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

Written by

Larry Finn Chief Technical Officer 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.	FCC ID:	2ALSL-CL3C
2500 Bee Caves Rd Bldg.2, Suite 240	Industry Canada ID:	N/A
Austin, TX 78746	Model(s):	CL-3-C
Certificate Date: 23 Mar 2016	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, <u>2400-2483.5 MHz</u> , 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)	

<sup>\*</sup>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.



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

Table 1.7.1: Applicable Documents			
Document	Title		
47 CFR	Part 15 – Radio Frequency Devices		
47 CFR	Subpart C -Intentional Radiators		
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-		
N33-247 ISSUE 2	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		
ANSI C05.10:2013	Wireless Devices		

Table 1.7.2: Applicable Clauses				
Parameter	FCC Part 15	IC RSS References		
Parameter	Rule Paragraphs	ic K33 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	Date			
	Fundamental Power			
15.247(a)(3) //	Conducted Limits	6 Apr 2017		
RSS-247 5.2	1 W	0 Apr 2017		
	Limit Restated as Field: 125.23 dBμV/m @ 3 m			

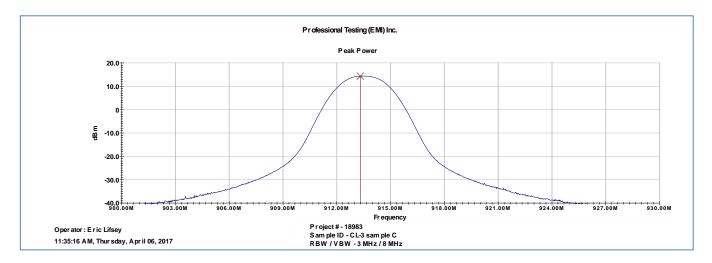
# 2.3 Test Results, Peak Power

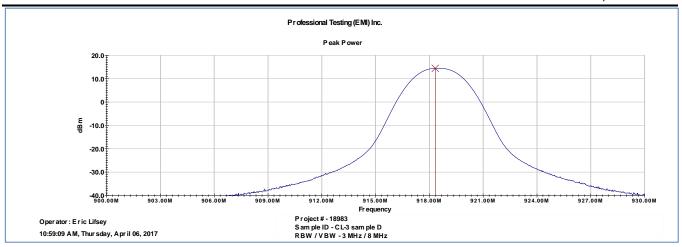
The EUT was measured for conducted power by connection directly to a spectrum analyzer.

Table 2.3.1 Power, Peak, Conducted					
Frequency Measured Peak Antenna Gain EIRP EIRP Pea MHz Power in dBm dBi dBm Restated					
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

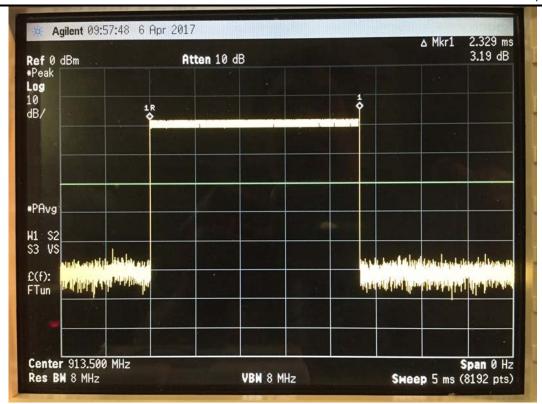
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power.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

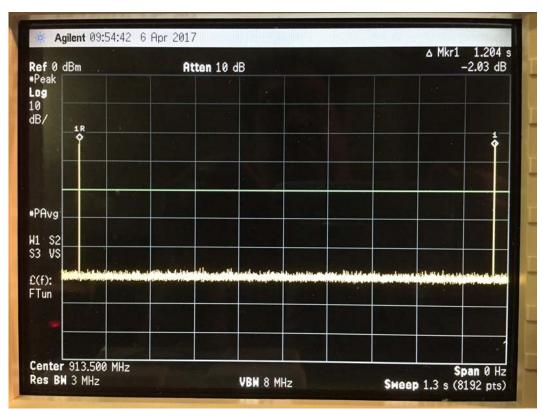
The weighted duty cycle for exposure purposes is:  $10 \log (2.33 / 1204) = -27.1 \text{ dB}$ 

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.

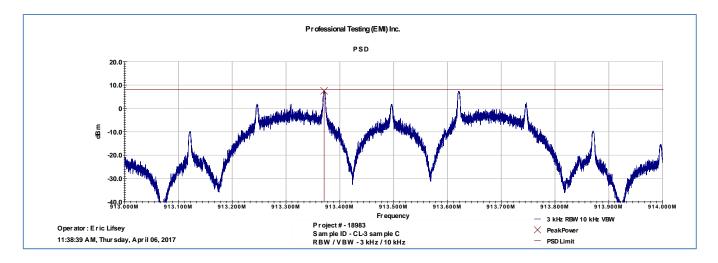
#### 3.2 Test Criteria

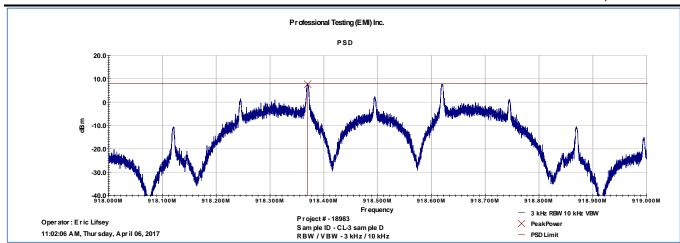
47 CFR (USA) // IC (Canada)				
Section Reference	Parameter	Date		
15.247(e) // RSS-247, 5.2	Power Spectral Density, Conducted Limit: 8 dBm / 3 kHz Restated as field strength limit: 103.23 dBμV/m at 3 m	6 Apr 2017		

#### 3.3 Test Results

Table 3.3.1 Power Spectral Density, Conducted							
Frequency Measured Peak Power MHz 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.

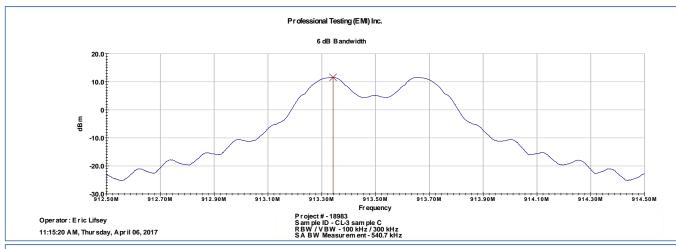
The EUT was found to be in compliance with applicable requirements.

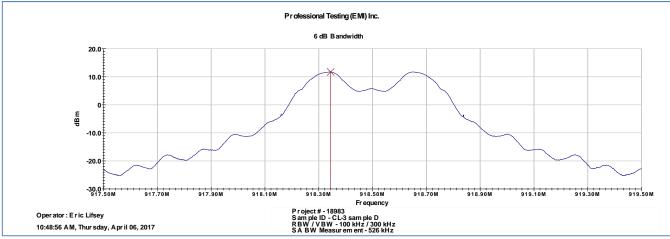
Table 4.3.1 Band	Table 4.3.1 Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW								
Low Channel High Channel Reported									
Measured BW		Measured BW	Minimum BW						
(kHz)		(kHz)	(kHz)						
540.7		526.0	526.0						

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

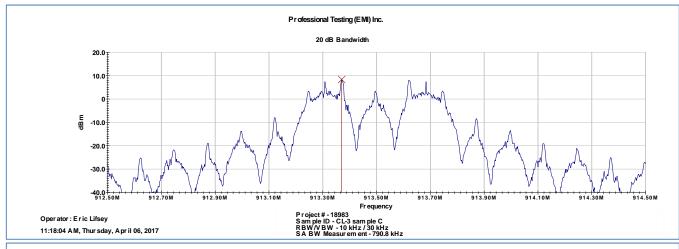
Plotted measurements appear on the following pages.

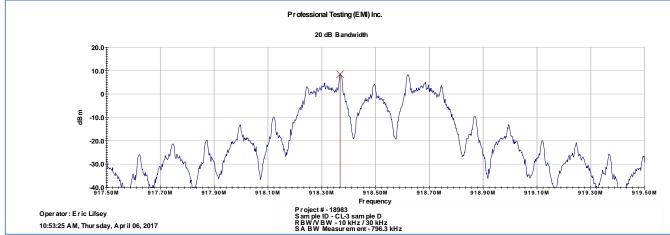
# 4.3.1 Bandwidth Plots, 6 dB





# 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

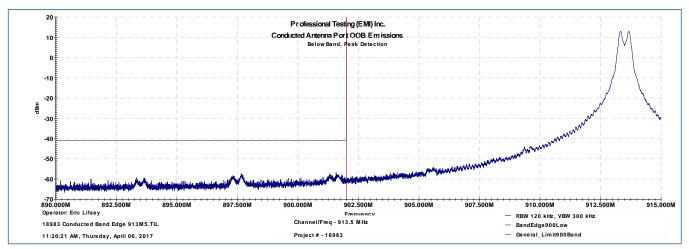
47 CFR (USA) // IC (Canada)							
Section Reference	Parameter	Date(s)					
15.247, 15.205 //	Unwanted Emissions Adjacent to Authorized	6 Apr 2017					
RSS-247 5.5, RSS-Gen 4.9	Band, Radiated	6 Apr 2017					

#### 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.

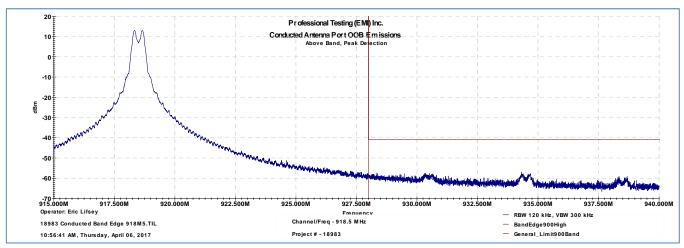
The EUT satisfied the criteria. Plotted results of peak detection appear on the following pages.

# 5.3.1 Low Channel Band Edge



Peak detection in 100 kHz RBW is employed.

# 5.3.2 High Channel Band Edge



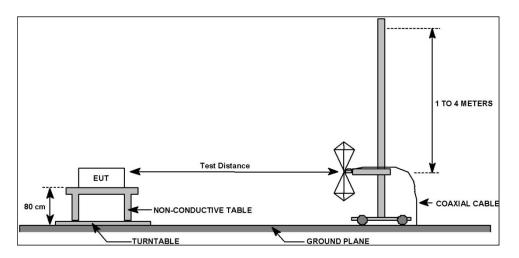
Peak detection is employed while the general emission limits for average are shown. The applicable duty cycle factor is -20 dB.

### 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

ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions fro Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz  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: Shelfbrucks 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  EUT Line Voltage: 3.2V VDC EUT Power Frequency: 0 N/A  Antenna Orientation: Vertical Frequency Receive Mode  Frequency Test Distance Direction (Meters) (Degrees) (Meters) Function (Meters) Function (Meters) (Degrees) (Meters) (GBμV/m) (Meters) (GBμV/m) (GB)  (MHz) (Meters) (Degrees) (Meters) (Degrees) (2.3.4 11.591 29.5 1.7.9 Pass 191.493 10 6 1.24 3.9.94 Quasi-peak 2.2 20.258 35.6 -15.3 Pass 191.493 10 6 6 1.54 Quasi-peak 21.7 21.7 35.6 1.3.9 Pass 191.8017 10 17 1.43 Quasi-peak 21.4 25.863 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.4 25.863 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.2 26.02 35.6 9.9.6 Pass 191.8017 10 17 1.43 Quasi-peak 21.7 21.7 21.7 21.7 21.7 21.7 21.7 21.7				Profess	sional Te	sting, El	MI, I	nc.					
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Test Date(s):		ce with:	Emissions		Federal Regulat	ions Part 47, S	Subpar	t B - Un	intention	al Rac	liators, Radi	ated	
Shelfbucks   EUT Part #:   none   Project Number:   18980, 18983   Test Technician:   Eric Lifsey   Protective Project Number:   18980, 18983   Test Technician:   Eric Lifsey   Professional Testing, EMI, Inc Rediated Emissions Test Results Data Sheet   Page:   1   of									_				
Project Number:   18980, 18983   Test Technician:   Eric Lifsey	•	):							_	none			
Supervisor:   Lisa Arndt   Devin Murphy   Devin Murphy			_				-						
Radiated Emissions Test Results Data Sheet   Page: 1 of				3983					7	_			
Radiated Emissions Test Results Data Sheet			_						_		•		
EUT Line Voltage: 3.2V VDC   EUT Power Frequency: 0 N/A	quip. Und	er Test:	MB-3-C, (	CL-3		Witness' N	ame:		Devin N	/lurpl	ny		
EUT Mode of Operation:   Receive Mode		F	Radiated E	missions Test	Results Data	a Sheet				Page	e: 1	of	1
Test   EUT   Mode of Operation:   Receive Mode	EUT Li	ne Voltage:	:	3.2V VDC		EUT Pow	ver Fr	equen	су:	0	N/A		
Test   Distance   Distance   (Meters)   Detector   Height   (Meters)   Detector   Distance   (Meters)   Detector   Distance   (Meters)   Detector   Distance   Distance   Detector   Distance   Distance   Distance   Detector   Det	Antenna	Orientatio	n:	Vertic	al	Frequ	ency F	Range:		;	30MHz to	1GHz	
Measured (MHz)		EUT N	lode of O	peration:				R	eceive N	/lode	!		
Solution	Measured	Distance	Direction	Height		Amplitude	Le	vel		_	_	Test R	esults
T41.649	33.9044	10	18	2.92	Quasi-peak	23.4	11.	591	29.5		-17.9	Pa	SS
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 Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz-1GHz Vertical Polarity Measured Emissions 10m Unitance 30MHz-1GHz Vertical Polarity Measured Emissions 100 MHz-1GHz Vertical Polarity MHz-1GHz Vertical Pol	651.529	10	132	3.79	Quasi-peak	22	20.	258	35.6		-15.3	Pa	SS
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 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 17 1.43 Quasi-peak 21.2 26.02 35.6 -9.6 Pass 918.817 10 10 10 10 10 10 10 10 10 10 10 10 10	741.649	10	278	3.94	Quasi-peak	21.7	2:	L.7	35.6		-13.9	Pa	SS
Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz-1GHz Vertical Polarity Measured Emissions  PROFESSION  Verified Low-PRF QP Reading  LPRF Verification Limit  PROFESSION  Frequency  Professional Testing, EMI, Inc Radiated Emissions, 10m Distance  Verified Low-PRF QP Reading  LPRF Verification Limit  PROFESSION  Frequency	811.493	10	6	1.54	Quasi-peak	21.5	23.	162	35.6		-12.4	Pa	SS
Professional Testing, EMI, Inc Radiated Emissions, 10m Distance 30MHz-1GHz Vertical Polarity Measured Emissions  Overfield Low-PRF QP Reading X LPRF Verification Limit  PROFESSION  To provide the provided the provided the provided that the provided the provided that the provided that the provided the provided that th	891.806	10	243	1.93	Quasi-peak	21.4	25.	863	35.6		-9.7	Pa	SS
Professional Testing, EM1, Inc Radiated Emissions, 10m Distance 30MHz-1GHz Vertical Polarity Measured Emissions  Corrected Peak Value  Verified Low-PRF QP Reading  LPRF Verification Limit  Estimated Testing and Testing Measured Emissions  The professional Testing and Testing Measured Emissions  Corrected Peak Value  Verified Low-PRF QP Reading  LPRF Verification Limit  Frequency	918.817	10	17	1.43	Quasi-peak	21.2	26	.02	35.6		-9.6	Pa	SS
The state of the s	Radiated 1	Emissions, 10m Di	stance	is				<ul><li>∇ Correct</li><li>Correct</li><li>∇ Verifie</li></ul>	cted Quasi-peak cted Peak Value d Low-PRF QP	k Reading		PROFESS	IONAL
30M 100M Frequency	Field Strength (dBpVm) × × × × × × × × × × × × × × × × × × ×	hrea produced a small of			Many later and the later and the			Musiking	A survey of the		× × ×	XX XX	T N G
Frequency		and the state of t	All the same of the same of the same of	100M	المنافقة والمنافقة والمناف							16	
Operator: Eric Lifsey EUT: MB-3-C & CL-3  Mode: Receive Power: 3.2 VDC Project Number: 18980+18983	Operator: E	-	) 1 'Spurio usRX.til	Mode: Re	ceiv e	quency					18983	10	

≤ 1GHz Vertical Antenna Polarity Measured Emissions

									Shelfbucks,	Inc. – CL-3-
			Profes	sional Te	sting, El	ΜI, I	Inc.			
Test Metho	d:			an National Star Electronic Equi					adio-Noise Em	nissions from
In accordan	ce with:	FCC Part 15.1 Emissions Lin		Federal Regulat	ions Part 47,	Subpar	rt B - Un	intentional R	adiators, Rad	iated
Section:		15.109								
Test Date(s	):	4/3/2017			EUT Serial	#:		00010, nor	ie	
Customer:		Shelfbucks			EUT Part #:			none		
Project Nun		18980, 189	83		Test Techn	ician:		Eric Lifsey		
Purchase O		0			Supervisor			Lisa Arndt		
Equip. Und	er Test:	MB-3-C, CL	-3		Witness' N	ame:		Devin Mur	phy	
	F	ladiated Em	issions Test	t Results Data	a Sheet			Pa	ge: 1	of 1
EUT Li	ne Voltage:	3.7	2V VDC		EUT Pov	ver Fr	equen	cy:	0 N/A	
Antenna	Orientatio	n:	Horizor	ntal	Frequ	ency	Range:		30MHz to	1GHz
	EUT N	lode of Ope	eration:				R	eceive Mod	le	
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Le	ected evel iV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
31.5525	10	222	3.57	Quasi-peak	24.2	12	2.22	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	2	6.1	35.6	-9.5	Pass
916.831	10	89	1.33	Quasi-peak	21.3	26	.109	35.6	-9.5	Pass
Radiated 1	ional Testing, Emissions, 10m Di GHz Horizontal Polari		s				∨ Corre	-peak Limit Level cted Quasi-peak Read cted Peak Value ed Low-PRF QP Read		
50								Verification Limit	mg	PROFESSIONAL TESTING
Field Strength (d B µ V/m)									*	**
Streng St							The state of the s	the state of the s	The state of the s	
10	Walter Str. S. Margary and State Market	philosophic and the local district	A STATE OF THE PERSON NAMED IN COLUMN TWO IS NOT THE OWNER, THE OW		the state of the s				_   _	_
0 30M			100M							1G
Operator: F 18980+189	Eric Lifsey 183'040317'RE'Rund M, Monday, April 03	-	Mode: Re Power: 32	ceiv e	uency		P	UT: MB-3-C & CL-3 roject Number: 1898 lient: Shelfbucks	0+18983	

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

# 6.3.2 Up to 10 GHz

			Profess	sional Te	sting, EN	VII, Inc.			
Test Metho	d:			n National Star Electronic Equi				dio-Noise Em	issions from
n accordan	ce with:	FCC Part 15. Emissions Li		ederal Regulat	tions Part 47, S	Subpart B - Ur	nintentional Ra	adiators, Rad	iated
Section:		15.109							
Test Date(s	):	4/3/2017 Shelfbucks			EUT Serial		00010, non	e	
Customer: Project Nun	nher:	18980, 189			EUT Part #:		none Eric Lifsey		
Purchase O		0	,03		Supervisor:		Lisa Arndt		
quip. Und		MB-3-C, CI	L-3		Witness' N		Devin Mur	ohy	
		Radiated Er	nissions Test	Results Data	a Sheet		Pa		of 1
EUT Li	ne Voltage:	: 3	.2V VDC		EUT Pow	ver Frequen	cy: (	N/A	
Antenna	Orientatio	n:	Vertic	al	Frequ	ency Range		Above 1	GHz
	EUT N	lode of Op	eration:			R	Receive Mod	е	
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 8966.89	3	184 231	2.89 3.59	Average Average	27.1 27.1	34.43 34.114	54.0 54.0	-19.5 -19.8	Pass Pass
Radiated 1-18 GHz V 90	ional Testing, Emissions, 3m Dis erticalPolarity Measu  Cric Lifsey 83 040317 RETRUM	tance red Emissions	Mode: Ree	ceiv e	quency	∨ Corre  Peak  Corre  COR	ge Limit Level  cted A verage Reading  Limit Level  cted Peak Reading  HORNV_PKk   UT: MB-3-C & CL-3  roject Number: 18980		PROFESSIONAL FESTING

								Shelfbucks,	Inc. – CL-3-0
			Profess	sional Te	sting, El	VII, Inc.			
Test Metho	d:			n National Stai Electronic Equi				dio-Noise Em	issions from
In accordan	ce with:	FCC Part 15.1 Emissions Lin		ederal Regula	tions Part 47, S	Subpart B - Ur	nintentional Ra	adiators, Rad	iated
Section:		15.109							
Test Date(s	):	4/3/2017			EUT Serial	#:	00010, non	e	
Customer:		Shelfbucks			EUT Part #:		none		
Project Nur		18980, 189	83		Test Techn	ician:	Eric Lifsey		
Purchase O		0			Supervisor		Lisa Arndt		
Equip. Und	er Test:	MB-3-C, CL	-3		Witness' N	ame:	Devin Mur	ohy	
	R	ladiated Em	issions Test	Results Dat	a Sheet		Pa	ge: 1	of 1
EUT Li	ne Voltage:	3.2	2V VDC		EUT Pow	ver Frequen	cy: (	N/A	
Antenna	Orientatio	n:	Horizon	tal	Frequ	ency Range		Above 1	GHz
	EUT N	lode of Ope	eration:			R	eceive Mod	e	
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
Radiated 1-18GHzH 90 80	ional Testing, Emissions, 3m Dist orizontal Polarity Me	tance				∨ Corre  — Peak l  — Corre	ge Limit Level cted A verage Reading Limit Level cted Peak Reading _HORNH_PKk		PROFESSIONAL TESTING
Field Strength (d Bright Control of Bright Contr	Eric Lifsey 183 W40317 RE'Run0	DI Spurious RX til	Mode: Rec	eiv e	quency		UT: MB-3-C & CL-3 roject Number: 18980	418983	10G

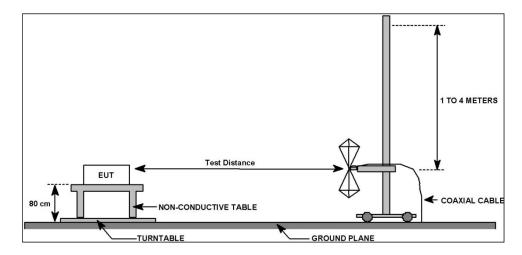
> 1GHz Horizontal Antenna Polarity Measured Emissions

#### 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

			Profes	sional Te	sting, EN	MI, Inc.			
Test Metho	od:	ANSI C63.10 Devices	: 2013: Ameri	can National Sta	andard of Proc	edures for Co	ompliance Test	ing of Unlice	nsed Wireless
In accordar	nce with:	FCC Part 15.	209 - Code of	Federal Regulat	ions Part 47, S	Subpart C - In	tentional Radia	ators, Radiate	ed Emissions
Section:		15.209					_		
Test Date(s	s):	4/3/2017			EUT Serial	#:	none		
Customer:		Shelfbucks			EUT Part #:		none		
Project Nui	mber:	19893			Test Techni	ician:	Eric Lifsey /	Spencer Fl	lint
Purchase O	rder #:	O			Supervisor:		Lisa Arndt		
Equip. Und	er Test:	CL-3 (2 EU	Ts for 2 char	nnels)	Witness' N	ame:	Devin Mur	ohy	
	ļ	Radiated En	nissions Tes	t Results Data	a Sheet		Pa	ge: 1	of 1
EUT Li	ine Voltage	: 3	.2 VDC		EUT Pow	ver Frequer	ncy: (	N/A	
Antenna	a Orientatio	on:	Vertic	al	Frequ	ency Range	:	30MHz to	1GHz
	EUT I	Mode of Op	eration:			T	ransmit Mod	le	
Frequency Measured	Test Distance	EUT Direction	Antenna Height	Detector Function	Recorded Amplitude	Corrected Level	Limit Level	Margin (dB)	Test Results
(MHz)	(Meters)	(Degrees)	(Meters)		(dBμV)	(dBµV/m)	()	(4.2)	
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
Radiated	sional Testing, Emissions, 10m E GHz Vertical Polarity					▽ Corr	ii-peak Limit Level ected Quasi-peak Read ected Peak Value	ing	
60 <sub>1</sub>						▽ Verif	ied Low-PRF QP Readi	ng	
50						× LPR1	F V erification Limit		PROFESSIONAL TESTING
‡							×	_   _ x	×
(d Bµ									
Field Strength (dB <sub>H</sub> V/m) 30 20 20 20 20 20 20 20 20 20 20 20 20 20								 	V 777
5 2 20 − −							Market Lands	y Y	
2 - WWW	MNs					Mary Mary Mary			
10	THE STREET STREET	Mary Mary Mary Mary Mary Mary Mary Mary	dulum Labor Mand	and the state of t	And the second s				-
1		The state of the s							
n±			100M	Evac	uency	·			1G
0±30M					DESTU				
Operator:	Spencer Flilnt		Mode: Ro		,,	1	EUT: CL-3		
Operator: 18983'040	Spencer Flilnt 617 'RE'Run01 'Spur PM, Thursday, April0		Power: 3.2	th:Transmit,unmod	,,	I	EUT: CL-3 Project Number: 18983 Client: Shelfbucks		

									She	lfbucks,	Inc. –	CL-3-C
Professional Testing, EMI, Inc.												
Test Method:  ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless  Devices												
In accordan	nce with:	FCC Part 15.2 Limits	209 - Code of	Federal Regulat	ions Part 47,	Subpar	t C - Int	entional Ra	adiators	, Radiate	ed Emis	sions
Section:		15.209										
Test Date(s): 4/3/2017					EUT Serial	#:		none				
<b>Customer:</b>		Shelfbucks			EUT Part #:			none				
Project Nur	mber:	19893			Test Techn	ician:		Eric Lifse	y / Spe	ncer Fl	int	
Purchase O	rder #:	0			Supervisor			Lisa Arno	lt			
Equip. Und	er Test:	CL-3 (2 EUT	s for 2 char	inels)	Witness' N	ame:		Devin M	urphy			
	F	Radiated Em	issions Test	Results Data	Sheet				Page:	1	of	1
EUT Li	ne Voltage	: 3	.2 VDC		EUT Pow	ver Fr	equen	су:	0	N/A		
Antenna	Orientation	n:	Horizor	ntal	Frequ	ency I	Range		301	∕IHz to	1GHz	
	EUT N	lode of Ope	eration:				Tr	ansmit M	lode			
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Le	ected vel .V/m)	Limit Leve	_	largin (dB)	Test R	esults
459.359	10	90	1.6	Quasi-peak	32.8	25.	474	35.6	_	10.1	Pa	SS
678.076	10	41	1.44	Quasi-peak	24.8	22.	369	35.6	-	13.2	Pa	SS
876.303	10	121	3.48	Quasi-peak	21.4		139	35.6	-	10.5	Pa	SS
883.674	10	51	3.52	Quasi-peak	21.4		514	35.6	_	10.1	Pa	SS
930.519	10	204	3.52	Quasi-peak	22.2	,	.058	35.6		-8.5	Pa	
933.317	10	206	1.28	Quasi-peak	21.2		.09	35.6		-9.5	Pa	
936.468	10	212	2.65	Quasi-peak	21.2		106	35.6		-9.5	Pa	
947.504	10	285	1.16	Quasi-peak	21.2	_	168	35.6		-9.4	Pa	
950.273	10	132	2.76	Quasi-peak	20.9		884	35.6	_	-9.7		SS
952.595	10	163	1.4	Quasi-peak	21	25.	987	35.6		-9.6	Pa	SS
		<u> </u>										
	sional Testing,							-peak Limit Level cted Quasi-peak F				$\equiv$
	Emissions, 10m D GHz Horizontal Polar	istance ity Measured Emission	s					cted Quasi-peak i cted Peak Value	сеания			ŧ
60 <sub>F</sub>								ed Low-PRF QP R	ea din o		7	
#								Verification Limit			PROFESS	IONAL
50 —							_	×			×××	. N G
40 —										×   _	- 45	
h (dB												
5 30										المانية المالية المالية	₩ ₩	
S 20 —	SE STATE OF THE ST											
10 = =	hanpunaling and a second			die gegen van de gegen de	A STATE OF THE STA		A Designation of the Land					
10	The state of the s											
0 30M			100M								16	,
	Spencer Flilnt			Free	luency		F	UT: CL-3			- 0	
-	Operator: Spencer Fillnt EUT: CL-3  18983 '040617 'RE'Run01 'SpuriousTX'x2chan.til Power: 3.2 Battery Project Number: 18983											
02:48:38 P	02:48:38 PM, Thursday, April06, 2017 Two EUTs, one channel each. Client: Shelfbucks											
	≤ 1GHz Horizontal Antenna Polarity Measured Emissions											

# 7.3.2 All Channels Up to 10 GHz

			Profess	sional Te	sting, EN	MI, Inc.			
Test Metho	od:	ANSI C63.10 Devices	: 2013: Americ	can National St	andard of Proc	edures for Co	mpliance Test	ing of Unlice	nsed Wireles
In accordar	ice with:	FCC Part 15.2 Limits	209 - Code of I	Federal Regula	tions Part 47, S	Subpart C - Int	tentional Radia	ators, Radiato	ed Emissions
Section:		15.209			1				
Test Date(s	s):	4/3/2017			EUT Serial		none		
Customer:		Shelfbucks			EUT Part #:		none		
Project Nur		19893			Test Techni		Eric Lifsey /	Spencer F	lint
Purchase O		0	. ( o .l	1 - 1	Supervisor:		Lisa Arndt	. 1.	
Equip. Und			s for 2 chan		Witness' N	ame:	Devin Mur	ony	
	F	Radiated En	nissions Test	Results Dat	a Sheet		Pa	ge: 1	of 1
EUT Li	ne Voltage	: 3	.2 VDC		EUT Pow	ver Frequen	cy: C	N/A	
Antenna	orientation	n:	Vertic	al	Freque	ency Range		Above 1	GHz
	EUT N	/lode of Op	eration:			Tı	ansmit Mod	de	
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 Result
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
Radiated	sional Testing, Emissions, 3m Dis erticalPolarity Measu	tance				<ul><li>∇ Corre</li><li>— Peak</li><li>— Corre</li></ul>	ge Limit Level ected A verage Reading Limit Level ected Peak Reading _HORNV_PKk		PROFESSIONAL TESTING
Field Strength (dBu Vim)	the same of the sa	A STATE OF THE STA							
18983'040	Spencer Fliint 617 RE'Run01 Spuri PM, Thursday, April0		Power: 3.2	th:Transmit,unmod	quency	P	IUT: CL-3 Project Number: 18983 Lient: Shelfbucks		10 G

								SI	helfbucks,	Inc. – C	CL-3-0
			Profess	sional Te	sting, El	VII, Ind	С.				
Test Metho	od:	ANSI C63.10: Devices	2013: Americ	can National St	andard of Proc	cedures fo	r Complianc	e Testin	g of Unlicer	nsed Wir	reless
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			<b>EUT Serial</b>	#:	none				
Customer:		Shelfbucks			EUT Part #:	:	none				
Project Nur	nber:	19893			Test Techn	ician:	Eric Lif	fsey / S	pencer Fl	int	
Purchase O	rder #:	o			Supervisor	:	Lisa Aı	rndt			
Equip. Und	er Test:	CL-3 (2 EUT	s for 2 chan	inels)	Witness' N	ame:	Devin	Murph	ıy		
	F	Radiated Em	issions Test	Results Data	a Sheet			Page	e: 1	of	1
EUT Li	ne Voltage	: 3	.2 VDC		EUT Pov	ver Frequ	uency:	0	N/A		
Antenna	Orientatio	on:	Horizor	ntal	Frequ	ency Ran	ige:		Above 10	GHz	
	EUT N	Node of Ope	eration:				Transmit	Mode	}		
Frequency	Test	EUT	Antenna		Recorded	Correcte	ed				
Measured	Distance	Direction	Height	Detector	Amplitude	Level	Limit L		Margin	Test Re	esults
(MHz)	(Meters)	(Degrees)	(Meters)	Function	(dBμV)	(dBμV/r	m) dBµV	//m)	(dB)		
1827.98	3	289	2.71	Peak	44.3	34.58	7 74.	0	-39.4	Pas	SS
1830.81	3	319	1.54	Peak	46.4	36.649	9 74.	.0	-37.3	Pas	SS
2740.5	3	137	3.87	Peak	67	59.03	6 74.	0	-14.9	Pas	SS
2755.47	3	20	2.37	Peak	75.2	67.31	5 74.	0	-6.6	Pas	SS
4567.48	3	216	2.49	Peak	43.1	38.652	2 74.	0	-35.3	Pas	SS
4592.48	3	249	2.44	Peak	45	40.62	74.	0	-33.3	Pas	SS
6394.52	3	77	1.94	Peak	39.7	40.346	6 74.	0	-33.6	Pas	SS
6429.51	3	263	1.85	Peak	38.9	39.51	1 74.	0	-34.4	Pas	SS
Radiated	sional Testing, Emissions, 3m Dis torizontal Polarity M	stance				<ul><li>□</li><li>□</li><li>□</li></ul>	A verage Limit Lev Corrected A verag Peak Limit Level Corrected Peak Re	e Reading			
80 -							COR_HORNH_F	Ŭ		PROFESS T E S T	IONAL IN 6
Field Strength (dBµVm)  05 09 000				*							
2 50 2 40			tent promote the second	the standard of the standard o	and the same		and the same				
30		And the second lives to the second lives	<u> </u>								
20 6								100	÷		
18983 040617 RERun01 SpuriousTX x2chan.til P				Fre th: Transmit, unmod 2 Battery , one channel each.	quency		EUT: CL-3 Project Numb Client: Shelfb			100	
		> 1G	Hz Horizont	al Antenna F	Polarity Mea	sured Er	nissions				

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

# 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

Radiat	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:

<sup>1.</sup> The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.

<sup>2.</sup> The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.

<sup>3.</sup> The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.

<sup>4.</sup> The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.

<sup>5.</sup> 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
Padiated Emissions	30 to 1,000 MHz	10 m	4.8
Radiated Emissions	1 to 18 GHz	3 m	5.7

# **End of Report**

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