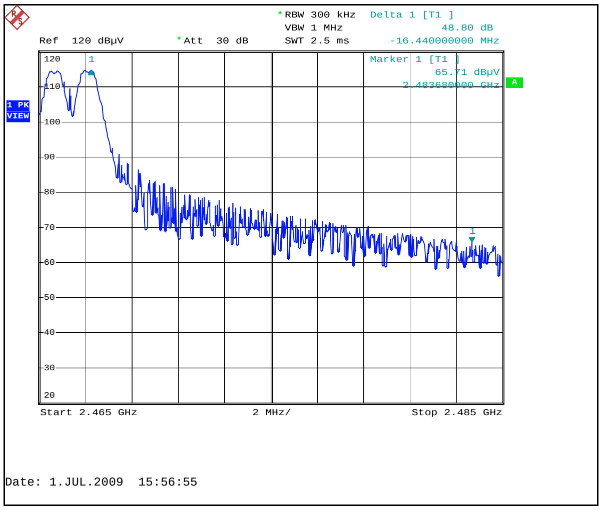

Figure 7.6.1.2-7: Upper Band-edge Hpol (Hopping) - Patch

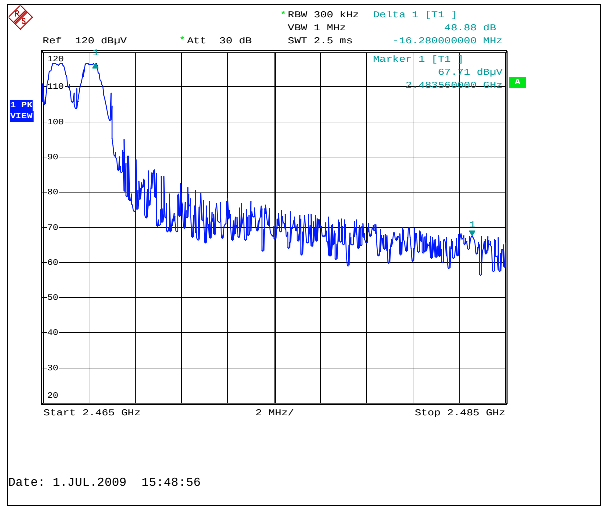

Figure 7.6.1.2-8: Upper Band-edge Vpol (Hopping) – Patch

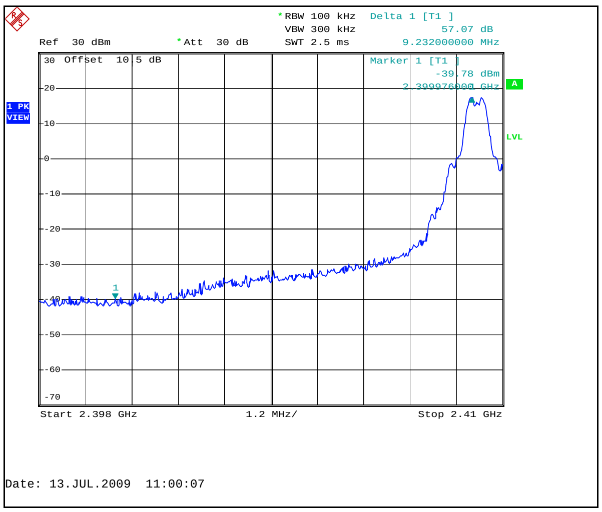

Figure 7.6.1.2-9: Lower Band-edge (Conducted)

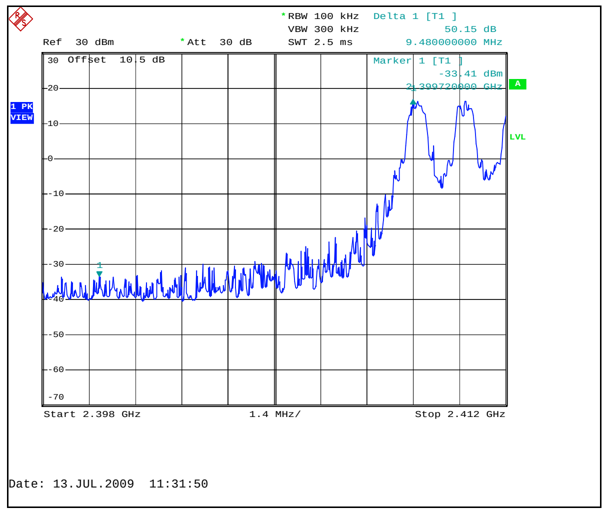

Figure 7.6.1.2-10: Lower Band-edge (Conducted Hopping)

7.6.2 RF Conducted Spurious Emissions

7.6.2.1 Test Methodology

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The EUT was investigated for conducted spurious emissions from 30MHz to 25GHz, 10 times the highest fundamental frequency. Measurements were made at the low, center and high channels of the EUT. For each measurement, the spectrum analyzer's RBW was set to 100kHz. A peak detector function was used with the trace set to max hold.

7.6.2.2 Test Results

All emission found were greater than 20dB down from the fundamental carrier. The RF conducted spurious emissions were measured in the band of 30MHz to 25GHz. Results are shown below in Figure 7.6.2-1 through 7.6.2-9.

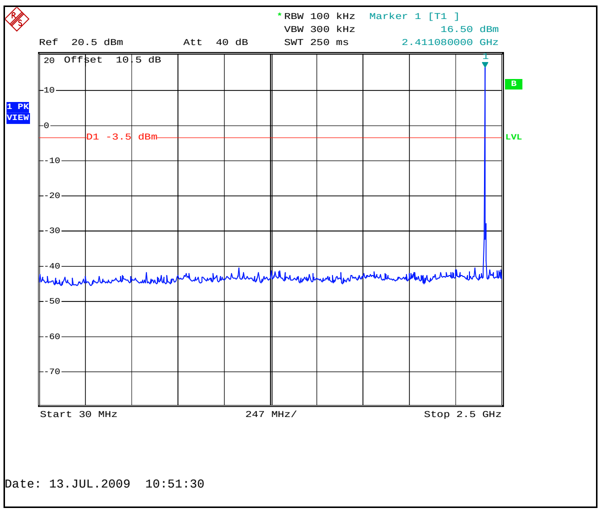

Figure 7.6.2.2-1: 30 MHz – 2.5 GHz – Low Channel

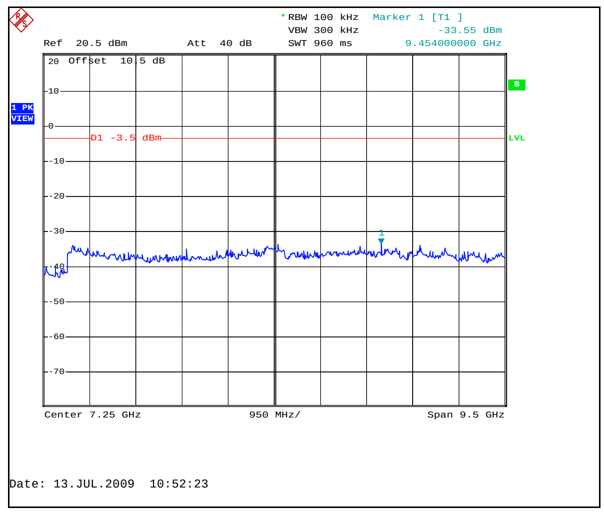

Figure 7.6.2.2-2: 2.5 GHz – 12.5 GHz – Low Channel

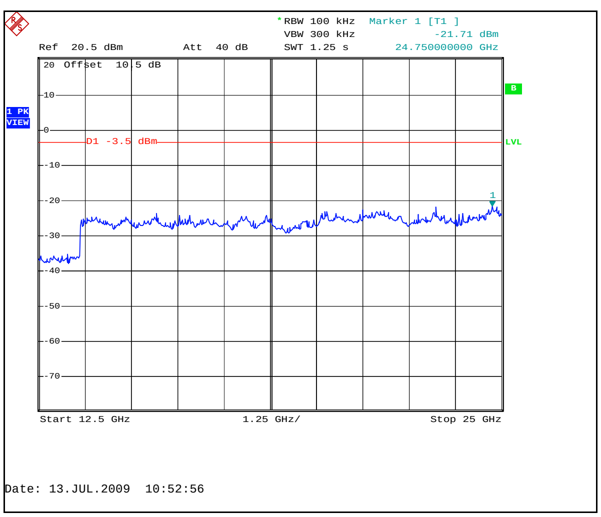

Figure 7.6.2.2-3: 12.5 GHz – 25 GHz – Low Channel

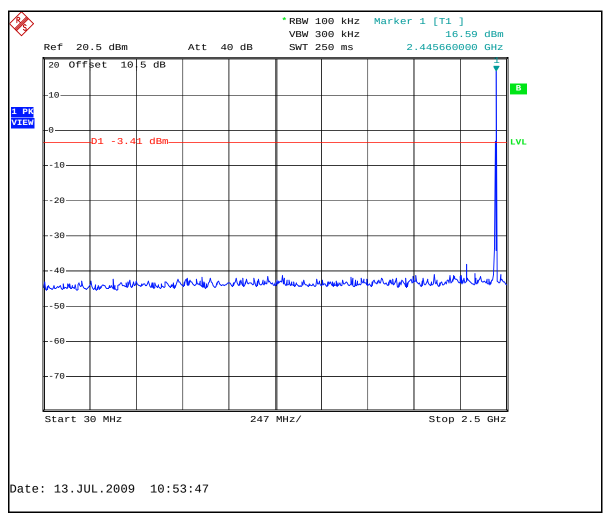

Figure 7.6.2.2-4: 30 MHz – 2.5 GHz – Mid Channel

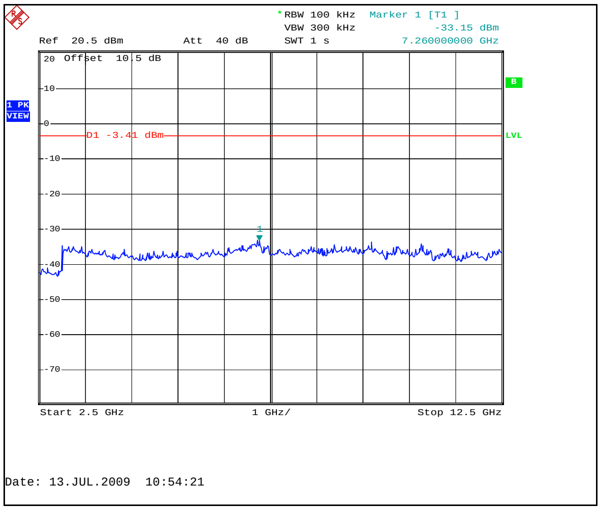

Figure 7.6.2.2-5: 2.5 GHz – 12.5 GHz – Mid Channel

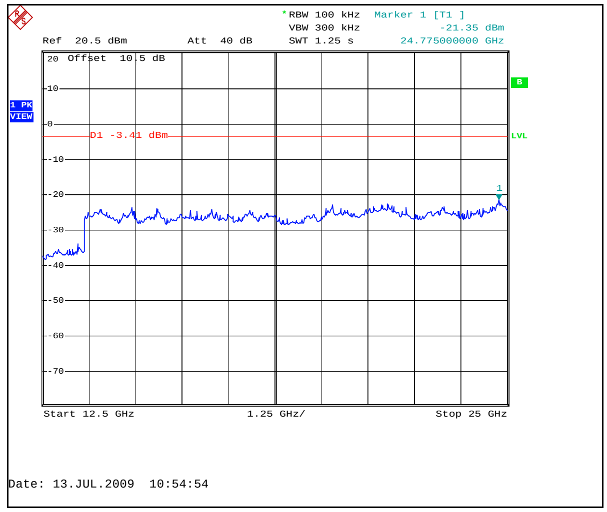

Figure 7.6.2.2-6: 12.5 GHz – 25 GHz – Mid Channel

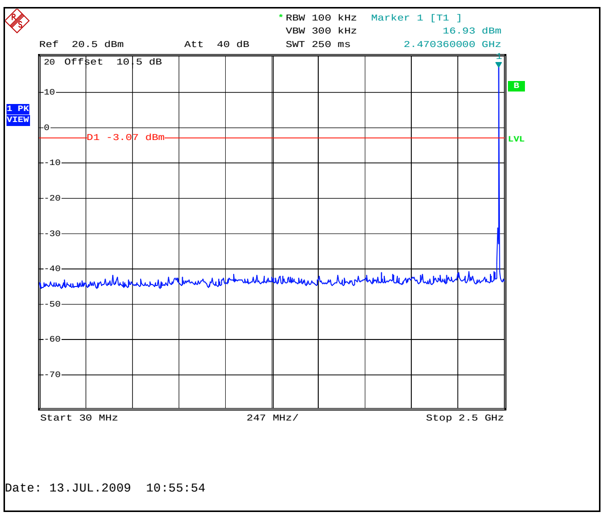

Figure 7.6.2.2-7: 30 MHz – 2.5 GHz – High Channel

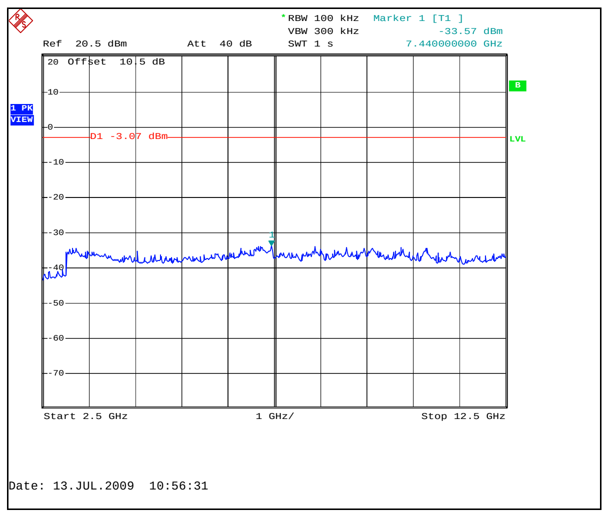

Figure 7.6.2.2-8: 2.5 GHz – 12.5 GHz – High Channel

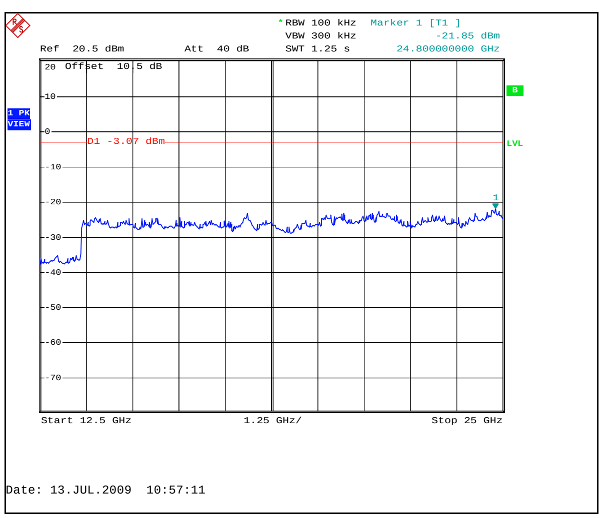

Figure 7.6.2.2-9: 12.5 GHz – 25 GHz – High Channel

7.6.3 Radiated Spurious Emissions - FCC Section 15.205 IC: RSS-210 2.6

7.6.3.1 Test Methodology
Radiated emissions tests were made over the frequency range of 30MHz to 25GHz, 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 1000MHz, peak and average measurements made with RBW and VBW of 1 MHz and 3 MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT to the average measurements for comparison to the average limit.

7.6.3.2 Duty Cycle Correction
For average radiated measurements, the measured level was reduced by a factor 10.81dB to account for the duty cycle of the EUT. Referencing the dwell time justification in section 7.5.3 above the worst case duty cycle within 100ms is 28.8% or 28.8ms. The duty cycle correction factor is determined using the formula: 20log (0.288) = 10.81dB.

7.6.3.3 Test Results
Radiated spurious emissions found in the band of 30MHz to 25GHz are reported in Tables 7.6.3.3-1 to 7.6.3.3-2.

Table 7.6.3.3-1: Radiated Spurious Emissions – Dipole Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4818.66	49.02	38.91	H	3.23	52.25	31.33	74.0	54.0	21.75	22.67
4818.66	52.70	45.90	V	3.23	55.93	38.32	74.0	54.0	18.07	15.68
12046.65	50.03	38.36	H	16.53	66.56	44.08	83.5	63.5	16.98	19.47
12046.65	52.88	43.18	V	16.53	69.41	48.90	83.5	63.5	14.13	14.65
Middle Channel										
4882.22	58.24	53.80	H	3.46	61.70	46.45	74.0	54.0	12.30	7.55
4882.22	64.68	60.07	V	3.46	68.14	52.72	74.0	54.0	5.86	1.28
7323.33	50.57	41.30	H	8.32	58.89	38.80	74.0	54.0	15.11	15.20
7323.33	54.32	46.15	V	8.32	62.64	43.65	74.0	54.0	11.36	10.35
12205.55	51.58	40.46	V	17.56	69.14	47.21	83.5	63.5	14.40	16.33
High Channel										
2483.5	---------	34.09	H	-4.17	---------	19.11	74.0	54.0	---------	34.89
2483.5	---------	35.36	V	-4.17	---------	20.38	74.0	54.0	---------	33.62
4934.2	54.30	47.40	H	3.66	57.96	40.24	74.0	54.0	16.04	13.76
4934.2	60.36	52.91	V	3.66	64.02	45.75	74.0	54.0	9.98	8.25
7401.3	52.48	45.11	H	8.39	60.87	42.69	74.0	54.0	13.13	11.31
7401.3	52.51	42.50	V	8.39	60.90	40.08	74.0	54.0	13.10	13.92
12335.5	50.36	39.14	V	18.41	68.77	46.74	83.5	63.5	14.77	16.81

***** The peak band-edge measurement at 2483.5 MHz is reported in section 7.6.1 using the marker-delta method.

Table 7.6.3.3-2: Radiated Spurious Emissions – Patch Antenna

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg	(H/V)	(dB)	pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4818.66	54.46	48.51	H	3.23	57.69	40.93	74.0	54.0	16.31	13.07
4818.66	55.05	49.76	V	3.23	58.28	42.18	74.0	54.0	15.72	11.82
12046.65	49.83	38.48	V	16.53	66.36	44.20	83.5	63.5	17.18	19.35
Middle Channel										
4882.22	56.17	51.21	H	3.46	59.63	43.86	74.0	54.0	14.37	10.14
4882.22	54.83	46.81	V	3.46	58.29	39.46	74.0	54.0	15.71	14.54
7323.33	48.23	37.98	H	8.32	56.55	35.48	74.0	54.0	17.45	18.52
7323.33	54.27	45.75	V	8.32	62.59	43.25	74.0	54.0	11.41	10.75
12205.55	50.41	37.75	V	17.56	67.97	44.50	83.5	63.5	15.57	19.04
High Channel										
4934.2	57.76	53.42	H	3.66	61.42	46.26	74.0	54.0	12.58	7.74
4934.2	57.65	51.82	V	3.66	61.31	44.66	74.0	54.0	12.69	9.34
7401.3	49.38	39.75	H	8.39	57.77	37.33	74.0	54.0	16.23	16.67
7401.3	53.54	45.67	V	8.39	61.93	43.25	74.0	54.0	12.07	10.75
12335.5	49.74	37.90	V	18.41	68.15	45.50	83.5	63.5	15.39	18.05

7.4.3.4 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: 49.02 + 3.23 = 52.25dBuV/m
Margin: 74dBuV/m – 52.25dBuV/m = 21.75dB

Example Calculation: Average
Corrected Level: 38.91 + 3.23 - 10.81 = 31.33dBuV
Margin: 54dBuV – 31.33dBuV = 22.67dB

8.0 CONCLUSION

In the opinion of ACS, Inc. the DNT2400C AND DNT2400P, manufactured by RFM/Cirronet Inc. meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT