Testing Tomorrow's Technology

Application

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and Part 15, Subpart F, paragraph 15.517

For the

Sanitag Technologies Corporation

Model: AT-004-H

FCC ID: 2AMOW-AT004H

UST Project: 17-0275
Issue Date: October 6, 2017

Total Pages in This Report: 29

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I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date October 6, 2017

TESTING
NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Sanitag Technologies Corporation

MODEL: AT-004-H

FCC ID: 2AMOW-AT004H

DATE: October 6, 2017

This report concerns (check one): Original grant [X]
Class II change

Equipment type: UWB Transmitter, handheld device

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date

agrees to notify the Commission by N/A
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

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Internal and External Photographs
Antenna Photographs
Theory of Operation
RF Exposure
User's Manual

PAG Request

1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 517.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on July 20, 2017 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Sanitag Technologies Corporation models AT-004-H. The EUT provides Real-Time Location Systems for the Healthcare Industry to track staff members. The product is intended for use in hospitals, senior living centers and rehab centers.

The EUT incorporates two different wireless radio technologies. The first is a 2.4 GHz ISM band radio utilizing IEEE 802.15.4 technology the second is a radio that utilizes Ultra Wide Band technology. This evaluation is for the UWB radio feature of the device.

UWB radio:

Frequency center= 4499 MHz = $f_c = (f_h + f_l)/2$
Frequency lower = 4213 MHz
Frequency higher= 4785 MHz

Antenna Type: Chip Antenna
Antenna Gain: 2.6dBi - 0.7dBi

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (2013)* and per FCC Part 15 Subpart F.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID	CABLES P/D
Sanitag Technologies Corporation	AT-004-H	Engineering Sample	Pending: FCC ID: 2AMOW-AT004H	N/A
Antenna See antenna details	--	--	--	--

U= Unshielded
S= Shielded
P= Power
D= Data

Figure 1. Block Diagram of Test Configuration

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The EUT is subject to the following FCC authorizations:

a) Certification under section 15.509 as a transmitter.
b) Verification under 15.101 as a digital device and receiver.

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report (part 15.107 and 15.109) for the EUT is included herein.

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2. Test Instruments

INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	11/23/2017 Extended
SPECTRUM ANALYZER	DSA815	RIGOL	DSA8A180300 138	12/01//2017
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	6/22/2018
BICONICAL ANTENNA	3110B	EMCO	9306-1708	5/02/2019 2 yr
BICONICAL ANTENNA	3110B	EMCO	9307-1431	8/25/2017 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	5/01/2019 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	9/21/2018 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 yr
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	10/26/2017
PRE-AMPLIFIER	8447D	HEWLETT-PACKARD	1937A02980	3/07/2018

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart F Intentional Radiator Limits for the transmitter portion of the EUT.

2.3 Frequency Range of Radiated Measurements (Part 15.33, 15.521(h))

2.3.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 5th harmonic of the peak level of fundamental frequency generated or 40 GHz, whichever is the lowest.

The highest frequency used to determine the frequency range over which measurements are made shall be based on the center frequency (fc). If the center frequency is less than 10 GHz there is no requirement to measure beyond 40 GHz.

2.4 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

FCC Part 15.207, 15.209, 15.517

2.4.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

2.4.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

2.5 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this module.

Table 3. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna	Taiyo Yuden	Chip	AH086M555003	2.7dBi max	solder

2.6 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other Spurious are examined for this requirement see paragraph 2.1

2.7 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

Power line conducted emissions testing was performed to ensure that with the EUT in operation (exercising all transmitter functions) the complete system continues to meet the applicable requirements for CFR 15.207. These measurements were completed and are displayed along with the 15.107 power line test data in the sections below.

2.8 Intentional Radiator, Radiated Emissions (CFR 15.517 (e), 15.521 (g))

UWB devices where the highest radiated emission, $\mathbf{f_M}$ (The frequency at which the highest radiated emission occurs), is above 960 MHz have a limit on the peak level of the emission within a 50 MHz bandwidth of 0 dBm EIRP. A different RBW was used, therefore the peak emissions limit was adjusted per CFR 15.521 (g). The limit was also converted to peak field strength at 3 meters.

The antenna was positioned as it would be in normal operation and the fundamental emission was maximized to ensure the maximum reading and measured with the receiving antenna in both horizontal and vertical position. Below is the measured peak radiated emission at a test distance of 1 meters. To extrapolate back to 3 meters a correction factor of -9.5 dB was used.

RBW used: 3 MHz

Peak EIRP Limit	=	20 log (RBW/50) dBM EIRP
	=	20 log(3/50) dBm EIRP
	=	-24.43 dBm EIRP
Peak Field Strength Limit	=	-24.43 dBm EIRP +95.2
	=	70.8 dBuV/m

Table 4. Intentional Radiated Emissions (CFR 15.517 (c),(e))

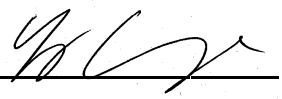
Frequency (MHz)	Distance / Polarization	Raw Test Data (dBuV)	Additional factor (dB) (extrapolation)	Correction Factors (dB/m) (Cable Loss + Ant)	Results (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
4490.00	Horizontal	44.72	-9.5	33.24	68.46	70.8	2.3	**PK**
4538.40	Horizontal	52.19*	-9.5	0.47	42.22	53.9	11.7	**AVG**

Note 1: The EUT was positioned at a test distance of 1 meter away from the receive antenna for fundamental measurements. The worst case test point is presented above.
Note 2: Measurements made at 1 meter are extrapolated back to 3 meters using an inverse extrapolation factor of -9.5 dB.
(*)= measured with a RBW of 1 MHz.

Sample Calculation at 4490.00 MHz:

Raw Test Data	44.72	dBuV
+Additional factor (extrapolation factor)	-9.5	dB
+Correction Factors (cable loss/antenna factor)	33.24	dB/m
Results	68.46	dBuV/m

Test Date: October 24, 2017

Tested By
Signature:  Name: George Yang

2.8.1 Pulse Repetition Frequency/Duty Cycle

The device employs pulse modulation and has a repetition rate of 153 Hz. The pulse signal has been verified below.

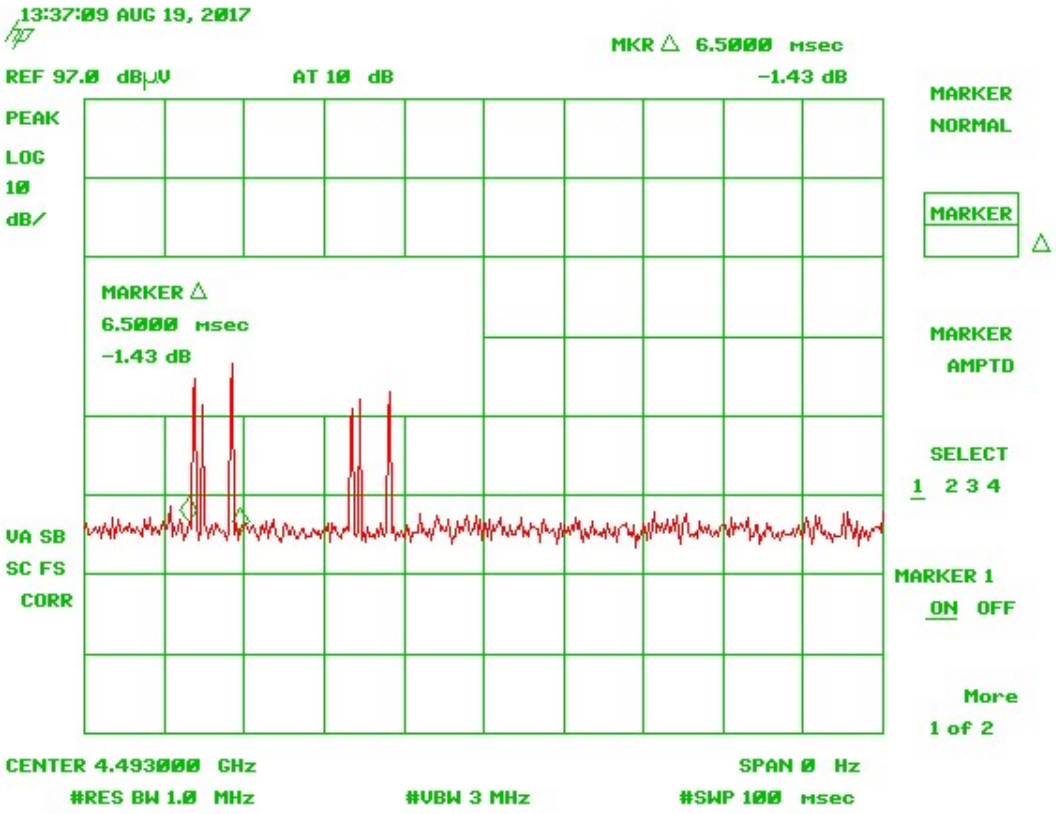


Figure 2. Pulse Repetition Frequency

Period= 6.5 mSec
Frequency= 1/seconds= 1/0.0065 secs = 153 Hz
Pulse Rate: 153 Hz

Duty Cycle Factor
Total ON time = 13.0 mSec (6.5 mSec x 2)
Duration = 100 mSec
DC= 20 log (13.0/100.0) = - 17.7 dB

2.9 UWB Bandwidth (CFR 15.517 (b), 15.521(e))

Bandwidth measurements were made in accordance with ANSI C63.10, Clause 10.1. The bandwidth of an imaging system under 15.509 must by below 10.6 GHz. The bandwidth is defined by the frequencies -10 dB from the maximum emissions found in section 2.10 of this test report. If multiple bandwidths occur, then the maximum bandwidth is used.

The bandwidth was determined from a radiated measurement using the designated antenna with which EUT will operate in the final product. This ensured that the true bandwidth of the EUT was measured. Below is the measured UWB bandwidth with the receiving antenna horizontal and vertical. Both polarities met the 10.6 GHz limit.

Emissions are contained within 3100 MHz to 10.6 GHz which meets the requirements of this subsection.

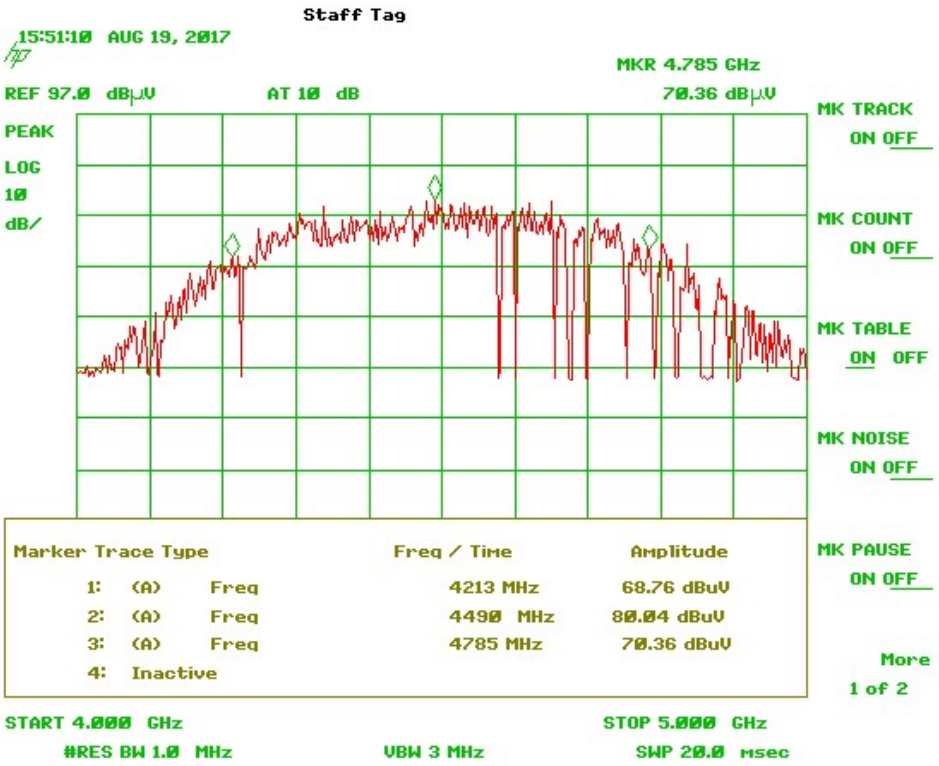


Figure 3. UWB 10 dB Bandwidth

10 dB Bandwidth= 572 MHz
Fractional Bandwidth= $2(f_h-f_l)/(f_h+f_l)= 2(572)/(8998) = 0.127$.

2.10 UWB Purpose, Part 90 License, and Coordination (CFR 15.517 (a))

This device is designed to used only in an indoor infrastructure as detailed in the User Guide provided in the submittal documentation. Without first setting up the network the device will not function as intended. The device is designed such that it will not be intentionally directed outside of the building. There are no provisions for the use of outdoor mounting antennas. There are no provisions for the use of field disturbance sensors. The device is designed such that it shall transmit only when the intentional radiator is sending information to an associated receiver.

The device is deemed to meet the requirements of this subsection.

2.11 Radiated Emissions at or Below 960 MHz (CFR 15.517 (c), 15.209))

The radiated emissions at or below 960 MHz from the transmitter shall not exceed the emissions levels in CFR 15.209. Furthermore the emissions due to the digital circuitry of the EUT must also comply with the limits for 15.209.

The worst-case radiated emission for the EUT in the range of 30 MHz to 960 MHz was 0.7 dB below the limit at 950.04 MHz. All other radiated emissions were at least 5.2 dB below the CFR 15.209 limits. This data can be found in the table below.

Table 5. Radiated Emissions Test Data Below 960 MHz

0.15 MHz to 960 MHz							
Test: Radiated Emissions				**Client:** Sanitag Technologies Corporation			
Project: 17-0275				**Model:** AT-004-H			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
No emissions seen greater than 20 dB below the applicable limit.							

Test Date: August 19, 2017
Tested by
Signature: _____ Name: George Yang

2.12 Radiated Emissions above 960 MHz (CFR 15.517 (c), 15.521(d,g,h))

The radiated emissions above 960 MHz from the transmitter shall comply with the AVG limits in Table 5 when measured using a resolution bandwidth of 1 MHz. The following are the worst case emissions with the receiving antenna in both horizontal and vertical polarities. The emissions were maximized using a Peak Detector, and the final measurement was taken using an Average Detector.

Table 6. Radiated Emissions above 960 MHz, CFR 15.517 (c), 15.521(g)

Frequency Range (MHz)	EIRP AVG Limit (dBm)	Field Strength AVG Limit at 3 meters (dBuV/m)
960 -1610	-75.3	19.9
1610 – 1990	-53.3	41.9
1990 – 3100	-51.3	43.9
3100 - 10600	-41.3	53.9
Above 10600	-51.3	43.9

The worst-case radiated emission for the EUT in the range above 960 MHz was 1.0 dB below the limit at 2716.00 MHz All other radiated emissions were at least 4.6 dB below the CFR 15.509 limits. This data can be found in the table below.

Table 7. Radiated Emissions from Transmitter Test Data Above 960 MHz

Above 960 MHz							
Test: Radiated Emissions				**Client:** Sanitag Technologies Corporation			
Project: 17-0275				**Model:** AT-004-H			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
No spurious emissions seen.							

Sample Calculation at N/A MHz:

Magnitude of Measured Frequency	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	dB/m
Corrected Result	dBuV/m

Test Date: December 13, 2017
Tested by
Signature: _____ Name: George Yang

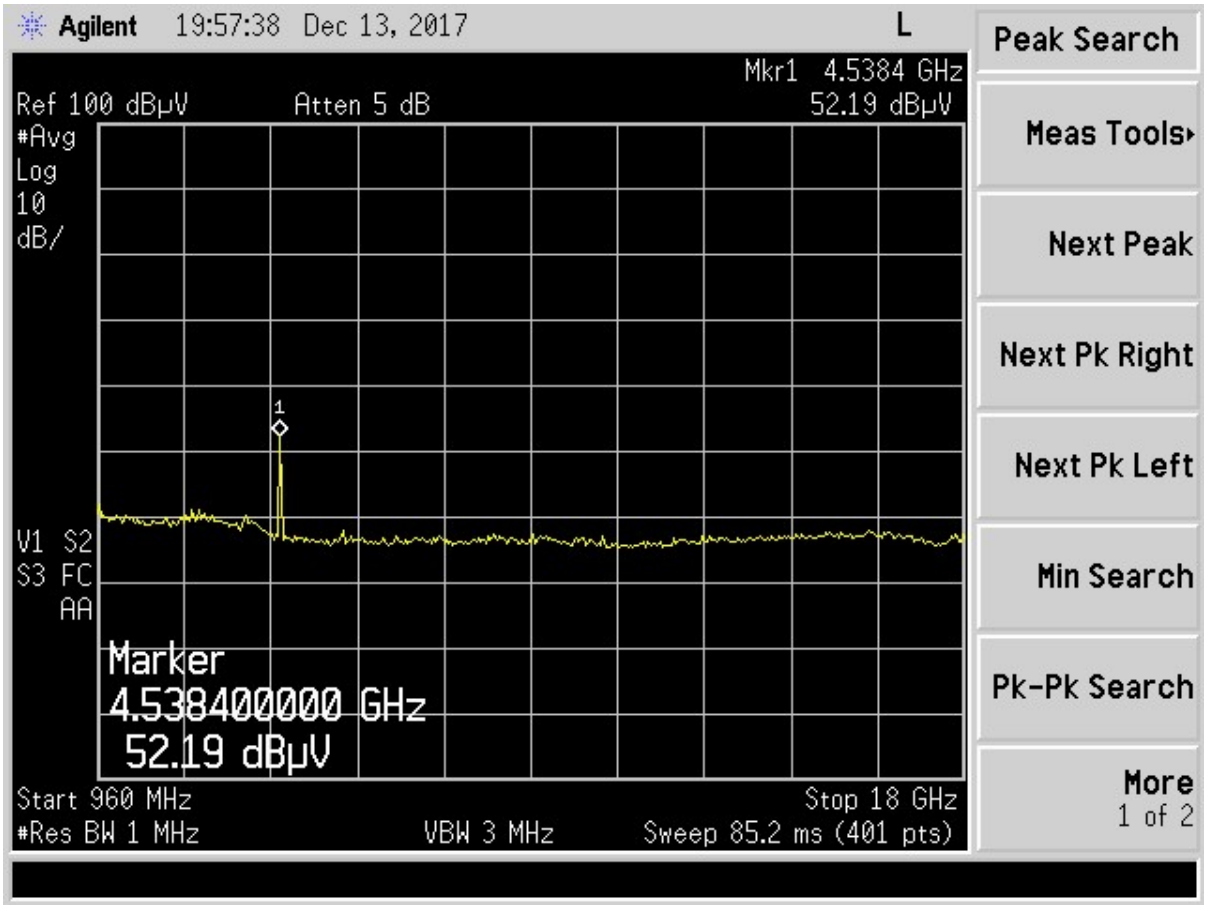


Figure 4. Spurious Emissions Plot

Note: Fundamental signal present

2.13 Radiated Emissions in the GPS band (CFR 15.517 (d), 15.521(g))

In addition the radiated emissions limits from CFR 15.509 (d), the transmitter shall not exceed the following average limits, in Table 8 when measured using a resolution bandwidth of no less than 1 kHz.

Table 8. Radiated Emissions in the GPS band (CFR 15.519 (e), 15.221(g))

Frequency Range (MHz)	EIRP Limit (dBm)	Field Strength Limit at 3 meters (dBuV/m)
1164-1240	-85.3	9.9
1559-1610	-85.3	9.9

In each of these bands, the emissions from the transmitter were maximized using a larger bandwidth and the peak detector, then the resolution bandwidth was decreased and the final measurement was taken using the average detector. The worse case emissions are seen below.

Table 9. Worst Case Radiated Emissions Test Data In The GPS Bands

1164 – 1240 MHz and 1559- 1610 MHz							
Test: Radiated Emissions				**Client:** Sanitag Technologies Corporation			
Project: 17-0275				**Model:** AT-001-H			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
1229.36	27.61	-10.77	16.84	29.9*	3.0m./HORZ	13.1	**PK**
1229.36	27.61	-28.47~	-0.86	9.9	3.0m./HORZ	10.8	**PK**
1568.05	27.16	-10.50	16.66	29.9*	3.0m./VERT	13.2	**PK**
1568.05	27.16	-28.20~	-1.04	9.9	3.0m./VERT	10.9	**PK**

Note 1: (*)= Peak Limit applied
Note 2: (~)=Duty cycle factor applied to Peak value compared to AVG limit

Sample Calculation at 1229.36 MHz:

Magnitude of Measured Frequency	27.61	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-10.77	dB/m
Corrected Result	16.84	dBuV/m

Test Date: August 19, 2017
Tested by
Signature: _____ Name: George Yang

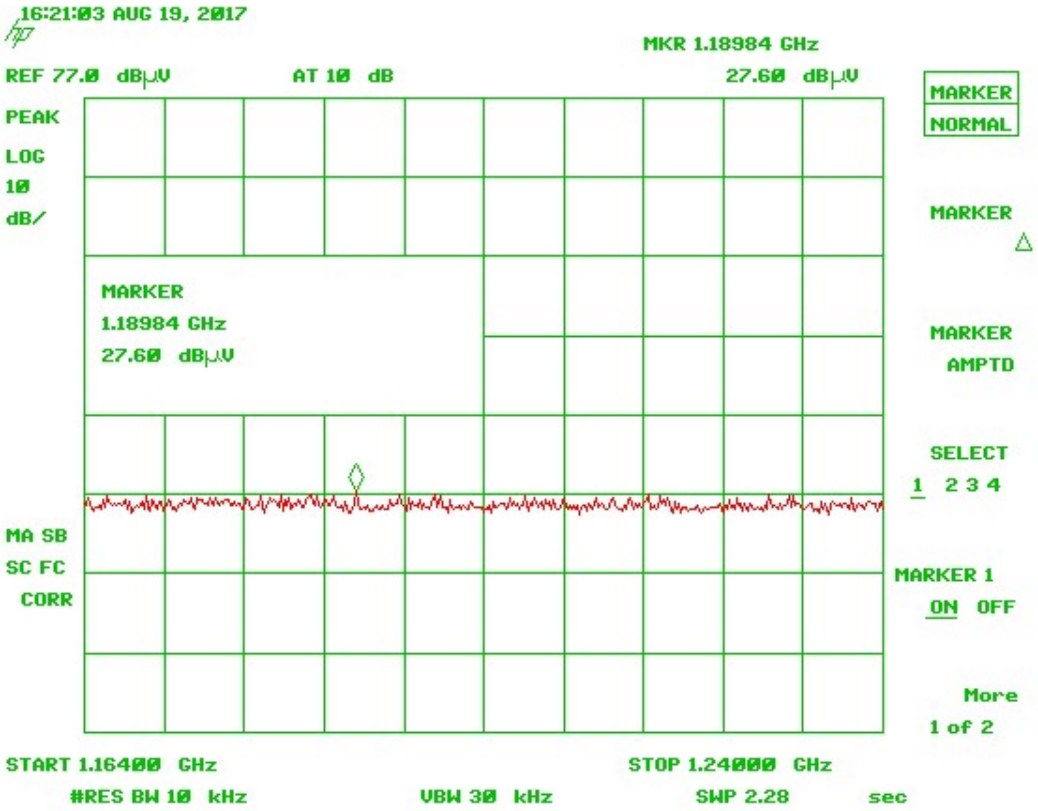


Figure 5. Peak Emissions 1164 – 1240 MHz Vertical

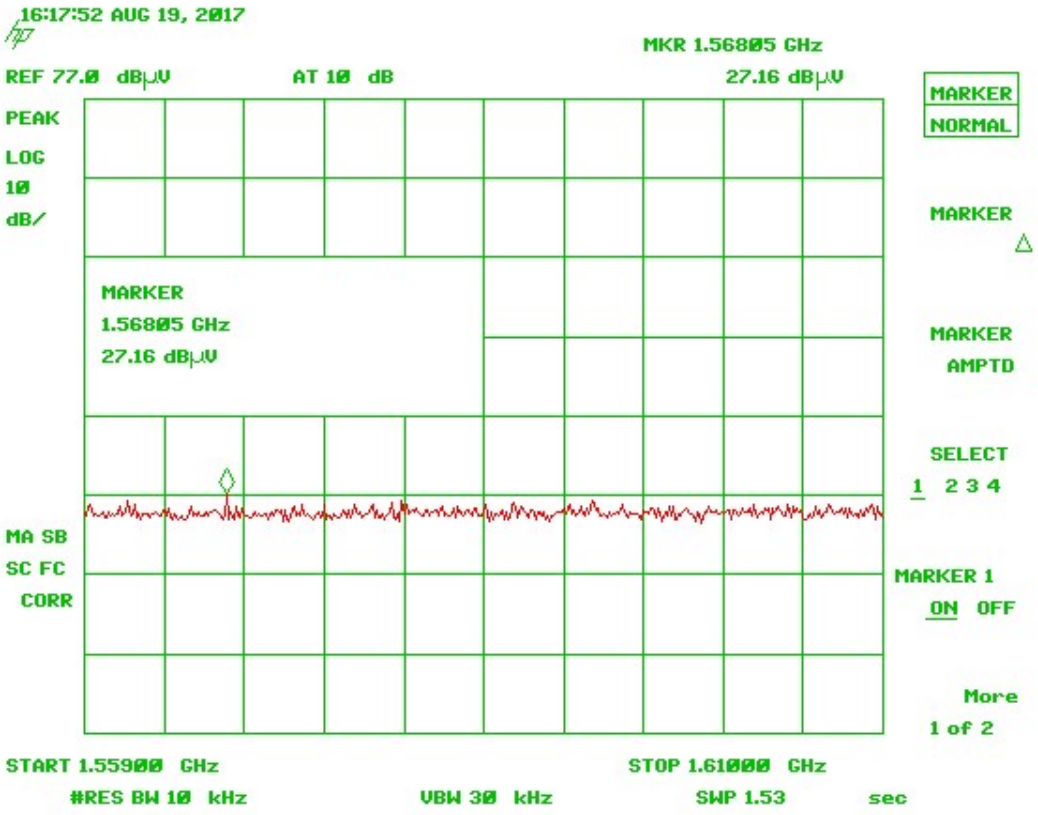


Figure 6. Peak Emissions 1559- 1610 MHz Vertical

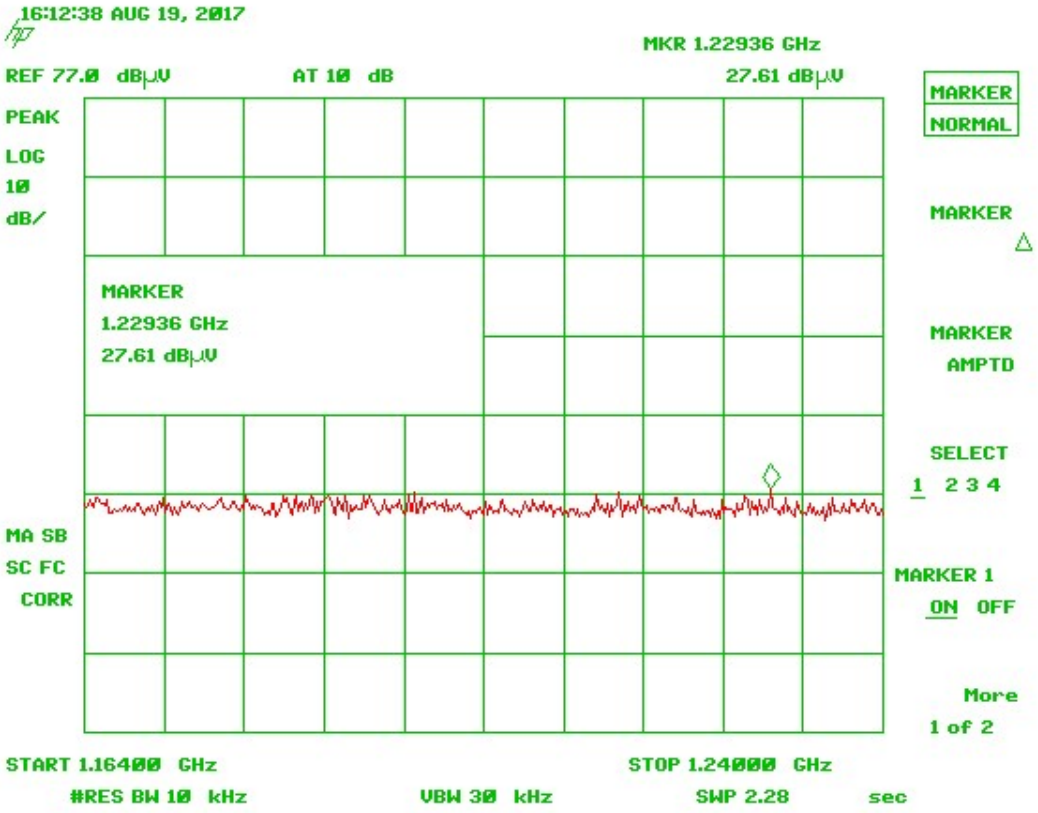


Figure 7. Peak Emissions 1164 – 1240 MHz Horizontal

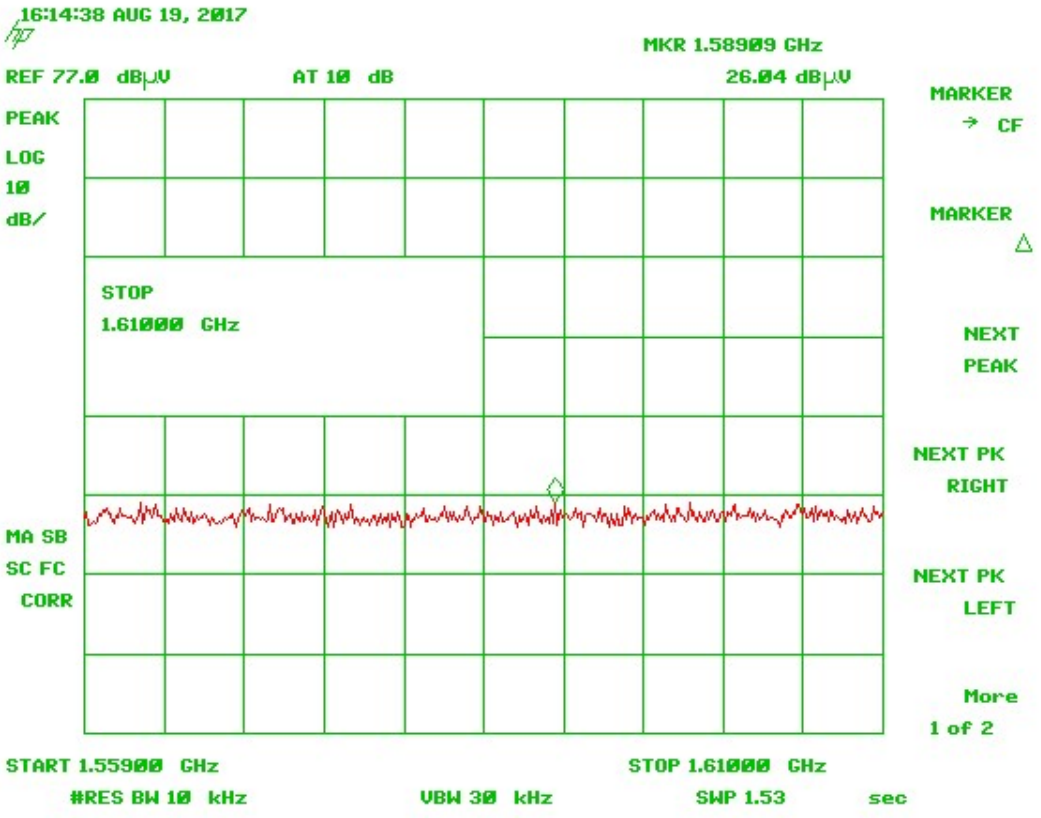


Figure 8. Peak Emissions 1559- 1610 MHz Horizontal

2.14 Unintentional Radiator, Radiated Emissions (CFR 15.109, 15.521 (c))

Any radiated emissions determined to be coming from the digital circuitry of the EUT and not the transmitter, were tested to make sure that they met the limits of 15.109.

Additionally the EUT was evaluated for co-location emissions coming from the EUT while both the UWB radio and the 802.15.4 radio were ON and actively transmitting as they would in normal operation.

Radiated emissions disturbance Measurements were performed with an instrument having peak, quasi-peak, and average detectors over the frequency range of 30 MHz to 10 GHz. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

NOTE: The test data provided in this section is to support the Verification and co-location requirement for the digital apparatus and the radios within.

Table 10. Unintentional Radiator, Peak Radiated Emissions (CFR 15.109), 30 MHz to 10 GHz

30 MHz to 22.5 GHz with 15.109 Limits							
Test: Radiated Emissions				**Client:** Sanitag Technologies Corp			
Project: 17-0275				**Model:** AT-004-H			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
No other emissions seen besides intentional spurious emissions. All other spurious emissions seen were greater than 20 dB from the applicable limit.							

Note: the 802.15.4 radio was ON and operating in a normal mode during radiated emissions testing. The emissions levels from the co-located radios did not exceed the limits as presented herein.

SAMPLE CALCULATION N/A

Test Date: August 19, 2017
Tested By
Signature: _____ Name: George Yang

2.15 Unintentional Radiator, Powerline Emissions (CFR 15.107, 15.207, 15.521 (j))

This EUT was evaluated for compliance for power line conducted emissions.

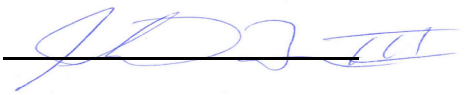
Table 11. Transmitter Power Line Conducted Emissions

150KHz to 30 MHz with Class B Limits						
Test: Power Line Conducted Emissions				**Client:** Sanitag Technologies Corp		
Project: 17-0274				**Model:** AT-004-H		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
120 VAC, 60 HZ Phase						
0.4790	43.38	0.06	43.44	46.4	2.9	**PK**
0.5117	41.20	0.13	41.33	46.0	4.7	**PK**
1.0733	37.60	0.16	37.76	46.0	8.2	**PK**
5.5583	32.86	0.31	33.17	50.0	16.8	**PK**
10.4833	28.49	1.13	29.62	50.0	20.4	**PK**
26.0500	27.39	0.83	28.22	50.0	21.8	**PK**
120 VAC, 60 HZ Neutral						
0.4831	36.51	0.20	36.71	46.3	9.6	**PK**
0.5025	35.82	0.28	36.10	46.0	9.9	**PK**
1.2600	33.77	0.30	34.07	46.0	11.9	**PK**
6.3830	31.10	0.46	31.56	50.0	18.4	**PK**
11.8667	28.74	1.29	30.03	50.0	20.0	**PK**
24.6667	27.28	0.90	28.18	50.0	21.8	**PK**

Sample Calculation at 0.4790 MHz:

Magnitude of Measured Frequency	43.38	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	.06	dB/m
Corrected Result	43.44	dBuV/m

Date: September 18, 2017

Signature:  Name: John Freeman

2.16 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2:2011. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.16.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.85 dB.

2.16.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.40 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.19 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.08dB.

3. Test Results

The EUT is deemed to have met all the applicable requirements for this evaluation.