
Project 18984-15

Shelfbucks, Inc.
GW-3-C

Wireless Certification Report

Prepared for:

Shelfbucks, Inc.
2500 Bee Caves Rd Bldg.2, Suite 240
Austin, TX 78746

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

8 Feb 2018

Reviewed by



Larry Finn
Chief Technical Officer

Written by



Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
Final 01		8 Feb 2018

Corrections:

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Compliance Certificate

Applicant	Device & Test Identification
Shelfbucks, Inc. 2500 Bee Caves Rd Bldg.2, Suite 240 Austin, TX 78746 Certificate Date: 28 Jul 2017	FCC ID: 2ALSL-GW3C Industry Canada ID: N/A Model(s): GW-3-C Laboratory Project ID: 18984-15

The device named above was tested utilizing the following documents and found to be in compliance with the required criteria:

Requirement	Reference	Detail
FCC 47 CFR Part 15 C	15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
FCC 47 CFR Part 15 C	15.209	Radiated emission limits; general requirements.
FCC 47 CFR Part 15 C	15.107, 15.207	Conducted emission limits.
FCC 47 CFR Part 15 C	15.205	Restricted Bands of Operation
KDB 558074 D01	DR01	DTS Measurement Guidance v03r02
KDB 412172	D01	Guidelines for Determining the ERP and EIRP of an RF Transmitting System
OET Bulletin 65*	Edition 97-01, and Supplement C, Ed. 01-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
RSS-247	Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen	Issue 4	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

*MPE is reported separately from this document. **Corresponding RSS references are listed in the body of the report.

I, Eric Lifsey, for Professional Testing (EMI), Inc., being familiar with the above requirements and test procedures have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Eric Lifsey
EMC Engineer

This report has been reviewed and accepted by the Applicant. The undersigned is responsible for ensuring that this device will continue to comply with the requirements listed above.

Representative of Applicant

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States and Canada.

Professional Testing (EMI), Inc., (PTI) follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing.

1.2 EUT Description

Table 1.2.1: Equipment Under Test		
Manufacturer / Model	Serial #	Description
Shelfbucks, Inc. Model: GW-3-C	none	902-928 MHz radio using 2 channels in a proprietary scheme

Table 1.2.2: Support Equipment		
Manufacturer / Model	Serial #	Description
CUI Inc Model : SWI12-5-N LPS P/N : SWI12-5-N-P5R	none	Switched-mode wall-plug power supply. Output DC 5V 2.5A 12.5 W Eff Level: VI

The EUT is a DC powered device that is normally fixed to a flat surface such as a wall. It receives data collected from a wireless proprietary network with signage units at the end points. It relays this data over a cellular network using a pre-certified cellular modem.

The EUT electronics are on a single circuit board which measures approximately 6 cm x 6 cm x 0.5 cm.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations.

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RSS-GEN, and is subsequently confirmed by laboratory accreditation (NVLAP). The test site is located at 11400 Burnet Road, Austin, Texas 78758, while the main office is located at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665.

1.6 Radiated Measurements

Radiated levels are determined as follows:

$$\text{Raw Measured Level} + \text{Antenna Factor} + \text{Cable Losses} - \text{Amplifier Gain} = \text{Corrected Level}$$

Conducted RF levels, if applicable, are determined as follows:

$$\text{Raw Measured Level} + \text{Attenuator Factor} + \text{Cable Losses} = \text{Corrected Level}$$

Conducted mains levels are determined as follows:

$$\text{Raw Measured Level} + \text{LISN Factor} + \text{Cable/Filter/Limiter Losses} = \text{Corrected Level}$$

Additionally, measurement distance extrapolation factors are applied and documented where used.

1.7 Applicable Documents and Clauses

Table 1.7.1: Applicable Documents	
Document	Title
47 CFR	Part 15 – Radio Frequency Devices Subpart C -Intentional Radiators
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 4	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Table 1.7.2: Applicable Clauses		
Parameter	FCC Part 15 Rule Paragraphs	IC RSS References
Transmitter Characteristics	15.247	RSS-247 5.2 (DTS) & 5.4, RSS-Gen
Bandwidth	15.247(a)(1), 2.1049, KDB 558074 D01	RSS-Gen 4.6
Spurious Emission	15.247, 15.209, 15.205	RSS-247 5.5, RSS-GEN 4.9, 4.10
Band Edge	15.247, 15.205	RSS-247 5.5, RSS-Gen 4.9
Antenna Requirement	15.203	RSS-Gen 8.3
Conducted Emissions, Mains	15.207	RSS-Gen 8.8

2.0 Fundamental Power

2.1 Test Procedure

Peak power is measured using conducted means and with modulation. The transmitter hopping sequence is disabled to operate on a single channel for the measurement.

2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(a)(3) // RSS-247 5.2	Fundamental Power Conducted Limits 1 W Limit Restated as Field: 125.23 dB μ V/m @ 3 m	26 Apr 2017

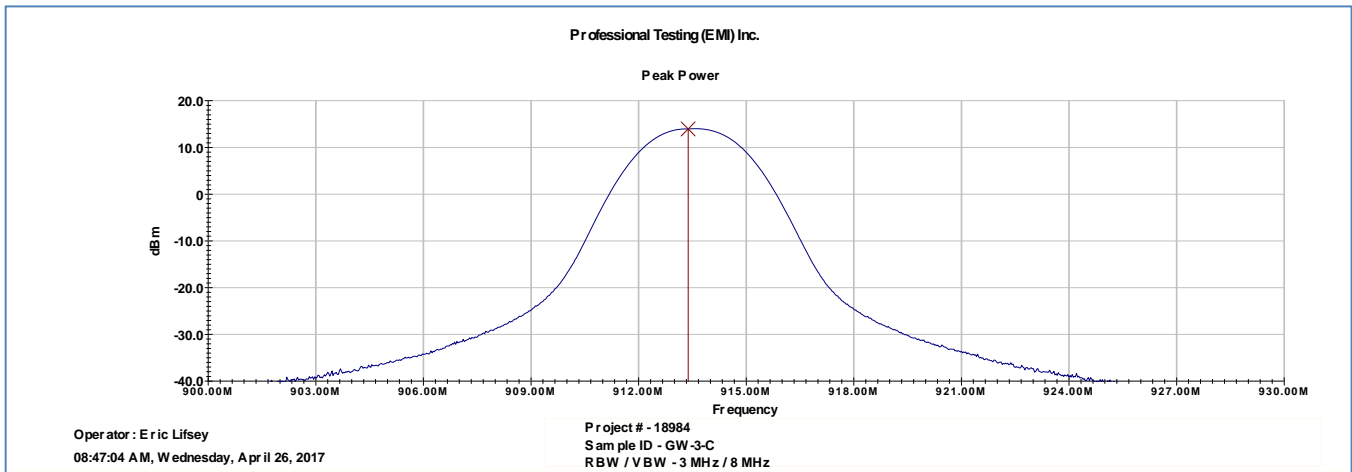
2.3 Test Results, Peak Power

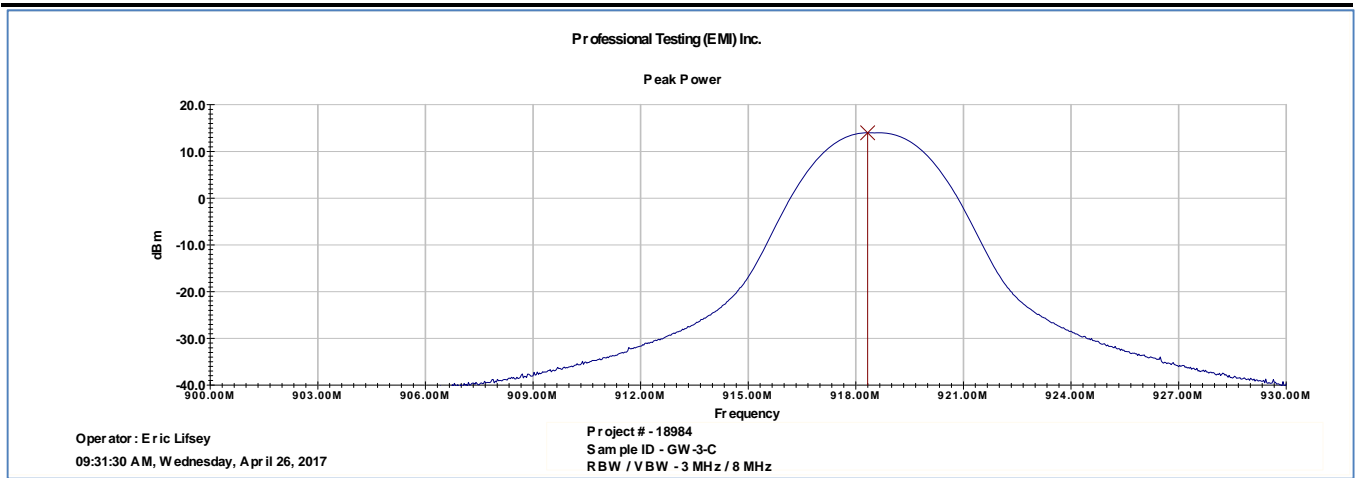
The EUT was measured for conducted power by connection directly to a spectrum analyzer.

Table 2.3.1 Power, Peak, Conducted				
Frequency MHz	Measured Peak Power in dBm	Antenna Gain dBi	EIRP dBm	EIRP Peak Power Restated in mW
913.5	14.0	2.15	16.2	41.7
918.5	14.0	2.15	16.2	41.7

Measured in 3 MHz RBW, 8 MHz VBW.

The EUT satisfied the requirements.





2.4 Test Results, Duty Cycle

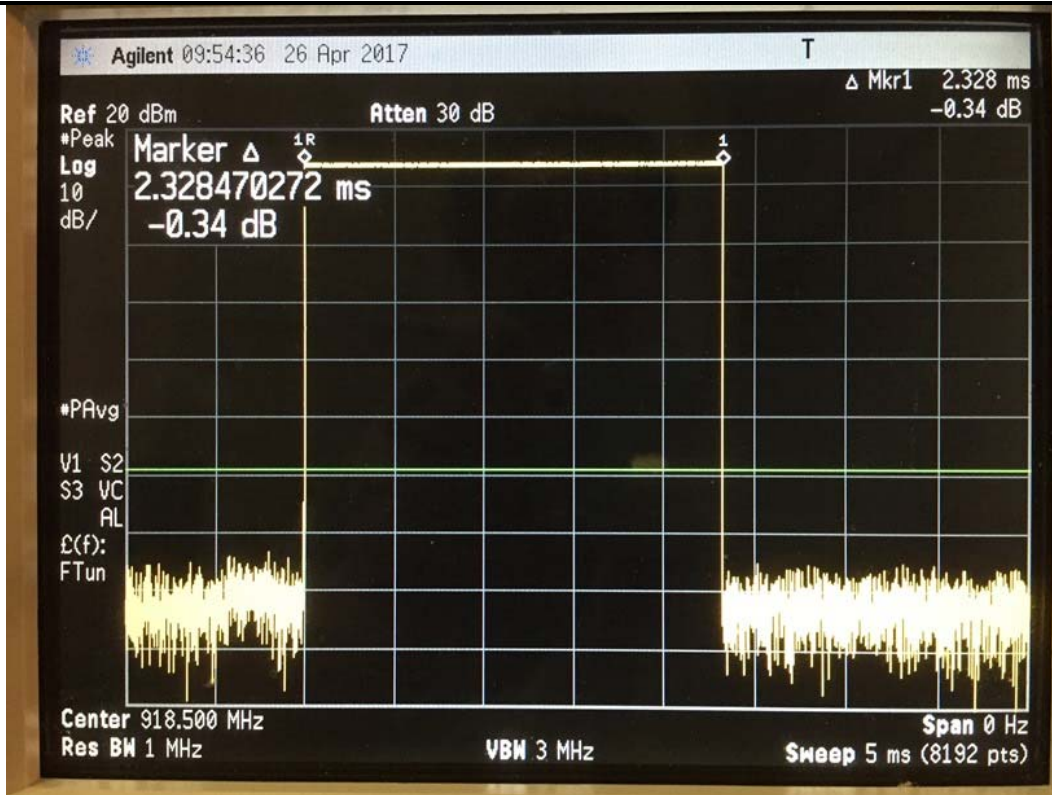
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. This is not a pass/fail measurement.

Table 2.5.1 Duty Cycle Results and Average Duty Cycle Factor Result				
Total Measured On Time (msec)	Measured Time Interval (msec)	Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB)
= 2.33	1205 Allowed 100	= 20 * Log ₁₀ (2.33 msec / 100 msec)	-32.7	-20

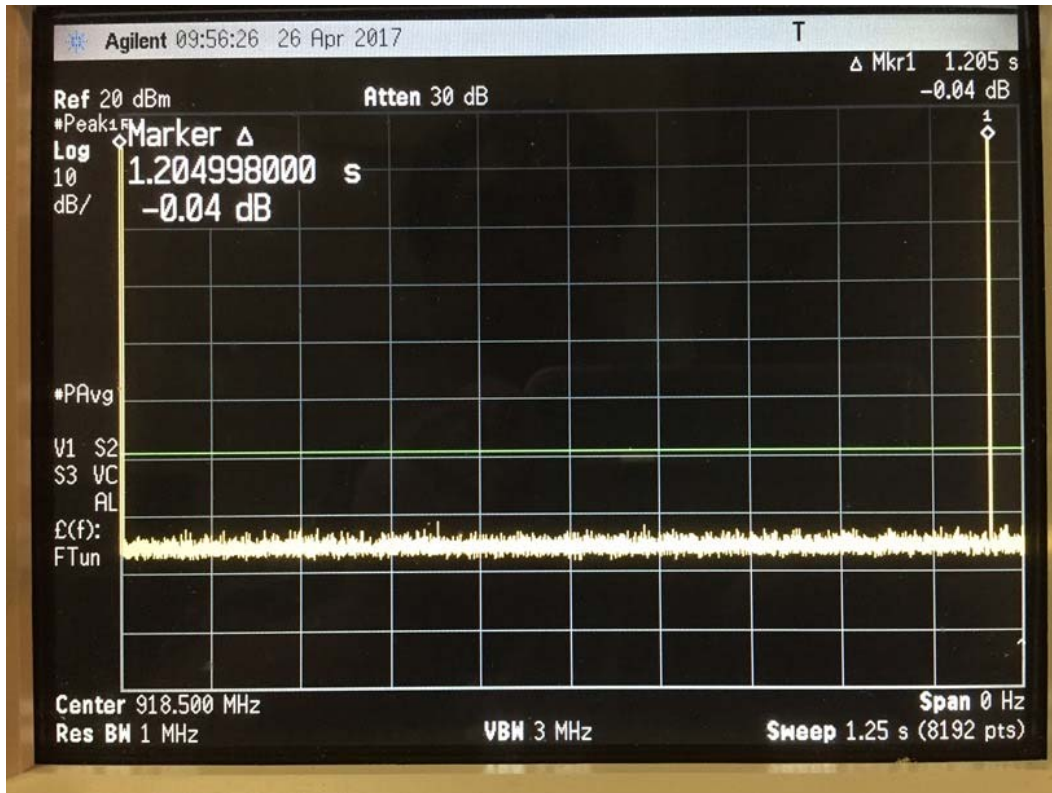
The weighted duty cycle for exposure purposes is: $10 \log (2.33 / 1205) = -27.1 \text{ dB}$

The allowed duty cycle factor is applied to peak measured harmonic signals to find average levels.

Plotted results appear below.



Transmit Event



Transmit Interval

3.0 Power Spectral Density

3.1 Test Procedure

A spectrum analyzer is either connected directly to the EUT or used by radiated means to measure the fundamental emission. It is adjusted to measure the power spectral density in the specified resolution bandwidth.

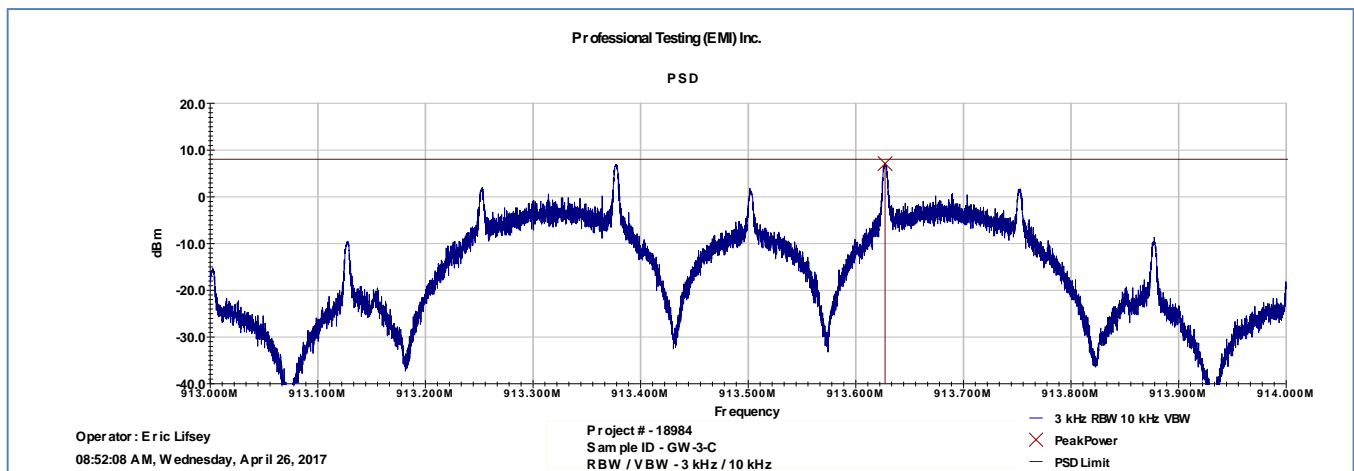
3.2 Test Criteria

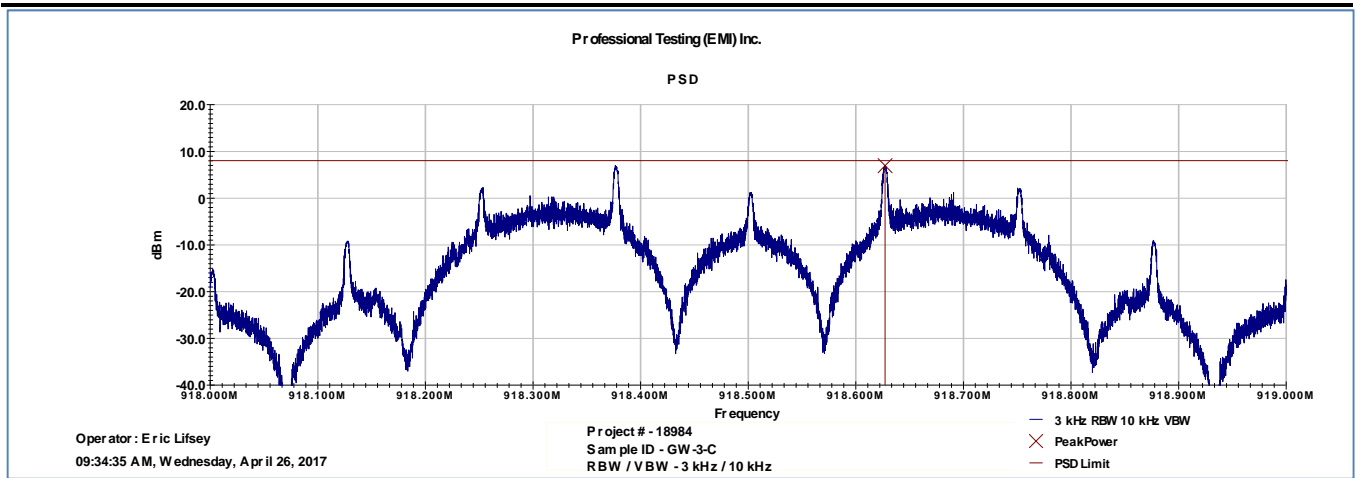
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(e) // RSS-247, 5.2	Power Spectral Density, Conducted Limit: 8 dBm / 3 kHz Restated as field strength limit: 103.23 dB μ V/m at 3 m	26 Apr 2017

3.3 Test Results

Table 3.3.1 Power Spectral Density, Conducted	
Frequency MHz	Measured Peak Power dBm
913.5	7.1
918.5	6.9

The EUT satisfied the requirement.





4.0 Occupied Bandwidth

4.1 Test Procedure

Bandwidth is measured by conducted means. A recording of the results is included.

4.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
14.247(a)(2), 2.1049, KDB 558074 D01 // RSS-Gen 4.6	Bandwidth, 6 dB, 20 dB	26 Apr 2017

4.3 Test Results

The bandwidth measurement is used to verify DTS characteristics and/or for general reporting for agency application.

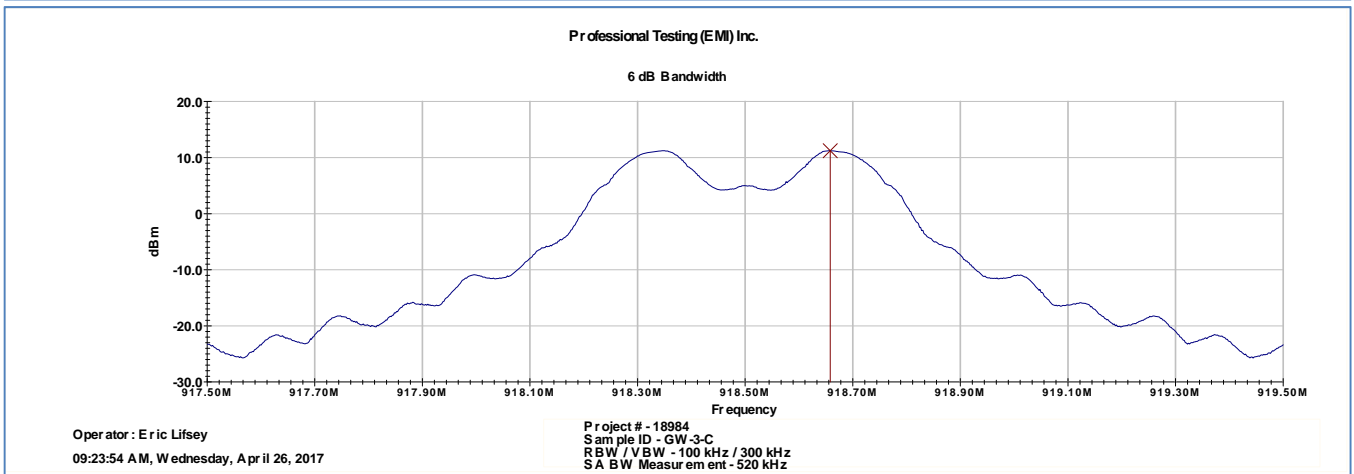
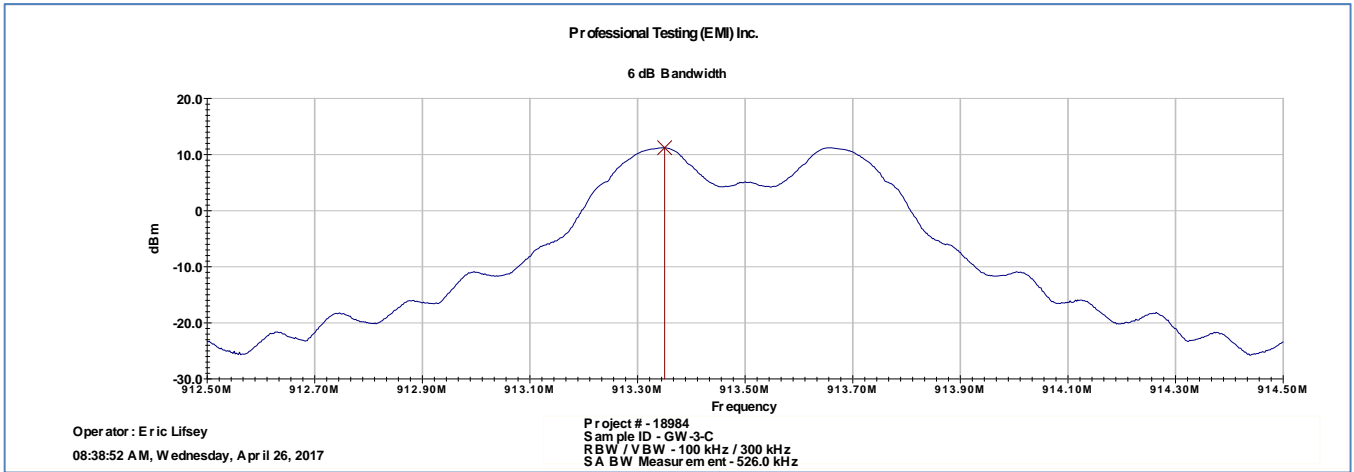
The EUT was found to be in compliance with applicable requirements.

Table 4.3.1 Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW			
Low Channel Measured BW (kHz)		High Channel Measured BW (kHz)	Reported Minimum BW (kHz)
526		520	520

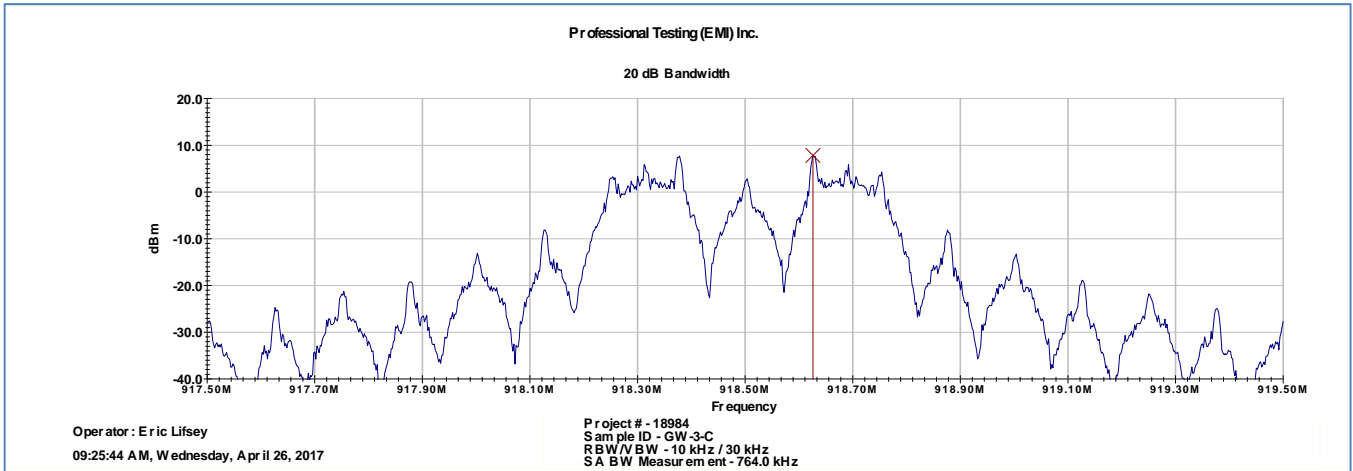
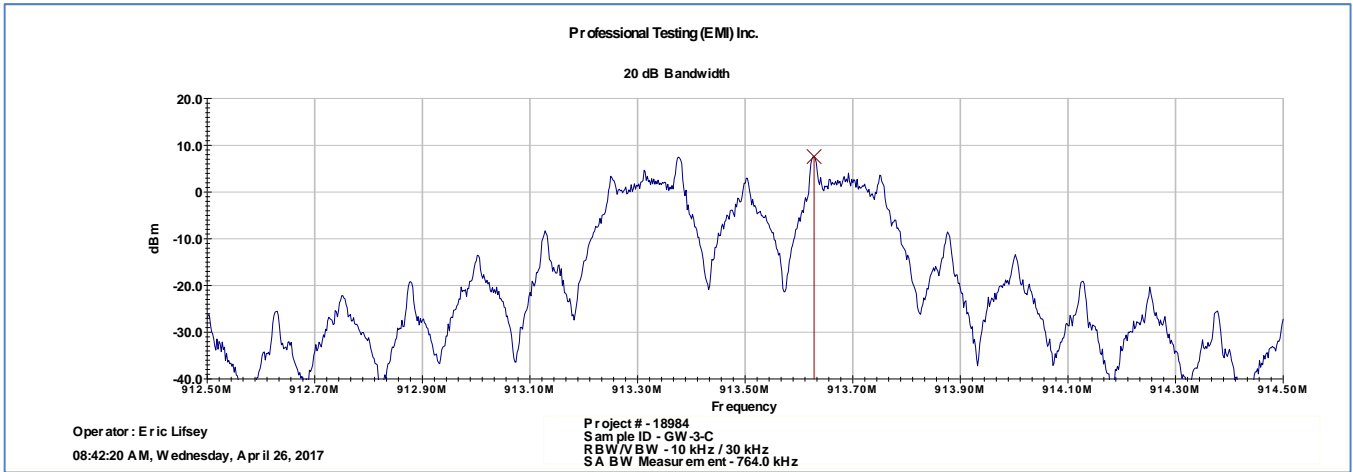
Table 4.3.2 Bandwidth 20 dB, Measure and Report			
Low Channel Measured BW (kHz)		High Channel Measured BW (kHz)	Reported Maximum BW (kHz)
764		764	764

Plotted measurements appear on the following pages.

4.3.1 Bandwidth Plots, 6 dB



4.3.2 Bandwidth Plots, 20 dB



5.0 Band Edge

5.1 Test Procedure

EUT is placed into normal transmit operation on the nearest band edge channel. The spectrum analyzer is approximately centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Measurement includes at least two standard bandwidths from the respective band edge. If required, the band-edge marker-delta method is utilized.

5.2 Test Criteria

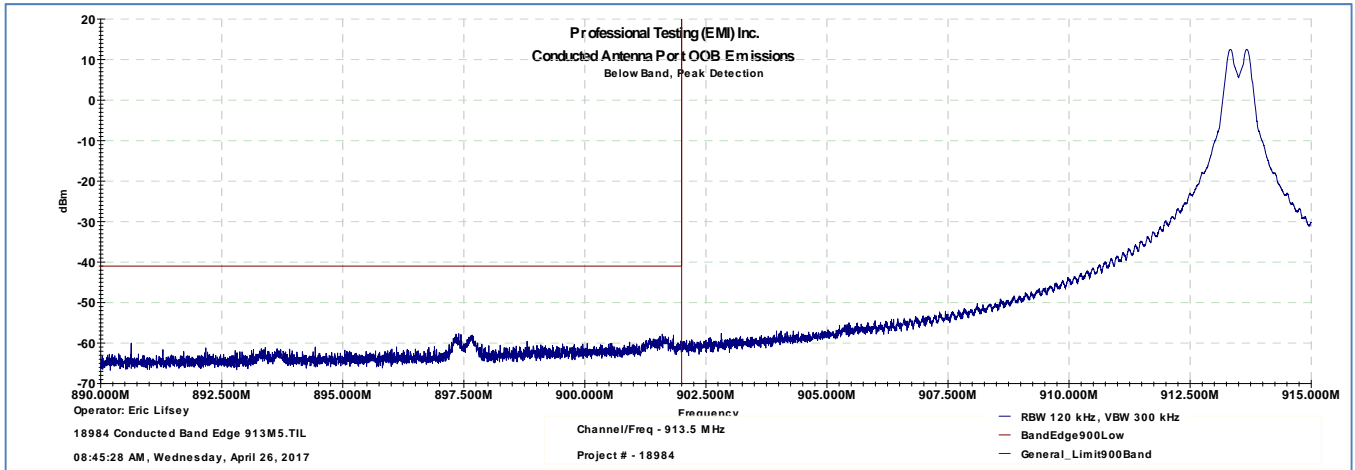
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.205 // RSS-247 5.5, RSS-Gen 4.9	Unwanted Emissions Adjacent to Authorized Band, Radiated	26 Apr 2017

5.3 Test Results

Measurements included more than 2 standard bandwidths (standard bandwidth 1 MHz) from the band edges to provide a clear view of the fundamental and the declining emission levels. Peak detection with max-hold was employed for a conducted measurement.

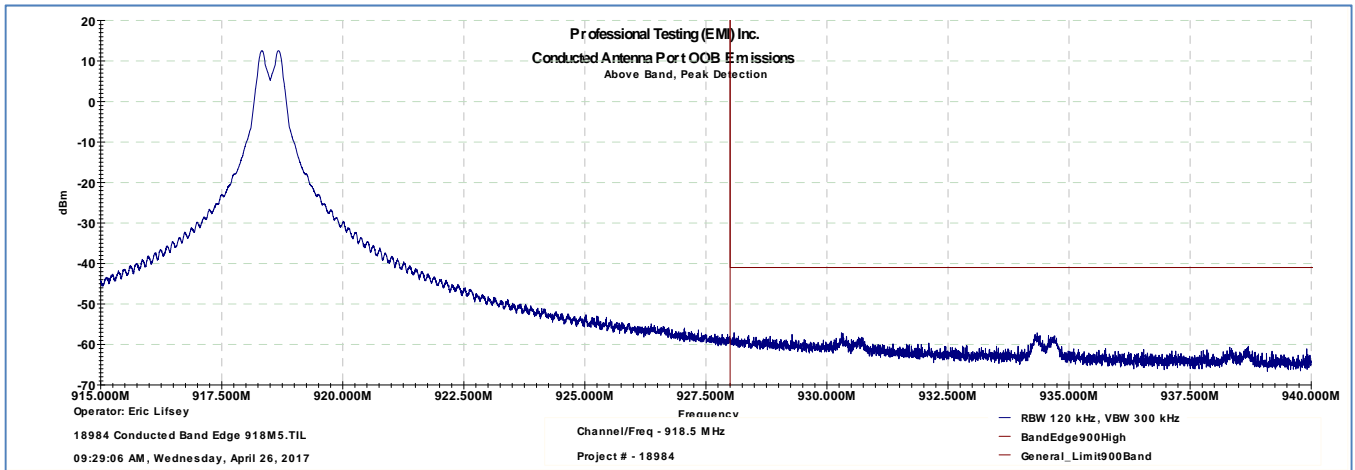
The EUT satisfied the criteria. Plotted results of peak detection appear on the following pages.

5.3.1 Low Channel Band Edge



Peak detection in 100 kHz RBW is employed.

5.3.2 High Channel Band Edge



Peak detection is employed while the general emission limits for average are shown.
 The applicable duty cycle factor is -20 dB.

6.0 Conducted Spurious Emissions, Receive Mode

6.1 Test Procedure

The EUT was connected directly to a spectrum analyzer for this measurement.

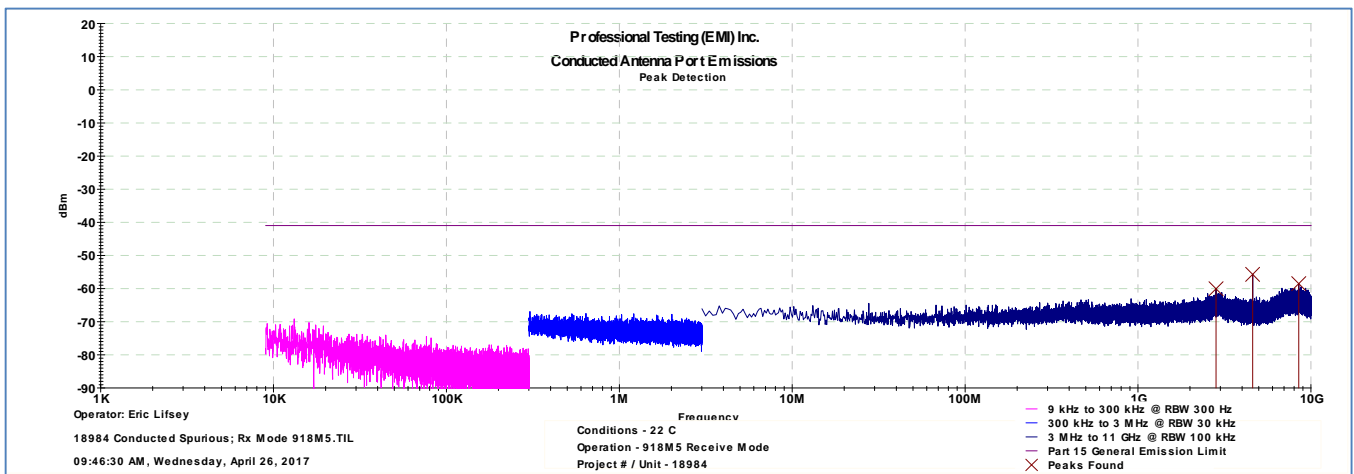
6.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode	

6.3 Test Results

The EUT was tuned to the middle channel and placed in receive mode.

The EUT satisfied the criteria. Recorded data is presented below.



Frequency	Peak Measured
2.817 GHz	-60.095 dBm
4.58756 GHz	-55.727 dBm
8.48249 GHz	-58.528 dBm

7.0 Conducted Spurious Emissions, Transmit Mode

7.1 Test Procedure

The EUT was connected directly to a spectrum analyzer for this measurement.

7.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Spurious/Harmonic Emissions Transmit Mode	26 Apr 2017

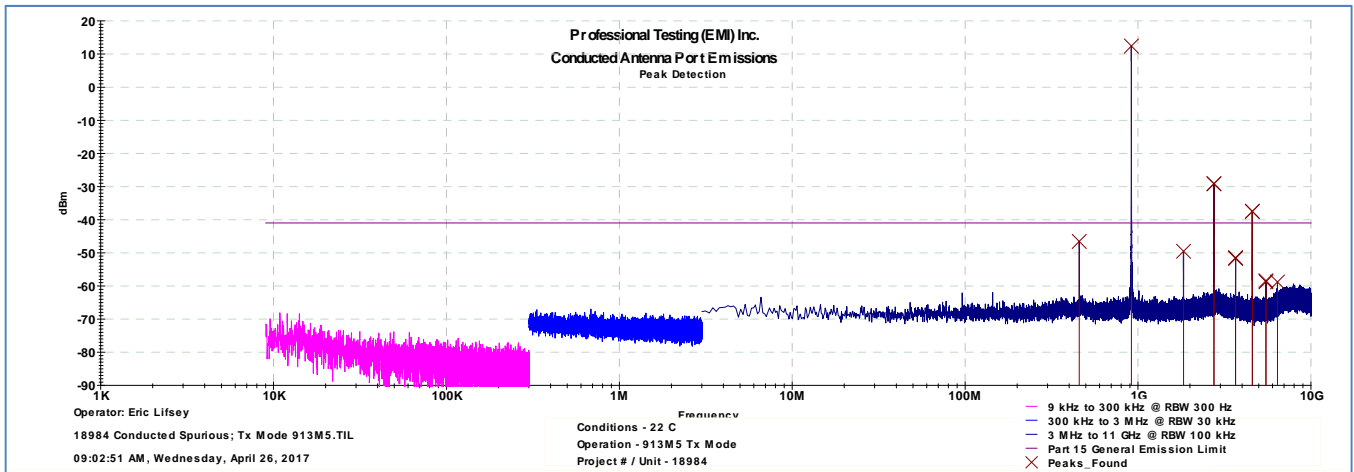
7.3 Test Results

Modulation was enabled for this test and the transmitter was placed into continuous transmit mode. The three standard channels were measured.

The duty cycle averaging factor applies -20.0 dB to the peaks recorded for the harmonics. Since the peak measurement satisfied the peak limit with margin above 1 GHz, the average emission would equally satisfy the average limit.

All measurements used peak detection.

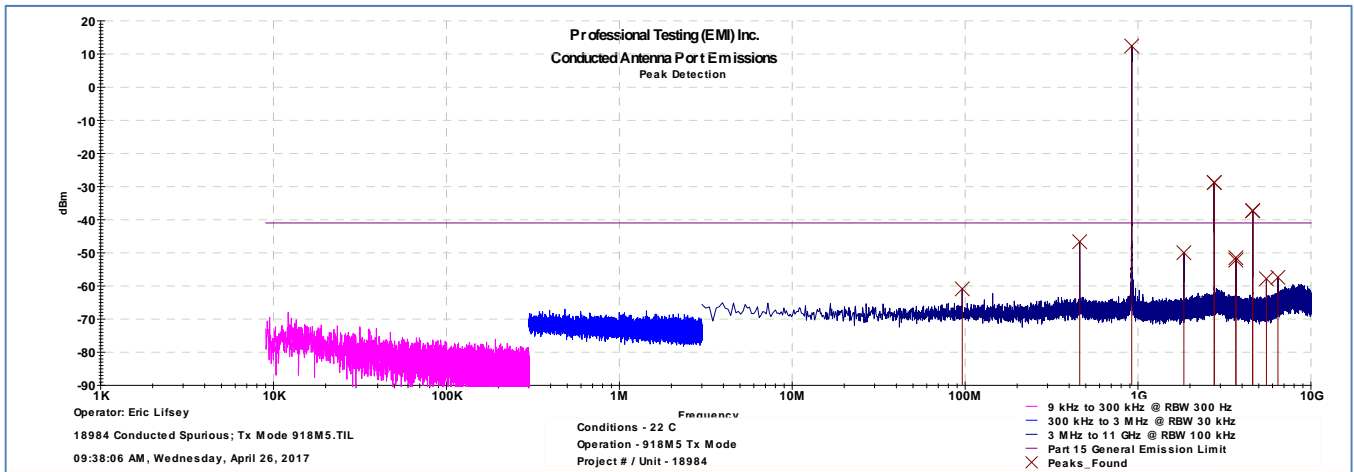
7.3.1 Bottom Channel



Frequency	Peak Measured
456.614 MHz	-46.577 dBm
1.8273 GHz	-49.541 dBm
2.73999 GHz	-29.236 dBm
2.74108 GHz	-29.112 dBm
3.65331 GHz	-51.469 dBm
3.65472 GHz	-51.712 dBm
4.56663 GHz	-37.493 dBm
4.56835 GHz	-37.488 dBm
5.47995 GHz	-58.739 dBm
5.48214 GHz	-58.447 dBm
6.39577 GHz	-58.804 dBm

Averaging factor -20 dB applies.

7.3.2 Top Channel



Frequency	Peak Measured
96.0971 MHz	-60.889 dBm
459.269 MHz	-46.688 dBm
1.83729 GHz	-50.005 dBm
2.75499 GHz	-28.850 dBm
2.75608 GHz	-28.790 dBm
3.6733 GHz	-51.484 dBm
3.67471 GHz	-52.223 dBm
4.59162 GHz	-37.248 dBm
4.59334 GHz	-37.386 dBm
5.50994 GHz	-57.881 dBm
6.42826 GHz	-57.397 dBm

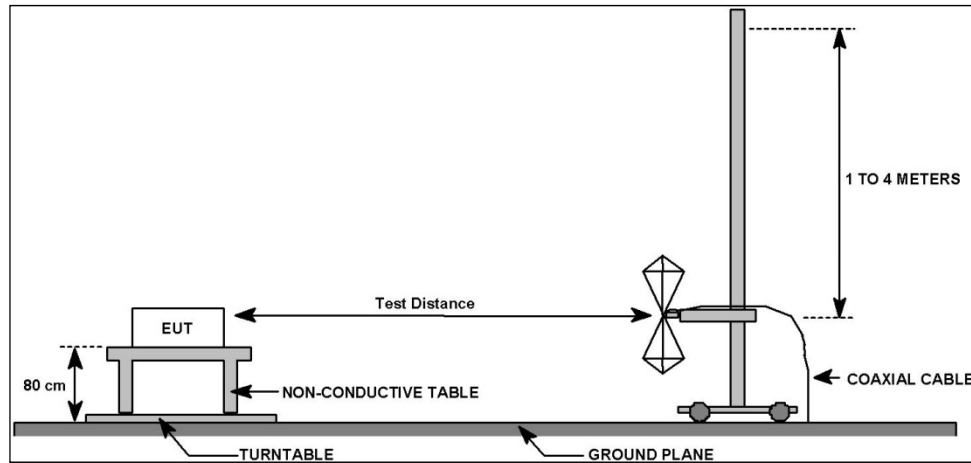
Averaging factor -20 dB applies.

8.0 Radiated Spurious Emissions, Transmit Mode

8.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The EUT was centered on a rotating turntable. Measurements below 1 GHz were taken at a test distance of 10 meters from the measurement antenna. Above 1 GHz the measurement distance was 3 meters.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken and average measured where appropriate using 1 MHz resolution bandwidth. A diagram showing the test setup appears below.



8.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode	25 Apr 2017

8.3 Test Results

This device was simultaneously tested with its companion device designated Remote. A very low resolution bandwidth was used during setup to confirm the two fundamental signals were present.

Modulation was enabled for this test and the transmitter was placed into continuous transmit mode.

The duty cycle averaging factor applies -20.0 dB to the peaks recorded for the harmonics. As all peaks were below the peak limit, the averaged emissions are also below the average limit.

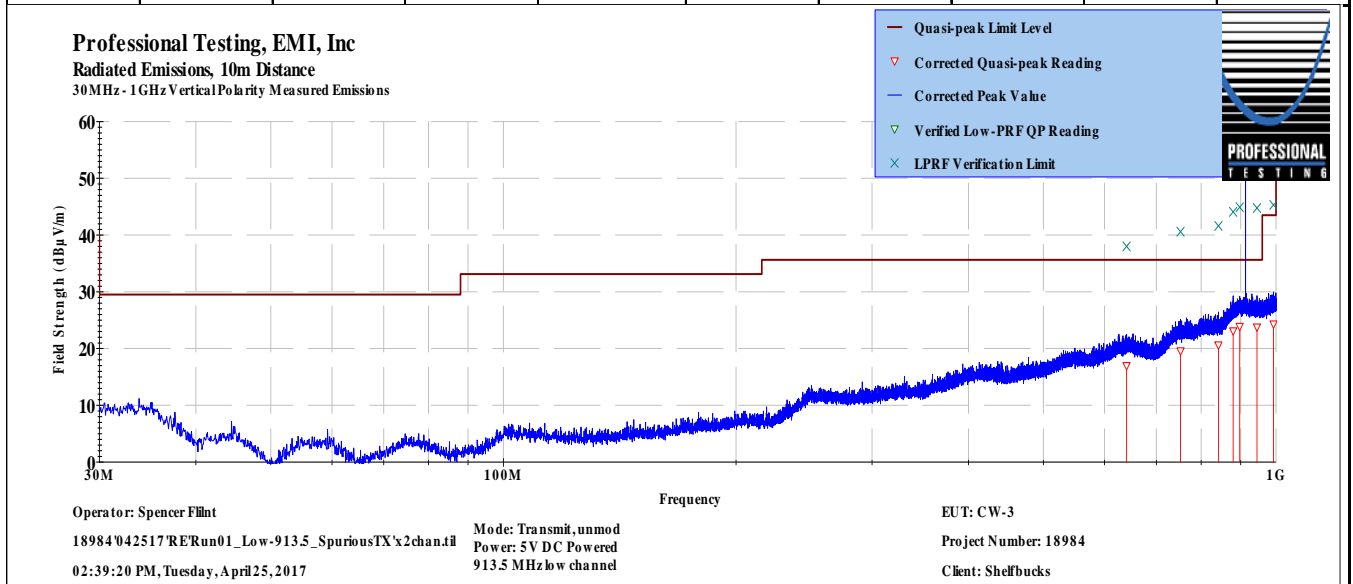
8.3.1 Middle Channel Up to 1 GHz

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	GW-3-C
Project Number:	18984	Test Technician:	Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:	5	VDC	EUT Power Frequency:	0	N/A				
Antenna Orientation:	Vertical		Frequency Range:	30MHz to 1GHz					
EUT Mode of Operation:			Transmit Mode						
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
640.67	10	248	3.6	Quasi-peak	18.9	16.984	35.6	-18.6	Pass
752.525	10	76	2.22	Quasi-peak	19	19.568	35.6	-16.0	Pass
842.464	10	174	3.24	Quasi-peak	18.9	20.601	35.6	-15.0	Pass
880.314	10	287	3.03	Quasi-peak	19.2	23.095	35.6	-12.5	Pass
897.559	10	11	3.78	Quasi-peak	19.1	23.884	35.6	-11.7	Pass
945.13	10	156	2.43	Quasi-peak	18.9	23.77	35.6	-11.8	Pass
992.866	10	44	2.83	Quasi-peak	19	24.304	43.5	-19.2	Pass



≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

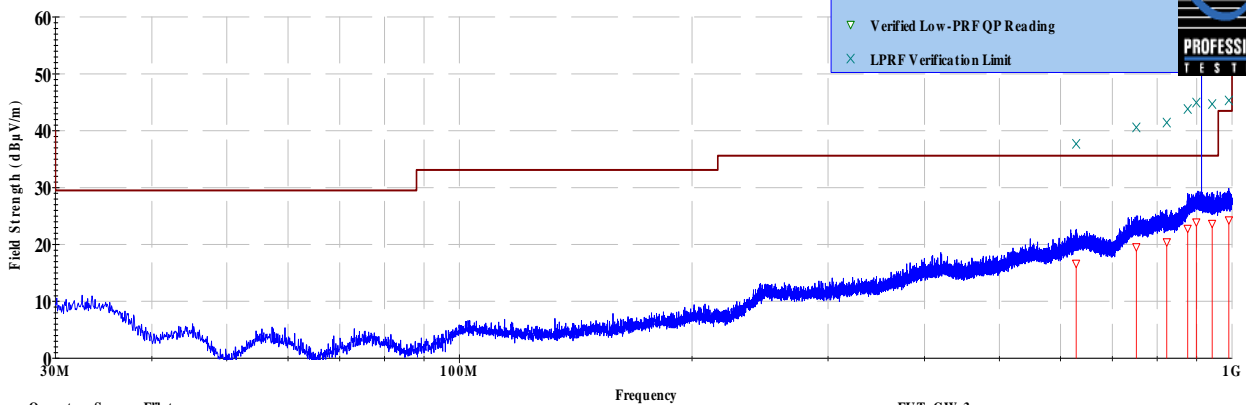
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	GW-3-C
Project Number:	18984	Test Technician:	Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		5 VDC		EUT Power Frequency:		0 N/A			
Antenna Orientation:		Horizontal		Frequency Range:		30MHz to 1GHz			
EUT Mode of Operation:					Transmit Mode				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
628.546	10	264	3.82	Quasi-peak	18.9	16.676	35.6	-18.9	Pass
752.064	10	100	3.99	Quasi-peak	19	19.576	35.6	-16.0	Pass
823.511	10	67	2.83	Quasi-peak	18.9	20.437	35.6	-15.2	Pass
876.446	10	341	2.14	Quasi-peak	19.1	22.819	35.6	-12.8	Pass
899.131	10	27	3.5	Quasi-peak	19.1	23.946	35.6	-11.7	Pass
942.764	10	24	2.26	Quasi-peak	18.8	23.704	35.6	-11.9	Pass
991.102	10	297	2.25	Quasi-peak	19.1	24.325	43.5	-19.2	Pass

Professional Testing, EMI, Inc
 Radiated Emissions, 10m Distance
 30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator: Spencer Flint
 18984\042517\RE\Run01_Low-913.5_SpuriousTX\chan.tif
 02:39:20 PM, Tuesday, April 25, 2017

Mode: Transmit, unmod
 Power: 5V DC Powered
 913.5 MHz low channel

EUT: CW-3
 Project Number: 18984
 Client: Shelfbucks

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

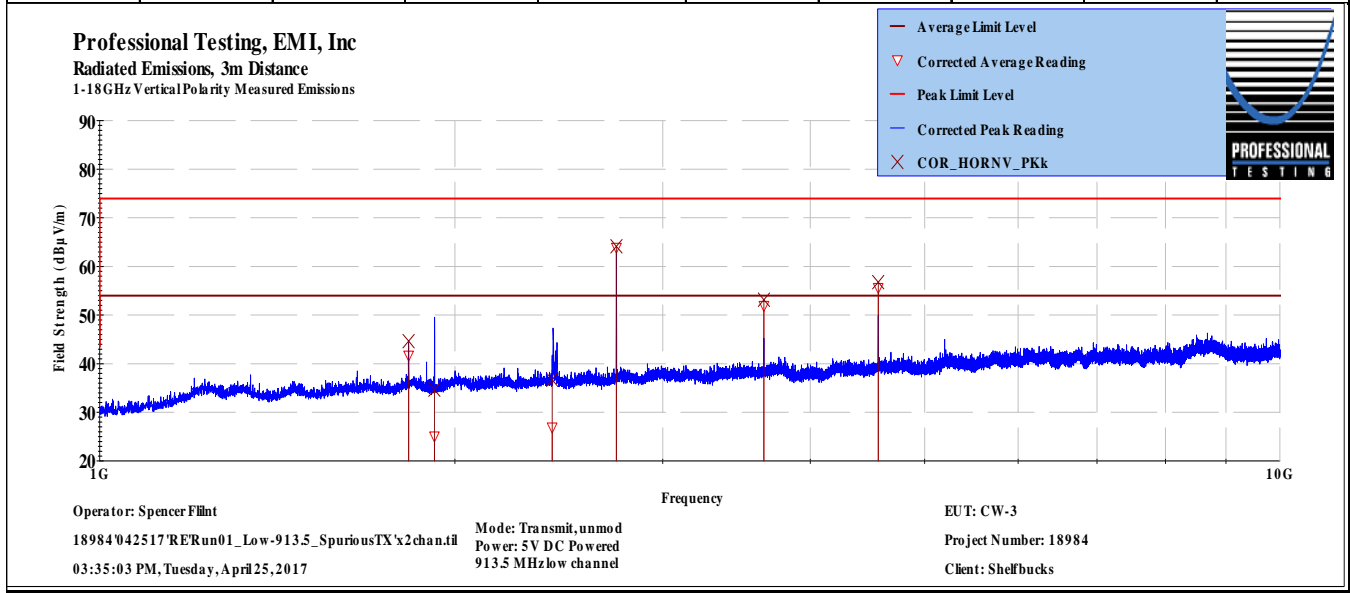
8.3.2 Bottom Channel Up to 10 GHz

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	GW-3-C
Project Number:	18984	Test Technician:	Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet Page: 1 of 1

EUT Line Voltage:	5 VDC	EUT Power Frequency:	0 N/A
Antenna Orientation:	Vertical	Frequency Range:	Above 1GHz

EUT Mode of Operation:					Transmit Mode, Bottom Channel				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1826.95	3	272	2.82	Peak	54.4	44.618	74.0	-29.3	Pass
1921.5	3	351	2.99	Peak	44	34.624	74.0	-39.3	Pass
2417.55	3	244	2.58	Peak	45.8	36.683	74.0	-37.3	Pass
2740.53	3	34	2.52	Peak	72	64.104	74.0	-9.9	Pass
3654	3	42	1.9	Peak	60	53.134	74.0	-20.8	Pass
4567.43	3	25	1.82	Peak	61.1	56.731	74.0	-17.2	Pass



> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

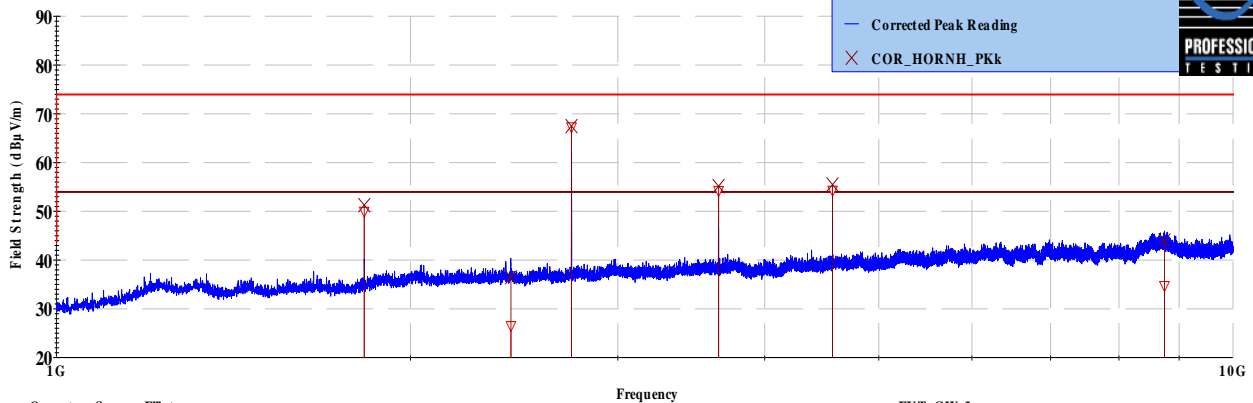
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	GW-3-C
Project Number:	18984	Test Technician:	Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:	5 VDC	EUT Power Frequency:	0 N/A						
Antenna Orientation:	Horizontal	Frequency Range:	Above 1GHz						
EUT Mode of Operation:		Transmit Mode, Bottom Channel							
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1826.88	3	282	3.49	Peak	61	51.263	74.0	-22.7	Pass
2433.79	3	217	2.35	Peak	45.5	36.461	74.0	-37.5	Pass
2740.47	3	188	2.44	Peak	75.4	67.456	74.0	-6.5	Pass
3653.99	3	254	2.29	Peak	62	55.146	74.0	-18.8	Pass
4567.44	3	109	1.96	Peak	59.9	55.465	74.0	-18.5	Pass
8746.48	3	35	3.37	Peak	36.5	43.981	74.0	-30.0	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Horizontal Polarity Measured Emissions



Operator: Spencer Flint

18984\042517\RE\Run01_Low-913.5_SpuriousTX\2chan.tif
03:35:03 PM, Tuesday, April 25, 2017

Mode: Transmit, unmod
Power: 5V DC Powered
913.5 MHz low channel

EUT: CW-3

Project Number: 18984
Client: Shelfbucks

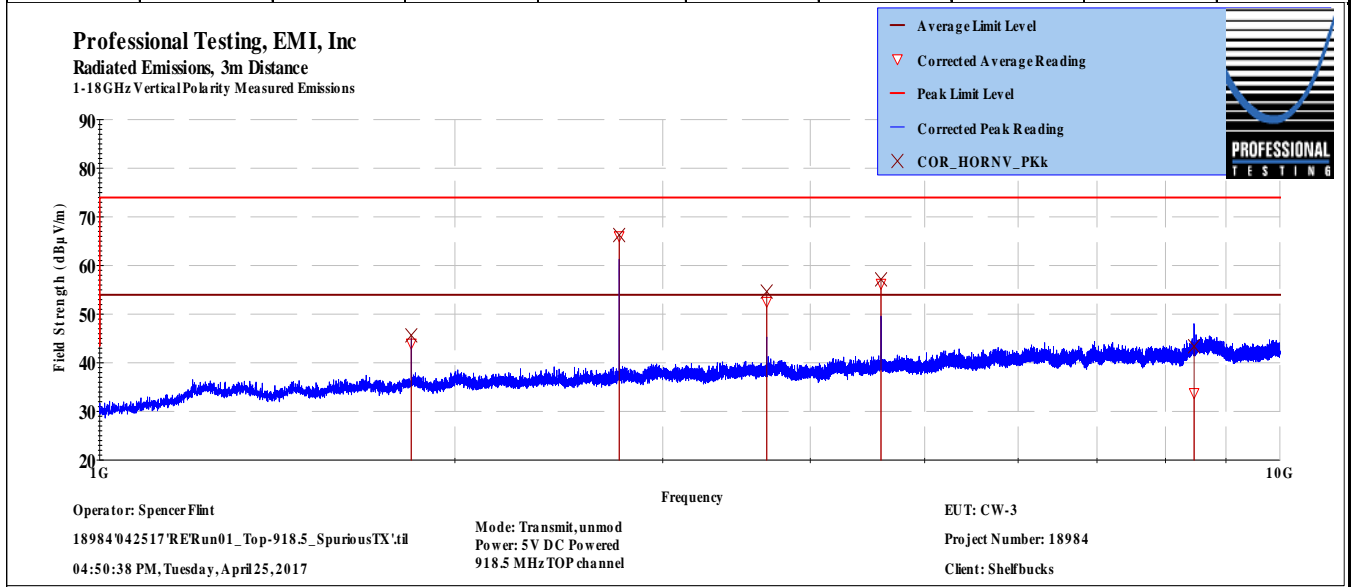
> 1GHz Horizontal Antenna Polarity Measured Emissions

8.3.3 Top Channel Up to 10 GHz

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	GW-3-C
Project Number:	18984	Test Technician:	Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet Page: 1 of 1

EUT Line Voltage:	5 VDC	EUT Power Frequency:	0 N/A						
Antenna Orientation:	Vertical	Frequency Range:	Above 1GHz						
EUT Mode of Operation:		Transmit Mode, Top Channel							
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1836.83	3	20	2.31	Peak	55.3	45.629	74.0	-28.3	Pass
2755.48	3	162	3.58	Peak	74.1	66.244	74.0	-7.7	Pass
3674.02	3	62	3.85	Peak	61.5	54.64	74.0	-19.3	Pass
4592.43	3	183	1.68	Peak	61.5	57.124	74.0	-16.8	Pass
8458.98	3	40	2.89	Peak	37.2	43.36	74.0	-30.6	Pass



> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

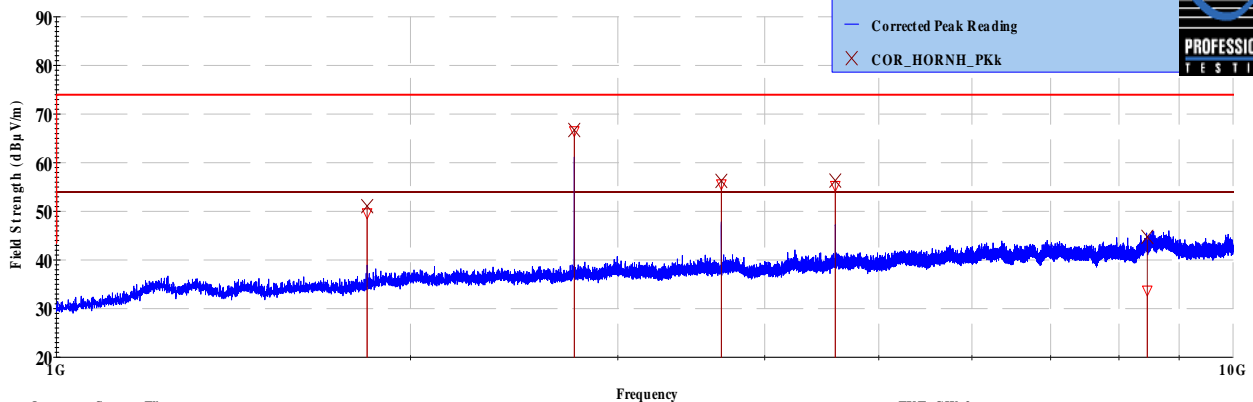
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/25/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	GW-3-C
Project Number:	18984	Test Technician:	Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:	5 VDC	EUT Power Frequency:	0 N/A						
Antenna Orientation:	Horizontal	Frequency Range:	Above 1GHz						
EUT Mode of Operation:		Transmit Mode, Top Channel							
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
1836.99	3	280	3.32	Peak	60.8	51.059	74.0	-22.9	Pass
2755.47	3	215	3.31	Peak	74.6	66.713	74.0	-7.2	Pass
3673.88	3	256	2.27	Peak	63.1	56.247	74.0	-17.7	Pass
4592.52	3	85	1.98	Peak	60.7	56.31	74.0	-17.6	Pass
8458.07	3	49	2.49	Peak	38.6	44.739	74.0	-29.2	Pass

Professional Testing, EMI, Inc
Radiated Emissions, 3m Distance
1-18GHz Horizontal Polarity Measured Emissions



Operator: Spencer Flint

18984\042517\RE\Run01_Top-918.5_SpuriousTX.tif

04:50:38 PM, Tuesday, April 25, 2017

Mode: Transmit, unmod
Power: 5V DC Powered
918.5 MHz TOP channel

EUT: CW-3

Project Number: 18984

Client: Shelfbucks

> 1GHz Horizontal Antenna Polarity Measured Emissions

9.0 Mains Conducted Emission

9.1 Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor and 0.4 meters from the conductive reference plane (wall). The EUT is powered through a line impedance stabilization network (LISN) that provides a measurement tap and a termination approximating 50 Ohms in the measurement range of 150 kHz to 30 MHz. A spectrum analyzer is connected, in turn, to each mains line measurement tap and software is employed to measure the radio frequency noise generated by the EUT.

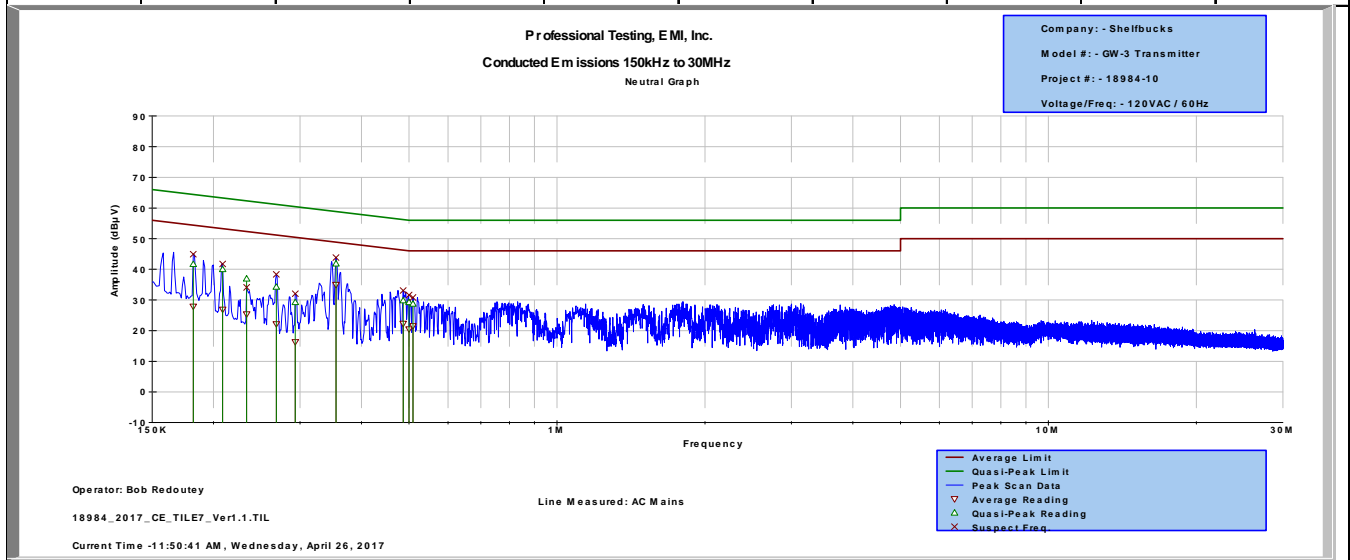
9.2 Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.207 // RSS-Gen 8.3	Mains Conducted Emission	26 Apr 2017

9.3 Results

Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Limits		
Section:	15.107		
Test Date(s):	4/26/2017	EUT Serial #:	None
Customer:	Shelfbucks	EUT Part #:	None
Project Number:	18984-10	Test Technician:	Bob Redoutey
Purchase Order #:	N/A	Supervisor:	Lisa Arndt
Equip. Under Test:	GW-3-C Transmitter	Witness' Name:	None

Conducted Emissions Test Results Data Sheet - Neutral Lead								Page:	1	of	2
EUT Line Voltage:			120	VAC	EUT Line Frequency:			60	Hz		
Frequency Measured (MHz)	Peak Detector Reading (dBµV)	Quasi-peak Detector Reading (dBµV)	Quasi-peak Detector Limit (dBµV)	Quasi-peak Detector Margin (dB)	Quasi-peak Detector Test Results	Average Detector Reading (dBµV)	Average Detector Limit (dBµV)	Average Detector Margin (dB)	Average Detector Test Results		
0.1818	47.4	41.7	64.4	-22.7	PASS	27.9	54.4	-26.5	PASS		
0.2087	44.1	40	63.3	-23.3	PASS	26.9	53.3	-26.4	PASS		
0.2336	41.5	36.9	62.3	-25.4	PASS	25.3	52.3	-27	PASS		
0.2684	38.2	34.2	61.2	-27	PASS	22.2	51.2	-29	PASS		
0.2933	35.7	29.2	60.4	-31.2	PASS	16.3	50.4	-34.2	PASS		
0.355	44.4	41.8	58.8	-17	PASS	35	48.8	-13.9	PASS		
0.4863	34.4	29.8	56.2	-26.5	PASS	22.3	46.2	-24	PASS		
0.5	33.2	29.2	56	-26.8	PASS	20.5	46	-25.5	PASS		
0.5092	33.1	28.7	56	-27.3	PASS	21.5	46	-24.5	PASS		



Measured Conducted Emissions - Neutral Lead

Professional Testing, EMI, Inc.

Test Method: ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

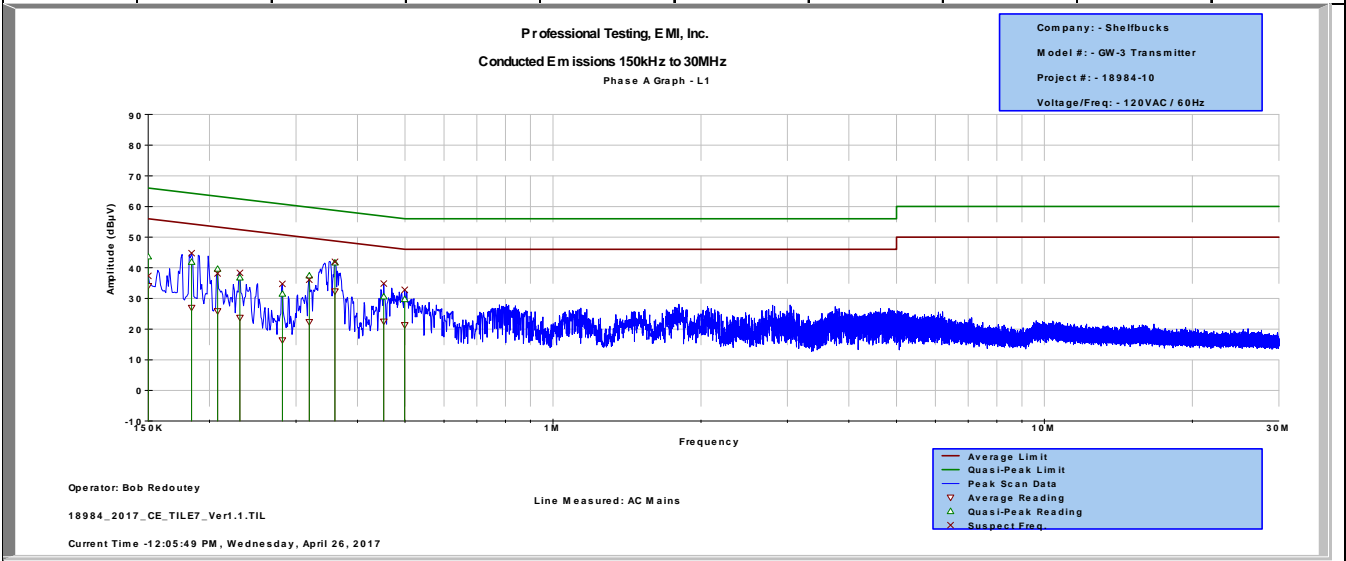
In accordance with: FCC Part 15.107 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Conducted Limits

Section: 15.107

Test Date(s): 4/26/2017	EUT Serial #: None
Customer: Shelfbucks	EUT Part #: None
Project Number: 18984-10	Test Technician: Bob Redoutey
Purchase Order #: N/A	Supervisor: Lisa Arndt
Equip. Under Test: GW-3-C Transmitter	Witness' Name: None

Conducted Emissions Test Results Data Sheet - Phase Lead (Line 1) Page: 2 of 2

EUT Line Voltage: 120 VAC			EUT Line Frequency: 60 Hz						
Frequency Measured (MHz)	Peak Detector Reading (dBµV)	Quasi-peak Detector Reading (dBµV)	Quasi-peak Detector Limit (dBµV)	Quasi-peak Detector Margin (dB)	Quasi-peak Detector Test Results	Average Detector Reading (dBµV)	Average Detector Limit (dBµV)	Average Detector Margin (dB)	Average Detector Test Results
0.15	49	43.6	66	-22.4	PASS	34.1	56	-21.9	PASS
0.1838	47.2	41.9	64.3	-22.4	PASS	27	54.3	-27.3	PASS
0.2077	44	39.6	63.3	-23.7	PASS	25.9	53.3	-27.4	PASS
0.2306	41.2	36.8	62.4	-25.7	PASS	23.8	52.4	-28.7	PASS
0.2813	37.7	31.4	60.8	-29.3	PASS	16.4	50.8	-34.4	PASS
0.3191	38.7	37.4	59.7	-22.3	PASS	22.3	49.7	-27.4	PASS
0.3599	44.9	41.7	58.7	-17.1	PASS	32.3	48.7	-16.4	PASS
0.4525	35.1	30.6	56.8	-26.3	PASS	22.5	46.8	-24.3	PASS
0.4992	32.3	29.7	56	-26.3	PASS	21.3	46	-24.7	PASS



Measured Conducted Emissions - Phase Lead (Line 1)

10.0 Antenna Construction Requirements

10.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevent wireless device antennas from being modified by end users.

10.2 Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.203 // RSS-Gen 8.3	Antenna Construction	28 Jul 2017

10.3 Results

Table 10.3.1 Antenna Construction Details
Manufacturer: Shelfbucks

- Antenna is a rigid whip quarter wave monopole antenna extending out of the plastic enclosure.
- The U.F.L connector used for conducted measurements is not present in the finished product.
- Peak gain is 2.15 dBi.

The antenna design above satisfies the requirements of the rules.

11.0 Equipment

11.1 Radiated Emissions 30 MHz to 10 GHz

Radiated Emissions Test Equipment List					
Tile! Software Version:		4.2.A, May 23, 2010, 08:38:52 AM			
Test Profile:		2016 RE_ClassA - Boresite+Mast_LowPRF_030617.til or 2016 RE_ClassB - Boresite+Mast_LowPRF_030617.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	N/A	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	7/10/2017
1890	HP	8447F	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	2/1/2018
1937	Agilent	E4440A	Spectrum Analyzer, 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/15/2017
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	3/7/2019
C027D	PTI	None	Relay	none	N/A
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
1509B	Braden	N/A	TDK 10M Chamber, VSWR > 1 GHz	DAC-012915-005	6/19/2017
2004	Miteq	AFS44-00101800- 2S-10P-44	Amplifier, 40dB, .1-18GHz	0	1/11/2018
C030	none	none	Cable Coax, N-N, 30m	none	10/1/2017
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	3/15/2019

11.2 Power, Power Spectral Density, Conducted Spurious, Band Edge, and Bandwidth

Asset #	Manufacturer	Model #	Description	Calibration Due
2295	Agilent	E4440A	Spectrum Analyzer	30 Sep 2017

11.3 Mains Conducted Emission

Conducted Emissions Test Equipment List					
Tile! Software Version:		Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM			
Test Profile:		2017_CE_TILE7_Ver1.1.TIL or CE_Marine_100616.TIL			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1145	HP	8568B	Spectrum Analyzer 100Hz-1.5GHz	2517A01821	7/20/2017
1834	HP	85662A	Spec Anal Dsply, use with A/N 1145	2349A06182	N/A
0990	HP	85685A	RF Preselector	3010A01119	7/20/2017
0085	HP	85650A	Quasi-Peak Adapter CISPR	3033A01458	7/20/2017
1173	PTI	100k HPF	Filter, High Pass, 100kHz	none	2/2/2018
1088	PTI	PTI-ALF4	Attenuator Limiter Filter	none	10/6/2017
C171	HP	08444-60018	Cable, RF, BNC-BNC, 18", Grey	none	6/13/2018
C303	Coleman Cable	RG-58A/U	Cable, BNC-BNC, 36" Black	None	3/25/2018
C107	Pomona	RG-223	Cable 9 ft BNC RG-223 (black)	none	8/4/2018
1185	EMCO	3825/2	LISN, 10kHz-100MHz	1235	8/1/2017

12.0 Measurement Bandwidths

Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan				
Frequency Band Start (MHz)	Frequency Band Stop (MHz)	6 dB Bandwidth (kHz)	Number of Ranges Used	Measurement Time per Range
0.009	0.15	0.3	2	Multiple Sweeps
0.15	30	9	6	Multiple Sweeps
30	1000	120	2	Multiple 800 mS Sweeps
1000	6000	1000	2	Multiple Sweeps
6000	18000	1000	2	Multiple Sweeps
18000	26500	1000	2	Multiple Sweeps

*Notes:

1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.
4. The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.
5. The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz.

Conducted Emissions Spectrum Analyzer Bandwidth and Measurement Time				
Frequency Band Start (MHz)	Frequency Band Stop (MHz)	6 dB Bandwidth (kHz)	Number of Ranges Used	Measurement Time per Range
0.01	0.15	0.3	7	Five 1 second sweeps
0.15	30	9	20	Five 1 second sweeps

*Notes:

1. The settings above are specifically calculated for the HP856X series of spectrum analyzers, which have 1,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 10-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.

Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Radiated Emissions	30 to 1,000 MHz	10 m	4.8
	1 to 18 GHz	3 m	5.7

End of Report

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