Excellence in Compliance Testing

Certification Test Report

FCC ID: HSW-DNT500FP
IC: 4492A-DNT500FP

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

ACS Report Number 09-0112-15C

Manufacturer: **RFM / Cirronet Inc.**
Model(s): **DNT500FP**

Test Begin Date: March 30, 2009
Test End Date: March 31, 2009

Report Issue Date: April 2, 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.

Prepared by: Ken Rivers

Ken Rivers
Wireless Certifications Technician
ACS, Inc.

Reviewed by: _____

Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

This report contains 22 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 DNT500FP FHSS transceiver module is a low cost, high-power solution for point-to point and point-to-multipoint wireless systems in the 900 MHz ISM band. The DNT500FP receiver includes a low-noise preamplifier protected by two SAW filters, providing an excellent combination of receiver sensitivity and out-of band interference rejection. The DNT500FP module includes analog, digital and serial I/O, providing the flexibility and versatility to serve applications ranging from cable replacements to sensor networks.

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

Test Sample Serial Number(s):
ACS#3 (Radiated Emissions)
ACS#4 (RF Conducted)

Antenna Information:
Antenna Factor ANT-916-JJ-ST, Gain <2 dBi

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 DNT500FP provides highly reliable wireless connectivity for either point-to-point or point-to-multipoint applications.

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.

For RF conducted measurements a test sample was provided modified with a U.FL connector for direct connection to test equipment. For radiated emissions a test sample was provided with integral antenna.

The DNT500FP was tested using a single data rate of 115.2Kbps for all tests.

Unintentional radiated emissions and ac power line conducted emissions data is provided in separate test reports.

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 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 4175
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:

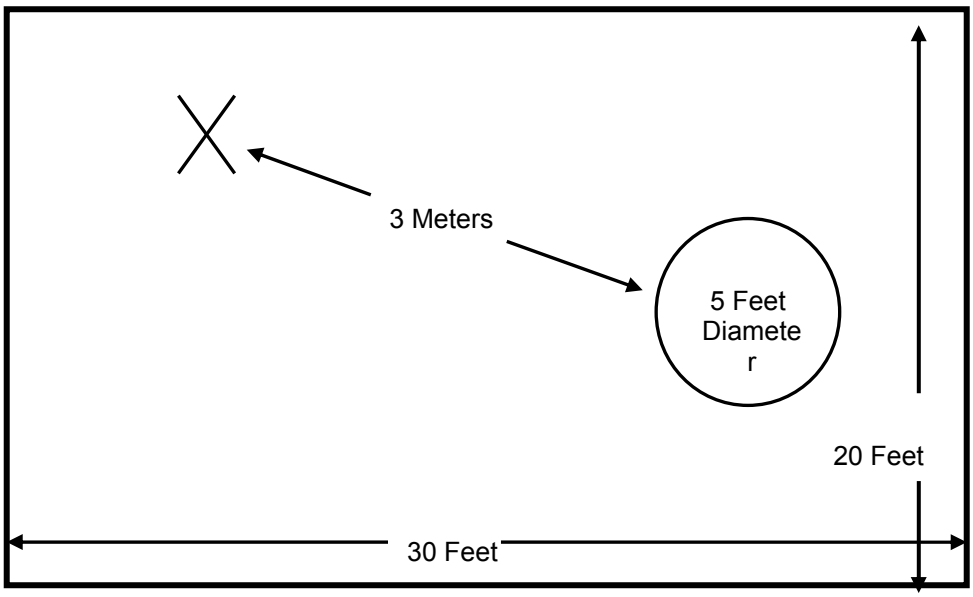

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

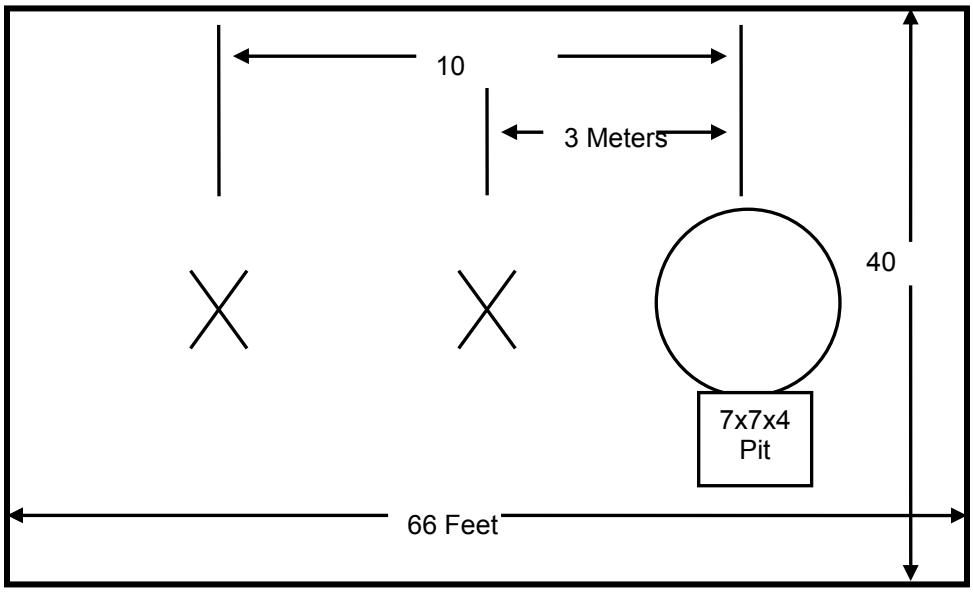

Figure 2.3-2: Open Area Test Site

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:

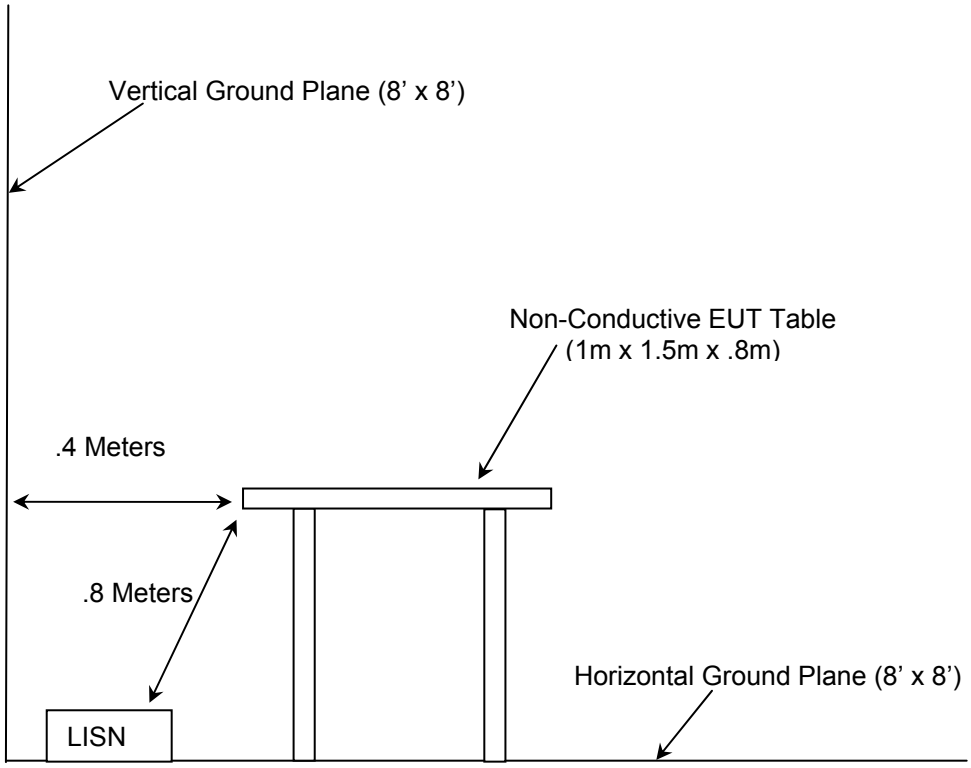

Figure 2.4-1: AC Mains Conducted EMI Site

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, 2008
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2008
- 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	05-07-2009
167	ACS	Cable Set	Chamber EMI Cable Set	167	02-06-2010 (See Note1)
283	Rohde & Schwarz	Spectrum Analyzers	FSP40	1000033	09-19-2009
291	Florida RF Cables	Cables	SMRE-200W-12.0-SMRE	None	11-24-2009 (See Note1)
292	Florida RF Cables	Cables	SMR-290AW-480.0-SMR	None	11-24-2009 (See Note1)
321	Hewlett Packard	Amplifiers	HPC 8447D	1937A02809	10-08-2009
331	Microwave Circuits	Filters	H1G513G1	31417	07-28-2009
340	Aeroflex/Weinschel	Attenuators	AS-20	7136	10-22-2009
422	Florida RF	Cables	SMS-200AW-72.0-SMR	805	02-05-2010 (See Note1)

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

5.0 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	AC Adapter 5V	CUI Inc.	EPAS-101W-05	NA
2	DNT500 Evaluation Board	Cirronet	800886 Rev PR2	ACS#2
3	AC Adaptor 9V	Volgen	SPU10R-2	NA
4	DNT500 Evaluation Board	Cirronet	800886 Rev PR2	ACS#1

6.0 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

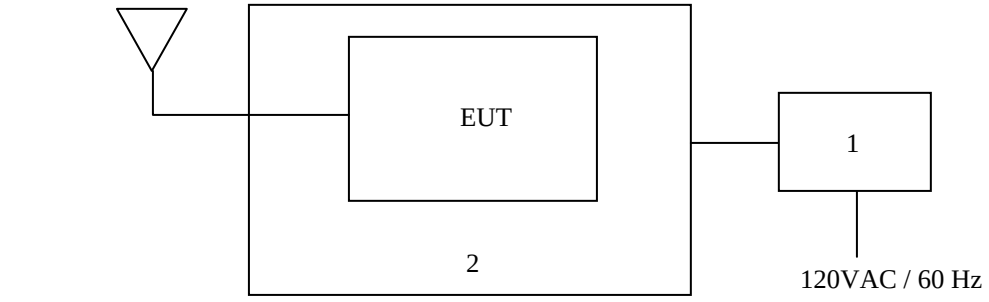

Figure 1: Radiated Emissions Setup

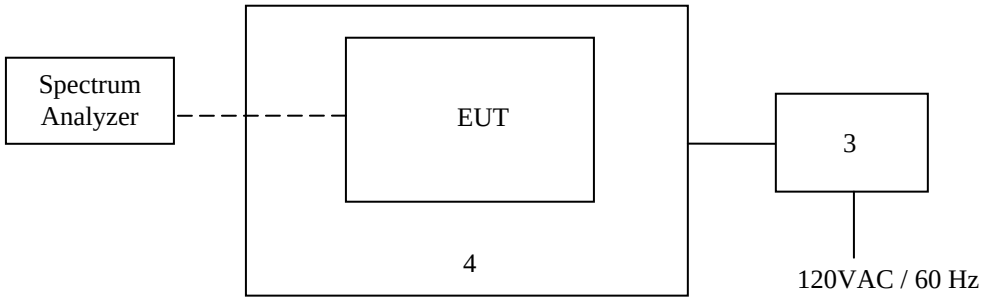

Figure 2: RF Conducted Setup

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 DNT500FP utilizes a ¼ wave monopole antenna which solder directly to the PCB board thus satisfying 15.203

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

7.2.1 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.

7.2.2 Test Results

Results are shown below in table 7.2-1 and the worst case was plotted and shown in figure 7.2-1 to 7.2-3 below:

Table 7.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
902.75	17.84
915.25	17.29
927.25	17.50

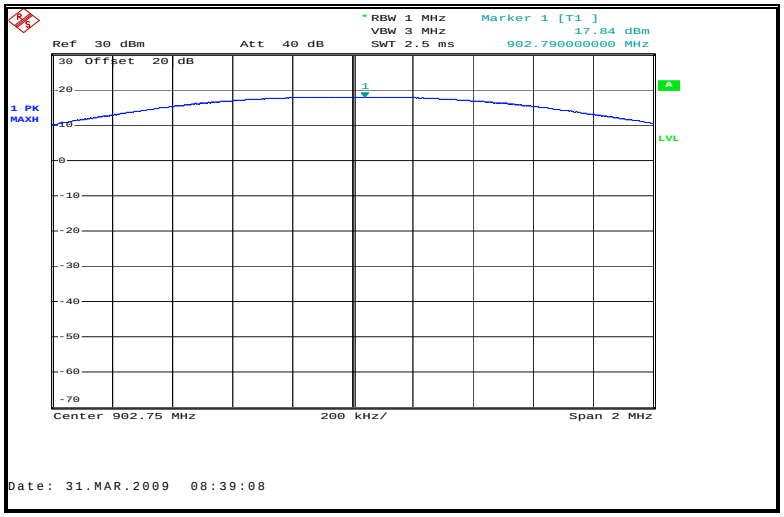

Figure 7.2-1: Output power – Low Channel

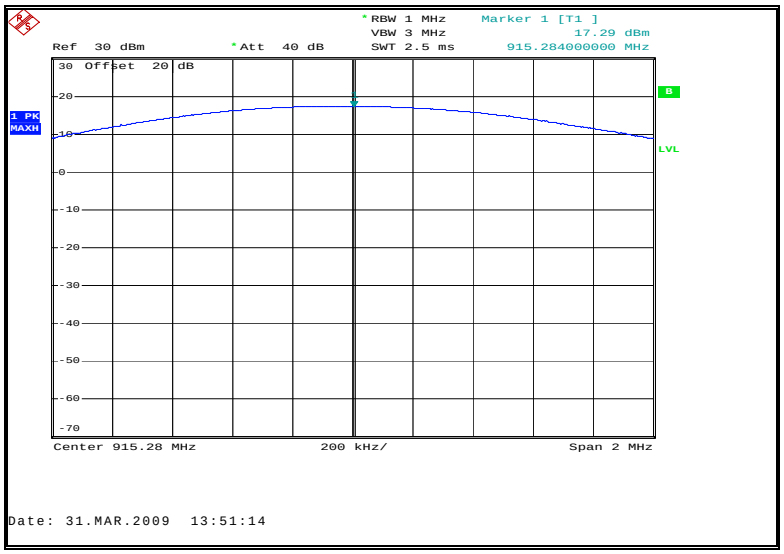

Figure 7.2-2: Output power – Mid Channel

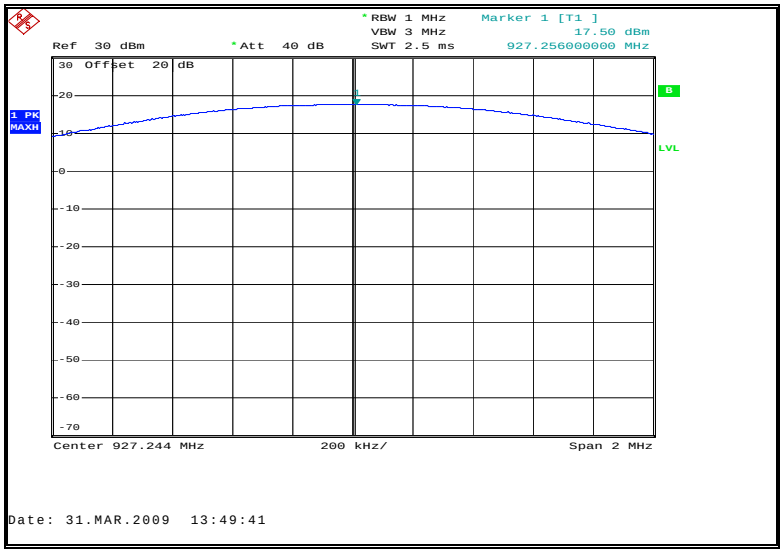

Figure 7.2-3: Output power – High Channel

7.3 Channel Usage Requirements

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

7.3.1.1 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.

7.3.1.2 Test Results

The maximum 20dB bandwidth of the hopping channel was measured to be 266kHz (See figure 7.3.4-1 to 7.3.4-3 below). The adjacent channel separation was measured to be 500.64kHz. Results are shown in figure 7.3.1-1 below:

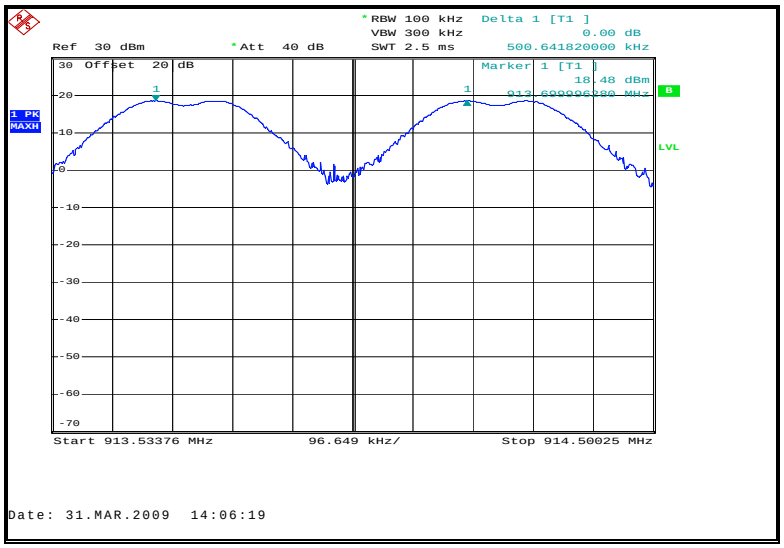

Figure 7.3.1-1: Carrier Frequency Separation

7.3.2 Number of Hopping Channels – FCC: Section 15.247(a)(1)(i) IC: RSS-210 A8.1(c)

The 20dB bandwidth of the device is greater than 250 kHz. The device employs greater than 25 hopping channels as required. Results are shown in Figure 7.3.2-1 below:

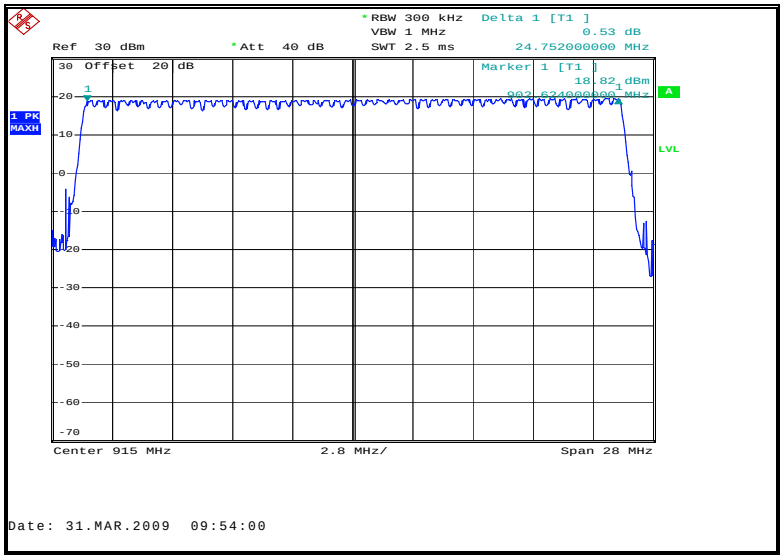

Figure 7.3.2-1: Number of Hopping Channels

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

7.3.3.1 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 100 kHz and the VBW to 300 kHz. Sweep time was set to 20 ms to capture the burst duration of the emission. The marker –delta function of the analyzer was employed to measure the burst duration.

7.3.3.2 Test Results

The duration of an RF transmission measured below is 15.63 ms however the theoretical maximum RF transmission is calculated as 16.2 ms. The maximum time of occupancy on any channel in a 20 second period is 275ms based on a detailed explanation of channel occupancy provided in the theory of operations. A single measured transmission is shown in figure 7.3.3-1 below:

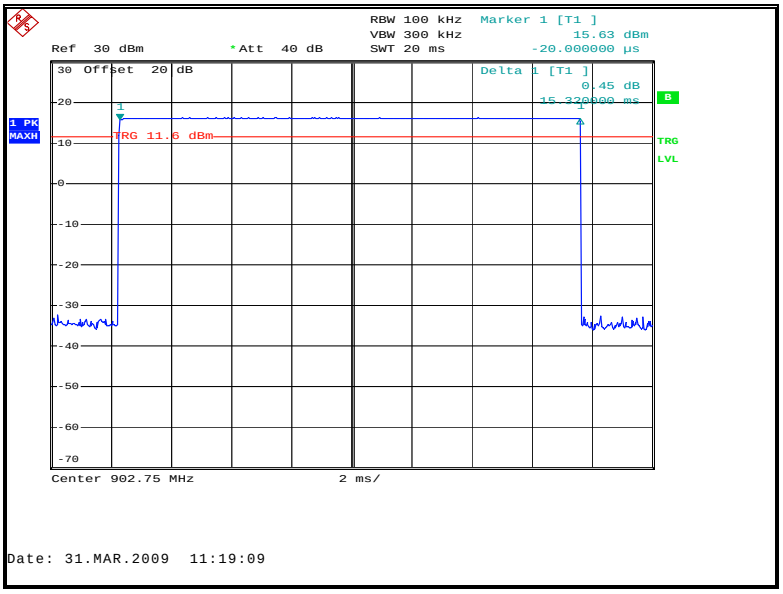

Figure 7.3.3-1: Channel Dwell Time

7.3.4 20dB & 99% Bandwidth - FCC: Section 15.247(a)(1)(i) IC: RSS-210 A8.1(c)

7.3.4.1 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).

7.3.4.2 Test Results

The maximum 20dB bandwidth was found to be approximately 266kHz. Results are shown below in Table 7.3.4-1 and Figures 7.3.4-1 through 7.3.4-6.

Table 7.3.4-1

Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
902.75	264	264
915.25	266	266
927.25	266	296

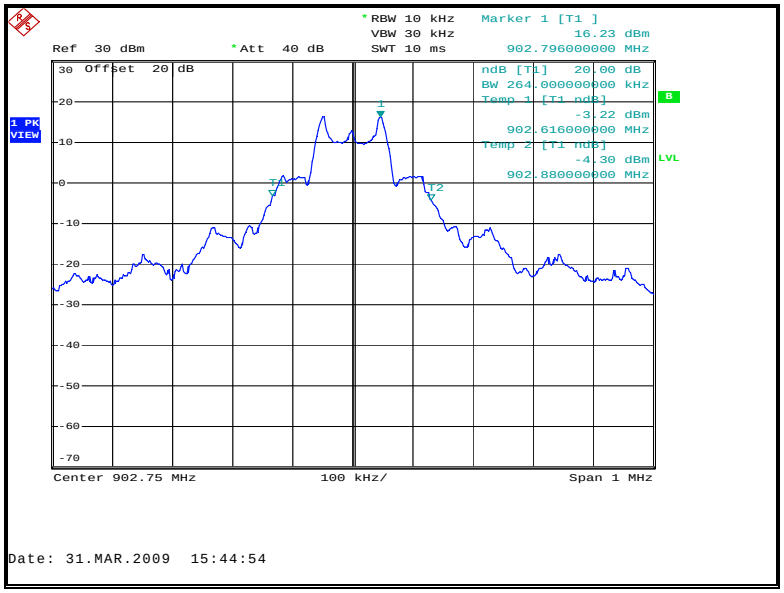

Figure 7.3.4-1: 20dB Bandwidth Low Channel

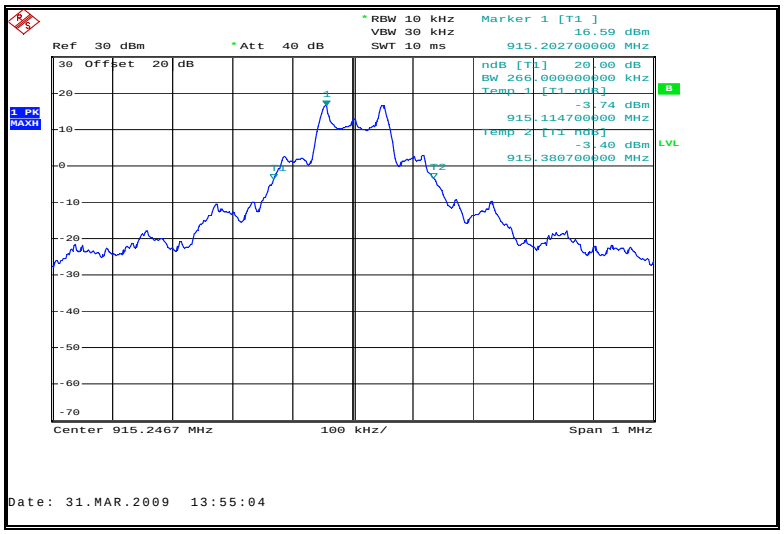

Figure 7.3.4-2: 20dB Bandwidth Mid Channel

Figure 7.3.4-3: 20dB Bandwidth High Channel

Figure 7.3.4-4: 99% Bandwidth Low Channel

Figure 7.3.4-5: 99% Bandwidth Mid Channel

Figure 7.3.4-6: 99% Bandwidth High Channel

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

7.4.1 Band-Edge Compliance of RF Conducted Emissions

7.4.1.1 Test Methodology

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The EUT was investigated at the lowest and highest channel available to determine band-edge compliance. For each measurement the spectrum analyzer's RBW was set to 100 kHz, which is ≥ 1% of the span, and the VBW was set to 300kHz.

7.4.1.2 Test Results

In a 100 kHz bandwidth at the lower and upper band-edge, the radio frequency power that was 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. Band-edge compliance is displayed in Figures 7.4.1-1 to 7.4.2-4.

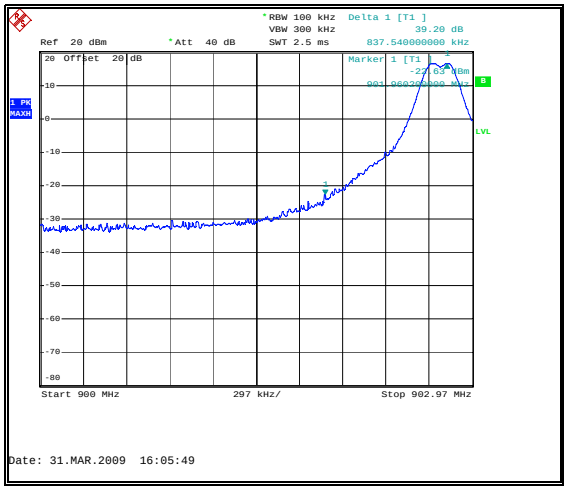

Figure 7.4.1-1: Lower Band-edge

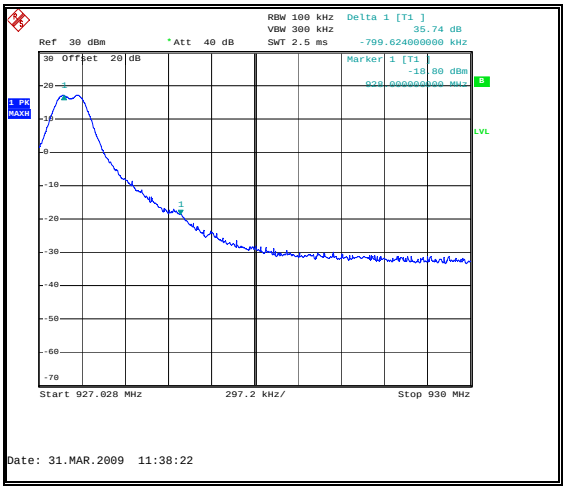

Figure 7.4.1-2: Upper Band-edge

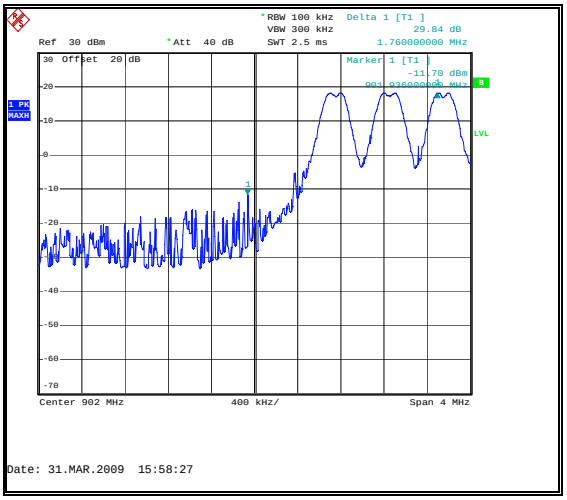

Figure 7.4.1-3: Lower Band-edge (Hopping Enabled)

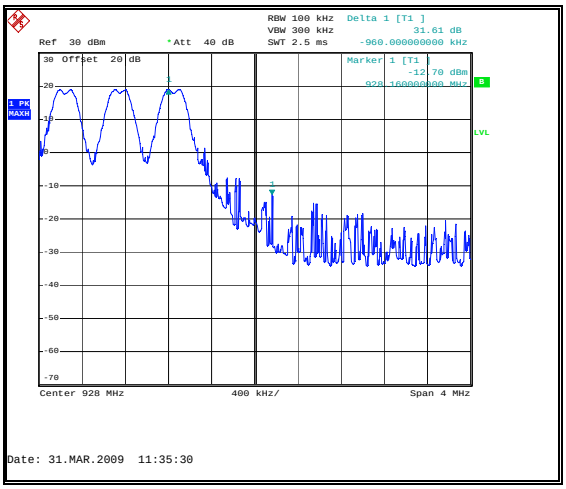

Figure 7.4.1-4: Upper Band-edge (Hopping Enabled)

7.4.2 RF Conducted Spurious Emissions

7.4.2.1 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 10GHz, 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.

7.4.2.2 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 10GHz. Results are shown below in Figure 7.4.2-1 through 7.4.2-6.

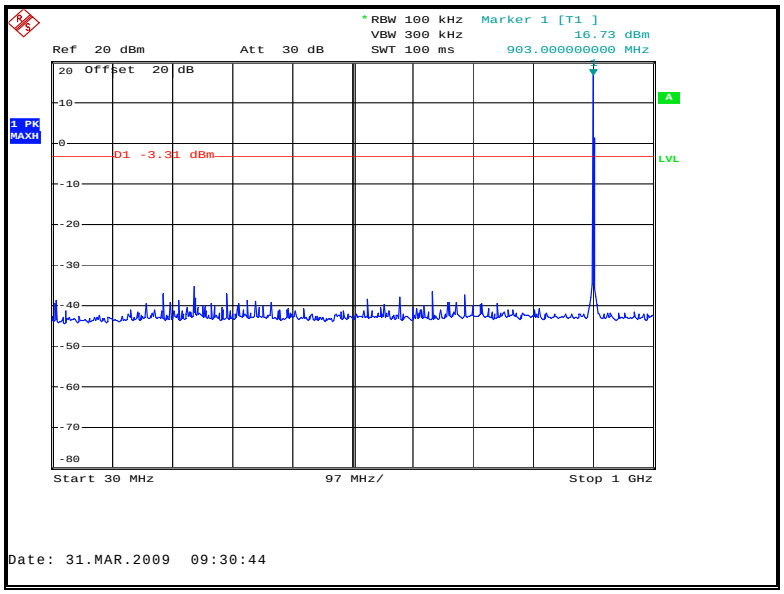

Figure 7.4.2.2-1: 30 MHz – 1 GHz – Low Channel

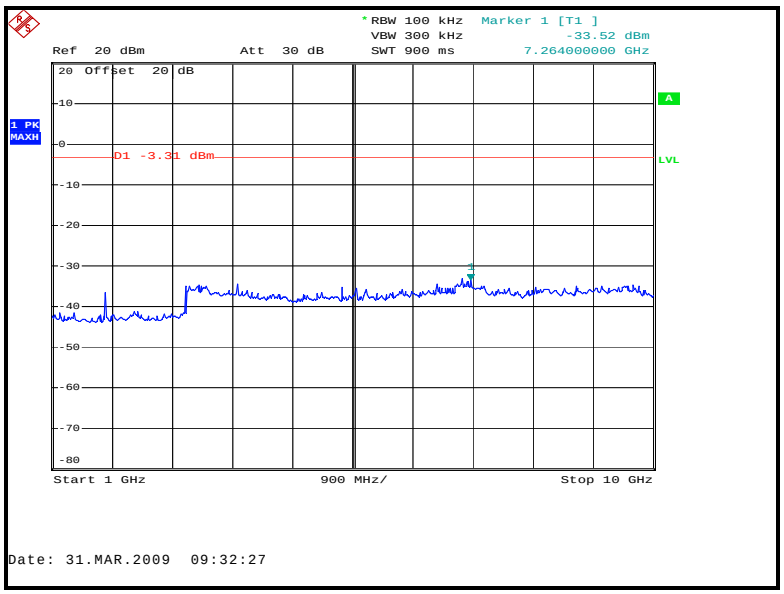

Figure 7.4.2.2-2: 1 GHz – 10 GHz – Low Channel

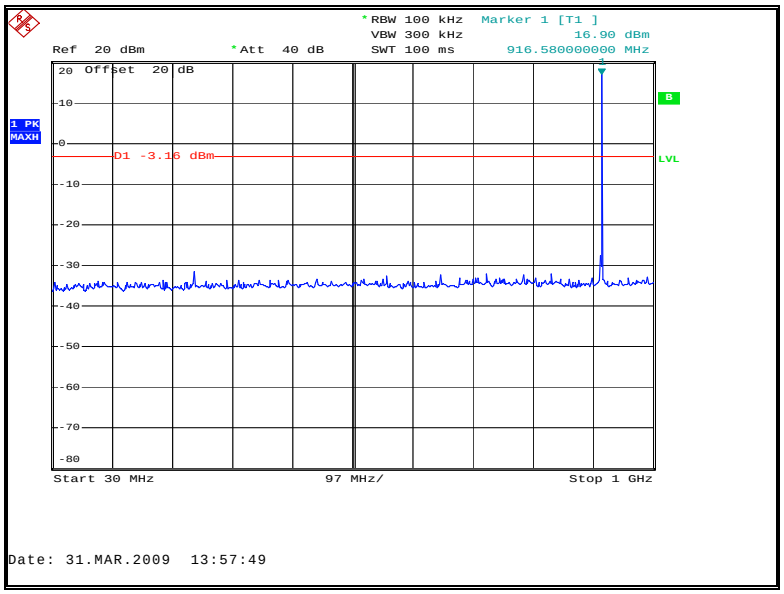

Figure 7.4.2.2-3: 30 MHz – 1 GHz –Mid Channel

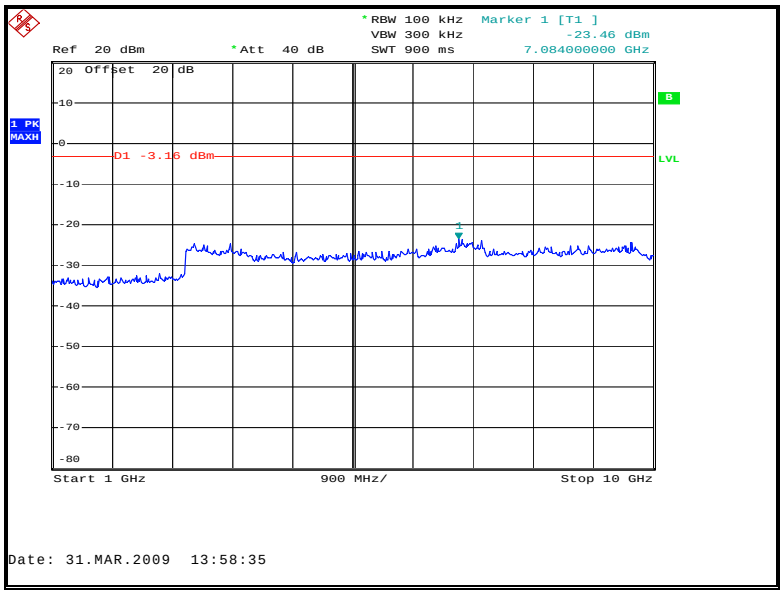

Figure 7.4.2.2-4: 1 GHz – 10 GHz – Mid Channel

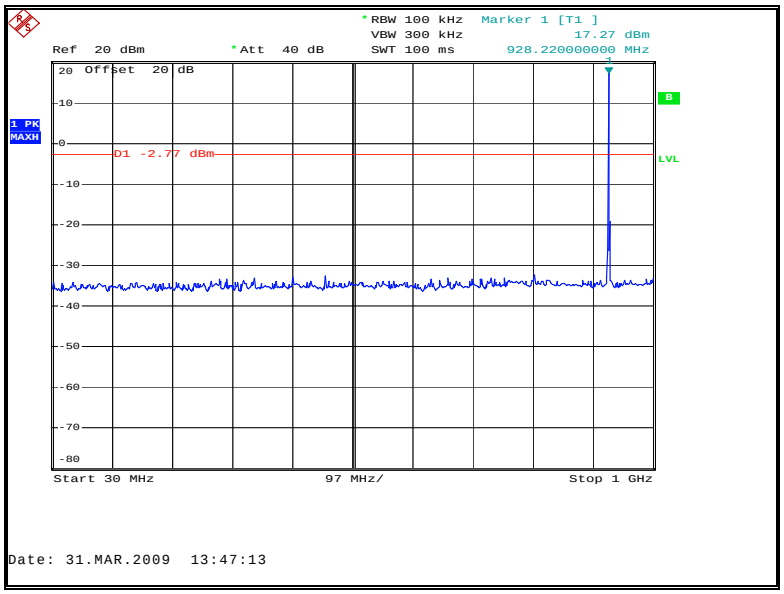

Figure 7.4.2.2-5: 30 MHz – 1 GHz – High Channel

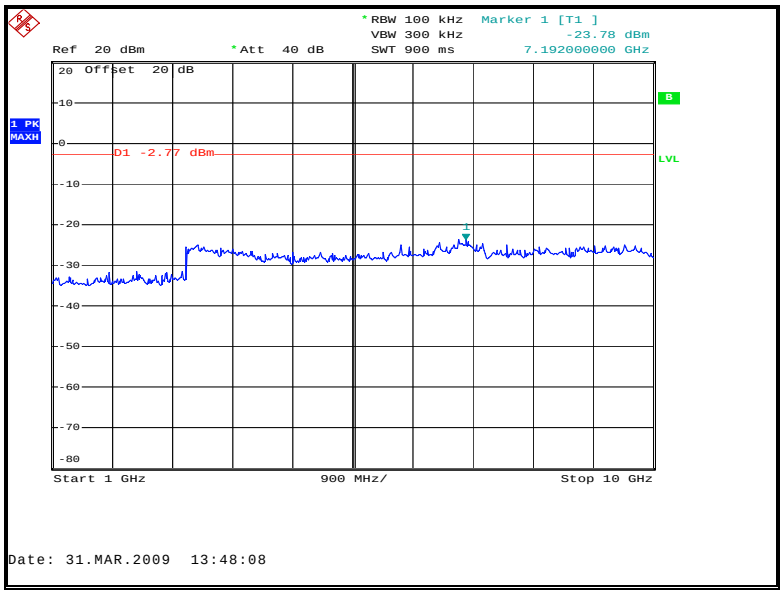

Figure 7.4.2.2-6: 1 GHz – 10 GHz –High Channel

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

7.4.3.1 Test Methodology

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

7.4.3.2 Duty Cycle Correction

For average radiated measurements, the measured level was reduced by a factor 15.81dB to account for the duty cycle of the EUT. Referencing the dwell time justification in section 7.3.3 above the worst case duty cycle within 100ms is 16.2% or 16.2ms. The duty cycle correction factor is determined using the formula: 20log (0.162)=15.81dB.

The more detailed justification of duty cycle can be found in the dwell time justification attached to the Theory of Operations.

7.4.3.3 Test Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in Table 7.4.3.3-1.

Table 7.4.3.3-1: Radiated Spurious Emissions

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										
2708.25	52.87	49.98	H	0.84	53.71	35.01	74.0	54.0	20.29	18.99
2708.25	54.47	51.76	V	0.64	55.11	36.59	74.0	54.0	18.89	17.41
3611	48.55	42.82	H	4.07	52.62	31.08	74.0	54.0	21.38	22.92
3611	49.51	44.19	V	4.09	53.60	32.47	74.0	54.0	20.40	21.53
4513.75	46.92	40.46	H	5.98	52.90	30.63	74.0	54.0	21.10	23.37
4513.75	47.05	40.41	V	6.08	53.13	30.68	74.0	54.0	20.87	23.32
Middle Channel										
2745.75	52.41	49.30	H	0.98	53.39	34.47	74.0	54.0	20.61	19.53
2745.75	53.65	51.13	V	0.78	54.43	36.10	74.0	54.0	19.57	17.90
3661	48.80	44.32	H	4.23	53.03	32.74	74.0	54.0	20.97	21.26
3661	49.26	43.81	V	4.26	53.52	32.26	74.0	54.0	20.48	21.74
4576.25	48.09	40.69	H	6.16	54.25	31.04	74.0	54.0	19.75	22.96
4576.25	46.92	40.76	V	6.26	53.18	31.21	74.0	54.0	20.82	22.79
High Channel										
2781.72	56.42	54.68	H	1.12	57.54	39.99	74.0	54.0	16.46	14.01
2781.72	61.82	60.27	V	0.92	62.74	45.38	74.0	54.0	11.26	8.62
3708.96	50.35	47.21	H	4.39	54.74	35.79	74.0	54.0	19.26	18.21
3708.96	50.63	46.76	V	4.43	55.06	35.38	74.0	54.0	18.94	18.62
4636.2	47.46	39.88	H	6.34	53.80	30.41	74.0	54.0	20.20	23.59
4636.2	46.03	40.23	V	6.44	52.47	30.86	74.0	54.0	21.53	23.14

***** The magnitude of all emissions not reported were below the noise floor of the measurement system.

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: 52.87 + 0.84 = 53.71dBuV/m
Margin: 74dBuV/m – 53.71dBuV/m = 20.29dB

Example Calculation: Average
Corrected Level: 49.98 + 0.84 - 15.81 = 35.01dBuV
Margin: 54dBuV – 35.01dBuV = 18.99dB

8.0 CONCLUSION
In the opinion of ACS, Inc. the DNT500FP, 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