

Certification Test Report

FCC ID: U90-HCTAG

FCC Rule Part: 15.249

ACS Report Number: 13-0253.W03.1A

Manufacturer: Synapse Wireless Inc.
Model: HCTAG

Test Begin Date: May 28, 2013
Test End Date: May 29, 2013

Report Issue Date: July 24, 2013



FOR THE SCOPE OF ACCREDITATION UNDER LAB Code 200612-0

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

A handwritten signature in black ink, appearing to read "Kirby Munroe", is placed over a horizontal line.

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

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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.

1.2 Product description

The HCTAG is a RTLS (Real Time Location Systems) 2.4GHz RF TAG with Infrared Sensor.

The HCTAG is intended to be used by OEMs and Integrators for RTLS. The HCTAG is intended to be worn by personnel or fixed to a mobile assets to determine their location within proximity of a wall mounted RF Sensor. The RF TAG contains the ability to wirelessly communicate between two mesh networks.

Technical Information:

Band of Operation: 2405 – 2480 MHz
Number of Channels: 16
Modulation Format: O-QPSK
Antenna Type/Gain: PCB Inverted F-antenna, 3.2dBi gain
Operating Voltage: 3V CR2477 Lithium Battery

Manufacturer Information:

Synapse Wireless, Inc.
500 Discovery Drive
Huntsville, AL 35806

Test Sample Serial Number(s): 92.00.93

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

1.3 Test Methodology and Considerations

For radiated emissions, including band edge, three orientations of the EUT were evaluated to determine worst case. The worst case orientation was determined to be the Z (side) position. No deviations from the standards were made or special considerations applicable.

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: 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:

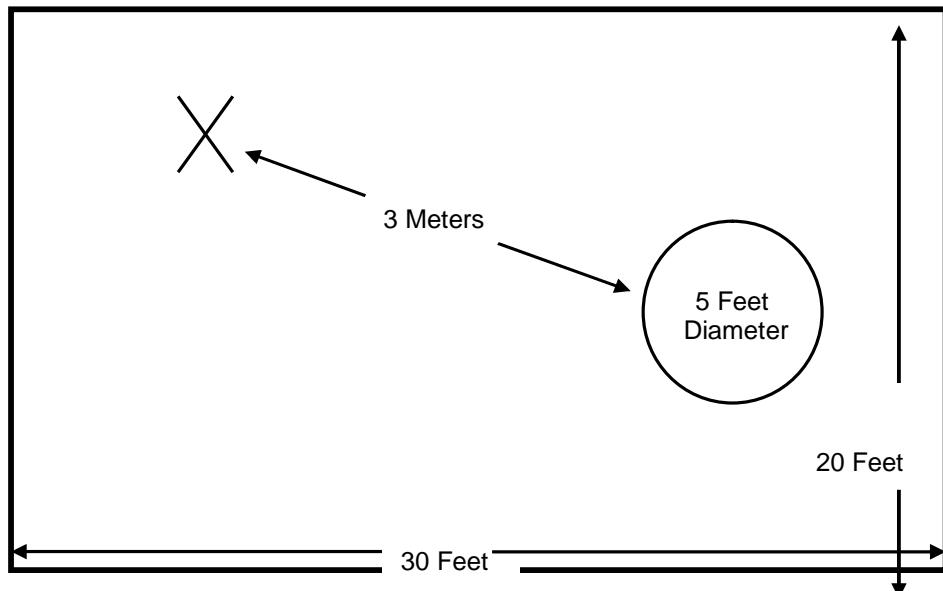


Figure 2.3-1: Semi-Anechoic Chamber Test Site

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:

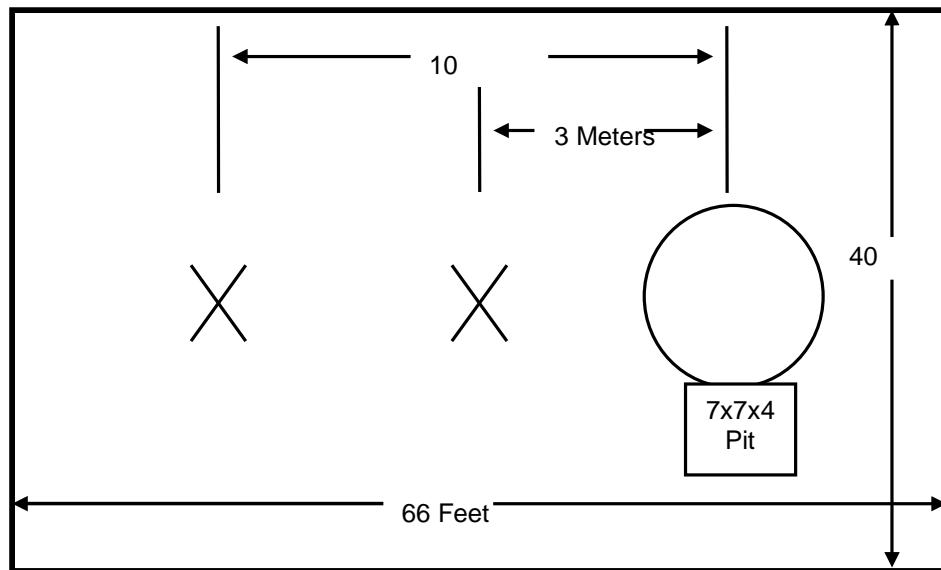


Figure 2.3-2: Open Area Test Site

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 4.1.3-1:

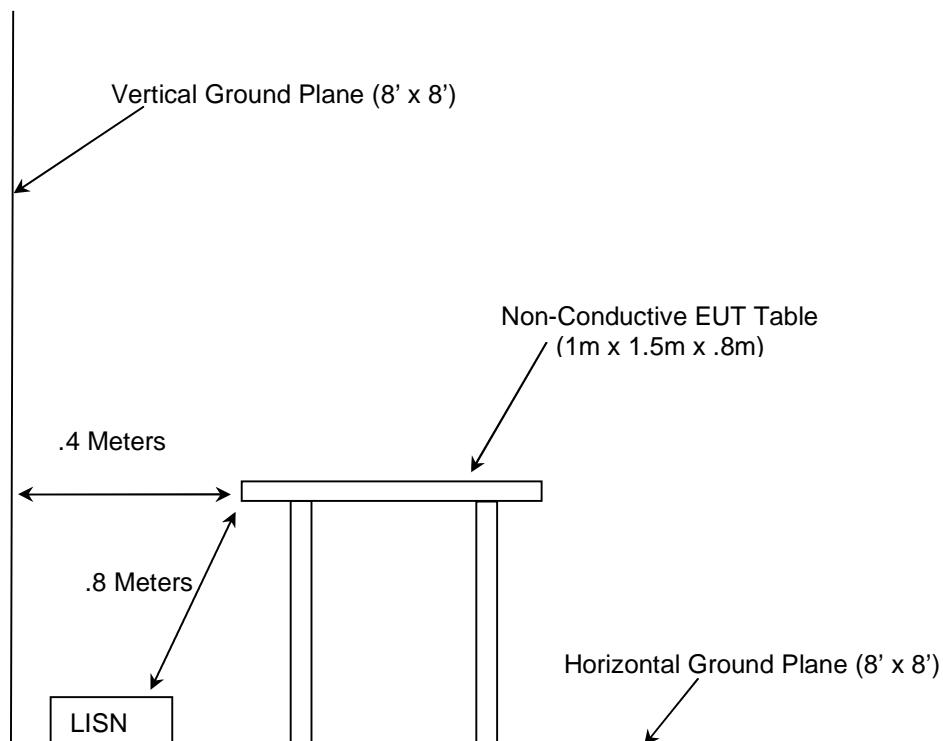


Figure 2.4-1: AC Mains Conducted EMI Site

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, 2013
- ❖ US Code of Federal Regulations (CFR): Title 47, Part 15, Subpart C: Radio Frequency Devices, Intentional Radiators, 2013
- ❖ 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

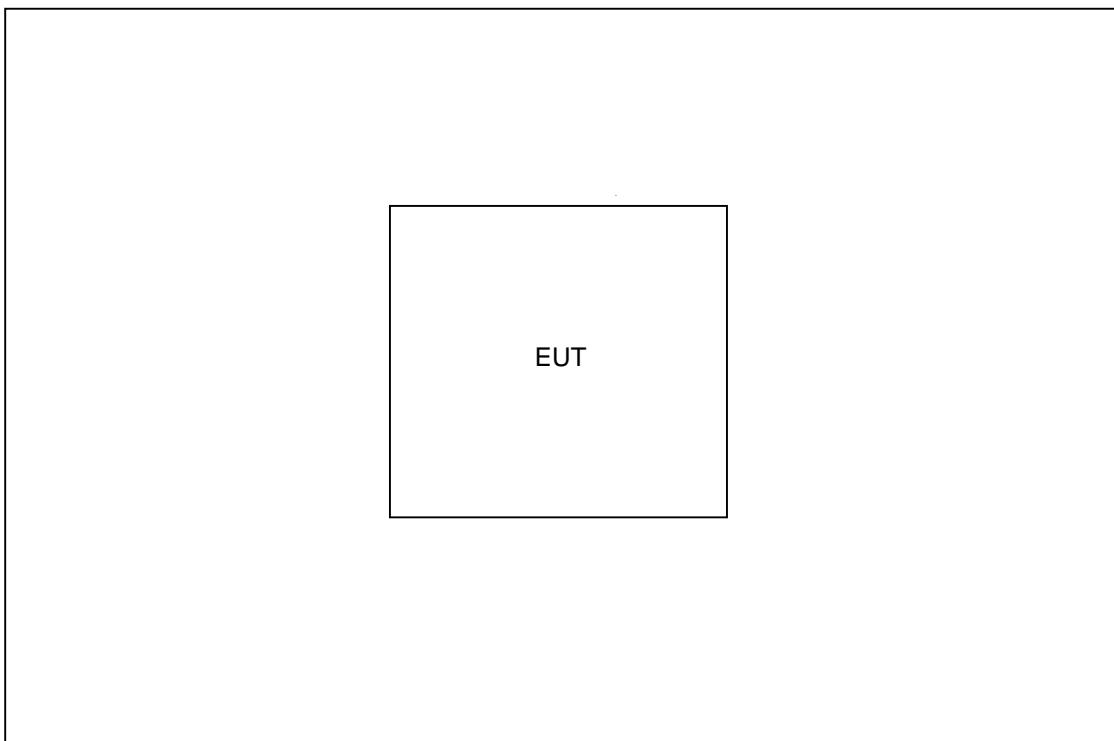
The calibration interval of test equipment is annually or the manufacturer's recommendations. Where the calibration interval deviates from the annual cycle based on the instrument manufacturer's recommendations, it shall be stated below.

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
		Chamber EMI Cable Set	Cable Set	167	12/17/2012	12/17/2013
167	ACS					
267	Agilent	N1911A	Meters	MY45100129	1/23/2012	1/23/2014
268	Agilent	N1921A	Sensors	MY45240184	1/17/2012	1/17/2014
283	Rohde & Schwarz	FSP40	Spectrum Analyzers	1000033	8/1/2012	8/1/2013
291	Florida RF Cables	SMRE-200W-12.0-SMRE	Cables	None	11/20/2012	11/20/2013
292	Florida RF Cables	SMR-290AW-480.0-SMR	Cables	None	3/26/2013	3/26/2014
321	Hewlett Packard	HPC 8447D	Amplifiers	1937A02809	8/27/2012	8/27/2013
334	Rohde&Schwarz	3160-09	Antennas	49404	11/4/2010	NCR
335	Suhner	SF-102A	Cables	882/2A	8/2/2012	8/2/2013
338	Hewlett Packard	8449B	Amplifiers	3008A01111	8/2/2012	8/2/2013
340	Aeroflex/Weinschel	AS-20	Attenuators	7136	8/2/2012	8/2/2013
345	Suhner Sucoflex	102A	Cables	1077/2A	8/2/2012	8/2/2013
412	Electro Metrics	LPA-25	Antennas	1241	7/27/2012	7/27/2014
422	Florida RF	SMS-200AW-72.0-SMR	Cables	805	11/20/2012	11/20/2013
432	Microwave Circuits	H3G020G4	Filters	264066	7/2/2012	7/2/2013

5 SUPPORT EQUIPMENT**Table 5-1: Support Equipment**

Item	Equipment Type	Manufacturer	Model Number	Serial Number
The EUT operates stand alone therefore no support equipment was utilized.				

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 antenna used is a PCB Inverted F-antenna with 3.2 dBi gain, which therefore meets the requirements of Section 15.203.

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

7.2.1 Measurement Procedure

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

7.3 20dB / 99% Bandwidth – FCC: Section 15.215, IC: RSS-Gen 4.6.1

7.3.1 Measurement Procedure

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 shall be set to 3 times the resolution bandwidth. A sampling detector was used.

7.3.2 Measurement Results

Results are shown below in table 7.3.2-1 and figure 7.3.2-1 to 7.3.2-6:

Table 7.3.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [MHz]	99% Bandwidth [MHz]
2405	2.40	2.32
2440	2.42	2.36
2480	2.64	2.66



Figure 7.3.2-1: 20dB Bandwidth Plot – LCH

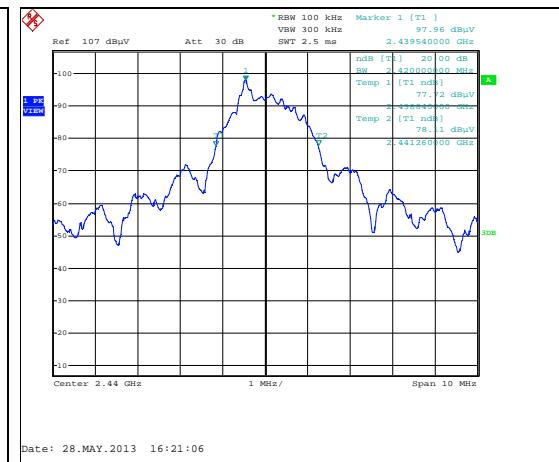


Figure 7.3.2-2: 20dB Bandwidth Plot – MCH

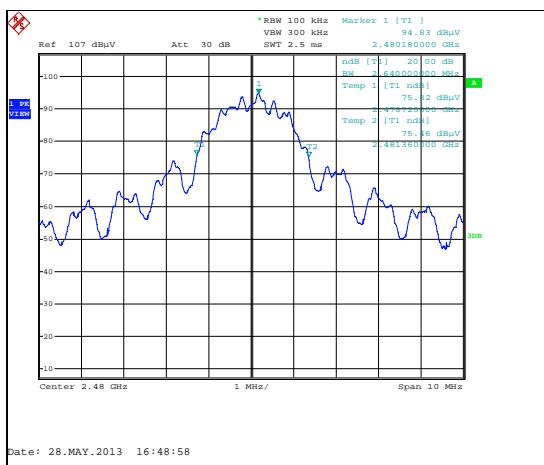


Figure 7.3.2-3: 20dB Bandwidth Plot – HCH

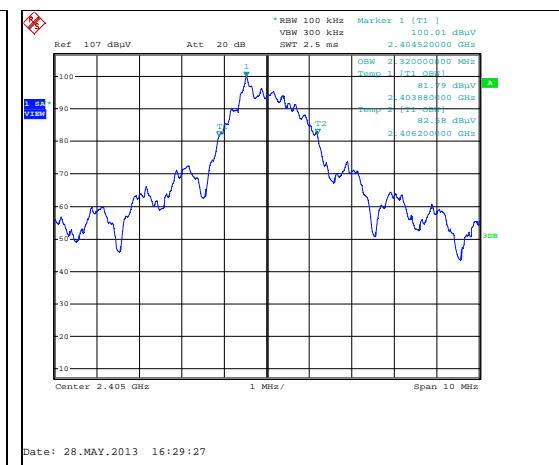


Figure 7.3.2-4: 99% Bandwidth Plot – LCH



Figure 7.3.2-5: 99% Bandwidth Plot – MCH

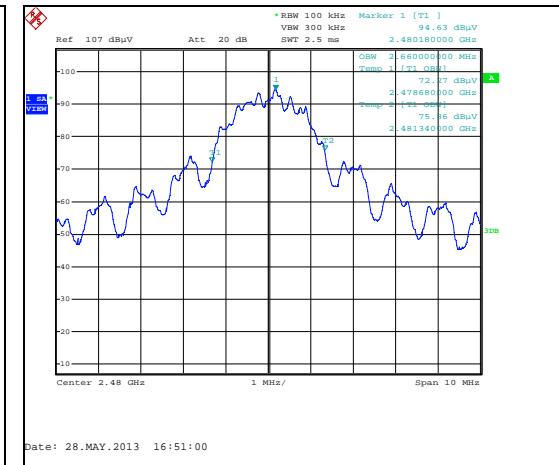


Figure 7.3.2-6: 99% Bandwidth Plot – HCH

7.4 Fundamental Field Strength – FCC: Section 15.249(a) IC: RSS-210 A2.9(a)

7.4.1 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. Peak and average measurements were made using a resolution bandwidth (RBW) of 3 MHz and a video bandwidth (VBW) of 10 MHz. RBW >> EBW.

7.4.2 Measurement Results

Results are shown below in Table 7.4.2-1.

Table 7.4.2-1: Fundamental Field Strength

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
2405	106.48	105.95	H	-5.25	101.23	83.69	114.0	94.0	12.8	10.3
2405	98.85	98.29	V	-5.25	93.60	76.03	114.0	94.0	20.4	18.0
2440	104.94	104.58	H	-5.07	99.87	82.49	114.0	94.0	14.1	11.5
2440	99.30	98.70	V	-5.07	94.23	76.61	114.0	94.0	19.8	17.4
2480	104.37	103.85	H	-4.87	99.50	81.96	114.0	94.0	14.5	12.0
2480	102.03	101.40	V	-4.87	97.16	79.51	114.0	94.0	16.8	14.5

7.5 Radiated Spurious Emissions - FCC: Section 15.249(a)(d)(e); IC:RSS-210 A2.9(a)(b)

7.5.1 Measurement Procedure

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

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

7.5.2 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: $20\log(14.1/100) = -17.01\text{dB}$.

An analysis of the duty cycle timing is provided in the Theory of Operation accompanying the original certification.

7.5.3 Measurement Results

Radiated spurious emissions are reported in the table 7.5.3-1 below.

Table 7.5.3-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity (H/V)	Correction Factors (dB)	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	Qpk/Avg			pk	Qpk/Avg	pk	Qpk/Avg	pk	Qpk/Avg
Low Channel										
4810	51.83	43.82	H	2.38	54.21	29.19	74.0	54.0	19.8	24.8
4810	53.36	42.11	V	2.38	55.74	27.48	74.0	54.0	18.3	26.5
2390	52.84	40.16	H	-5.32	47.52	17.82	74.0	54.0	26.5	36.2
2390	49.31	37.92	V	-5.32	43.99	15.58	74.0	54.0	30.0	38.4
Middle Channel										
4880	50.93	43.86	H	2.63	53.56	29.48	74.0	54.0	20.4	24.5
4880	52.14	45.57	V	2.63	54.77	31.19	74.0	54.0	19.2	22.8
High Channel										
4960	50.54	40.87	H	2.92	53.46	26.77	74.0	54.0	20.5	27.2
4960	51.34	41.38	V	2.92	54.26	27.28	74.0	54.0	19.7	26.7
2483.5	74.36	64.21	H	-4.86	69.50	42.34	74.0	54.0	4.5	11.7
2483.5	66.34	56.26	V	-4.86	61.48	34.39	74.0	54.0	12.5	19.6

7.5.4 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

$$\text{Corrected Level: } 51.83 + 2.38 = 54.21\text{dBuV}$$

$$\text{Margin: } 74\text{dBuV} - 54.21\text{dBuV} = 19.8\text{dB}$$

Example Calculation: Average

$$\text{Corrected Level: } 43.82 + 2.38 - 17.01 = 29.19\text{dBuV}$$

$$\text{Margin: } 54\text{dBuV} - 29.19\text{dBuV} = 24.8\text{dB}$$

8 CONCLUSION

In the opinion of ACS, Inc. the HCTAG, manufactured by Synapse Wireless, Inc. meet the requirements of FCC Part 15 subpart C and Industry Canada's Radio Standards Specification RSS-210.

END REPORT