Excellence in Compliance Testing

Certification Test Report

FCC ID: U9O-HCTAG01

FCC Rule Part: 15.249

ACS Report Number: 14-2059.W06.1A

Manufacturer: Synapse Wireless, Inc.
Model: HCTAG01

Test Begin Date: **May 21, 2014**
Test End Date: **May 23, 2014**

Report Issue Date: July 7, 2014

ACCREDITED TESTING

FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER AT-1533

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

Reviewed by:
Thierry Jean-Charles
EMC Engineer
Advanced Compliance Solutions, Inc.

This report contains 17 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 Synapse Wireless HCTAG01 is an IEEE 802.15.4 battery powered RF device operating in the ISM 2.4 GHz band. The model HCTAG01 is intended to be worn by personnel or fixed to mobile assets to determine their location within proximity of a wall mounted RF Sensor.

Technical Details
Frequency of Operation: 2405 - 2480 MHz
Number of Channels: 16
Modulation: O-QPSK
Data Rate: 2 Mbps
Antenna / Gain: Chip Antenna, 2.8 dBi
Input Voltage: 3 VDC (AAA battery)

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

Test Sample Serial Number(s): 154390016

Test Sample Condition: Good

1.3 Test Methodology and Considerations

The EUT was evaluated for radiated emissions. Preliminary evaluations were performed on the EUT set in three orthogonal orientations. The worst case orientation was observed to be the upright position and the corresponding measurement results are documented in this test report.

The EUT was also evaluated for unintentional emissions. The results are documented separately in a verification test report.

2 TEST FACILITIES

2.1 Location

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

Advanced Compliance Solutions, Inc.
3998 FAU Blvd, Suite 310
Boca Raton, Florida 33431
Phone: (561) 961-5585
Fax: (561) 961-5587
www.acstestlab.com

FCC Test Firm Registration #: 475089
Industry Canada Lab Code: 4175C

2.2 Laboratory Accreditations/Recognitions/Certifications

ACS is accredited to ISO/IEC 17025 by ANSI-ASQ National Accreditation Board under their ACLASS program and has been issued certificate number AT-1533 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.

2.3 Radiated & Conducted Emissions Test Site Description

2.3.1 Semi-Anechoic Chamber Test Site

The EMC radiated test facility consists of an RF-shielded enclosure. The interior dimensions of the indoor semi-anechoic chamber are approximately 48 feet (14.6 m) long by 36 feet (10.8 m) wide by 24 feet (7.3 m) high and consist of rigid, 1/8 inch (0.32 cm) steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. 8-foot RF absorbing cones are installed on 4 walls and the ceiling. The steel-clad ground plane is covered with vinyl floor.

The turntable is driven by pneumatic motor, which is capable of supporting a 2000 lb. load. The turntable is flushed with the chamber floor which it is connected to, around its circumference, with a continuous metallic loaded spring. An EMCO Model 1050 Multi-device Controller controls the turntable position.

A pneumatic motor is used to control antenna polarizations and height relative to the ground. The height information is displayed on the control unit EMCO Model 1050.

The control room is an RF shielded enclosure attached to the semi-anechoic chamber with two bulkhead panels for connecting RF, and control cables. The dimension of the room is 7.3 m x 4.9 m x 3 m high and the entrance doors of both control and conducted rooms are 3 feet (0.91 m) by 7 feet (2.13 m).

A diagram of the Semi-Anechoic Chamber Test Site is shown in Figure 2.3.1-1 below:

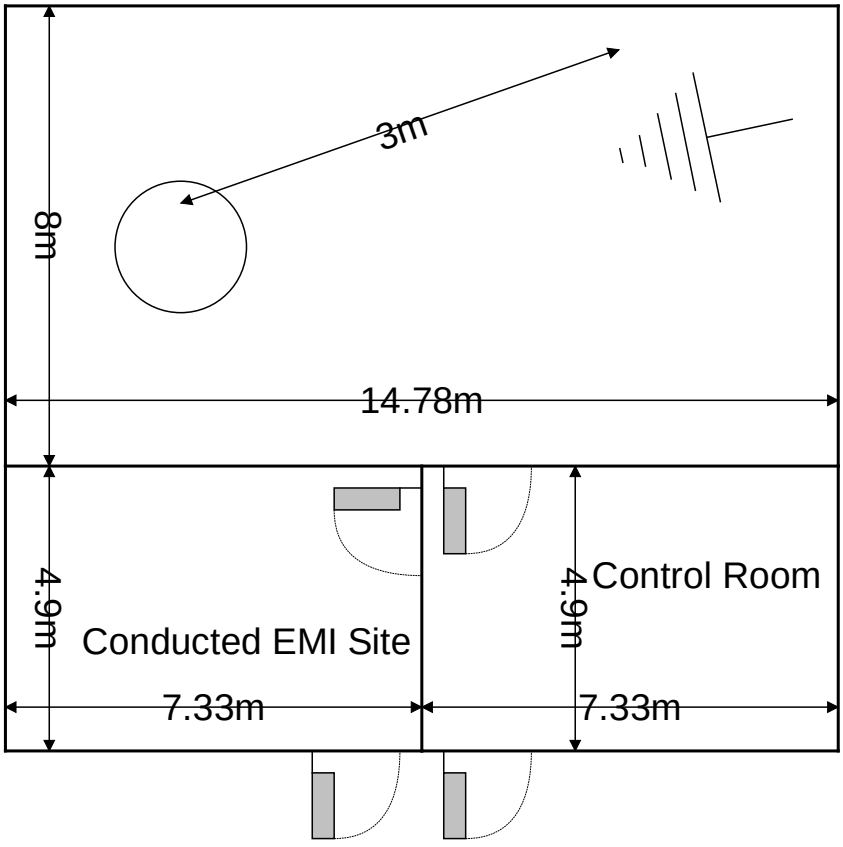


Figure 2.3.1-1: Semi-Anechoic Chamber Test Site

2.3.2 Conducted Emissions Test Site Description

The dimensions of the shielded conducted room are 7.3 x 4.9 x 3 m^3. As per ANSI C63.4 2003 requirements, the data were taken using two LISNs; a Solar Model 8028-50 50 Ω/50 µH and an EMCO Model 3825, which are installed as shown in Photograph 3. For 220 V, 50 Hz, a Polarad LISN (S/N 879341/048) is used in conjunction with a 1 kVA, 50 Hz/220 V EDGAR variable frequency generator, Model 1001B, to filter conducted noise from the generator.

A diagram of the room is shown below in figure 2.3.2-1:

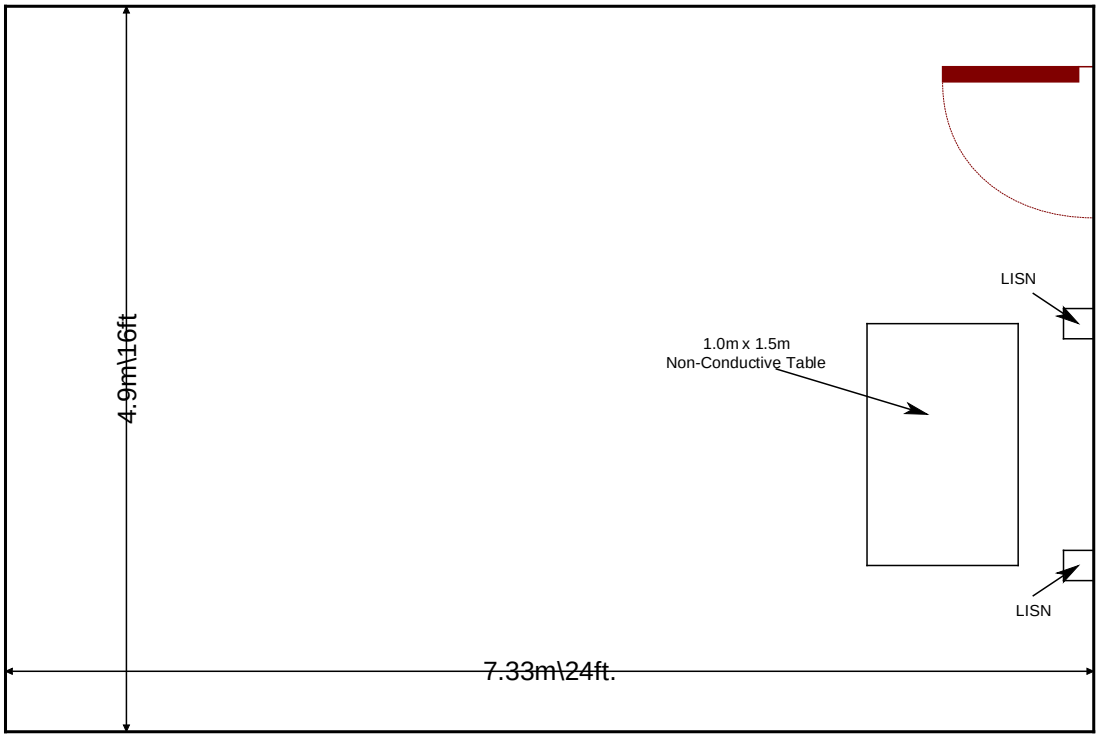


Figure 2.3.2-1: AC Mains Conducted EMI Site

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
- 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 Radio communication 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
523	Agilent	E7405	Spectrum Analyzers	MY45103293	1/8/2013	1/8/2015
2002	EMCO	3108	Antennas	2147	11/22/2013	11/22/2015
2004	EMCO	3146	Antennas	1385	11/22/2013	11/22/2015
2006	EMCO	3115	Antennas	2573	4/24/2013	4/24/2015
2008	COM-Power	AH-826	Antennas	81009	NCR	NCR
2011	Hewlett-Packard	HP 8447D	Amplifiers	2443A03952	12/31/2013	12/31/2014
2037	ACS Boca	Chamber EMI Cable Set	Cable Set	2037	2/27/2014	2/27/2015
2044	QMI	N/A	Cables	2044	12/31/2013	12/31/2014
2070	Mini Circuits	VHF-8400+	Filter	2070	1/1/2014	1/1/2015
2072	Mini Circuits	VHF-3100+	Filter	30737	1/1/2014	1/1/2015
2076	Hewlett Packard	HP5061-5458	Cables	2076	12/31/2013	12/31/2014
2086	Merrimac	FAN-6-10K	Attenuators	23148-83-1	12/31/2013	12/31/2014
2089	Agilent Technologies, Inc.	83017A	Amplifiers	3123A00214	12/16/2013	12/16/2014
2095	ETS Lindgren	TILE4! - Version 4.2.A	Software	85242	NCR	NCR

Notes NCR=No Calibration Required

5 SUPPORT EQUIPMENT

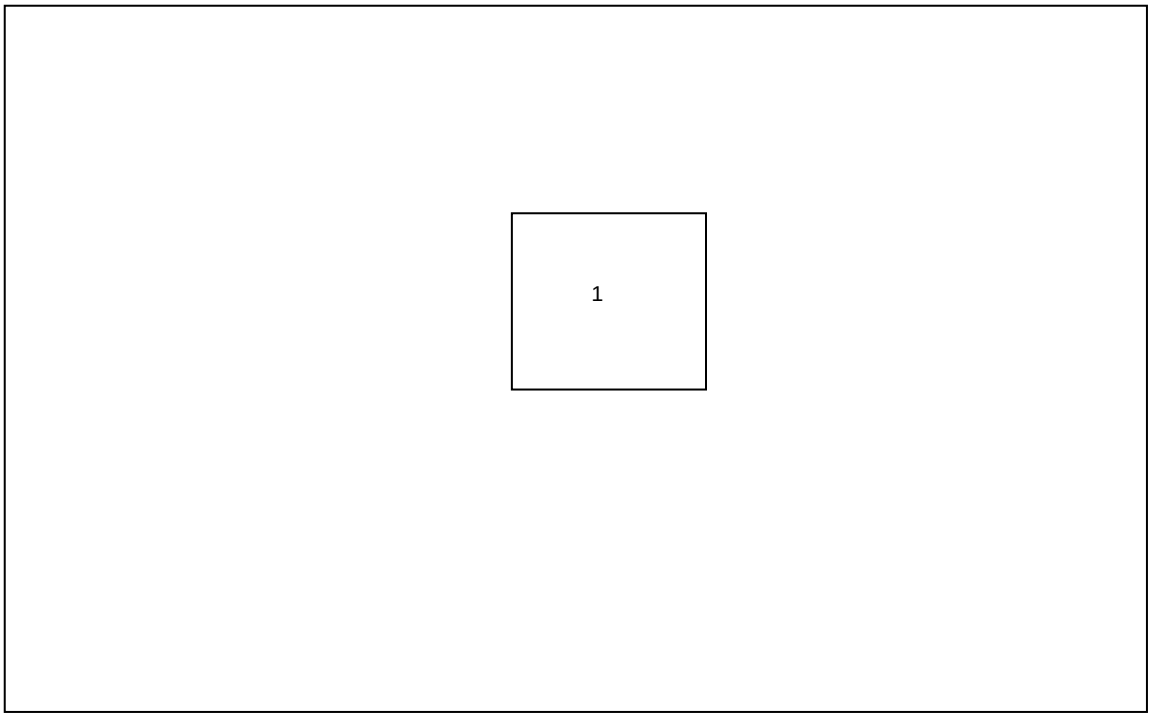
Table 5-1: EUT and Support Equipment Description

Item #	Type Device	Manufacturer	Model/Part #	Serial #
1	EUT	Synapse Wireless, Inc.	HCTAG01	154390016

Table 5-2: Cable Description

Cable #	Cable Type	Length	Shield	Termination
	The EUT is standalone equipment with no provision for cable connection.			

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 EUT uses an internal chip antenna that is soldered to the PCB. The antenna cannot be replaced without permanently damaging the device, hence meeting the requirements of FCC Section 15.203.

7.2 20dB / 99% Bandwidth

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.

The spectrum analyzer span was set to 2 to 5 times the estimated 20 dB bandwidth of the signal. The RBW was set to ≥ 1% to 5% of the estimated emission bandwidth. The trace was set to max hold using a peak detector and the reference level was set to the highest amplitude observed. The bandwidth was measured 20 dB down from the reference level using the delta function of the analyzer.

The 99% occupied bandwidth was measured with the spectrum analyzer span set to fully display the emission, including the emissions skirts. The RBW was greater or equal to 1% of the span. The occupied 99% bandwidth was measured by using a delta marker at the lower and upper frequencies leading to 0.5% of the total power.

7.2.2 Measurement Results

Results are shown below in Table 7.2.2-1 and Figures 7.2.2-1 through 7.2.2-6

Table 7.2.2-1: 20dB / 99% Bandwidth

Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]
2405	2526	2353
2440	2510	2406
2480	2536	2386

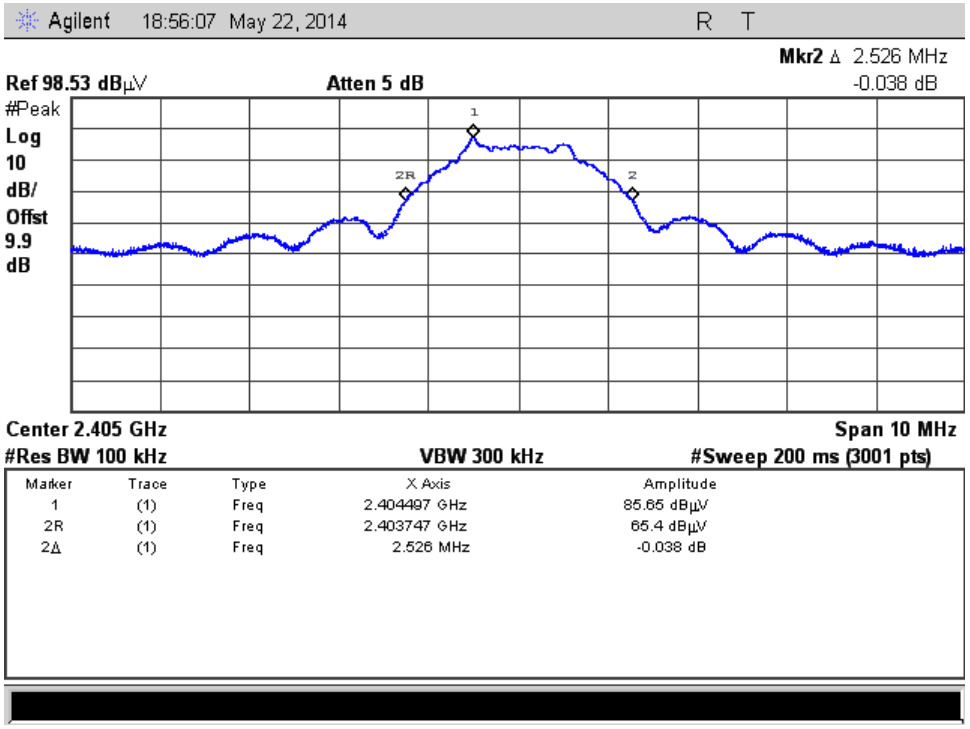


Figure 7.2.2-1: 20dB BW – Low Channel

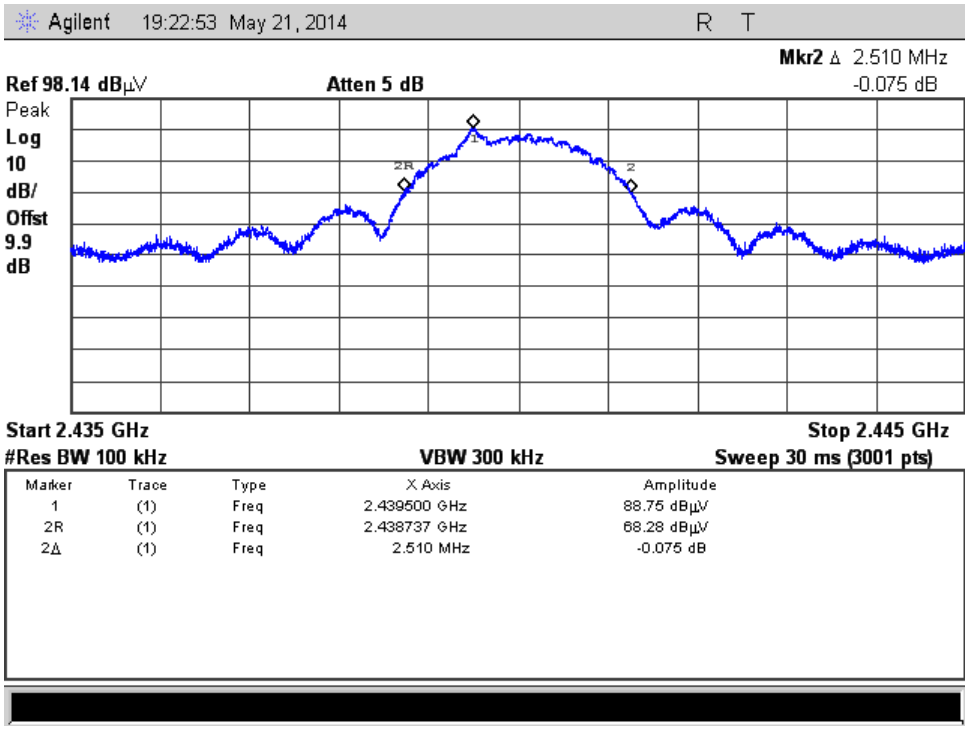


Figure 7.2.2-2: 20dB BW – Middle Channel

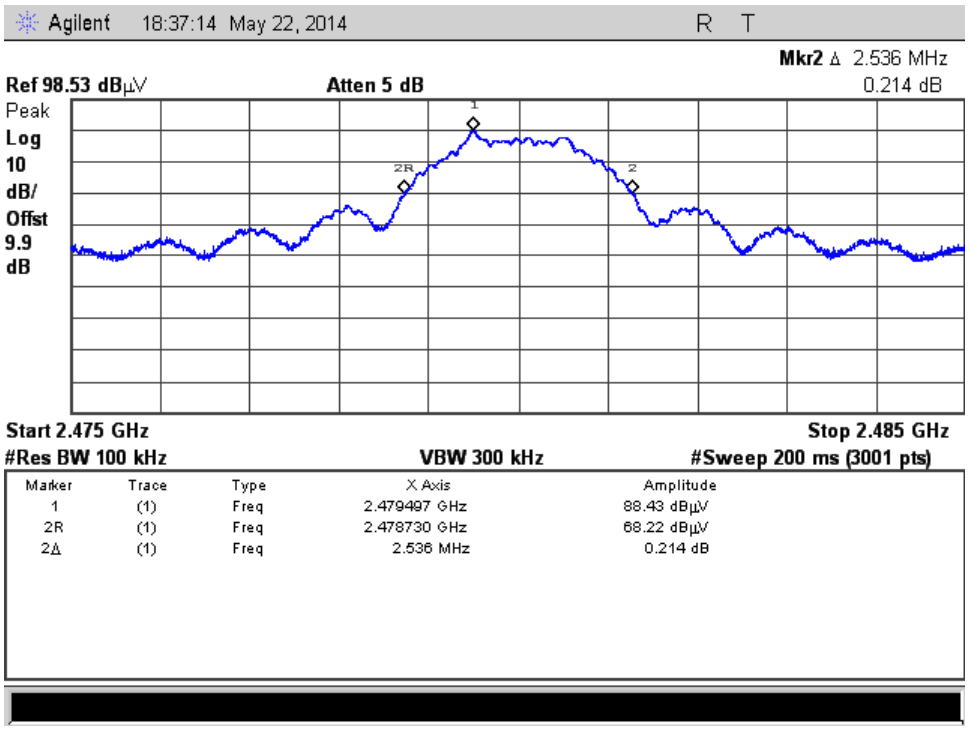


Figure 7.2.2-3: 20dB BW – High Channel

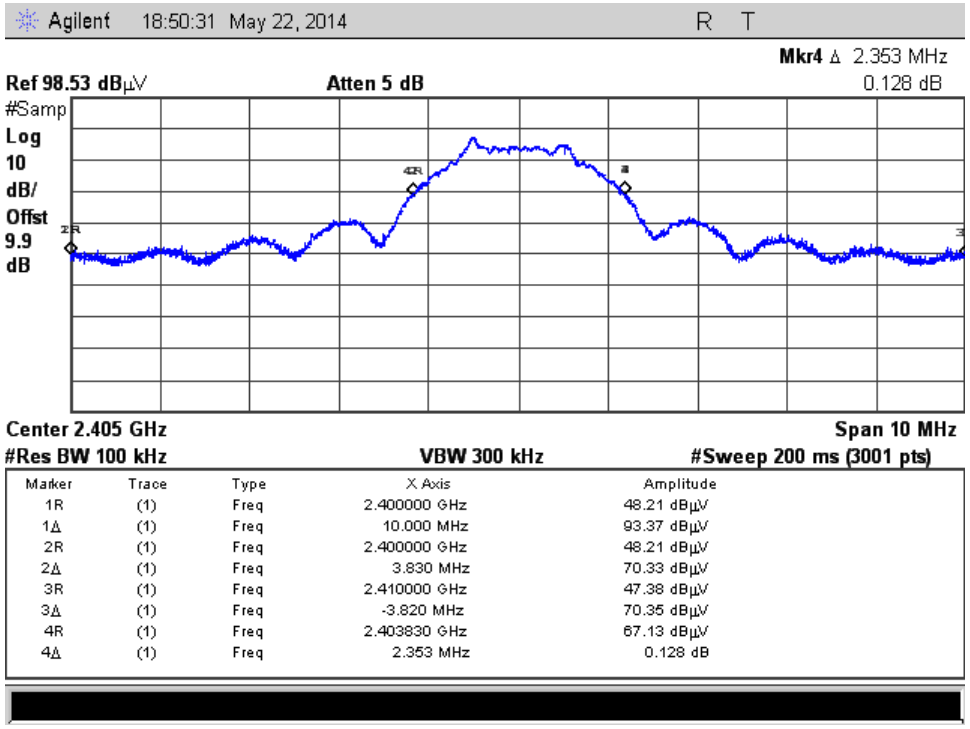
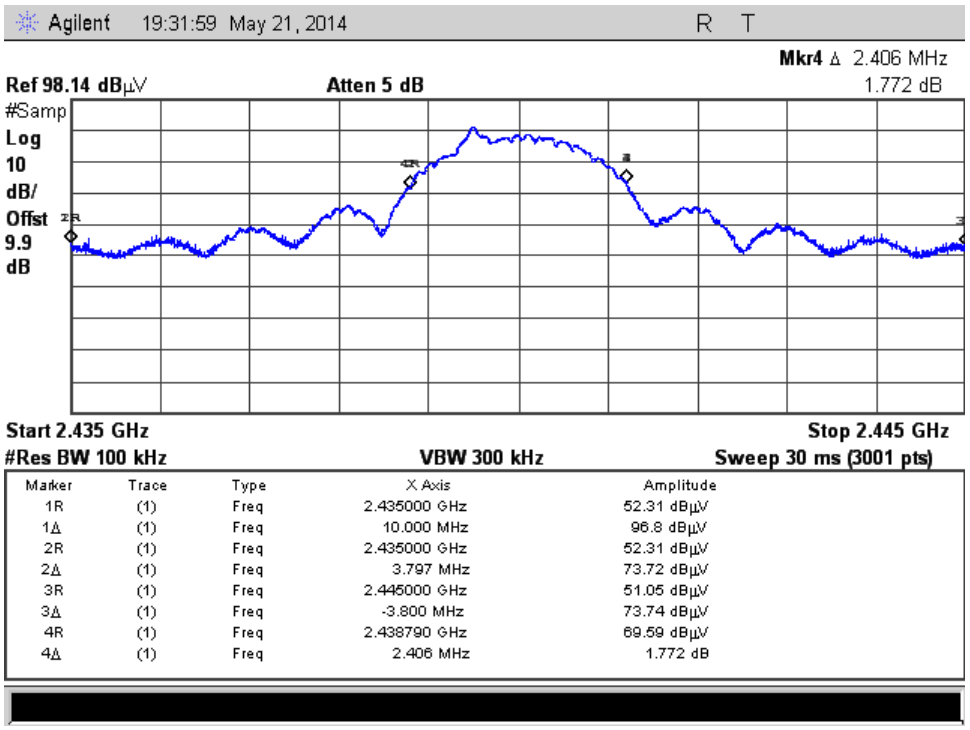
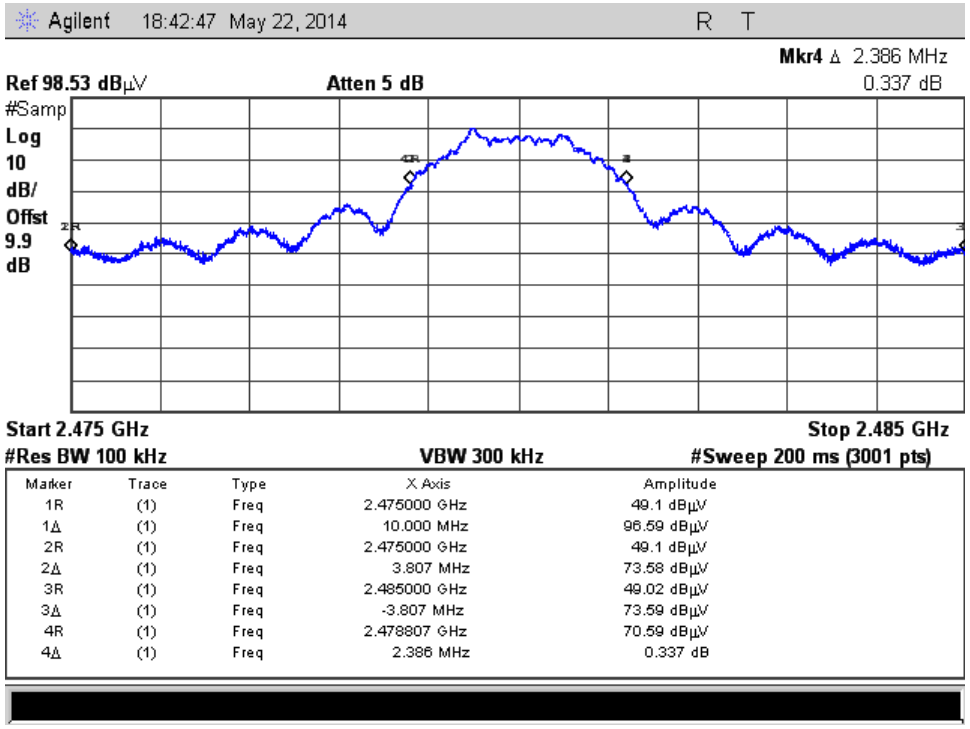


Figure 7.2.2-4: 99% OBW – Low Channel



Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Freq	2.435000 GHz	52.31 dBµV
1Δ	(1)	Freq	10.000 MHz	96.8 dBµV
2R	(1)	Freq	2.435000 GHz	52.31 dBµV
2Δ	(1)	Freq	3.797 MHz	73.72 dBµV
3R	(1)	Freq	2.445000 GHz	51.05 dBµV
3Δ	(1)	Freq	-3.800 MHz	73.74 dBµV
4R	(1)	Freq	2.438790 GHz	69.59 dBµV
4Δ	(1)	Freq	2.406 MHz	1.772 dB

Figure 7.2.2-5: 99% OBW – Middle Channel



Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Freq	2.475000 GHz	49.1 dBµV
1Δ	(1)	Freq	10.000 MHz	96.59 dBµV
2R	(1)	Freq	2.475000 GHz	49.1 dBµV
2Δ	(1)	Freq	3.807 MHz	73.58 dBµV
3R	(1)	Freq	2.485000 GHz	49.02 dBµV
3Δ	(1)	Freq	-3.807 MHz	73.59 dBµV
4R	(1)	Freq	2.478807 GHz	70.59 dBµV
4Δ	(1)	Freq	2.386 MHz	0.337 dB

Figure 7.2.2-6: 99% OBW – High Channel

7.3 Radiated Spurious Emissions - FCC Section 15.249 (a)

7.3.1 Measurement Procedure

Radiated emissions tests were made over the frequency range of 30MHz to 26GHz, 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 3MHz respectively.

7.3.2 Measurement Results

Radiated spurious emissions found in the band of 30MHz to 26GHz are reported in the Table 7.3.2-1 below.

Table 7.3.2-1: Radiated Spurious Emissions Tabulated Data

Frequency (MHz)	Level (dBuV)		Antenna Polarity	Correction Factors	Corrected Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
	pk	avg	(H/V)	(dB)	pk	avg	pk	avg	pk	avg
Low Channel										
Fundamental Frequency										
2405	87.65	86.88	H	-7.94	79.71	78.94	114	94	34.3	15.1
2405	86.09	85.41	V	-7.94	78.15	77.47	114	94	35.8	16.5
Spurious Emissions										
4810	48.86	38.41	H	-0.26	48.60	38.15	74	54	25.4	15.8
4810	48.22	37.33	V	-0.26	47.96	37.07	74	54	26.0	16.9
9620	44.41	31.67	H	8.55	52.96	40.22	74	54	21.0	13.8
9620	44.59	32.18	V	8.55	53.14	40.73	74	54	20.9	13.3
12025	44.53	32.07	H	12.74	57.27	44.81	83.5	63.5	26.2	18.7
Middle Channel										
Fundamental Frequency										
2440	89.05	88.34	H	-7.79	81.26	80.55	114	94	32.7	13.5
2440	87.41	86.58	V	-7.79	79.62	78.79	114	94	34.4	15.2
Spurious Emissions										
4880	47.60	36.01	H	-0.04	47.56	35.97	74	54	26.4	18.0
4880	48.78	38.67	V	-0.04	48.74	38.63	74	54	25.3	15.4
9760	45.05	33.43	H	8.86	53.91	42.29	74	54	20.1	11.7
9760	45.98	33.87	V	8.86	54.84	42.73	74	54	19.2	11.3
12200	46.31	34.24	H	12.99	59.30	47.23	83.5	63.5	24.2	16.3
High Channel										
Fundamental Frequency										
2480	91.89	90.92	H	-7.62	84.27	83.30	114	94	29.7	10.7
2480	89.69	88.95	V	-7.62	82.07	81.33	114	94	31.9	12.7
Spurious Emissions										
2483.5	63.79	52.52	H	-7.61	56.18	44.91	74	54	17.8	9.1
2483.5	63.02	51.06	V	-7.61	55.41	43.45	74	54	18.6	10.5
4960	47.65	36.02	H	0.20	47.85	36.22	74	54	26.1	17.8
4960	49.30	38.28	V	0.20	49.50	38.48	74	54	24.5	15.5
7440	46.95	34.12	H	6.00	52.95	40.12	74	54	21.1	13.9
9920	45.35	33.47	H	9.21	54.56	42.68	74	54	19.4	11.3
9920	46.04	34.19	V	9.21	55.25	43.40	74	54	18.7	10.6
12400	46.70	36.40	H	13.28	59.98	49.68	83.5	63.5	23.5	13.8
12400	44.20	32.19	V	13.28	57.48	45.47	83.5	63.5	26.0	18.0
14880	43.68	30.66	H	21.11	64.79	51.77	83.5	63.5	18.7	11.7
14880	43.68	30.56	V	21.11	64.79	51.67	83.5	63.5	18.7	11.8
17360	41.92	29.63	H	23.97	65.89	53.60	83.5	63.5	17.6	9.9

*** Notes:**

- **All emissions above 17360 MHz were attenuated below the permissible limits and the noise floor of the measurement equipment.**
- **The fundamental frequency was measured using a RBW of 3 MHz.**
- **The emissions above 10 GHz were measured at a distance of 1m. The limits are corrected accordingly using a distance correction factor of 20*log(3/1) dB.**

7.3.3 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: 48.86 + (-0.26) = 48.6 dBµV/m
Margin: 74dBuV/m – 48.6 dBµV/m = 25.4 dB

Example Calculation: Average
Corrected Level: 38.41 + (-0.26) = 38.15 dBµV/m
Margin: 54dBuV/m – 38.15 dBµV/m = 15.8 dB

8 CONCLUSION

In the opinion of ACS, Inc. the HCTAG01, manufactured by Synapse Wireless, Inc. meet the requirements of FCC Part 15 subpart C.

END REPORT