C2PC Test Report

FCC ID: U9O-SM200
IC: 7084A-SM200

FCC Rule Part: 15.249
IC Radio Standards Specification: RSS-210

TÜV SÜD Report Number: RD72136089.101

Manufacturer: Synapse Wireless, Inc.
Model: SM200

Test Begin Date: April 9, 2018
Test End Date: April 12, 2018

Report Issue Date: May 7, 2018

FOR THE SCOPE OF ACCREDITATION UNDER LAB Code AT-1921

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

Prepared by:

Charles Callis
EMC Technician
TÜV SÜD America, Inc.

Reviewed by:

Randle Sherian
EMC Manager
TÜV SÜD America, Inc.

TABLE OF CONTENTS

1 GENERAL

1.1 Purpose

The purpose of this report is to demonstrate compliance specific to a class 2 permissive change with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-210 for a single modular approval because the gain of the chip antenna increased. The dipole (Whip) antenna data has also been included in this report for reference. Based on the results, the dipole antenna is considered a class 1 permissive change.

1.2 Product description

The Synapse Wireless SM200 Module is an IEEE 802.15.4 compliant RF module. The frequencies of RF transmission are in the ISM 2.4GHz band with 16 total channels of operation. These RF modules are intended to be used by OEM and Integrators with a host board in order to add RF wireless communication to their products.

There are four part numbers included under the model SM200. Differences in part numbers are described below.

SM200P81: Chip antenna; reflow solder mounting
RF200P81: Chip antenna; mounted on RF Engine carrier board, reflow solder or socket mounted
SM200PU1: U.FL connector for external antenna; reflow solder mounting
RF200PU1: U.FL connector for external antenna; mounted on RF Engine carrier board with PCB traces to U.FL connector, reflow solder or socket mounting

The differences between the 'SM' and 'RF' part numbers is the 'RF' module part numbers are placed on a RF Engine carrier board. This carrier board provides PCB trace to the U.FL connectors for the RF200PU1 part number variant.

Band of operation:	2405 – 2480 MHz
Number of hopping channels:	16
Channel spacing	5 MHz
Modulation format:	O-QPSK
Antenna:	Patron SDBTPTR3015 Chip, 1.96dBi gain (Applicable to part numbers SM200P81 and RF200P81 only); Dipole, 3.2dBi gain (Applicable to part numbers SM200PU1 and RF200PU1 only)
RF connector:	U.FL (Applicable to part numbers SM200PU1 and RF200PU1 only)
Operating Voltage:	1.8 - 3.6VDC (9VDC to Evaluation Board)

Manufacturer Information:
Synapse Wireless, Inc.
500 Discovery Drive
Huntsville, AL 35806

Test Sample Serial Number(s): TUV# 346752.1 (Chip), TUV# 346751.1 (Dipole)

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

1.3 Test Methodology and Considerations

Only part numbers RF200P81 (chip antenna) and RF200PU1 (dipole antenna) were evaluated for showing compliance. These part numbers allowed use of an evaluation board for providing power and programming test modes during testing. See Section 5.0 – 6.0 for additional details.

For radiated emissions, including band edge, three orientations of the EUT were evaluated with data representing worst-case provided. The "Y" axis was determined to be worst-case for the RF200P81 while the "Z" axis was determined to be the worst-case orientation for the RF200PU1. Power setting 0 was used which corresponds to 3.5dBm for both units.

2 TEST FACILITIES

2.1 Location

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

TÜV SÜD America Inc.
2320 Presidential Drive, Suite 101
Durham, NC 27703
Phone: (919) 381-4235

2.2 Laboratory Accreditations/Recognitions/Certifications

TÜV SÜD America Inc. is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ANAB program and has been issued certificate number AT-1921 in recognition of this accreditation. Unless otherwise specified, all test methods described within this report are covered under the ISO/IEC 17025 scope of accreditation.

FCC Registered Test Site Number: 637011
ISED Canada Test Site Registration Number: 20446

2.3 Radiated Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The Semi-Anechoic Chamber Test Site consists of a 18' x 28' x 18' shielded enclosure. The chamber is lined with Samwha Electronics Co. LTD Ferrite Absorber, model number SFA300 (HSN-1). The ferrite tile is 10cm x 10 cm and weighs approximately 1.4lbs. These tiles are mounted on steel panels and installed directly on the inner walls of the chamber. On top of the ferrite tiles is DMAS HT-45 (Dutch Microwave Absorber Solutions) hybrid absorber on all walls except the wall behind the antenna mast which has a shorter DMAS HT-25 absorber.

The turntable is 1.50m in diameter and is located 150cm 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 short #6 copper wire. 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 turntable. 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.

Behind the turntable is a 2' x 6' x 1.5' deep shielded pit used for support equipment if necessary. The pit is equipped with 2 - 4" PVC chase 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:

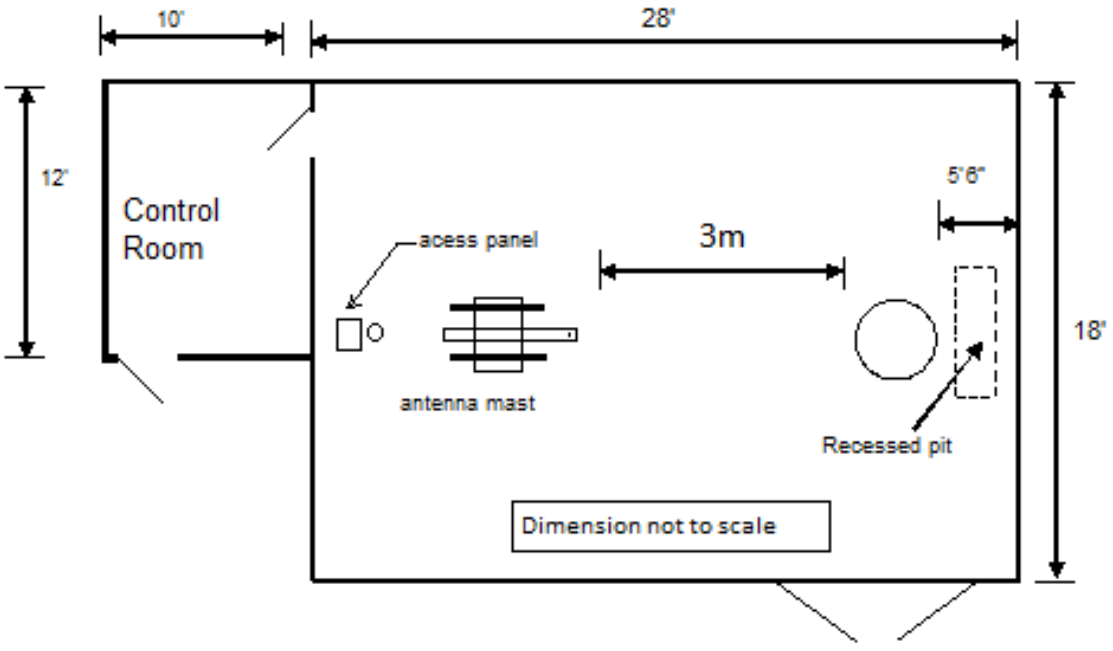


Figure 2.3-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The AC mains conducted EMI site is located in the main EMC lab. It consists of an 8' x 10' sheet galvanized steel horizontal ground reference plane (GRP) bonded every 6" to an 8' X 8' aluminum vertical ground plane.

A diagram of the room is shown below in figure 2.4-1:

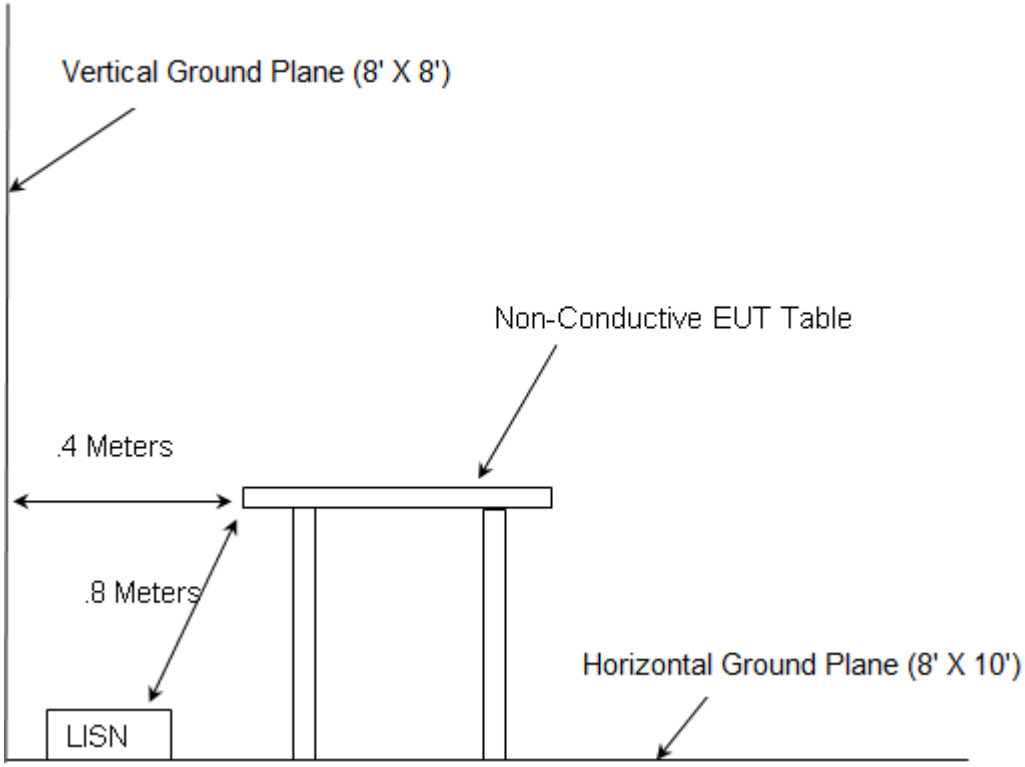


Figure 2.4-1: AC Mains Conducted EMI Site

3 APPLICABLE STANDARD REFERENCES

The following standards were used:

- ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2017
- ISED Canada Radio Standards Specification: RSS-210, Licence-Exempt Radio Apparatus: Category I Equipment Issue 9, August 2016
- ISED Canada Radio Standards Specification: RSS-GEN – General Requirements for Compliance of Radio Apparatus, Issue 4 Amendment 1, March 2018

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

Asset ID	Manufacturer	Model #	Equipment Type	Serial #	Last Calibration Date	Calibration Due Date
DEMC0277	EMCO	93146	Antennas	9904-5199	9/12/2016	9/12/2018
DEMC0626	EMCO	3110B	Antennas	9411-1945	3/21/2017	3/21/2019
DEMC3002	Rohde & Schwarz	ESU40	Receiver	100346	7/24/2017	7/24/2018
DEMC3006	Rohde & Schwarz	TS-PR18	Amplifiers	122006	1/10/2018	1/10/2019
DEMC3007	Rohde & Schwarz	TS-PR26	Amplifiers	100051	1/10/2018	1/10/2019
DEMC3012	Rohde & Schwarz	EMC32-EB	Software	100731	NCR	NCR
DEMC3016	Fei Teng Wireless Technology	HA-07M18G-NF	Antennas	2013120203	2/7/2018	2/7/2020
DEMC3027	Micro-Tronics	BRM50702	Filter	175	1/7/2018	1/7/2019
DEMC3032	Hasco, Inc.	HLL142-S1-S1-192/WA	Cables	3075	1/9/2018	1/9/2019
DEMC3038	Florida RF Labs	NMSE-290AW-60.0-NMSE	Cable Set	1448	1/5/2018	1/5/2019
DEMC3039	Florida RF Labs	NMSE-290AW-396.0-NMSE	Cable Set	1447	1/5/2018	1/5/2019
DEMC3045	Aeroflex Inmet	18N10W-20	Attenuator	1437	1/8/2018	1/8/2019
DEMC3057	Advanced Technical Materials	42-441-6/BR	Antennas	R110602	NCR	NCR
DEMC3059	Mountain View Cable	A	Cables	3059	1/9/2018	1/9/2019

5 SUPPORT EQUIPMENT

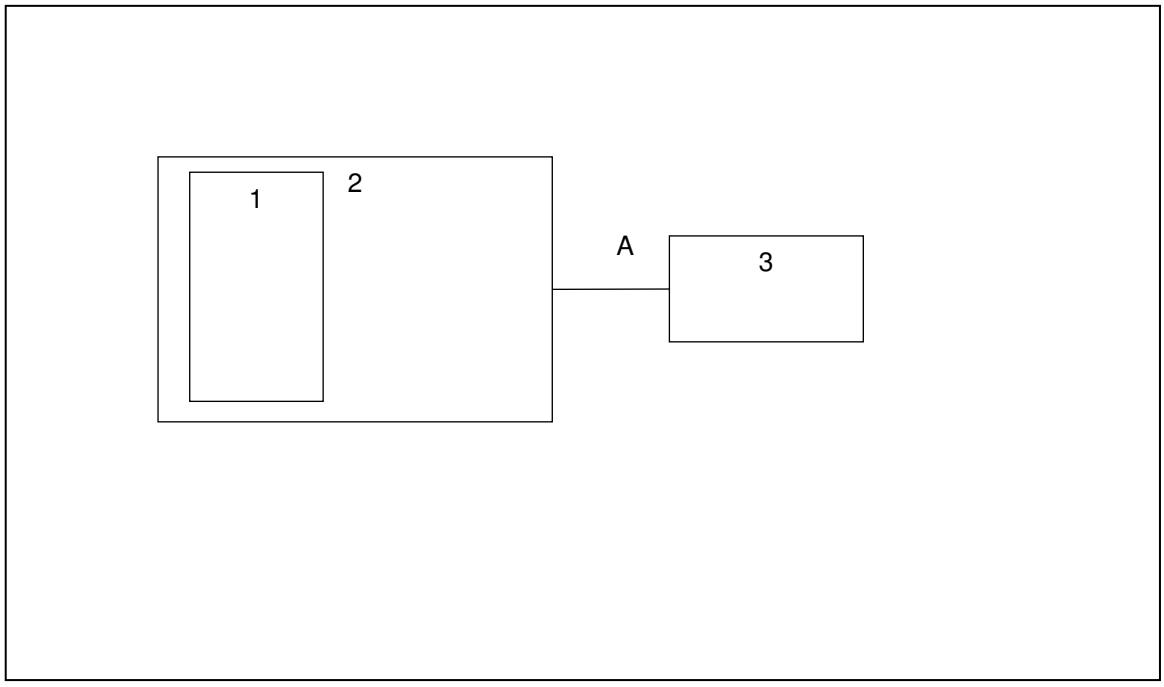
Table 5-1: Support Equipment Table

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Synapse Wireless, Inc	RF200P81, RF200PU1	See Product Description
2	Evaluation Board	Synapse Wireless, Inc	500202.01A	TUV# 346749.1
3	AC/DC Power Supply	V-INFINITY	EPS050100	TUV# 346753.1

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
A	Power Cable	1.85m	No	3 to 2

6 EQUIPMENT UNDER 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 SM200 utilizes an integrated chip antenna and a U.FL connector for external antenna use. Therefore, the EUT meets this requirement.

7.2 Fundamental Field Strength – FCC: Section 15.249(a) IC: RSS-210 B.10(a)

7.2.1 Measurement Procedure

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 fundamentals below 1GHz, quasi-peak measurements were made using a resolution bandwidth (RBW) of 120 kHz and a video bandwidth (VBW) of 300 kHz. For fundamentals above 1GHz, peak and average measurements were made using a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 3 MHz.

Where applicable, the measured average emissions where further corrected for the duty cycle. See section 7.3.2 for the duty cycle justification.

7.2.2 Measurement Results

Performed by: Charles Callis

Results are shown below in Tables 7.2.2-1 and 7.2.2-2.

Table 7.2.2-1: Fundamental Field Strength – Chip 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
2405	91.20	88.80	H	-3.84	87.36	67.94	114.0	94.0	26.6	26.0
2405	99.80	97.50	V	-3.84	95.96	76.64	114.0	94.0	18.0	17.3
2440	89.60	87.20	H	-3.76	85.84	66.42	114.0	94.0	28.2	27.6
2440	97.90	95.60	V	-3.76	94.14	74.82	114.0	94.0	19.9	19.2
2480	87.50	84.90	H	-3.67	83.83	64.22	114.0	94.0	30.2	29.8
2480	95.30	92.50	V	-3.67	91.63	71.82	114.0	94.0	22.4	22.2

Table 7.2.2-2: Fundamental Field Strength – 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
2405	92.20	89.70	H	-3.84	88.36	68.84	114.0	94.0	25.6	25.1
2405	101.30	98.80	V	-3.84	97.46	77.94	114.0	94.0	16.5	16.0
2440	90.90	88.40	H	-3.76	87.14	67.62	114.0	94.0	26.9	26.4
2440	100.70	98.20	V	-3.76	96.94	77.42	114.0	94.0	17.1	16.6
2480	89.90	87.30	H	-3.67	86.23	66.62	114.0	94.0	27.8	27.4
2480	101.40	98.90	V	-3.67	97.73	78.22	114.0	94.0	16.3	15.8

7.3 Radiated Spurious Emissions - FCC: Section 15.249(a)(d)(e); IC:RSS-210 B.10(a)(b)

7.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 25 GHz, 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 3 MHz respectively. The average emissions were further corrected by applying the duty cycle correction of the EUT for comparison to the average limit.

All out of band emissions, including emissions at the band-edge, were evaluated.

7.3.2 Duty Cycle Correction

For average radiated measurements, using a 14.1 duty cycle, the measured level was reduced by a factor 17.01dB. The duty cycle correction factor is determined using the formula: 20log (14.1/100) = -17.01dB.

A detailed analysis of the duty cycle timing is provided in the original Theory of Operation.
See ACS report 11-0216.W06.1A.

7.3.3 Measurement Results

Performed by: Charles Callis

Radiated spurious emissions found in the band of 30MHz to 25GHz are reported in tables 7.5.3-1 and 7.5.3-2 below.

Table 7.3.3-1: Radiated Spurious Emissions Tabulated Data – Chip 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										
50.53		11.6	V	10.17	---------	21.77	--------	40.0	---------	18.2
2400	61.00	48.20	H	-3.85	57.15	27.33	74.0	54.0	16.9	26.7
2400	65.00	55.50	V	-3.85	61.15	34.63	74.0	54.0	12.9	19.4
4810	46.90	39.00	H	2.63	49.53	24.62	74.0	54.0	24.5	29.4
4810	47.50	39.00	V	2.63	50.13	24.62	74.0	54.0	23.9	29.4
Middle Channel										
50.74		12.00	V	10.16	---------	22.16	--------	40.0	---------	17.8
4880	43.50	32.00	H	2.61	46.11	17.59	74.0	54.0	27.9	36.4
4880	43.30	31.90	V	2.61	45.91	17.49	74.0	54.0	28.1	36.5
7320	39.30	27.10	H	7.24	46.54	17.32	74.0	54.0	27.5	36.7
High Channel										
50.8		11.80	V	10.15	---------	21.95	--------	40.0	---------	18.0
2483.6	62.20	49.20	H	-3.66	58.54	28.53	74.0	54.0	15.5	25.5
2483.5	67.10	56.10	V	-3.66	63.44	35.43	74.0	54.0	10.6	18.6
4960	43.40	33.20	H	2.58	45.98	18.76	74.0	54.0	28.0	35.2
4960	42.40	31.70	V	2.58	44.98	17.26	74.0	54.0	29.0	36.7

Table 7.3.3-2: Radiated Spurious Emissions Tabulated Data – 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										
52.07		12.3	V	10.08	---------	22.38	---------	40.0	---------	17.6
2400	61.40	49.10	H	-3.85	57.55	28.23	74.0	54.0	16.5	25.8
2400	65.90	56.40	V	-3.85	62.05	35.53	74.0	54.0	12.0	18.5
4810	41.20	29.40	H	2.63	43.83	15.02	74.0	54.0	30.2	39.0
4810	44.80	34.20	V	2.63	47.43	19.82	74.0	54.0	26.6	34.2
Middle Channel										
51.35		11.30	V	10.12	---------	21.42	--------	40.0	---------	18.6
4880	44.80	35.20	H	2.61	47.41	20.79	74.0	54.0	26.6	33.2
4880	43.60	31.80	V	2.61	46.21	17.39	74.0	54.0	27.8	36.6
High Channel										
51.79		4.80	V	10.09	---------	14.89	--------	40.0	---------	25.1
2483.5	63.80	51.70	H	-3.66	60.14	31.03	74.0	54.0	13.9	23.0
2483.5	72.90	62.40	V	-3.66	69.24	41.73	74.0	54.0	4.8	12.3
4960	41.70	28.90	H	2.58	44.28	14.46	74.0	54.0	29.7	39.5
4960	42.00	29.70	V	2.58	44.58	15.26	74.0	54.0	29.4	38.7

7.3.4 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: 63.80 - 3.66 = 60.14dBuV/m
Margin: 74dBuV/m – 60.1dBuV/m = 13.9dB

Example Calculation: Average

Corrected Level: 51.70 - 3.66 - 17.01 = 31.03dBuV
Margin: 54dBuV – 31.0dBuV = 23.0dB

8 MEASUREMENT UNCERTAINTY

The expanded laboratory measurement uncertainty figures (U_{Lab}) provided below correspond to an expansion factor (coverage factor) k = 1.96 which provide confidence levels of 95%.

Parameter	U_{lab}
Occupied Channel Bandwidth	**± 0.004%**
RF Conducted Output Power	**± 0.689 dB**
Power Spectral Density	**±0.5 dB**
Antenna Port Conducted Emissions	**± 2.717 dB**
Radiated Emissions	**± 5.877 dB**
Temperature	**± 0.860 °C**
Radio Frequency	**±2.832 x 10-8**
AC Power Line Conducted Emissions	**±2.85**

9 CONCLUSION

In the opinion of TÜV SÜD America Inc. the SM200, manufactured by Synapse Wireless, Inc. meets the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT