
Project 18980-15

Shelfbucks, Inc.
CL-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		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: 23 Mar 2016	FCC ID: 2ALSL-CL3C Industry Canada ID: N/A Model(s): CL-3-C Laboratory Project ID: 18980-15

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: CL-3-C	none	902-928 MHz radio using 2 channels in a proprietary scheme

Table 1.2.2: Support Equipment		
Manufacturer / Model	Serial #	Description
N/A	none	

The EUT is a small battery powered device that is magnetically mounted inverted to a metal ceiling frame member or similar. It collects and relays widely time-spaced status information from MB-3-C end points via a proprietary wireless network. It is battery powered by a CR123A type lithium battery cell.

The EUT electronics are on a single circuit board which measures approximately 12 cm x 2.5 cm x 1.7 cm including the battery holder. It is installed in a plastic enclosure with a magnet to hold the device in place.

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:

Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain = Corrected Level

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

Raw Measured Level + Attenuator Factor + Cable Losses = Corrected Level

Conducted mains levels are determined as follows:

Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses = Corrected Level

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

1.7 Applicable Documents and Clauses

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

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.

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	6 Apr 2017

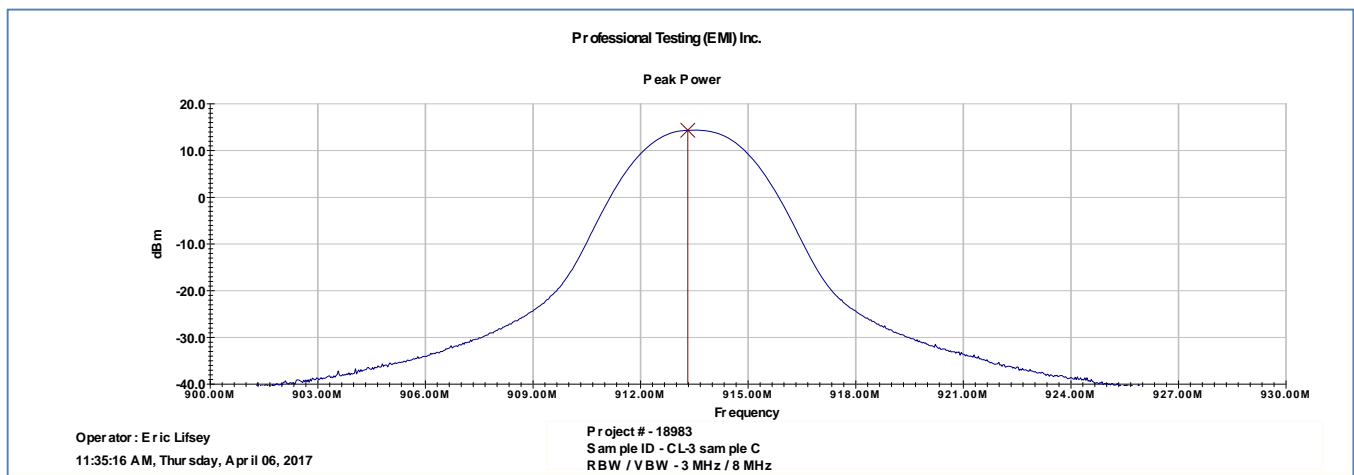
2.3 Test Results, Peak Power

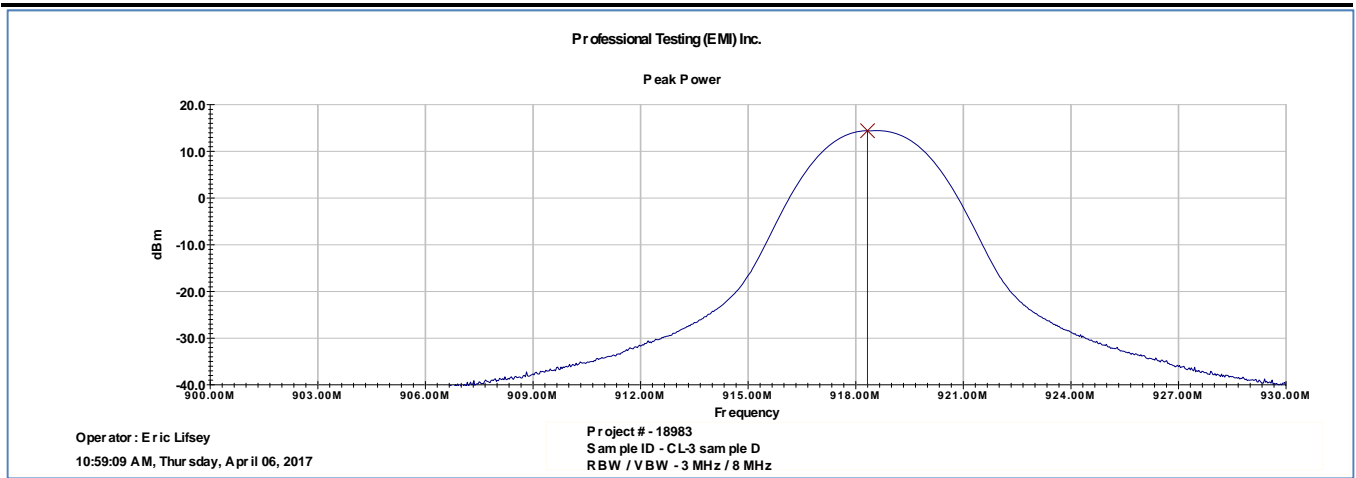
The EUT was measured for conducted power by connection directly to a spectrum analyzer.

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	14.3	2.15	16.5	44.7
918.5	14.4	2.15	16.6	45.7

Measured in 3 MHz RBW, 8 MHz VBW.

The EUT satisfied the requirements.





2.4 Test Results, Duty Cycle

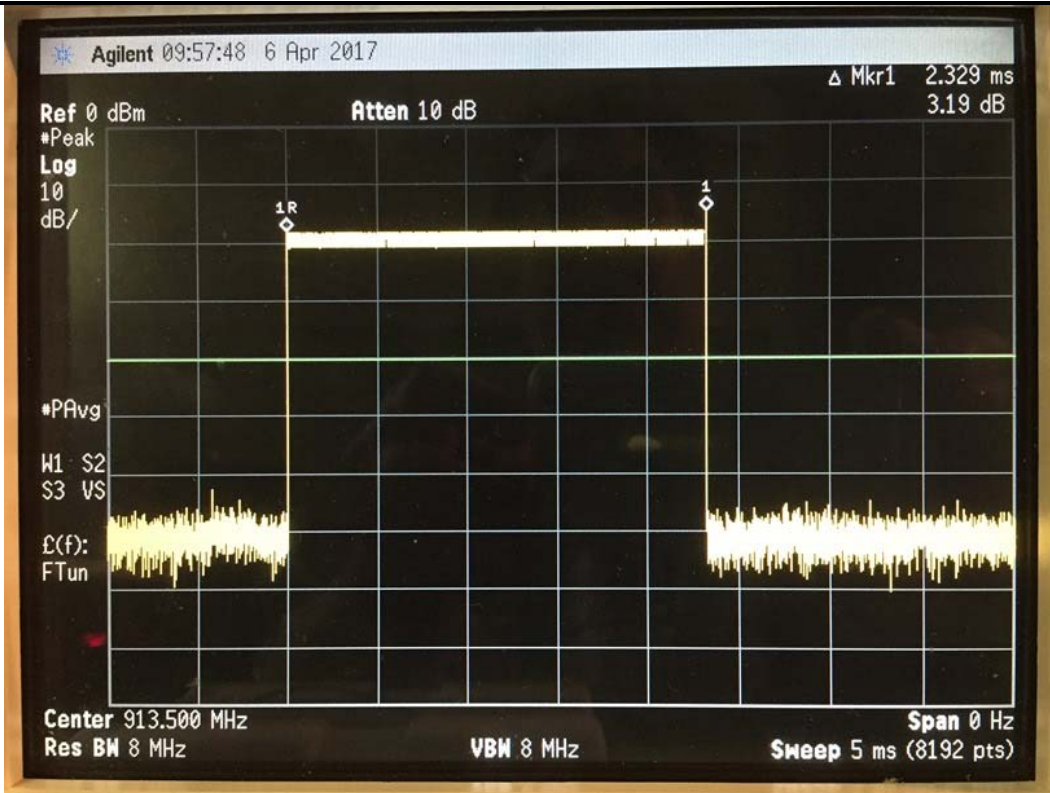
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. 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	1204 100 allowed	= 20 * Log ₁₀ (2.33 msec / 100 msec)	-32.7	-20

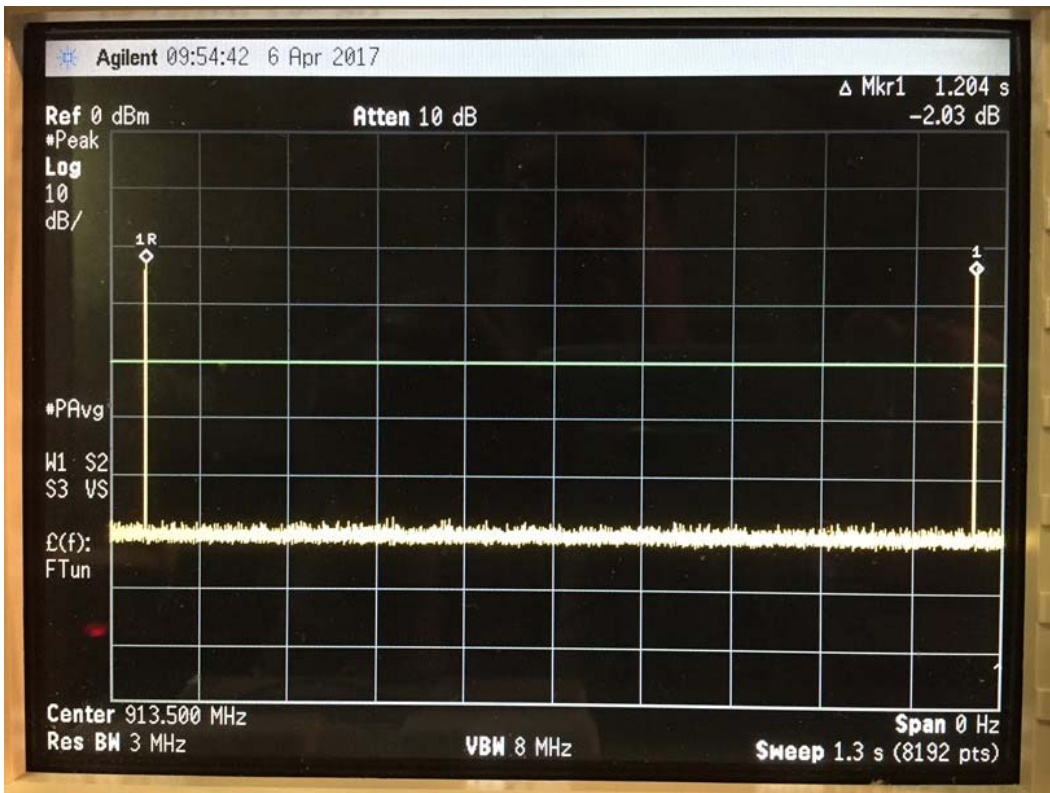
The weighted duty cycle for exposure purposes is: $10 \log (2.33 / 1204) = -27.1 \text{ dB}$

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.

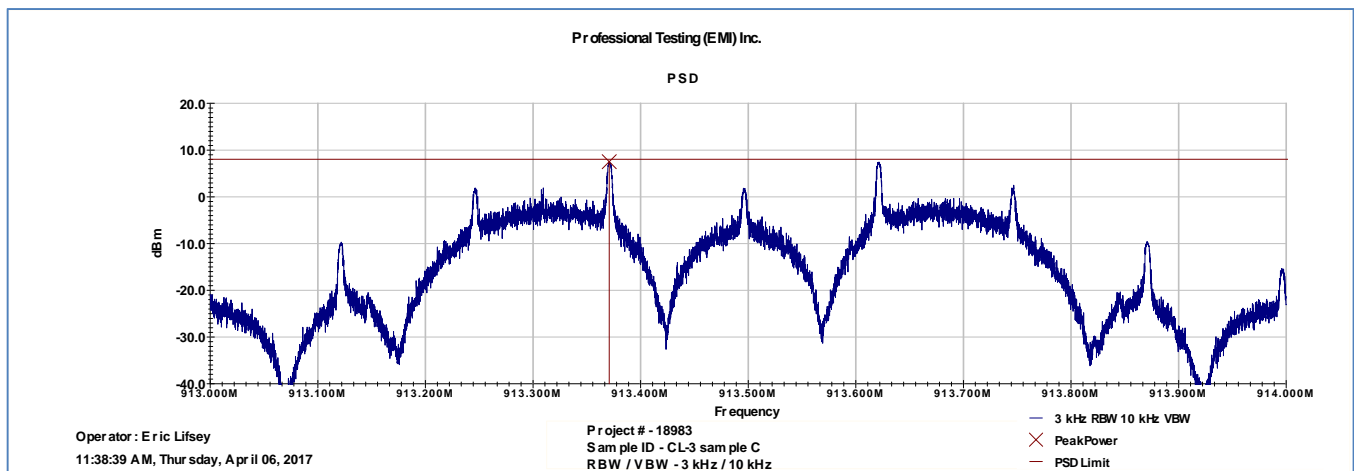
3.2 Test Criteria

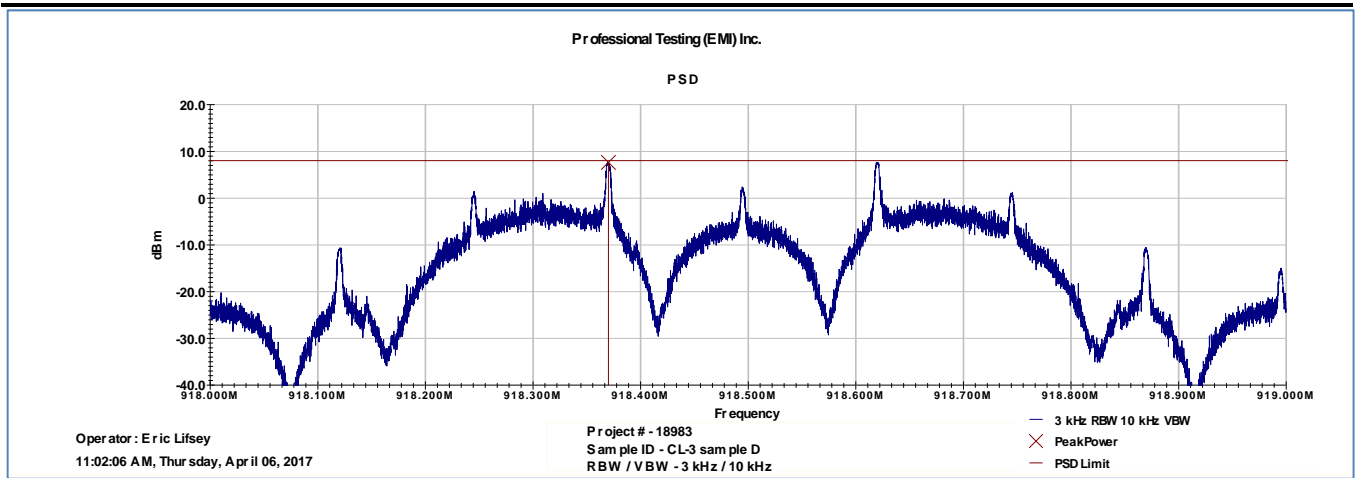
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(e) // RSS-247, 5.2	Power Spectral Density, Conducted Limit: 8 dBm / 3 kHz Restated as field strength limit: 103.23 dB μ V/m at 3 m	6 Apr 2017

3.3 Test Results

Table 3.3.1 Power Spectral Density, Conducted	
Frequency MHz	Measured Peak Power dBm
913.5	7.5
918.5	7.6

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	6 Apr 2017

4.3 Test Results

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

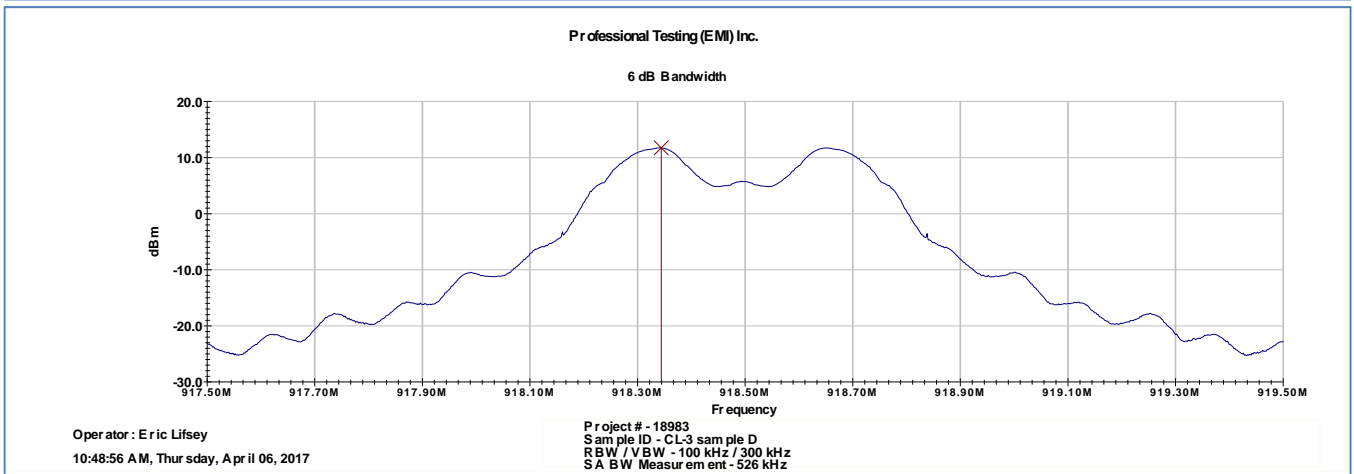
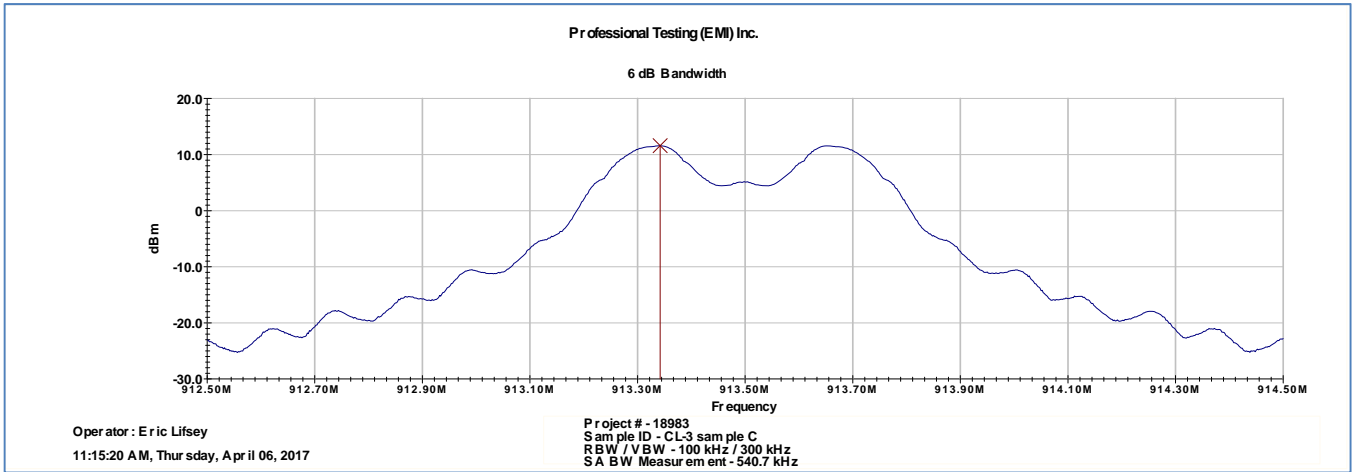
The EUT was found to be in compliance with applicable requirements.

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)
540.7		526.0	526.0

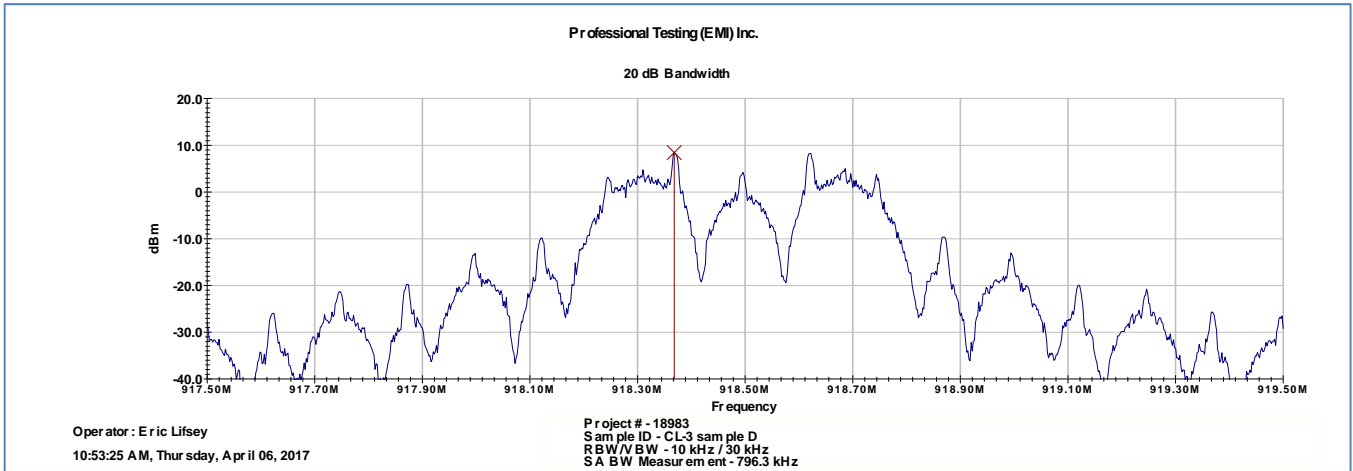
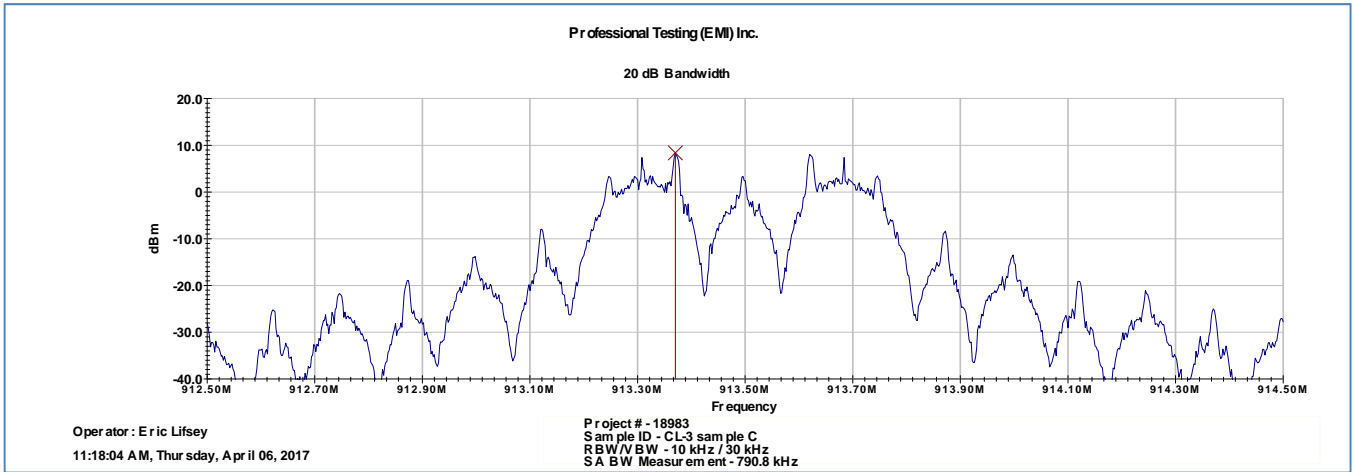
Table 4.3.2 Bandwidth 20 dB, Measure and Report			
Low Channel Measured BW (kHz)		High Channel Measured BW (kHz)	Reported Maximum BW (kHz)
790.8		796.3	796.3

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

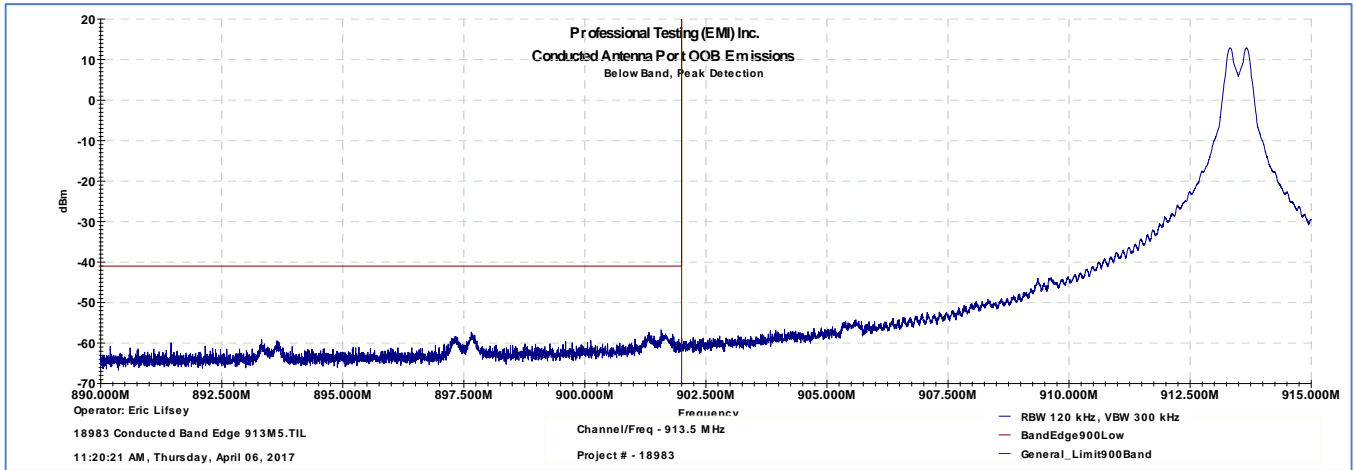
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.205 // RSS-247 5.5, RSS-Gen 4.9	Unwanted Emissions Adjacent to Authorized Band, Radiated	6 Apr 2017

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.

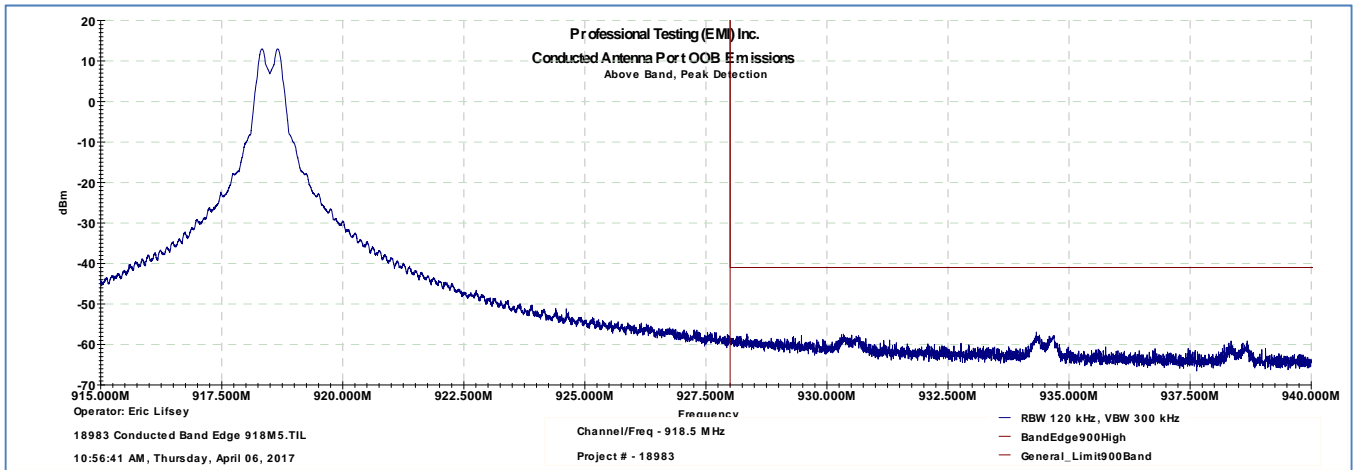
The EUT satisfied the criteria. Plotted results of peak detection appear on the following pages.

5.3.1 Low Channel Band Edge



Peak detection in 100 kHz RBW is employed.

5.3.2 High Channel Band Edge



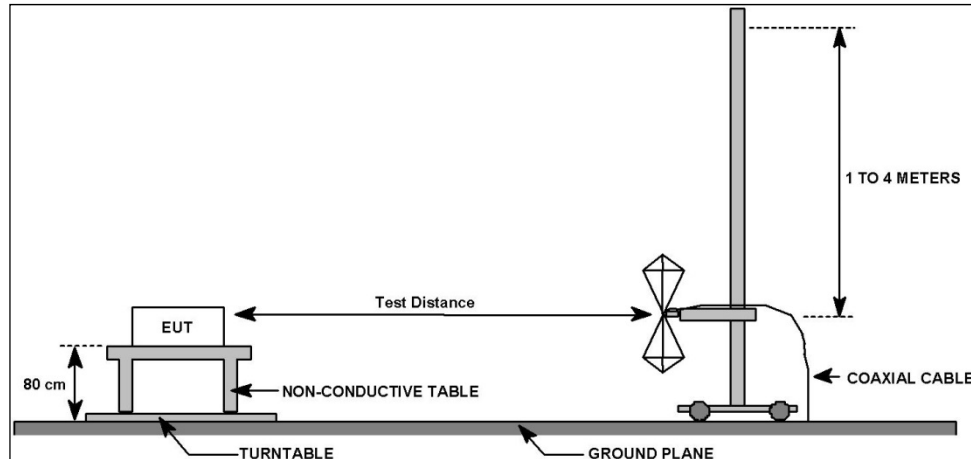
Peak detection is employed while the general emission limits for average are shown.
 The applicable duty cycle factor is -20 dB.

6.0 Radiated Spurious Emissions, Receive Mode

6.1 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 and 1 MHz resolution bandwidth. A diagram showing the test setup appears below.



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	3 Apr 2017

6.3 Test Results

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

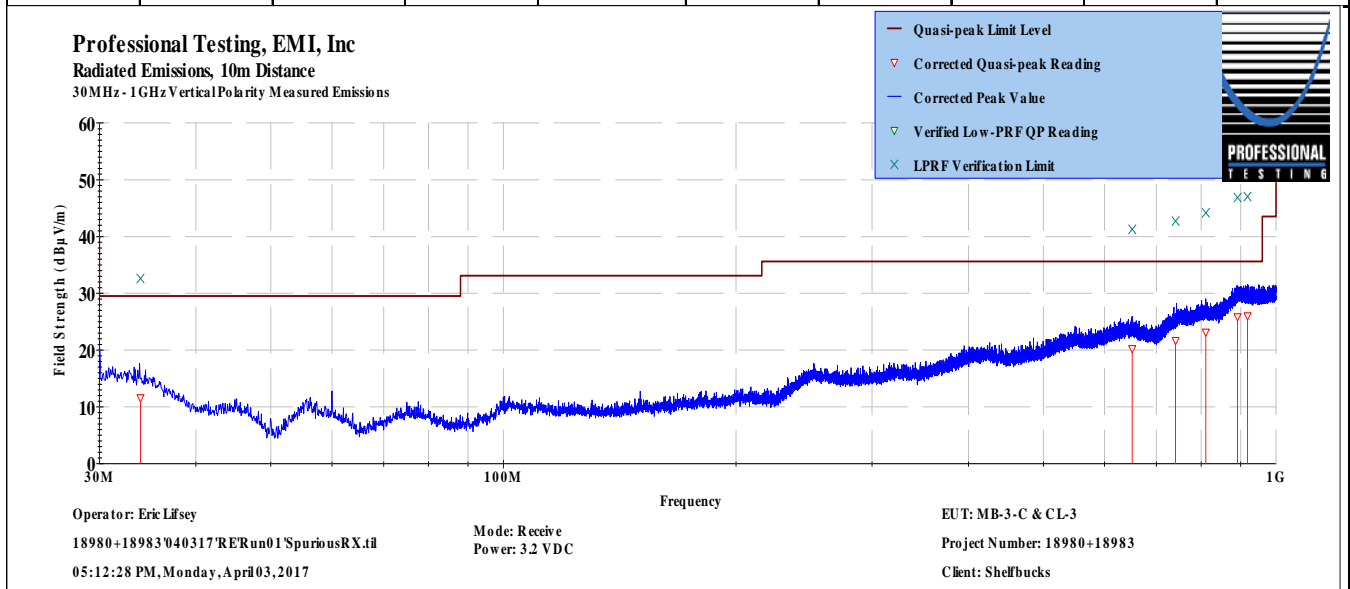
The EUT satisfied the criteria. Recorded data is presented below.

6.3.1 Up to 1 GHz

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 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	00010, none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980, 18983	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C, CL-3	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet Page: 1 of 1

EUT Line Voltage:	3.2V	VDC	EUT Power Frequency:	0	N/A				
Antenna Orientation:	Vertical		Frequency Range:	30MHz to 1GHz					
EUT Mode of Operation:			Receive 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
33.9044	10	18	2.92	Quasi-peak	23.4	11.591	29.5	-17.9	Pass
651.529	10	132	3.79	Quasi-peak	22	20.258	35.6	-15.3	Pass
741.649	10	278	3.94	Quasi-peak	21.7	21.7	35.6	-13.9	Pass
811.493	10	6	1.54	Quasi-peak	21.5	23.162	35.6	-12.4	Pass
891.806	10	243	1.93	Quasi-peak	21.4	25.863	35.6	-9.7	Pass
918.817	10	17	1.43	Quasi-peak	21.2	26.02	35.6	-9.6	Pass



≤ 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

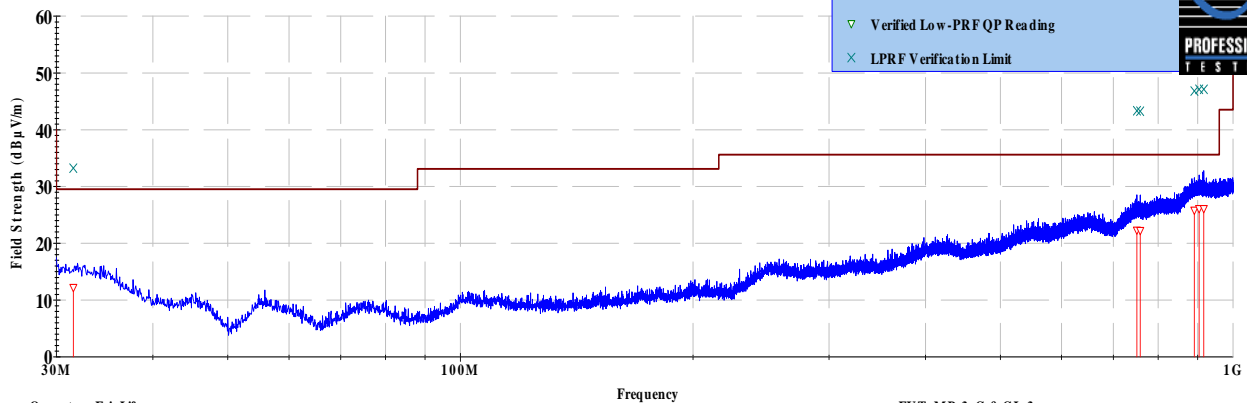
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	00010, none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980, 18983	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C, CL-3	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		3.2V VDC		EUT Power Frequency:		0 N/A			
Antenna Orientation:		Horizontal		Frequency Range:		30MHz to 1GHz			
EUT Mode of Operation:					Receive 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
31.5525	10	222	3.57	Quasi-peak	24.2	12.22	29.5	-17.3	Pass
751.134	10	227	2.06	Quasi-peak	21.7	22.322	35.6	-13.3	Pass
758.632	10	169	2.9	Quasi-peak	21.6	22.234	35.6	-13.4	Pass
891.336	10	117	3.7	Quasi-peak	21.3	25.812	35.6	-9.8	Pass
904.238	10	36	3.96	Quasi-peak	21.2	26.1	35.6	-9.5	Pass
916.831	10	89	1.33	Quasi-peak	21.3	26.109	35.6	-9.5	Pass

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



Operator: Erik Lifsey

18980+18983\040317\RE\Run01\SpuriousRX.tif

05:12:28 PM, Monday, April 03, 2017

Mode: Receive
 Power: 3.2 VDC

EUT: MB-3-C & CL-3

Project Number: 18980+18983

Client: Shelfbucks

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

6.3.2 Up to 10 GHz

Professional Testing, EMI, Inc.

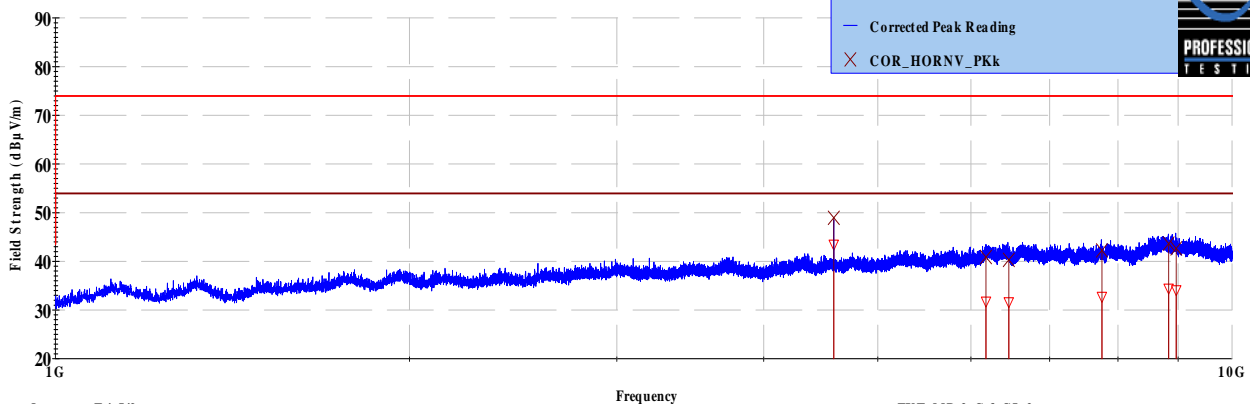
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	00010, none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980, 18983	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C, CL-3	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

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EUT Line Voltage:	3.2V VDC	EUT Power Frequency:	0 N/A						
Antenna Orientation:	Vertical	Frequency Range:	Above 1GHz						
EUT Mode of Operation: Receive 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
4587.49	3	217	1.67	Average	47.8	43.46	54.0	-10.5	Pass
6179.24	3	184	2.75	Average	31.6	31.782	54.0	-22.2	Pass
6462.01	3	176	1.28	Average	31	31.662	54.0	-22.3	Pass
7752.33	3	23	3.03	Average	28.1	32.752	54.0	-21.2	Pass
8835.35	3	184	2.89	Average	27.1	34.43	54.0	-19.5	Pass
8966.89	3	231	3.59	Average	27.1	34.114	54.0	-19.8	Pass

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



Operator: Eric Lifsey

18980+18983\040317\RE\Run01\SpuriousRX.til

05:55:17 PM, Monday, April 03, 2017

Mode: Receive
Power: 3.2 VDC

EUT: MB-3-C & CL-3

Project Number: 18980+18983

Client: Shelfbucks

> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

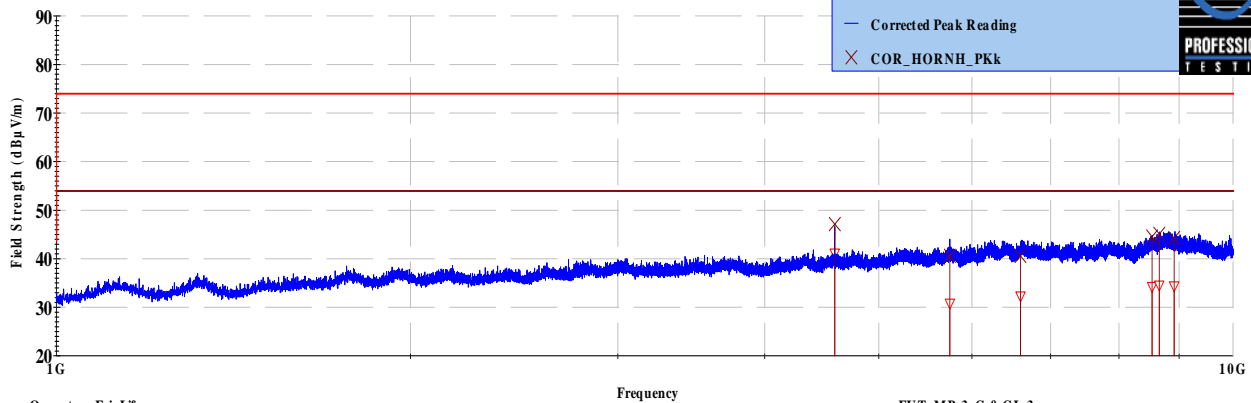
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, Radiated Emissions Limits		
Section:	15.109		
Test Date(s):	4/3/2017	EUT Serial #:	00010, none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980, 18983	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C, CL-3	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		3.2V VDC		EUT Power Frequency:		0 N/A			
Antenna Orientation:		Horizontal		Frequency Range:		Above 1GHz			
EUT Mode of Operation:					Receive 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
4587.54	3	184	1.17	Average	45.5	41.108	54.0	-12.8	Pass
5746.93	3	39	2.66	Average	32.1	30.808	54.0	-23.1	Pass
6598.08	3	220	2.96	Average	30.9	32.292	54.0	-21.7	Pass
8538.31	3	83	2.88	Average	27.6	34.236	54.0	-19.7	Pass
8656.92	3	305	1.79	Average	27.4	34.535	54.0	-19.4	Pass
8912.57	3	246	2.4	Average	27.3	34.382	54.0	-19.6	Pass

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



Operator: Eric Lifsey
 18980+18983 040317 RERun01 SpuriousRX.ttl
 05:55:17 PM, Monday, April 03, 2017

Mode: Receive
 Power: 3.2 VDC

EUT: MB-3-C & CL-3
 Project Number: 18980+18983
 Client: Shelfbucks

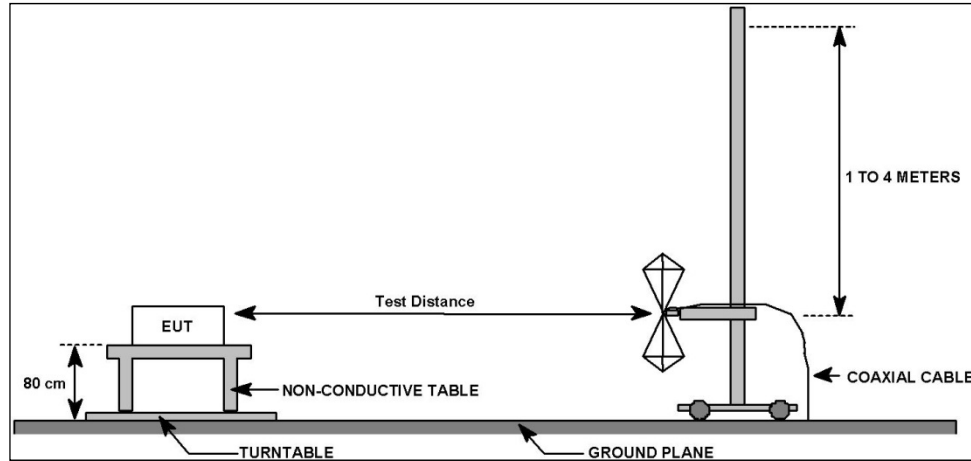
> 1GHz Horizontal Antenna Polarity Measured Emissions

7.0 Radiated Spurious Emissions, Transmit Mode

7.1 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.



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	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode	3 Apr 2017

7.3 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.

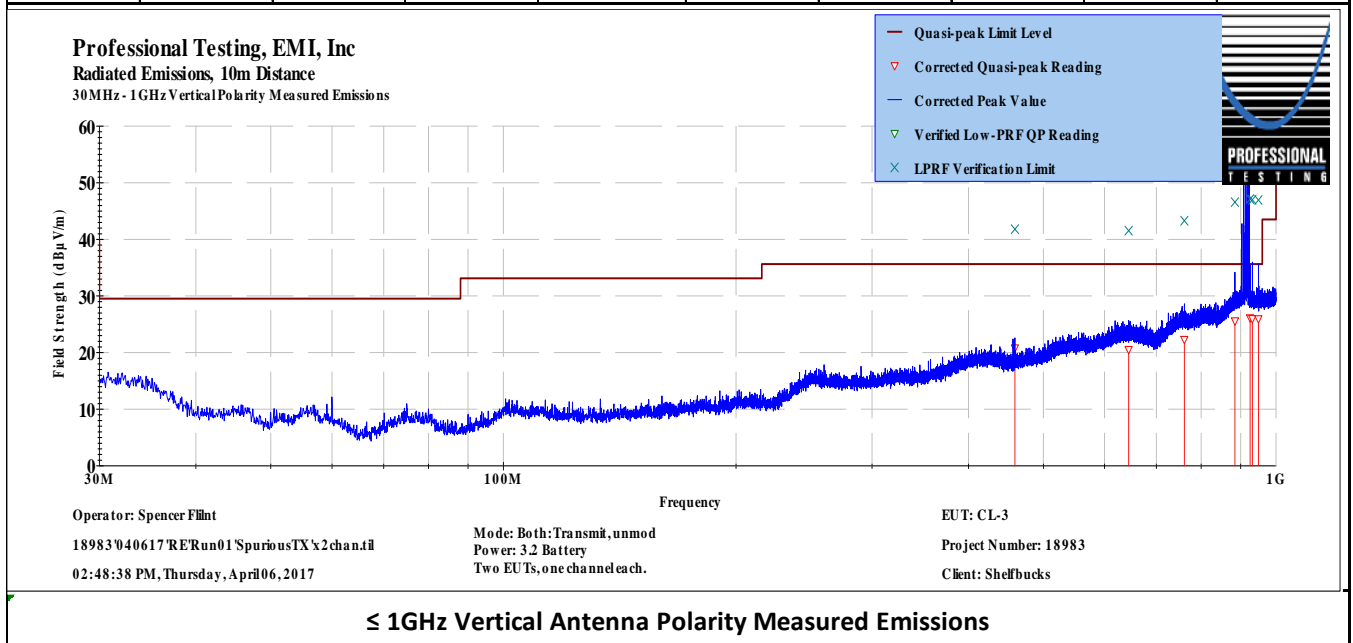
The duty cycle averaging factor applies -20.0 dB to the peaks recorded for the harmonics. As all peaks were below the peak limit above 1 GHz, the averaged emissions are also below the average limit.

7.3.1 All Channels 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):	4/3/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	19893	Test Technician:	Eric Lifsey / Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	CL-3 (2 EUTs for 2 channels)	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet Page: 1 of 1

EUT Line Voltage:	3.2 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
459.245	10	329	3.16	Quasi-peak	28.1	20.801	35.6	-14.8	Pass
644.723	10	286	2.95	Quasi-peak	22.4	20.536	35.6	-15.1	Pass
761.089	10	134	3.78	Quasi-peak	21.7	22.288	35.6	-13.3	Pass
884.889	10	355	3.7	Quasi-peak	21.4	25.564	35.6	-10.0	Pass
925.911	10	210	3.7	Quasi-peak	21.3	26.108	35.6	-9.5	Pass
932.063	10	158	2.41	Quasi-peak	21.1	25.986	35.6	-9.6	Pass
949	10	228	3.86	Quasi-peak	21	25.949	35.6	-9.7	Pass



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):	4/3/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	19893	Test Technician:	Eric Lifsey / Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	CL-3 (2 EUTs for 2 channels)	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

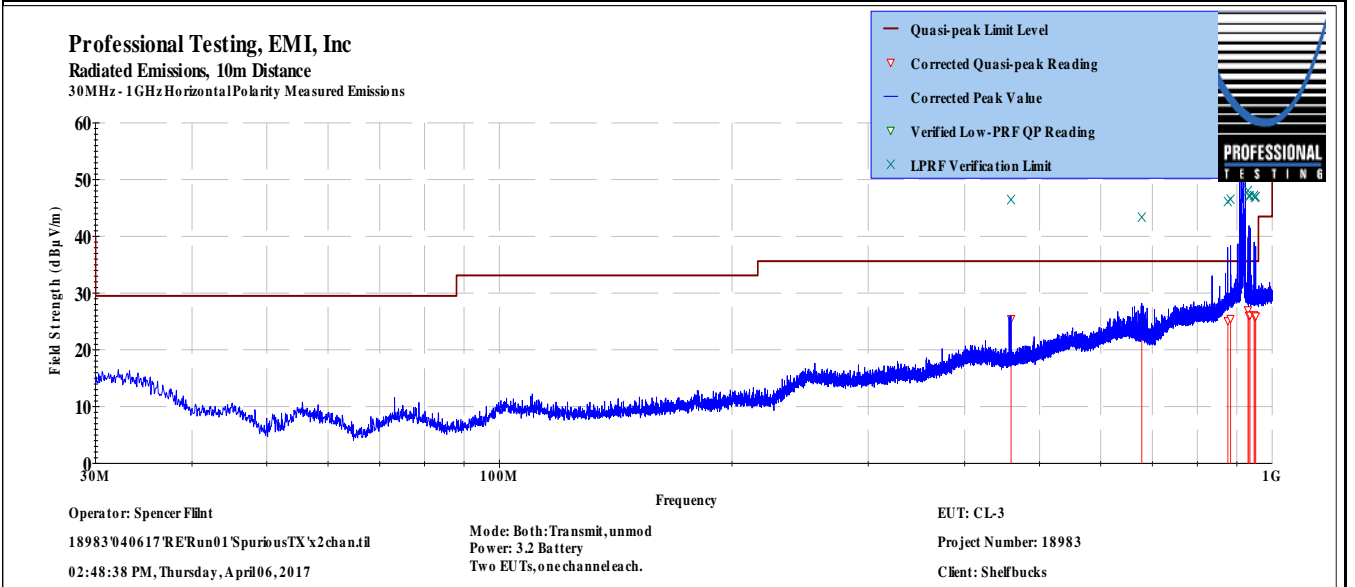
Page: 1 of 1

EUT Line Voltage:	3.2 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
459.359	10	90	1.6	Quasi-peak	32.8	25.474	35.6	-10.1	Pass
678.076	10	41	1.44	Quasi-peak	24.8	22.369	35.6	-13.2	Pass
876.303	10	121	3.48	Quasi-peak	21.4	25.139	35.6	-10.5	Pass
883.674	10	51	3.52	Quasi-peak	21.4	25.514	35.6	-10.1	Pass
930.519	10	204	3.52	Quasi-peak	22.2	27.058	35.6	-8.5	Pass
933.317	10	206	1.28	Quasi-peak	21.2	26.09	35.6	-9.5	Pass
936.468	10	212	2.65	Quasi-peak	21.2	26.106	35.6	-9.5	Pass
947.504	10	285	1.16	Quasi-peak	21.2	26.168	35.6	-9.4	Pass
950.273	10	132	2.76	Quasi-peak	20.9	25.884	35.6	-9.7	Pass
952.595	10	163	1.4	Quasi-peak	21	25.987	35.6	-9.6	Pass



≤ 1GHz Horizontal Antenna Polarity Measured Emissions

7.3.2 All Channels Up to 10 GHz

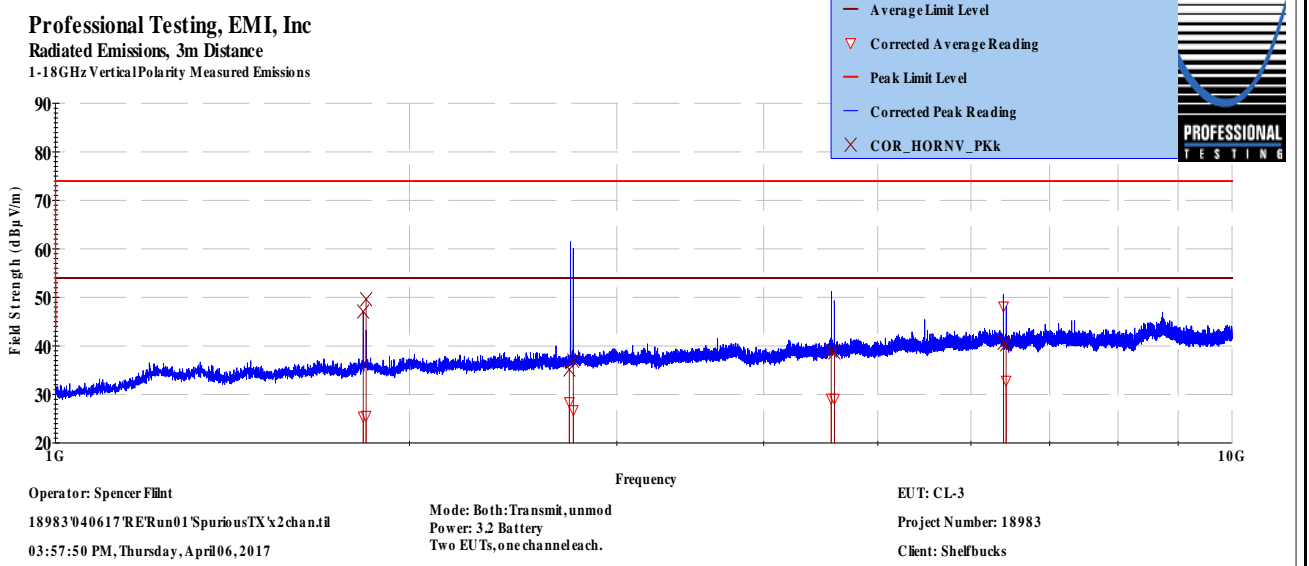
Professional Testing, EMI, Inc.			
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/3/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	19893	Test Technician:	Eric Lifsey / Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	CL-3 (2 EUTs for 2 channels)	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet Page: 1 of 1

EUT Line Voltage:	3.2 VDC	EUT Power Frequency:	0 N/A
Antenna Orientation:	Vertical	Frequency Range:	Above 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
1826.49	3	219	3.69	Peak	56.8	47.052	74.0	-26.9	Pass
1837	3	42	3.58	Peak	59.3	49.605	74.0	-24.4	Pass
2734.53	3	302	3.78	Peak	43.1	35.134	74.0	-38.8	Pass
2755.52	3	25	2.96	Peak	44.8	36.94	74.0	-37.0	Pass
4564.22	3	351	2.67	Peak	43.4	38.971	74.0	-35.0	Pass
4593.01	3	215	3.04	Peak	43	38.633	74.0	-35.3	Pass
6395.25	3	277	1.45	Peak	40	40.614	74.0	-33.3	Pass
6427.84	3	141	2.46	Peak	39.7	40.311	74.0	-33.6	Pass



> 1GHz Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

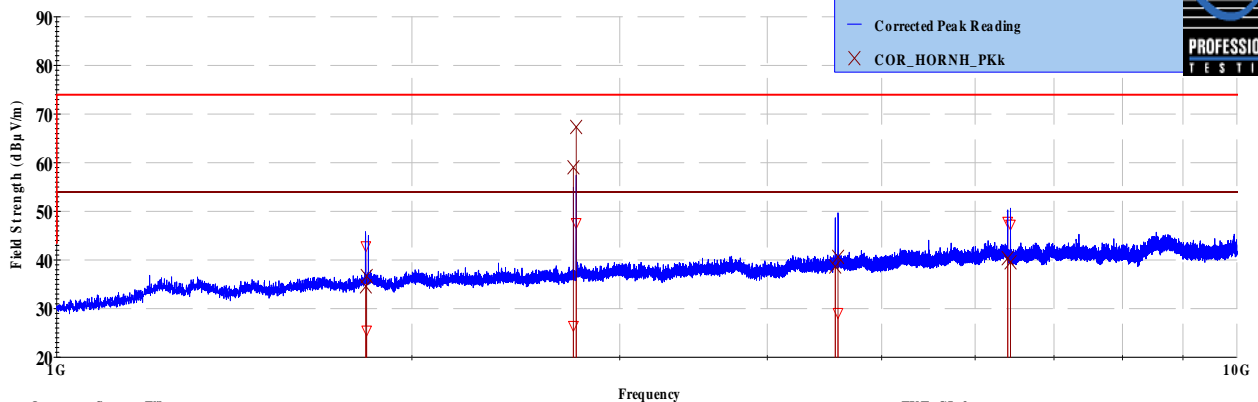
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/3/2017	EUT Serial #:	none
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	19893	Test Technician:	Eric Lifsey / Spencer Flint
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	CL-3 (2 EUTs for 2 channels)	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:	3.2 VDC	EUT Power Frequency:	0 N/A						
Antenna Orientation:	Horizontal	Frequency Range:	Above 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
1827.98	3	289	2.71	Peak	44.3	34.587	74.0	-39.4	Pass
1830.81	3	319	1.54	Peak	46.4	36.649	74.0	-37.3	Pass
2740.5	3	137	3.87	Peak	67	59.036	74.0	-14.9	Pass
2755.47	3	20	2.37	Peak	75.2	67.315	74.0	-6.6	Pass
4567.48	3	216	2.49	Peak	43.1	38.652	74.0	-35.3	Pass
4592.48	3	249	2.44	Peak	45	40.62	74.0	-33.3	Pass
6394.52	3	77	1.94	Peak	39.7	40.346	74.0	-33.6	Pass
6429.51	3	263	1.85	Peak	38.9	39.511	74.0	-34.4	Pass

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



Operator: Spencer Flint

18983\040617\RE\Run01\SpuriousTXx2chan.fil

03:57:50 PM, Thursday, April 06, 2017

Mode: Both:Transmit, unmod
Power: 3.2 Battery
Two EUTs, one channel each.

EUT: CL-3

Project Number: 18983

Client: Shelfbucks

> 1GHz Horizontal Antenna Polarity Measured Emissions

8.0 Antenna Construction Requirements

8.1 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.

8.2 Criteria

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

8.3 Results

Table 8.3.1 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.

9.0 Equipment

9.1 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

9.2 Power, Power Spectral Density, Bandwidth, and Duty Cycle

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

10.0 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.

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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