Excellence in Compliance Testing

Certification Test Report

FCC ID: U9O-SM220
IC: 7084A-SM220

FCC Rule Part: 15.247
ISED Canada Radio Standards Specification: RSS-247

ACS Report Number: 16-0505.W04.1C

Manufacturer: Synapse Wireless, Inc.
Model: SM220

Test Begin Date: November 18, 2016
Test End Date: December 5, 2016

Report Issue Date: April 10, 2017

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

FOR THE SCOPE OF ACCREDITATION UNDER Certificate Number: AT-2021

This report must not be used by the client to claim product certification, approval, or endorsement by ANAB, NIST, or any agency of the Federal Government.

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This report contains 14 pages

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1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Innovation, Science and Economic Development (ISED) Canada's Radio Standards Specification RSS-247 for a Class II Permissive Change Certification.

The purpose of this Class II Permissive Change is to add new external antennas.

1.2 Product Description

The Synapse Wireless model SM220 is an IEEE 802.15.4 RF module. The radio contains two radio ports. Port one uses an internal compact F antenna and all 16 channels are available to transmit and receive; port two is for use with an external antenna. The last channel at 2.480 GHz is not available for use on port two except for receive mode.

Technical Information:

Detail	Description
Frequency Range	2405 - 2480 MHz (Port 1) 2405 – 2475 MHz (Port 2)
Number of Channels	16 Channels (Port 1) 15 Channels (Port 2)
Channel Separation	5 MHz
Modulation Format	O-QPSK
Input Power	5 VDC
Antenna Type(s) / Gain(s)	Dipole Antenna: Pulse RO2408NF / 8dBi Stubby Antenna: Linx ANT-2.4-CW-RAH-RPS / 1.6dBi (Right Angle Connector) Linx ANT-2.4-CW-RH-RPS / 1.6dBi (Strait Connector)

Manufacturer Information:
Synapse Wireless
6723 Odyssey Drive
Huntsville, AL 35806

EUT Serial Numbers: 2607E0A2

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

1.3 Test Methodology and Considerations

The stubby dipole antennas are equivalent antennas. The antenna model ANT-2.4-CW-RAH-RPS was used during the evaluation and the results are deemed representative of model ANT-2.4-CW-RH-RPS.

For radiated emissions three orientations of the EUT were evaluated to determine worst case. The worst case orientation with the Dipole antenna was determined to be the Y orientation for spurious emissions and Z orientation on the band edges. The worst case orientation with the Stubby antenna was determined to be the Y orientation for spurious emissions and X orientation on the band edges.

The Class II Permissive Change testing was to add additional antennas to the original certification, therefore only radiated emissions were performed.

The EUT was connected to an evaluation board to facilitate programming and control.

Multiple antenna types are available for use with the EUT. The highest gain of each antenna type was evaluated for compliance.

u.fl Port – LCH Power Setting: 9
u.fl Port – MCH Power Setting: 9
u.fl Port – HCH Power Setting: 11

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 ANSI-ASQ National Accreditation Board/ANAB accreditation program, and has been issued certificate number AT-2021 in recognition of this accreditation. 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, ISED Canada and the Japanese Voluntary Control Council for Interference by information technology equipment.

FCC Registration Number: 391271
ISED Canada Lab Code: IC 4175A
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:

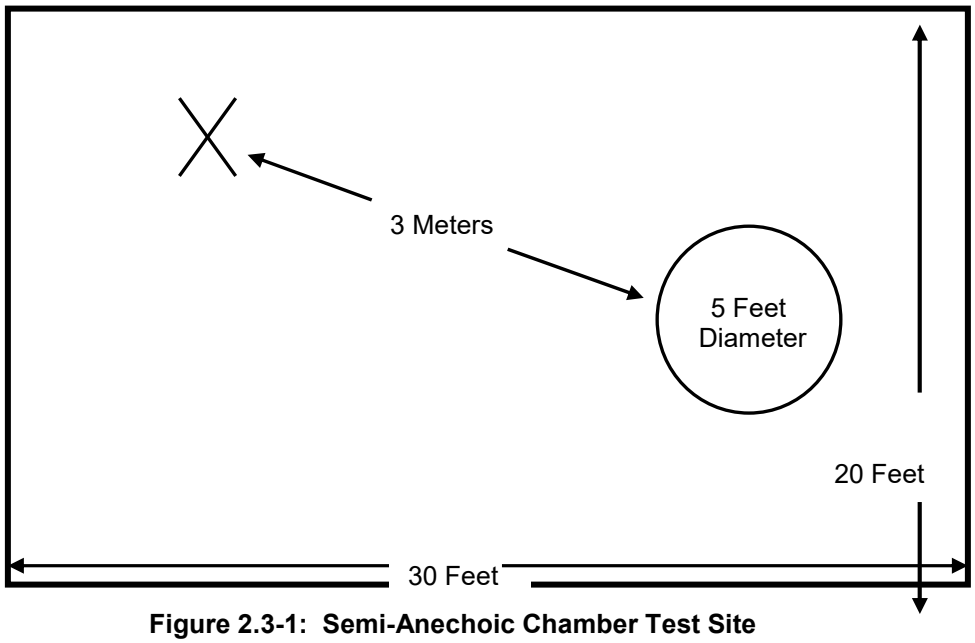

Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

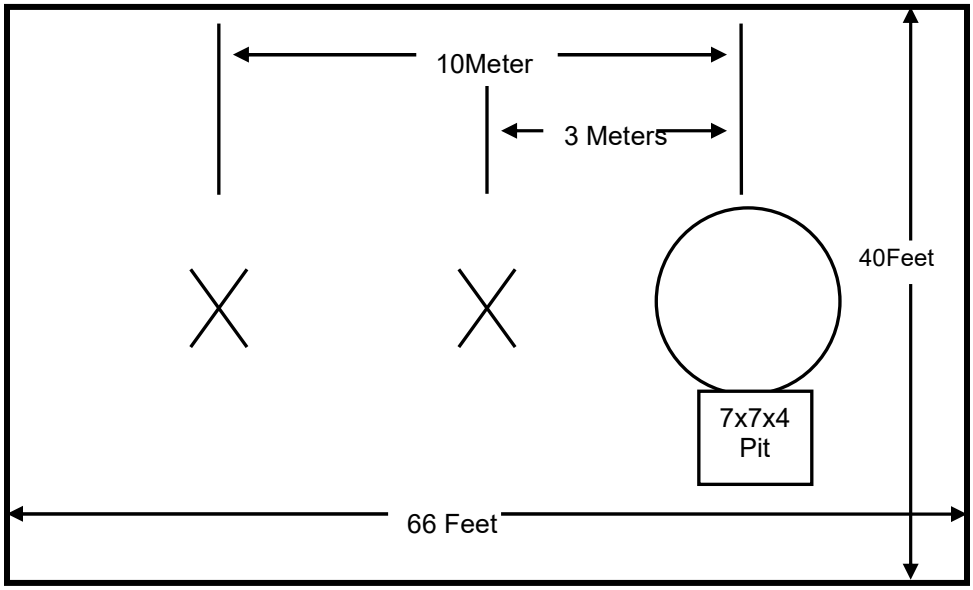

Figure 2.3-2: Open Area Test Site

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 C63.10.

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

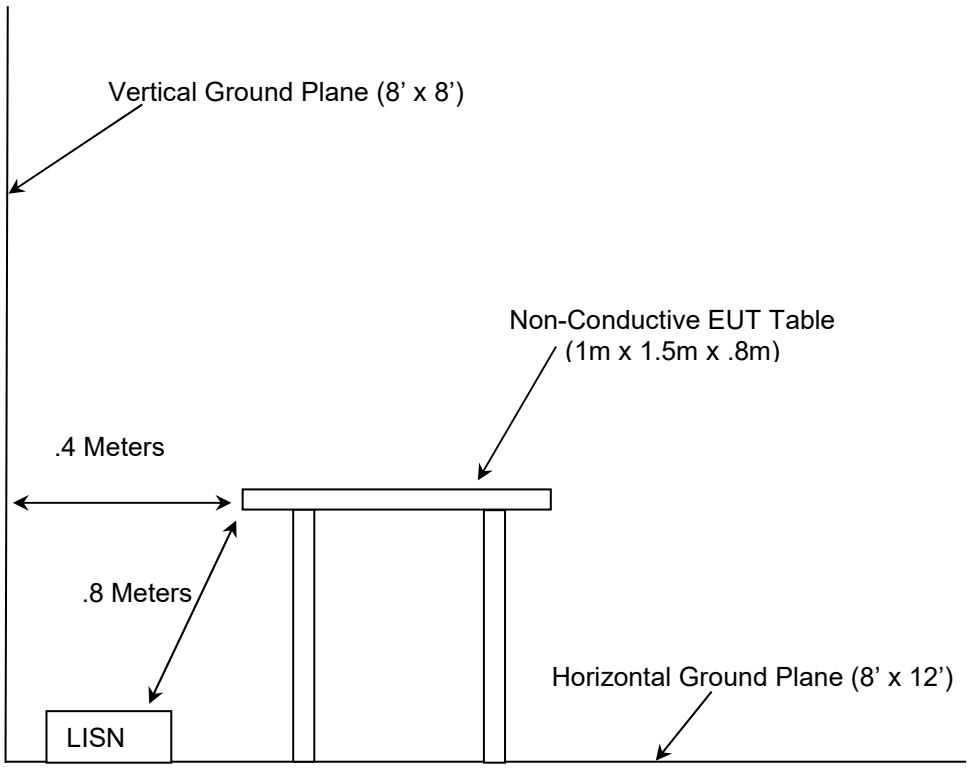

Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 2, Subpart J: Equipment Authorization Procedures, 2016
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2016
- FCC KDB 558074 D01 DTS Meas Guidance v03r05 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, April 8, 2016
- ISED Canada Radio Standards Specification: RSS-247 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices, Issue 1, May 2015
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements and Information for the Certification of Radiocommunication Equipment, Issue 4, Nov 2014.

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
30	Spectrum Technologies	DRH-0118	Antennas	970102	4/30/2015	4/30/2017
40	EMCO	3104	Antennas	3211	2/10/2015	2/10/2017
73	Agilent	8447D	Amplifiers	2727A05624	7/21/2016	7/21/2017
167	ACS	Chamber EMI Cable Set	Cable Set	167	9/30/2016	9/30/2017
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/21/2015	8/21/2017
412	Electro Metrics	LPA-25	Antennas	1241	8/8/2016	8/8/2018
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	10/27/2016	10/27/2017
432	Microwave Circuits	H3G020G4	Filters	264066	5/13/2016	5/13/2017
616	Florida RF Cables	SMRE	Cables	N/A	9/2/2016	9/2/2017
676	Florida RF Labs	SMS-290AW-480.0-SMS	Cables	MFR2Y194	11/4/2016	11/4/2017
RE619	Rhode & Schwarz	ESU26	Spectrum Analyzers	1302.6005K26 Ser. 100190	11/5/2014	1/5/2017

5 SUPPORT EQUIPMENT

Table 5-1: Support Equipment

Item	Equipment Type	Manufacturer	Model/Part Number	Serial Number
1	Evaluation Board	Synapse Wireless	200210.01A	N/A
2	Bench Power Supply	Hewlett Packard	E3630A	KR64308603

6 EQUIPMENT UNDER TEST SETUP BLOCK DIAGRAM

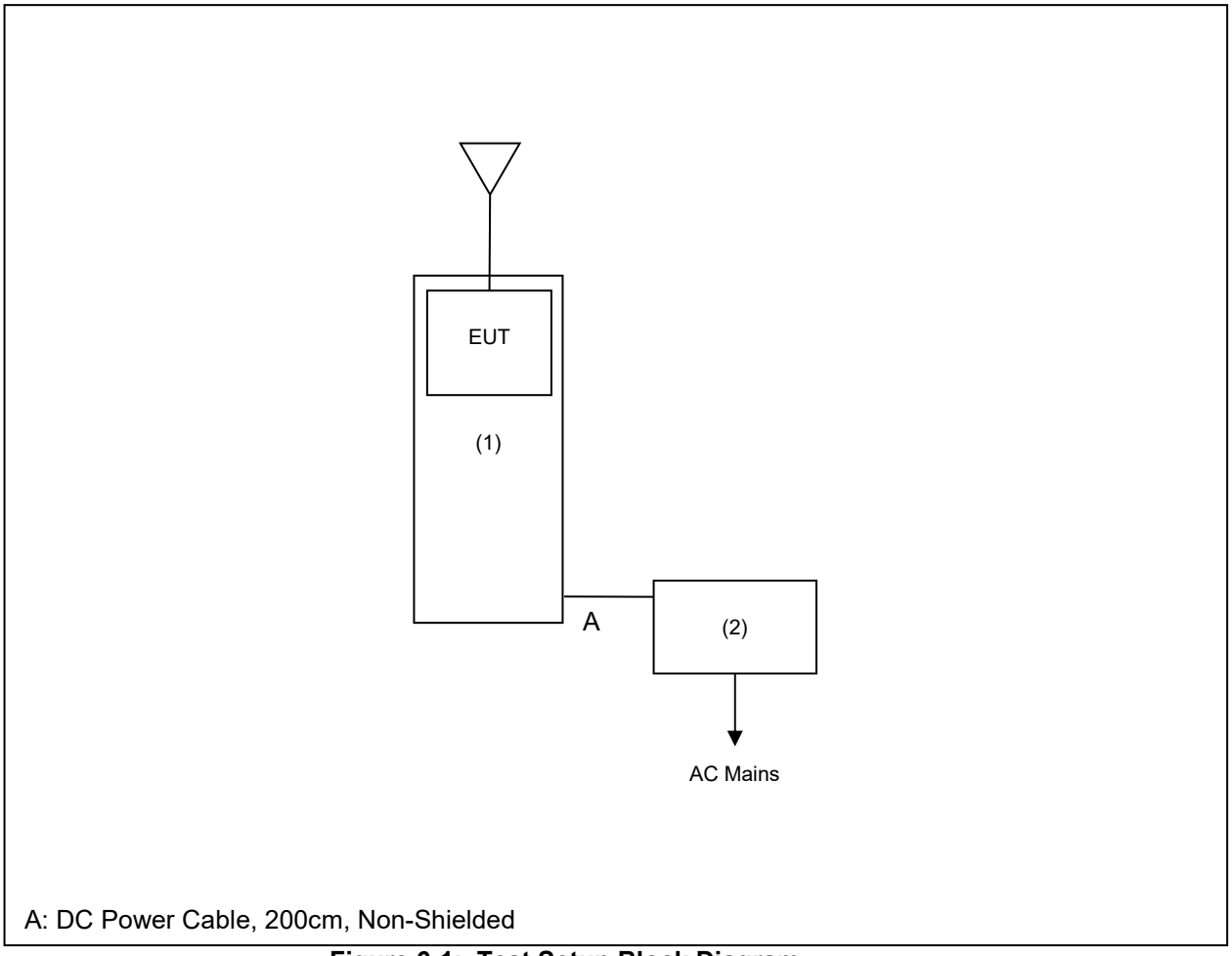

Figure 6-1: Test Setup Block Diagram

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 15.203

The EUT uses a U.FL connector for external antenna connected (RF Port 2). The 1.6 dBi Stubby antennas marketed with the product use RSMA connectors which connect to the PCB module via a U.FL to RSMA cable adapter. The 8dBi Dipole Antenna marketed with the product uses an N-Female connector which connect to the PCB module via U.FL to N-male cable adapter. The U.FL to N-male cable adapter will be permanently attached to the 8dBi Dipole Antenna per the manufacturer. The EUT uses unique antenna connectors and therefore meets the requirements of the FCC Section 15.203.

7.2 Band Edge and Spurious Emissions

7.2.1 Emissions into Restricted Frequency Bands – FCC 15.205, 15.209; ISED Canada RSS-Gen 8.9/8.10

7.2.1.1 Measurement Procedure

The unwanted emissions into restricted bands were measured radiated 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 RBW of 120 kHz and a VBW of 300 kHz. For frequencies above 1000MHz, peak and average measurements were made with RBW and VBW of 1 MHz and 3 MHz respectively.

Each emission found to be in a restricted band as defined by section 15.205, including any emission at the operational band-edge, was compared to the radiated emission limits as defined in section 15.209.

7.2.1.2 Duty Cycle Correction

For average radiated measurements, using a 14.1% duty cycle, the measured level was reduced by a factor 17.02dB. The duty cycle correction factor is determined using the formula: 20log (14.1/100) = -17.02dB. A detailed analysis of the duty cycle timing is provided in the Theory of Operation accompanying the application for certification.

7.2.1.3 Measurement Results

Table 7.2.1.3-1: Radiated Spurious Emissions Tabulated Data – Antenna 1 (Dipole)

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										
2390	52.90	41.70	H	-5.40	47.50	19.28	74.0	54.0	26.5	34.7
2390	68.40	60.10	V	-5.40	63.00	37.68	74.0	54.0	11.0	16.3
4810	52.00	40.60	H	1.82	53.82	25.41	74.0	54.0	20.2	28.6
4810	52.70	41.70	V	1.82	54.52	26.51	74.0	54.0	19.5	27.5
Middle Channel										
4880	50.40	38.70	H	2.04	52.44	23.72	74.0	54.0	21.6	30.3
4880	51.30	39.90	V	2.04	53.34	24.92	74.0	54.0	20.7	29.1
7320	49.10	36.10	H	7.74	56.84	26.82	74.0	54.0	17.2	27.2
7320	49.30	35.90	V	7.74	57.04	26.62	74.0	54.0	17.0	27.4
High Channel										
2483.5	52.90	40.90	H	-4.94	47.96	18.94	74.0	54.0	26.0	35.1
2483.5	77.70	67.20	V	-4.94	72.76	45.24	74.0	54.0	1.2	8.8
4950	50.90	40.70	H	2.26	53.16	25.94	74.0	54.0	20.8	28.1
4950	52.10	43.00	V	2.26	54.36	28.24	74.0	54.0	19.6	25.8
7425	48.60	35.80	H	7.82	56.42	26.61	74.0	54.0	17.6	27.4
7425	49.00	37.30	V	7.82	56.82	28.11	74.0	54.0	17.2	25.9

Table 7.2.1.3-2: Radiated Spurious Emissions Tabulated Data – Antenna 2 (Stubby)

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										
2390	58.80	50.20	H	-5.40	53.40	27.78	74.0	54.0	20.6	26.2
2390	63.40	55.00	V	-5.40	58.00	32.58	74.0	54.0	16.0	21.4
4810	45.70	40.30	H	1.82	47.52	25.11	74.0	54.0	26.5	28.9
4810	47.60	42.70	V	1.82	49.42	27.51	74.0	54.0	24.6	26.5
12025	40.40	34.70	V	14.47	54.87	32.15	83.5	63.5	28.6	31.4
Middle Channel										
4880	43.70	39.50	H	2.04	45.74	24.52	74.0	54.0	28.3	29.5
4880	43.00	38.10	V	2.04	45.04	23.12	74.0	54.0	29.0	30.9
7320	42.60	37.20	H	7.74	50.34	27.92	74.0	54.0	23.7	26.1
7320	48.40	44.20	V	7.74	56.14	34.92	74.0	54.0	17.9	19.1
12200	42.20	36.50	V	15.50	57.70	34.98	83.5	63.5	25.8	28.6
High Channel										
2483.5	65.60	54.90	H	-4.94	60.66	32.94	74.0	54.0	13.3	21.1
2483.5	68.00	57.30	V	-4.94	63.06	35.34	74.0	54.0	10.9	18.7
4950	40.70	35.80	H	2.26	42.96	21.04	74.0	54.0	31.0	33.0
4950	42.00	36.60	V	2.26	44.26	21.84	74.0	54.0	29.7	32.2
7425	40.10	34.50	H	7.82	47.92	25.31	74.0	54.0	26.1	28.7
7425	40.20	34.10	V	7.82	48.02	24.91	74.0	54.0	26.0	29.1

7.2.1.4 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 (Antenna 1)

Corrected Level: 52.90 - 5.40 = 47.50dBuV/m
Margin: 74.0dBuV/m – 47.50dBuV/m = 26.5dB

Example Calculation: Average (Antenna 1)

Corrected Level: 41.70 - 5.40 - 17.02 = 19.28dBuV
Margin: 54.0dBuV – 19.28dBuV =34.7dB

8 CONCLUSION

In the opinion of ACS, Inc. the SM220, provided by Synapse Wireless, Inc. meets the requirements of FCC Part 15 subpart C and ISED Canada's Radio Standards Specification RSS-247 for a Class II Permissive Change Certification, for the tests detailed in this report.

END REPORT