Excellence in Compliance Testing

Certification Test Report

FCC ID: P2SR900M
IC: 4171B-R900M

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

ACS Report Number: 14-0148.W04.1A

Manufacturer: Neptune Technology Group, Inc.
Model: R900M

Test Begin Date: May 6, 2014
Test End Date: May 8, 2014

Report Issue Date: May 13, 2014

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.

Reviewed by:
Kirby Munroe
Director, Wireless Certifications
ACS, Inc.

This report contains 19 pages

TABLE OF CONTENTS

1 GENERAL

1.1 Purpose

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

The purpose of this Class II Permissive Change is to add GFSK modulation to the existing OOK modulation included in the original certification filing.

1.2 Product description

The battery powered R900M spread-spectrum (frequency hopping) transceiver is designed for operation in water meter RF telemetry. The R900M's primary function is to transmit the readings of the attached utility meter encoder.

Technical Details:

Frequency Range:	911.0815 - 919.0769
Number of Channels:	50
Modulation Format:	GFSK
Antenna Type / Gain:	Internal: Wire Antenna, 2.1dBi External: Patch Antenna, Neptune Technologies Group Inc., P/N: 12527-XXX, 0dBi
Operating Voltage:	3.6 VDC (Lithium Battery)

Manufacturer Information:
Neptune Technology Group, Inc.
1600 Alabama Highway 229
Tallassee, AL 36078

EUT Serial Numbers: 1540011844

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

1.3 Test Methodology and Considerations

The EUT was tested for radiated emissions in multiple orientations and worst case data provided where applicable. Worst case orientation for radiated emissions was Z-position.

Power settings utilized during testing are as follows:
LCH (911.08147MHz) Power Setting: 34
HCH (919.07686MHz) Power Setting: 37

2 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

ACS is accredited to ISO/IEC 17025 by the National Institute of Standards and Technology under their National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 200612-0. Unless otherwise specified, all tests methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

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.

FCC Registration Number: 511277
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

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:

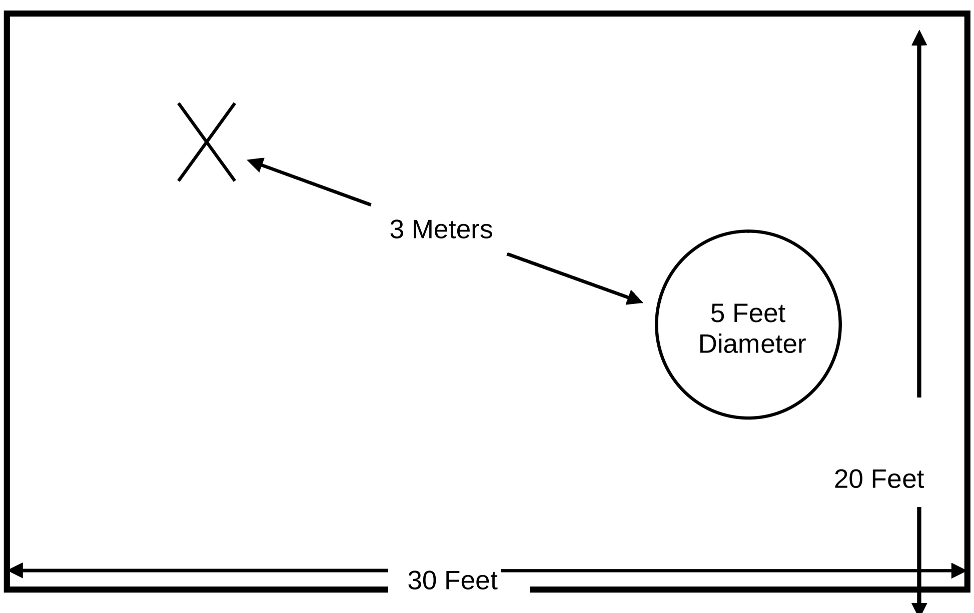

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

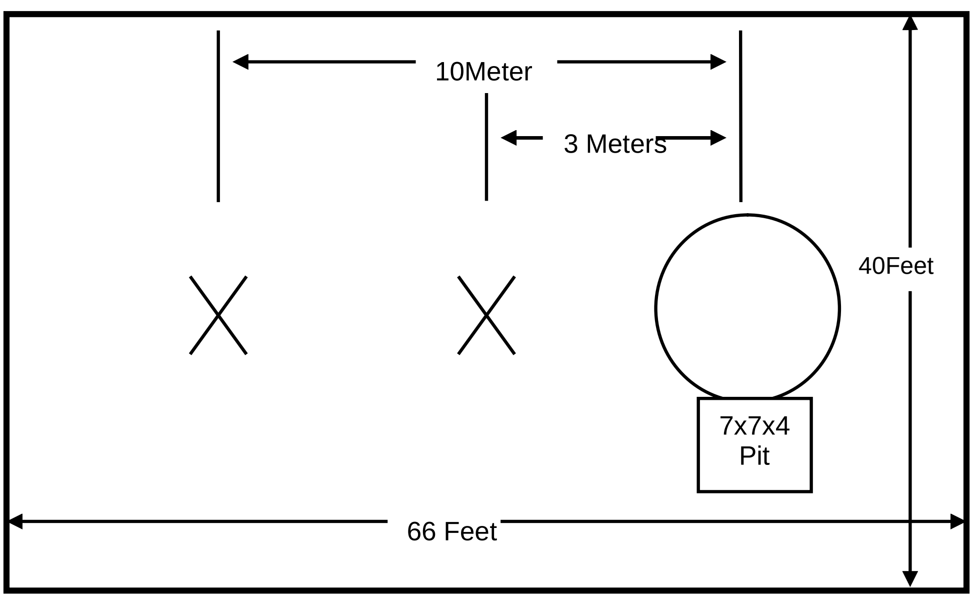

Figure 2.3-2: Open Area Test Site

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 ground 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 2.4-1:

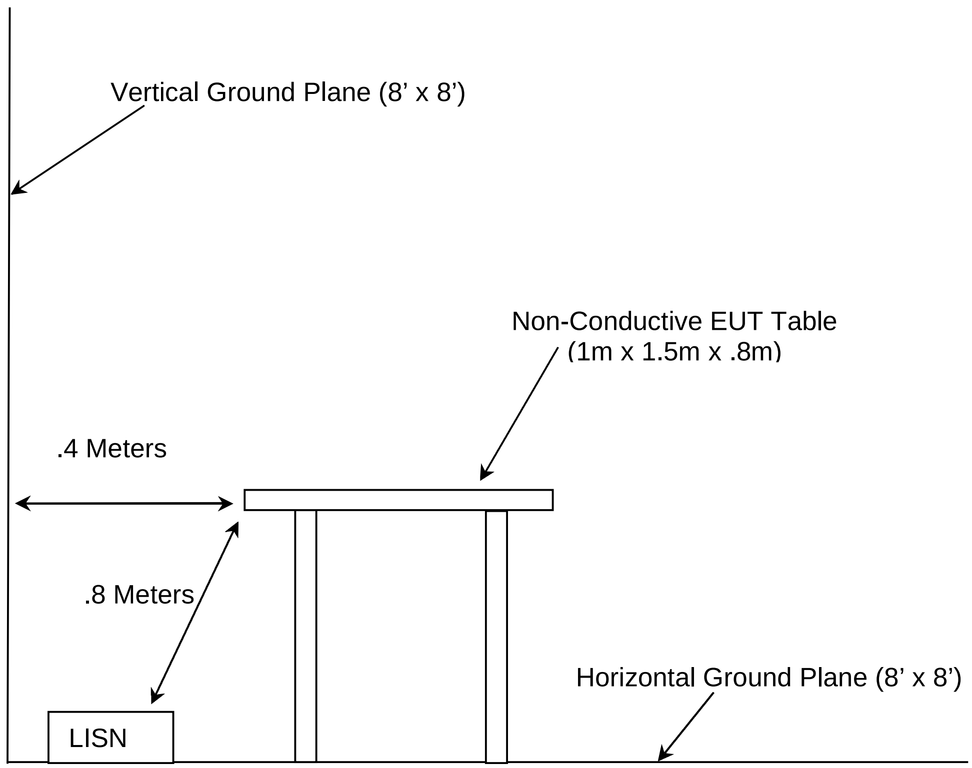

Figure 2.4-1: AC Mains Conducted EMI Site

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 9KHz to 40GHz
- 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
- 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 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
1	Rohde & Schwarz	ESMI - Display	Spectrum Analyzers	833771/007	8/2/2012	8/2/2014
2	Rohde & Schwarz	ESMI-Receiver	Spectrum Analyzers	839587/003	8/2/2012	8/2/2014
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/23/2013	4/23/2015
40	EMCO	3104	Antennas	3211	2/14/2013	2/14/2015
73	Agilent	8447D	Amplifiers	2727A05624	7/16/2013	7/16/2014
167	ACS	Chamber EMI Cable Set	Cable Set	167	11/7/2013	11/7/2014
267	Agilent	N1911A	Meters	MY45100129	7/30/2013	7/30/2015
268	Agilent	N1921A	Sensors	MY45240184	7/30/2013	7/30/2015
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	3/17/2014	3/17/2015
337	Microwave Circuits	H1G513G1	Filters	282706	6/19/2013	6/19/2014
338	Hewlett Packard	8449B	Amplifiers	3008A01111	7/30/2013	7/30/2015
339	Aeroflex/Weinschel	AS-18	Attenuators	7142	6/19/2013	6/19/2014
412	Electro Metrics	LPA-25	Antennas	1241	7/27/2012	7/27/2014
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	11/7/2013	11/7/2014
616	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	N/A	9/26/2013	9/26/2014
622	Rohde & Schwarz	FSV40	Analyzers	101338	11/19/2013	11/19/2014

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model Number	Serial Number
1	Battery	Tadiran Batteries	TL4930	NA

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

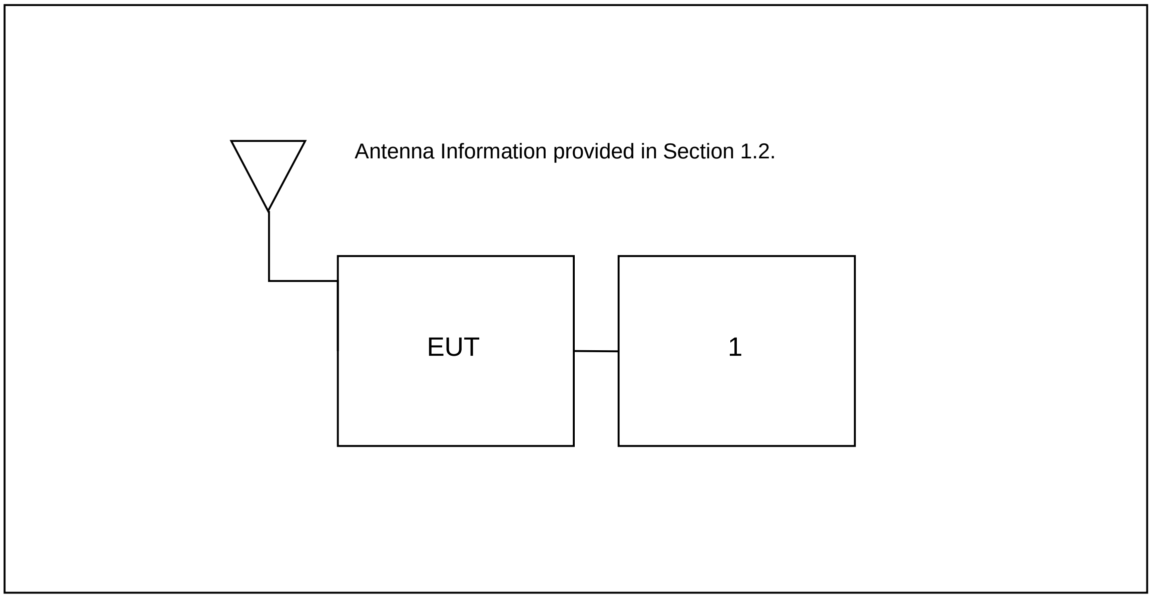

Figure 6-1: Test Setup Block Diagram

7 SUMMARY OF TESTS

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

7.1 Antenna Requirement – FCC: Section 15.203

The external patch antenna interfaces with the EUT via a coax cable and special sealed connector. The internal antenna is an integral wire antenna to the EUT and cannot be removed or modified without permanently damaging the device. Professional installation is applicable.

7.2 Power Line Conducted Emissions – FCC: Section 15.207 IC: RSS-Gen 7.2.4

7.2.1 Measurement Procedure

The EUT is battery operated therefore AC power line conducted emissions is not applicable.

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

7.3.1 Measurement Procedure (Conducted Method)

The RF output port of the EUT was directly connected to the input of a power meter. The device employs ≥ 50 channels therefore the power is limited to 1 Watt.

7.3.2 Measurement Results

Results are shown below in Table 7.3.2-1 below:

Table 7.3.2-1: RF Output Power

Frequency [MHz]	Level [dBm]
911.0815	29.92
919.0769	29.90

7.4 Channel Usage Requirements

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

7.4.1.1 Measurement Procedure

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.

7.4.1.2 Measurement Results

Results are shown below in Figure 7.4.1.2-1.

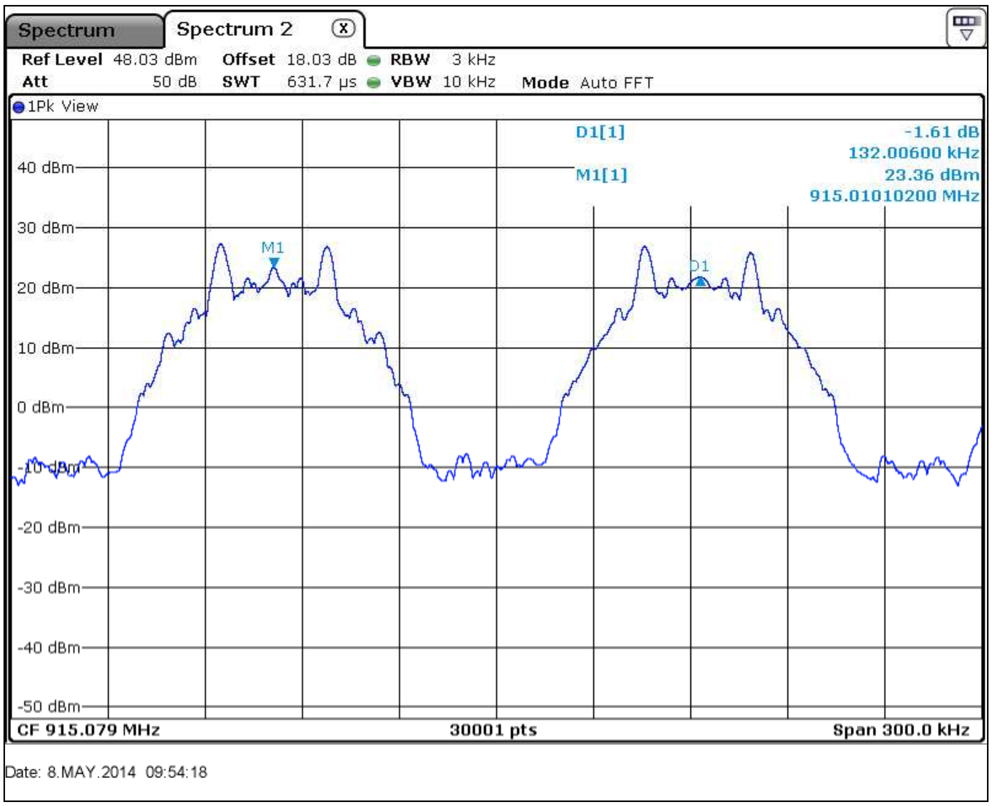

Figure 7.4.1.2-1: Carrier Frequency Separation

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

7.4.2.1 Measurement Procedure

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 the frequency band of operation. The RBW was set to ≥ 1% of the span and VBW set to ≥ RBW.

7.4.2.2 Measurement Results

Results are shown below in Figure 7.4.2.2-1.

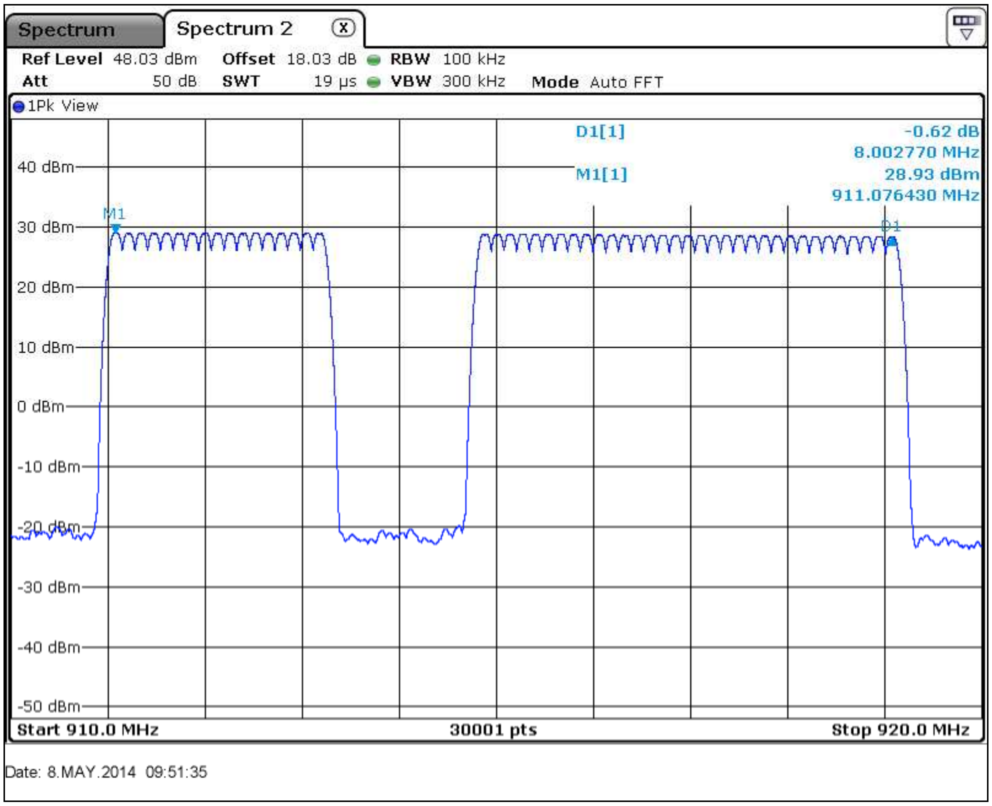

Figure 7.4.2.2-1: Number of Hopping Channels

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

7.4.3.1 Measurement Procedure

The span was set to 0 Hz, centered on a hopping channel. The RBW was set to 1 MHz and the VBW to 3MHz. Sweep time was set such to capture the burst duration of the emission. The marker – delta function of the analyzer was employed to measure the burst duration.

7.4.3.2 Measurement Results

The duration of the RF transmission was measured as 8.414 ms. There are 50 channels therefore the average time of occupancy on any channel in a 20 second period is 400ms. See the theory of operation for additional justification. A single transmission is shown in Figure 7.4.3.2-1 below.

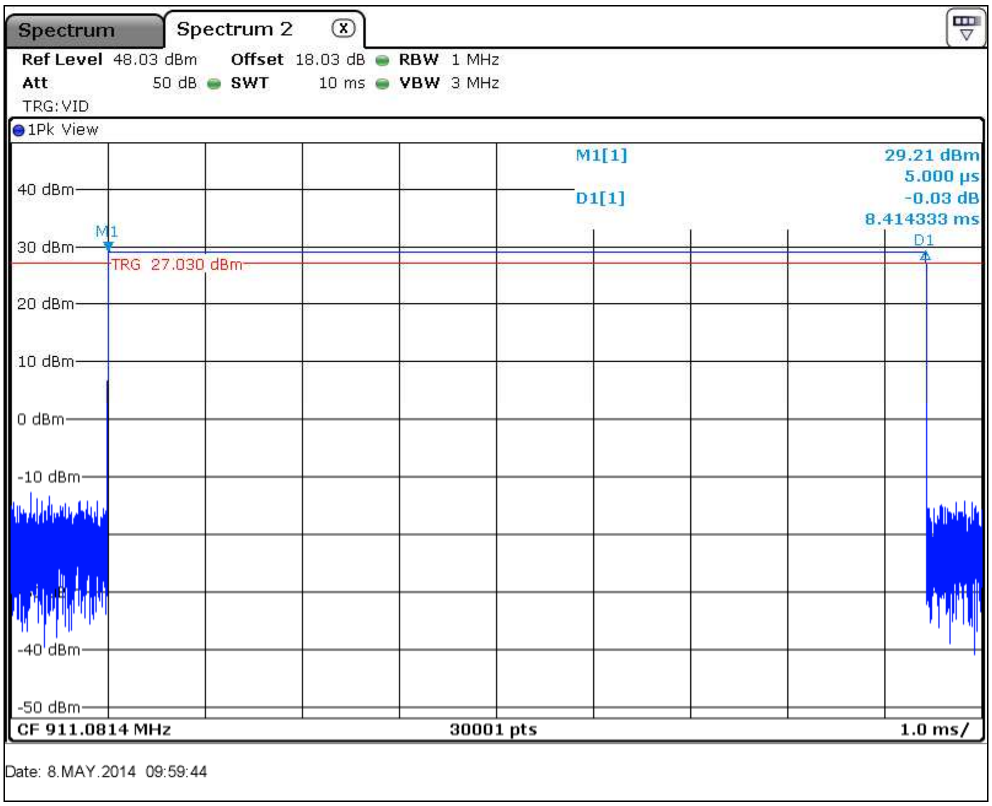

Figure 7.4.3.2-1: Dwell Time

7.4.4 20dB / 99% Bandwidth - FCC: Section 15.247(a)(1)(i) IC: RSS-210 A8.1(c)

7.4.4.1 Measurement Procedure

The RF output port of the EUT was directly connected to the input of the spectrum analyzer. The span of the spectrum analyzer display was set between two times and five times the occupied bandwidth (OBW) of the emission. The RBW of the spectrum analyzer was set to approximately 1 % to 5 % of the OBW. 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 occupied bandwidth measurement function of the analyzer was used for the 99% bandwidth. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth was set to 3 times the resolution bandwidth. A sampling detector was used.

7.4.4.2 Measurement Results

Results are shown in Table 7.4.4.2-1 and Figures 7.4.4.2-1 to 7.4.4.2-4 below.

Table 7.4.4.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
911.0815	70.87	67.30
919.0769	70.84	67.08

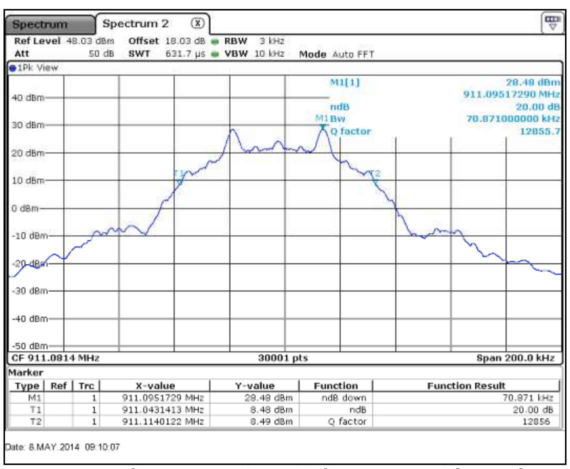

Figure 7.4.4.2-1: 20dB BW Low Channel

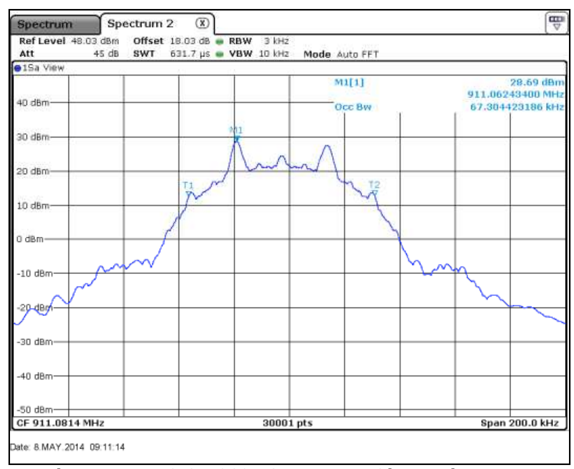

Figure 7.4.4.2-2: 99% OBW Low Channel

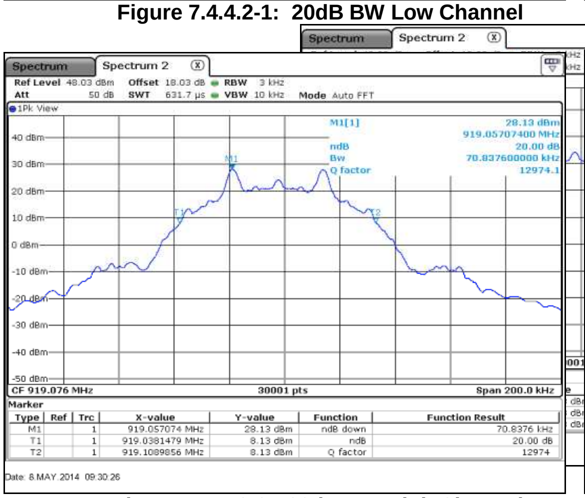

Figure 7.4.4.2-3: 20dB BW High Channel

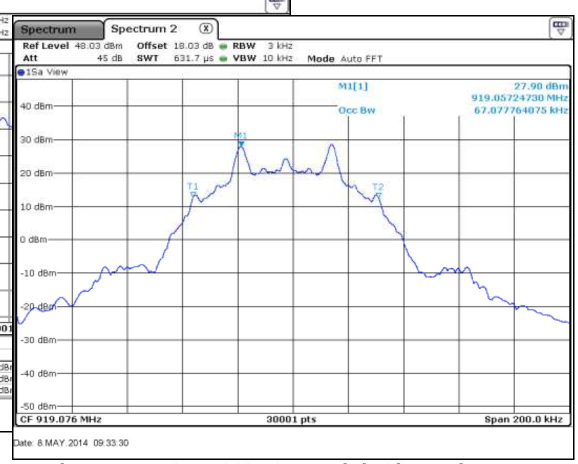

Figure 7.4.4.2-4: 99% OBW High Channel

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

7.5.1 Band-Edge Compliance of RF Conducted Emissions

7.5.1.1 Measurement Procedure

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 ≥ 1% of the span, and the VBW was set to >> RBW.

7.5.1.2 Measurement Results

Results are shown in the Figures 7.5.1.2-1 to 7.5.1.2-4 below.

<u>**NON-HOPPING MODE:**</u>

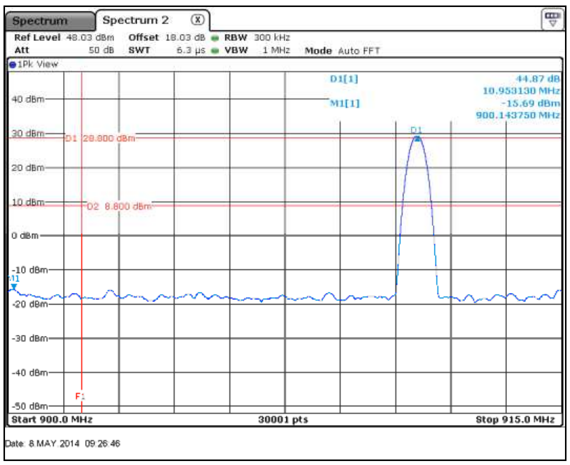

Figure 7.5.1.2-1: Lower Band-edge

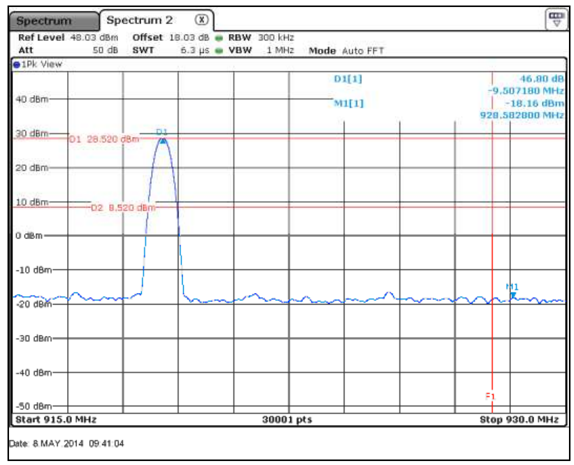

Figure 7.5.1.2-2: Upper Band-edge

<u>**HOPPING MODE:**</u>

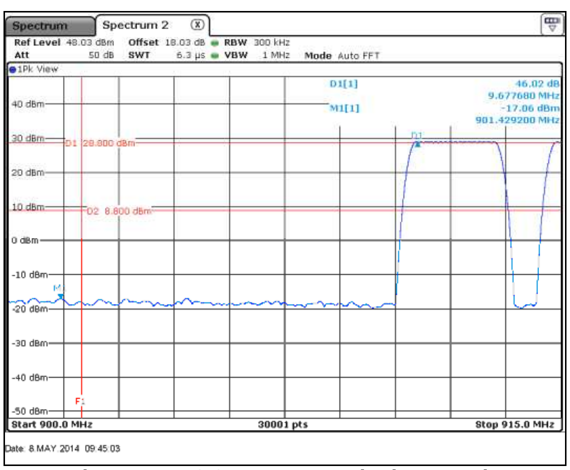

Figure 7.5.1.2-3: Lower Band-edge Hopping

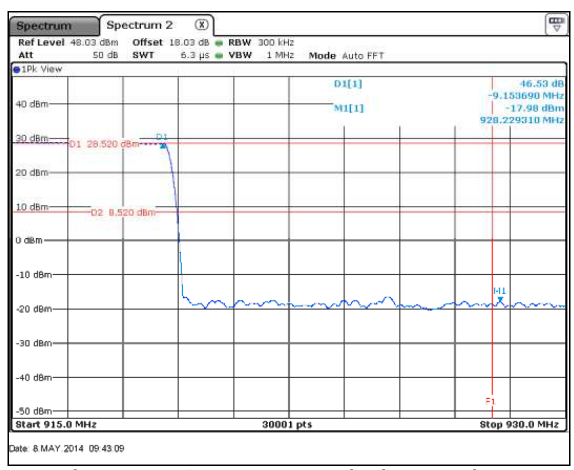

Figure 7.5.1.2-4: Upper Band-edge Hopping

7.5.2 RF Conducted Spurious Emissions

7.5.2.1 Measurement Procedure

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.

7.5.2.2 Measurement Results

Results are shown below in Figures 7.5.2.2-1 to 7.5.2.2-4:

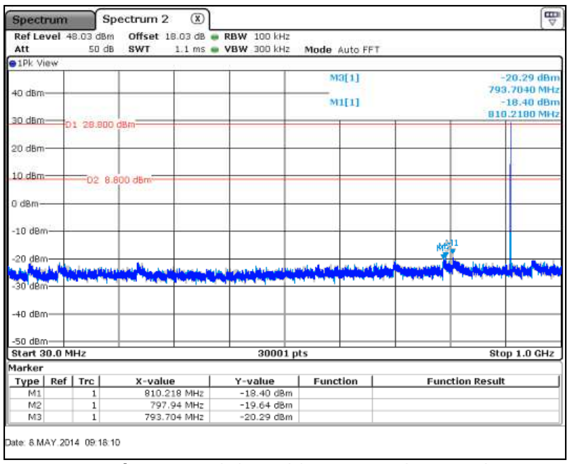

Figure 7.5.2.2-1: 30 MHz – 1 GHz – LCH

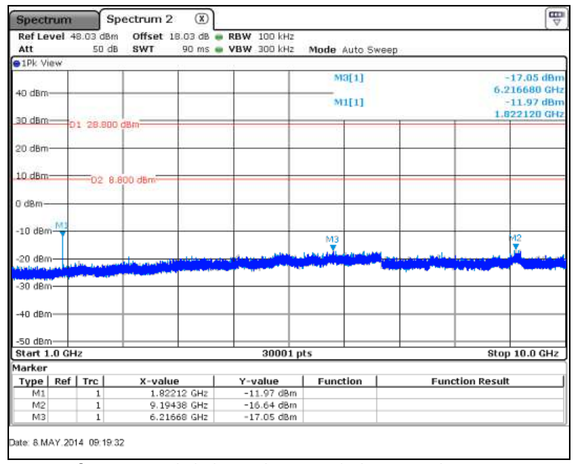

Figure 7.5.2.2-2: 1 GHz – 10 GHz – LCH

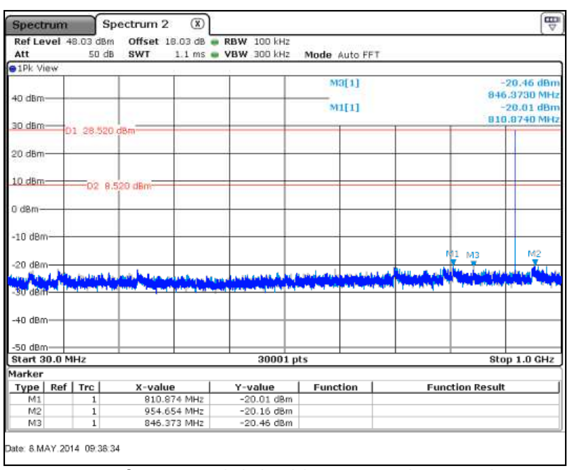

Figure 7.5.2.2-3: 30 MHz – 1 GHz – HCH

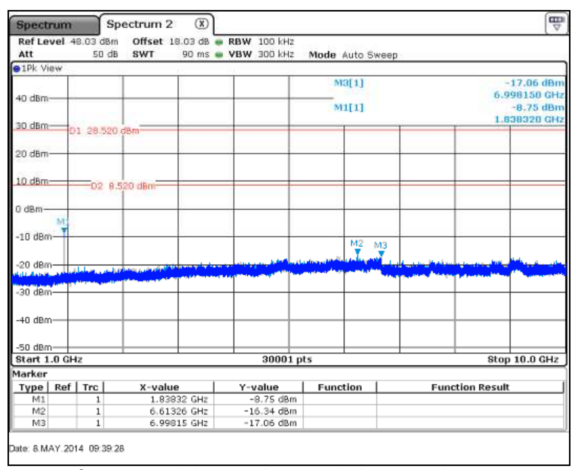

Figure 7.5.2.2-4: 1 GHz – 10 GHz – HCH

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

7.5.3.1 Measurement Procedure

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 were made with RBW and VBW of 1 MHz and 3MHz respectively.

The EUT was caused to generate a continuous modulated carrier on the hopping channel.

Each emission found to be in a restricted band was compared to the applicable radiated emission limits.

Radiated spurious emissions were evaluated for all orientations and worst case data presented. Worst case orientation was Z-position. See test setup photos for additional detail.

7.5.3.2 Duty Cycle Correction

For average radiated measurements, using an 8.414% duty cycle, the measured level was reduced by a factor 21.5dB. The duty cycle correction factor is determined using the formula: 20log (8.414/100) = -21.5dB. See Section 7.4.3 for details.

7.5.3.3 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 10GHz are reported in the Tables 7.5.3.3-1 to 7.5.3.3-2 below.

Table 7.5.3.3-1: Radiated Spurious Emissions Tabulated Data – Internal 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										
1055.2	51.24	39.83	H	-13.08	38.16	5.25	74.00	54.0	35.8	48.8
1055.2	59.43	47.22	V	-13.08	46.35	12.64	74.00	54.0	27.7	41.4
2733.243	67.15	66.39	H	-4.36	62.79	40.53	74.00	54.0	11.2	13.5
2733.243	60.45	58.80	V	-4.36	56.09	32.94	74.00	54.0	17.9	21.1
3644.324	53.21	48.03	H	-1.03	52.18	25.50	74.0	54.0	21.8	28.5
3644.324	50.41	42.57	V	-1.03	49.38	20.04	74.0	54.0	24.6	34.0
4555.405	52.37	47.45	H	1.29	53.66	27.24	74.0	54.0	20.3	26.8
4555.405	48.11	37.11	V	1.29	49.40	16.90	74.0	54.0	24.6	37.1
High Channel										
1046.1	52.29	41.07	H	-13.15	39.14	6.42	74.00	54.0	34.9	47.6
1046.1	60.75	48.03	V	-13.15	47.60	13.38	74.00	54.0	26.4	40.6
2757.23058	64.33	63.37	H	-4.26	60.07	37.61	74.0	54.0	13.9	16.4
2757.23058	58.16	56.11	V	-4.26	53.90	30.35	74.0	54.0	20.1	23.7
3676.30744	54.06	49.40	H	-0.90	53.16	27.00	74.0	54.0	20.8	27.0
3676.30744	50.11	41.94	V	-0.90	49.21	19.54	74.0	54.0	24.8	34.5
4595.3843	52.04	47.02	H	1.34	53.38	26.86	74.0	54.0	20.6	27.1
4595.3843	47.25	37.75	V	1.34	48.59	17.59	74.0	54.0	25.4	36.4

Table 7.5.3.3-2: Radiated Spurious Emissions Tabulated Data – External 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										
2733.24441	55.78	52.86	H	-4.36	51.42	27.00	74.00	54.0	22.60	27.0
2733.24441	59.87	58.11	V	-4.36	55.51	32.25	74.00	54.0	18.50	21.7
3644.32588	51.31	44.86	H	-1.03	50.28	22.33	74.0	54.0	23.7	31.7
3644.32588	51.16	45.32	V	-1.03	50.13	22.79	74.0	54.0	23.9	31.2
4555.40735	49.33	41.94	H	1.29	50.62	21.73	74.0	54.0	23.4	32.3
4555.40735	48.17	38.38	V	1.29	49.46	18.17	74.0	54.0	24.5	35.8
High Channel										
2757.23058	56.51	53.97	H	-4.26	52.25	28.21	74.00	54.0	21.80	25.8
2757.23058	59.84	58.22	V	-4.26	55.58	32.46	74.00	54.0	18.40	21.5
3676.30744	52.46	46.46	H	-0.90	51.56	24.06	74.0	54.0	22.4	29.9
3676.30744	54.58	50.77	V	-0.90	53.68	28.37	74.0	54.0	20.3	25.6
4595.3843	50.12	42.95	H	1.34	51.46	22.79	74.0	54.0	22.5	31.2
4595.3843	47.68	37.82	V	1.34	49.02	17.66	74.0	54.0	25.0	36.3

7.5.3.4 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: 51.24 - 13.08 = 38.16dBuV/m
Margin: 74dBuV/m – 38.16dBuV/m = 35.8dB

Example Calculation: Average

Corrected Level: 39.83 - 13.08 - 21.5 = 5.25dBuV
Margin: 54dBuV – 5.25dBuV = 48.8dB

8 CONCLUSION

In the opinion of ACS, Inc. the R900M, manufactured by Neptune Technology Group, Inc. meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT