
Project 18980-15

Shelfbucks, Inc.
MB-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:

Table of Contents

Revision History.....	2
Compliance Certificate.....	4
1.0 Introduction.....	5
1.1 Scope.....	5
1.2 EUT Description	5
1.3 EUT Operation.....	5
1.4 Modifications to Equipment.....	5
1.5 Test Site	5
1.6 Radiated Measurements	6
1.7 Applicable Documents and Clauses.....	6
2.0 Fundamental Power	7
2.1 Test Procedure	7
2.2 Test Criteria	7
2.3 Test Results, Peak Power	7
2.4 Test Results, Duty Cycle.....	8
3.0 Power Spectral Density.....	10
3.1 Test Procedure	10
3.2 Test Criteria	10
3.3 Test Results.....	10
4.0 Occupied Bandwidth.....	11
4.1 Test Procedure	11
4.2 Test Criteria	11
4.3 Test Results.....	11
4.3.1 Bandwidth Plots, 6 dB.....	12
4.3.2 Bandwidth Plots, 20 dB.....	12
5.0 Band Edge.....	13
5.1 Test Procedure	13
5.2 Test Criteria	13
5.3 Test Results.....	13
5.3.1 Low Channel Band Edge.....	14
5.3.2 High Channel Band Edge	14
6.0 Radiated Spurious Emissions, Receive Mode.....	15
6.1 Test Procedure	15
6.2 Test Criteria	15
6.3 Test Results.....	15
6.3.1 Up to 1 GHz	16
6.3.2 Up to 10 GHz	18
7.0 Radiated Spurious Emissions, Transmit Mode	20
7.1 Test Procedure	20
7.2 Test Criteria	20
7.3 Test Results.....	20
7.3.1 Up to 1 GHz	21
7.3.2 Up to 10 GHz	23
8.0 Antenna Construction Requirements	25
8.1 Procedure	25
8.2 Criteria	25
8.3 Results.....	25
9.0 Equipment.....	26
9.1 Radiated Emissions 30 MHz to 10 GHz	26
9.2 Bandwidth, Power, Power Spectral Density, and Duty Cycle	27
10.0 Measurement Bandwidths.....	28
Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty	29
End of Report	30

NOTICE: (1) This Report must not be used to claim product endorsement, by NVLAP, NIST, the FCC or any other Agency. This report also does not warrant certification by NVLAP or NIST. (2) This report shall not be reproduced except in full, without the written approval of Professional Testing (EMI), Inc. (3) The significance of this report is dependent on the representative character of the test sample submitted for evaluation and the results apply only in reference to the sample tested. The manufacturer must continuously implement the changes shown herein to attain and maintain the required degree of compliance.



Compliance Certificate

Applicant	Device & Test Identification
Shelfbucks, Inc. 2500 Bee Caves Rd Bldg.2, Suite 240 Austin, TX 78746 Certificate Date: 11 Jul 2017	FCC ID: 2ALSL-MB-3-C Industry Canada ID: N/A Model(s): MB-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: MB-3-C	none	902-928 MHz radio using 1 channel 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 attaches to signage. It sends widely-spaced status information via a proprietary wireless network. It is battery powered by coin type cells.

The EUT electronics are on a single circuit board which measures approximately 5.8 cm x 2.1 cm x 0.5 cm. The EUT is placed inside a small bag and the bag is affixed to the signage.

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.

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 dBμV/m @ 3 m	5 Apr 2017

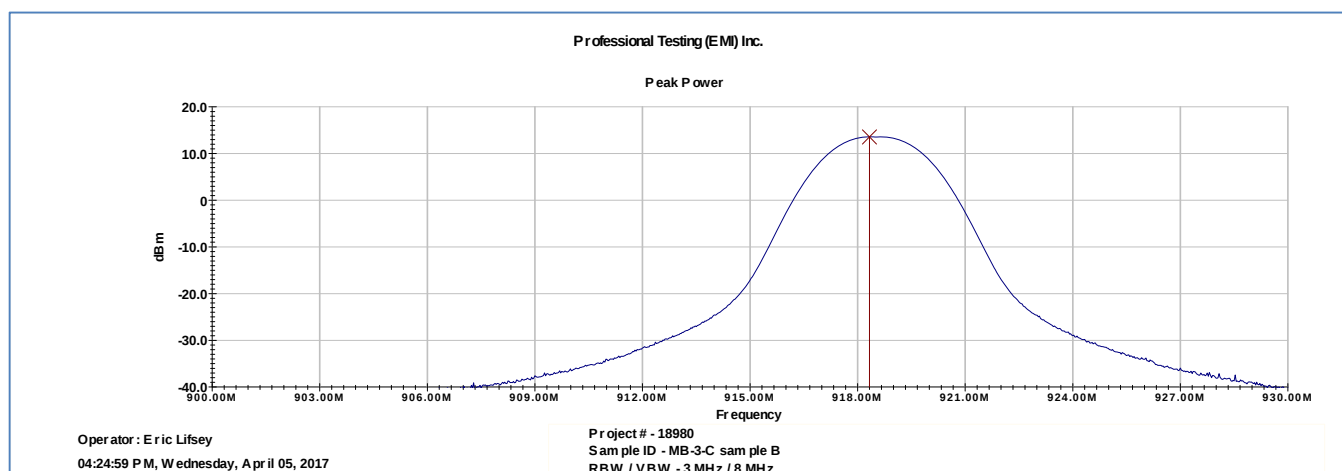
2.3 Test Results, Peak Power

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	Measured Peak Power in mW
918.33	13.5	22.4

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.

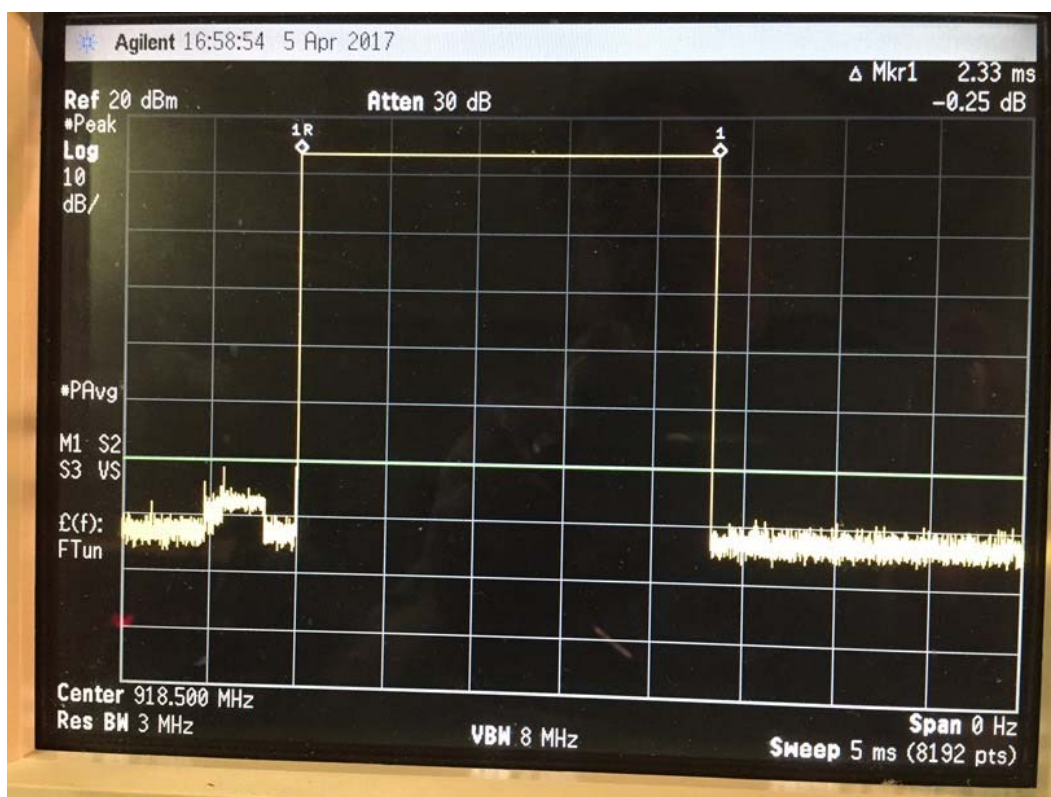
Table 2.4.1 Duty Cycle Results and Average Duty Cycle Factor Result

Total Measured On Time (msec)	Measured Time Interval (msec)	Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB)
= 2.33	100	$= 20 * \log_{10} (2.33 \text{ msec} / 100 \text{ msec})$	-32.7	-20

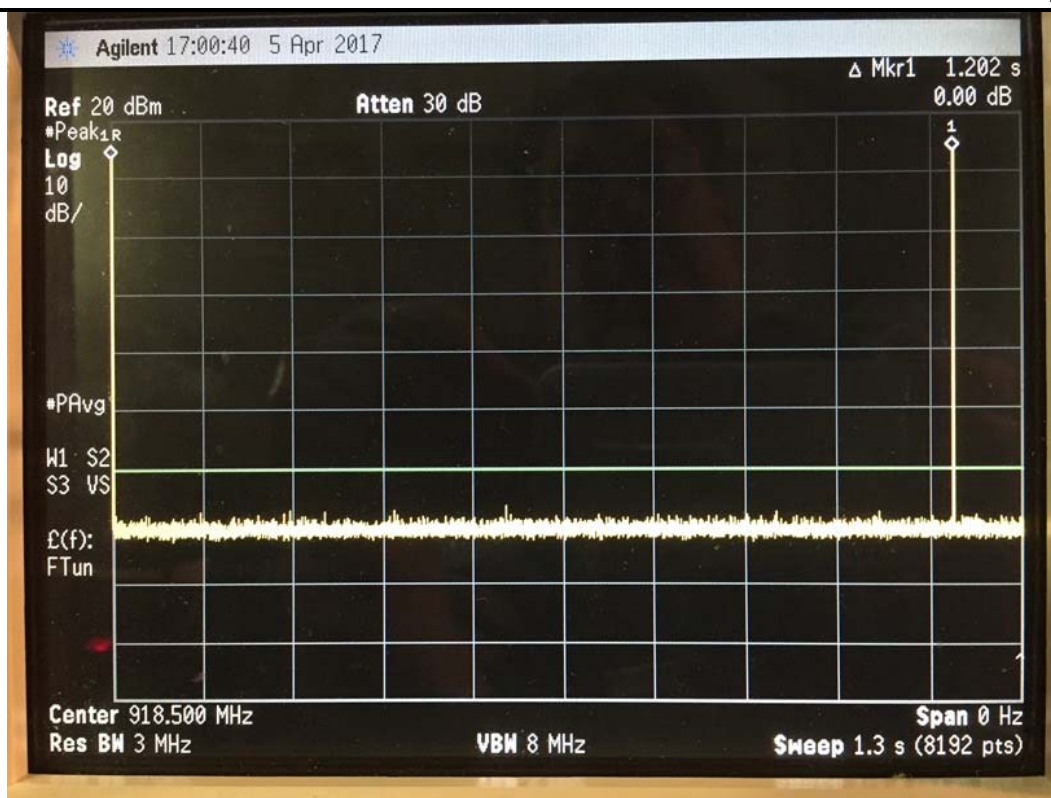
Factor for averaging exposure: $-32.7 / 2 = 16.35 \text{ dB}$

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

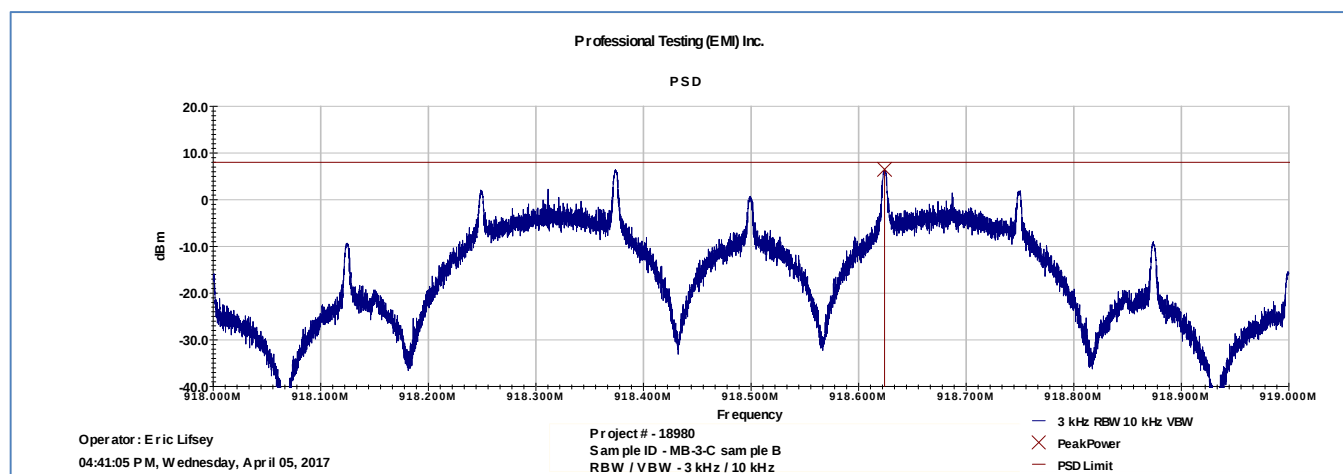
A spectrum analyzer is either connected directly to the EUT or used by radiated means to measure the fundamental emission. It is adjusted to measure the power spectral density in the specified resolution bandwidth.

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	5 Apr 2017

3.3 Test Results

The EUT satisfied the requirements.



Peak Power 6.5 dBm

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	5 Apr 2017

4.3 Test Results

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

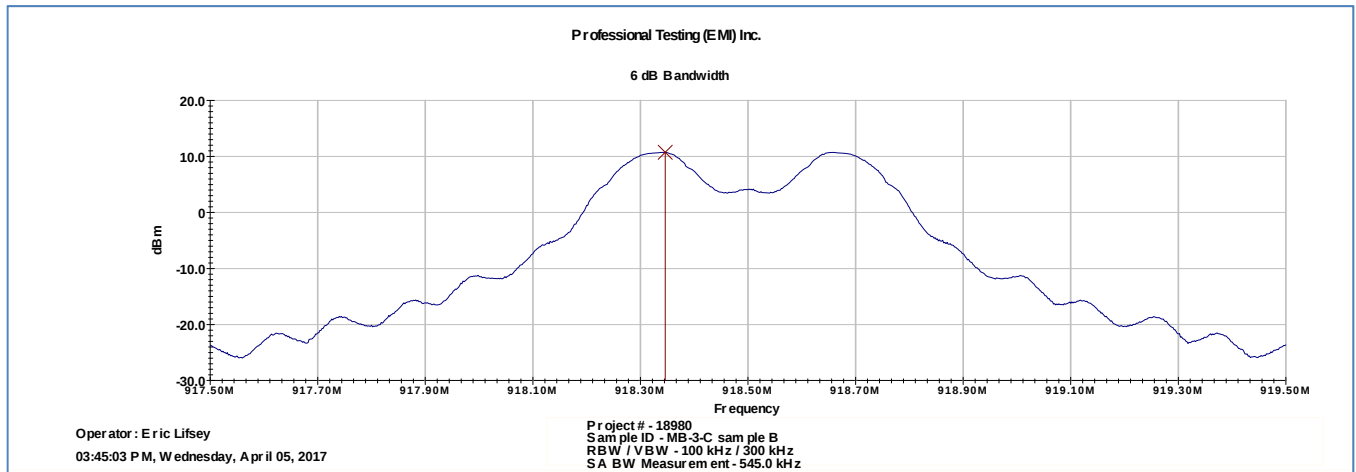
The EUT was found to be in compliance with applicable requirements.

Table 4.3.1 Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW			
	Channel Measured BW (kHz)		Reported Minimum BW (kHz)
	545		545

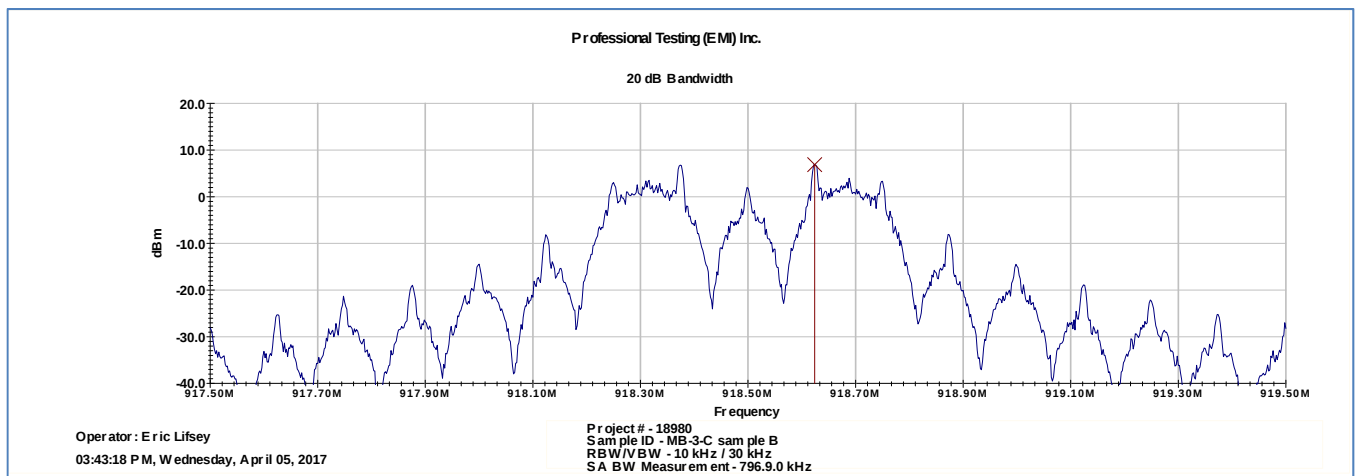
Table 4.3.2 Bandwidth 20 dB, Measure and Report			
	Channel Measured BW (kHz)		Reported Maximum BW (kHz)
	796.9		796.9

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

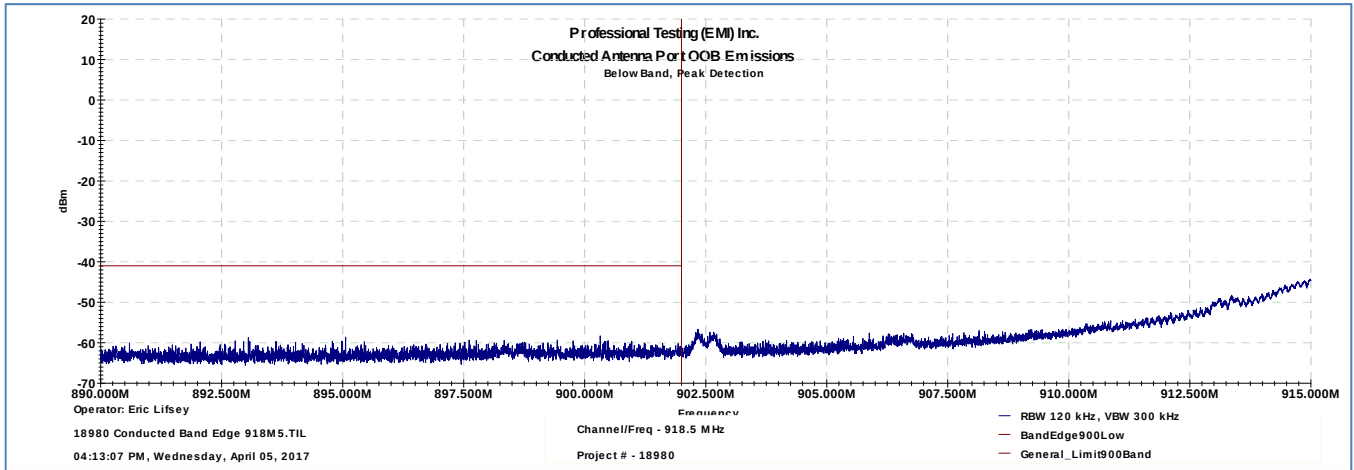
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.205 // RSS-247 5.5, RSS-Gen 4.9	Unwanted Emissions Adjacent to Authorized Band, Radiated	5 Apr 2017

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.

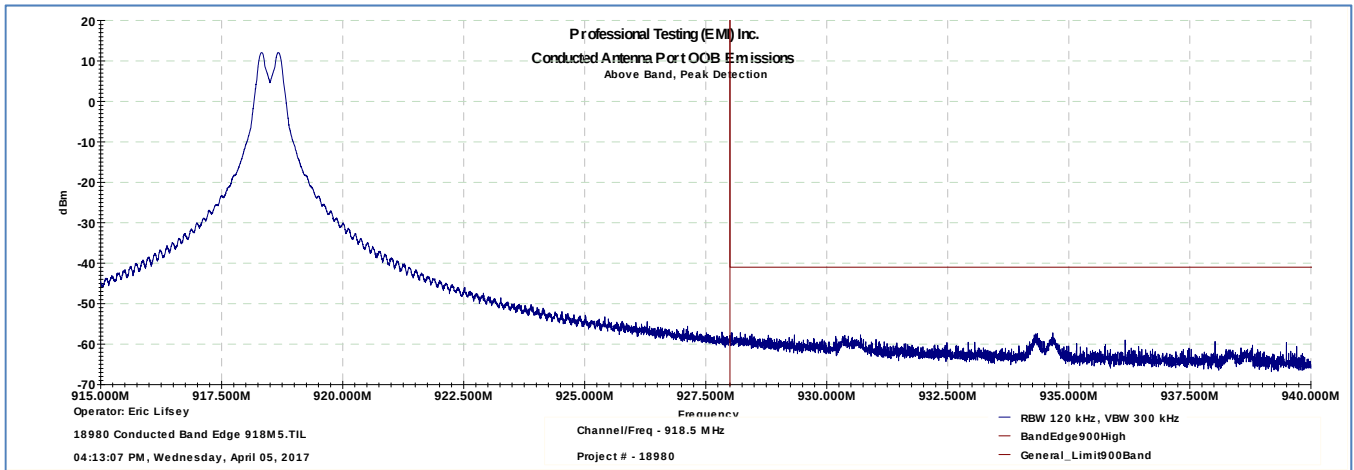
The EUT satisfied the criteria. Plotted results of peak detection appear on the following pages.

5.3.1 Low Channel Band Edge



Peak detection in 100 kHz RBW is employed.

5.3.2 High Channel Band Edge



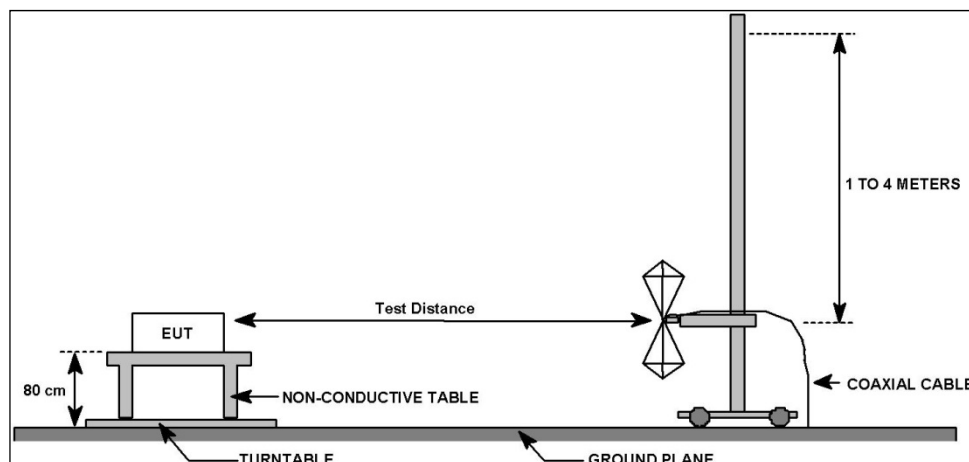
Peak detection is employed while the general emission limits for average and peak levels are shown.
The applicable duty cycle factor is -20 dB.

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

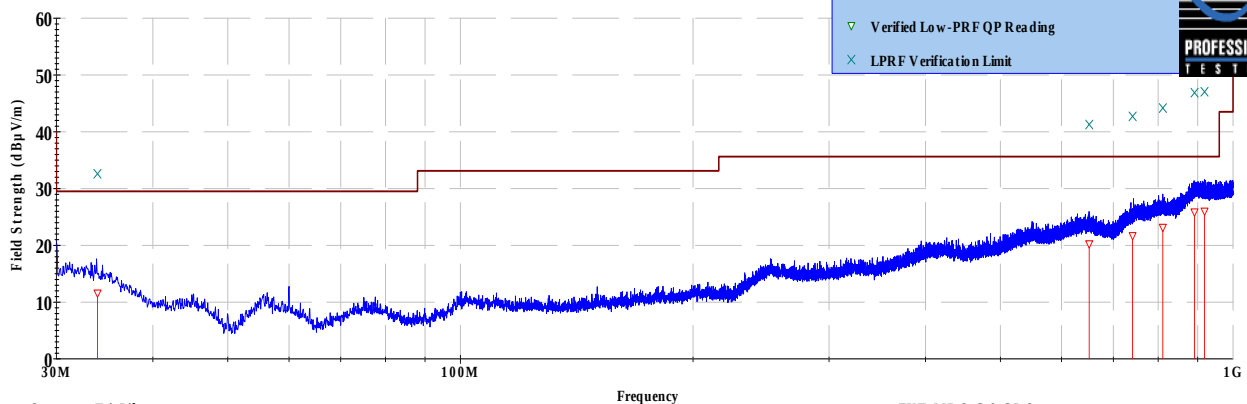
Page: 1 of 1

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

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance

30MHz - 1GHz Vertical Polarity Measured Emissions



Operator: Eric Lifsey

18980+18983\040317\RERun01\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 Vertical Antenna Polarity Measured Emissions

Professional Testing, EMI, Inc.

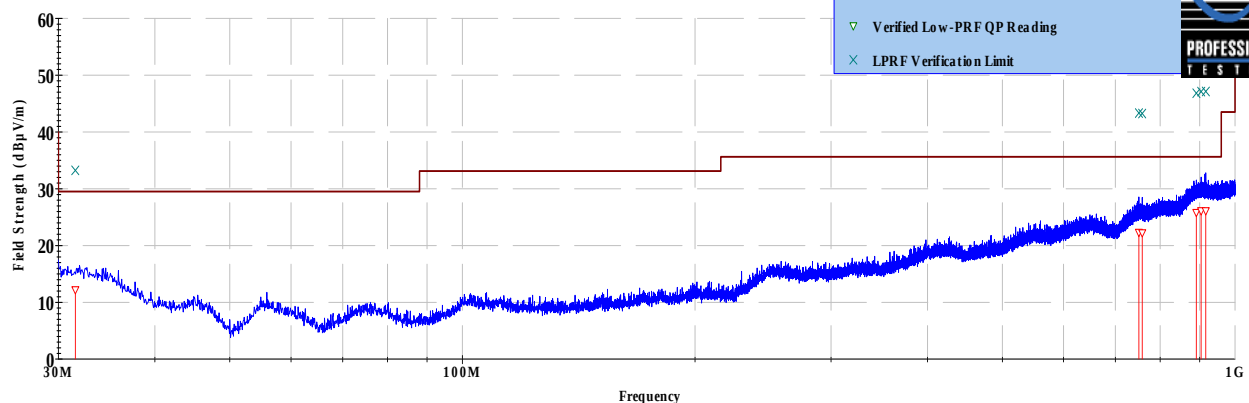
Test Method:	ANSI C63.4: 2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz		
In accordance with:	FCC Part 15.109 - Code of Federal Regulations Part 47, Subpart B - Unintentional Radiators, 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
30 MHz - 1 GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

18980+18983\040317\RERun01\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								Page: 1 of 1	
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 Vertical Polarity Measured Emissions Operator: Erik Lifsey 18980+18983\040317\RERun01\SpuriousRX.tif 05:55:17 PM, Monday, April 03, 2017 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

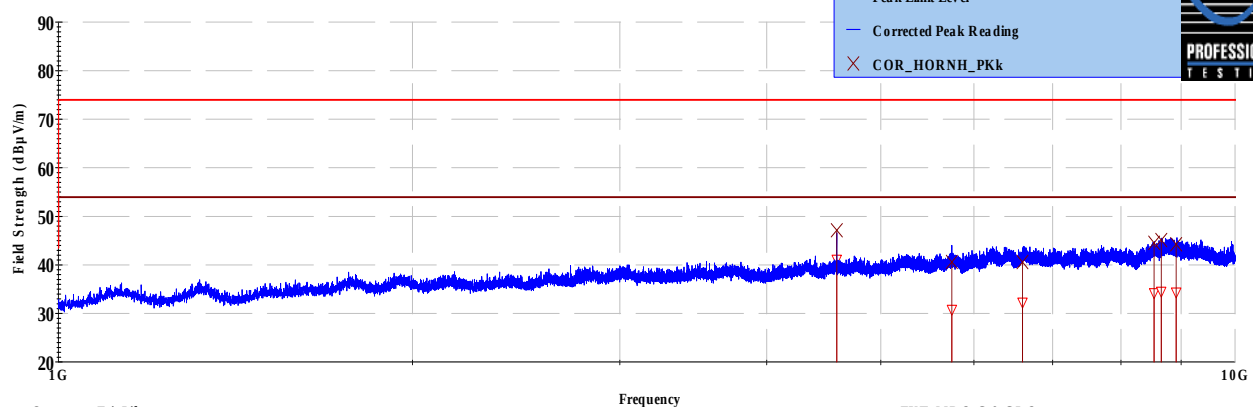
Page: 1 of 1

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.tif

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

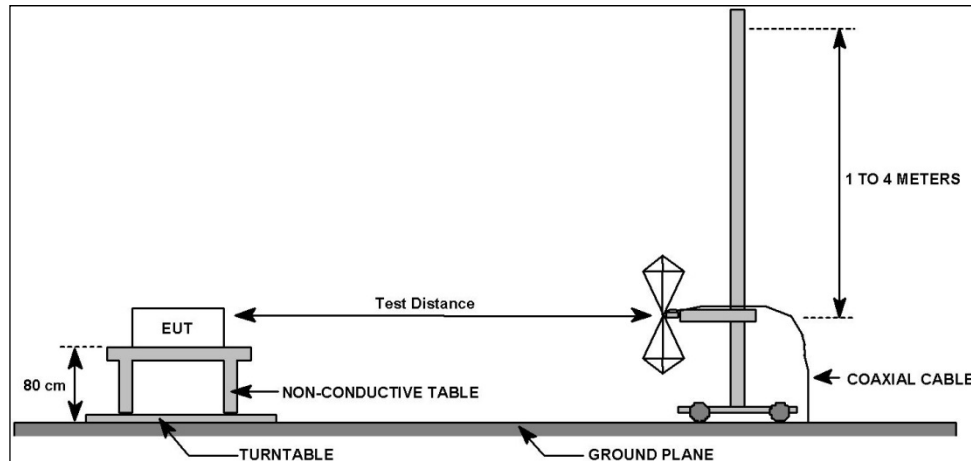
> 1GHz Horizontal Antenna Polarity Measured Emissions

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, the averaged emissions are also below the average limit.

7.3.1 Up to 1 GHz

Professional Testing, EMI, Inc.

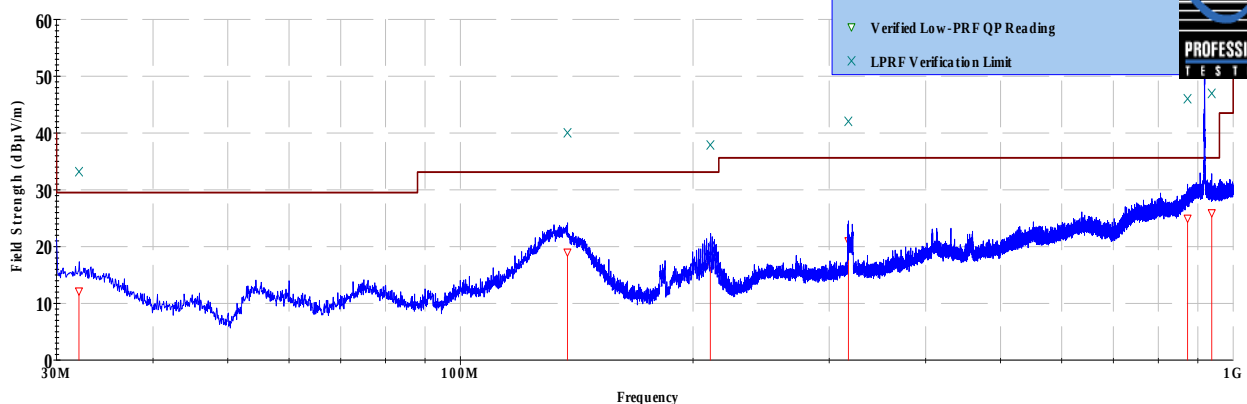
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices								
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits								
Section:	15.209								
Test Date(s):	4/3/2017	EUT Serial #:	00026						
Customer:	Shelfbucks	EUT Part #:	none						
Project Number:	18980	Test Technician:	Eric Lifsey						
Purchase Order #:	0	Supervisor:	Lisa Arndt						
Equip. Under Test:	MB-3-C	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
32.0859	10	316	2.21	Quasi-peak	24.1	12.177	29.5	-17.3	Pass
137.557	10	24	1.52	Quasi-peak	36.2	19.023	33.1	-14.1	Pass
210.582	10	17	1.23	Quasi-peak	31.3	16.888	33.1	-16.2	Pass
317.758	10	323	1.64	Quasi-peak	30.8	21.029	35.6	-14.6	Pass
873.223	10	242	4.1	Quasi-peak	21.5	25	35.6	-10.6	Pass
938.371	10	79	2.97	Quasi-peak	21.1	25.958	35.6	-9.6	Pass

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



Operator: Erik Lifsey

18980 040317 RE Run01 SpuriousTX.tif

02:51:03 PM, Monday, April 03, 2017

Mode: Transmit, unmod
Power: 3.2 VDC

EUT: MB-3-C

Project Number: 18980

Client: Shelfbucks

≤ 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 #:	00026
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C	Witness' Name:	Devin Murphy

Radiated Emissions Test Results Data Sheet

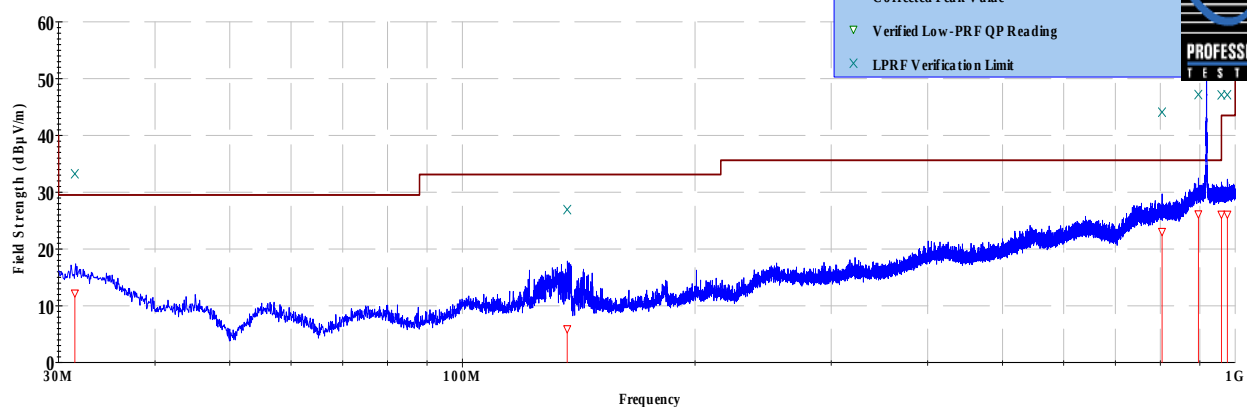
Page: 1 of 1

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
31.5003	10	12	2.53	Quasi-peak	24.2	12.231	29.5	-17.3	Pass
136.627	10	308	1.2	Quasi-peak	23.1	5.934	33.1	-27.2	Pass
804.25	10	343	1.94	Quasi-peak	21.4	23.069	35.6	-12.5	Pass
896.338	10	47	1.13	Quasi-peak	21.5	26.179	35.6	-9.4	Pass
959.908	10	23	1.42	Quasi-peak	21.1	26.112	35.6	-9.5	Pass
977.219	10	42	2.75	Quasi-peak	21	26.131	43.5	-17.4	Pass

Professional Testing, EMI, Inc

Radiated Emissions, 10m Distance

30 MHz - 1 GHz Horizontal Polarity Measured Emissions



Operator: Eric Lifsey

18980 040317 RE Run01 SpuriousTX.tif

02:51:03 PM, Monday, April 03, 2017

Mode: Transmit, unmod
Power: 3.2 VDC

EUT: MB-3-C

Project Number: 18980

Client: Shelfbucks

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

7.3.2 Up to 10 GHz

Professional Testing, EMI, Inc.

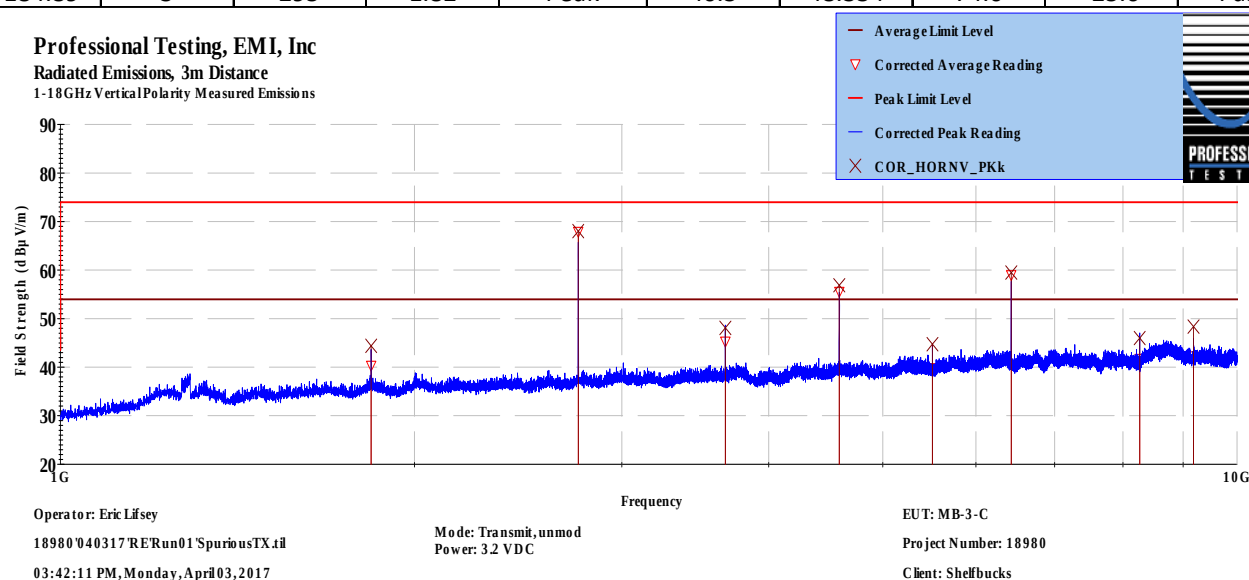
Test Method:	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
In accordance with:	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
Section:	15.209		
Test Date(s):	4/3/2017	EUT Serial #:	00026
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C	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
1837.08	3	36	3.42	Peak	54.1	44.36	74.0	-29.6	Pass
2755.43	3	220	1.44	Peak	75.9	68.011	74.0	-5.9	Pass
3673.97	3	288	2.16	Peak	55	48.066	74.0	-25.9	Pass
4592.54	3	255	1.55	Peak	61.2	56.85	74.0	-17.1	Pass
5511.03	3	199	1.45	Peak	47.3	44.721	74.0	-29.2	Pass
6429.39	3	230	1.25	Peak	58.9	59.46	74.0	-14.5	Pass
8266.42	3	240	1.88	Peak	41.3	45.989	74.0	-28.0	Pass
9184.89	3	295	1.82	Peak	40.5	48.334	74.0	-25.6	Pass

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



> 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 #:	00026
Customer:	Shelfbucks	EUT Part #:	none
Project Number:	18980	Test Technician:	Eric Lifsey
Purchase Order #:	0	Supervisor:	Lisa Arndt
Equip. Under Test:	MB-3-C	Witness' Name:	Devin Murphy

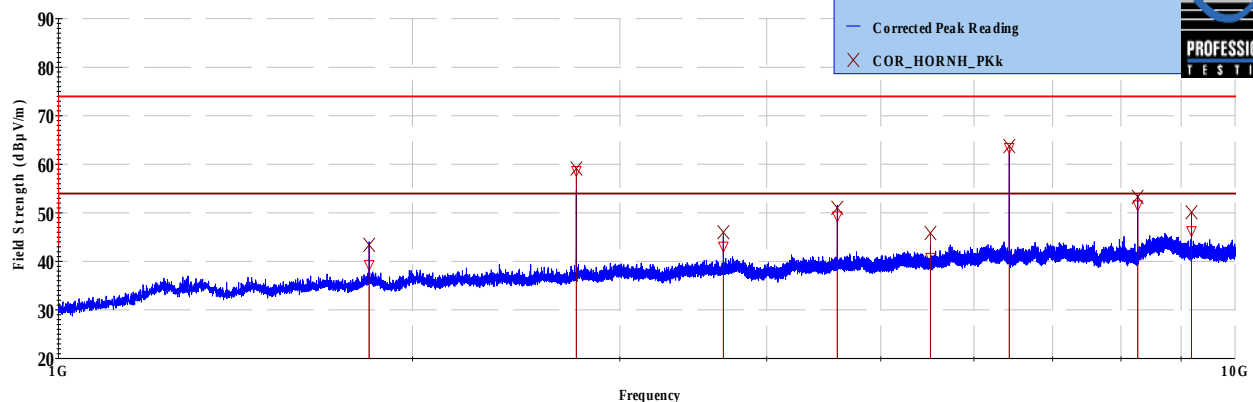
Radiated Emissions Test Results Data Sheet

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
1837.01	3	58	1.73	Peak	53.1	43.385	74.0	-30.6	Pass
2755.56	3	354	3.78	Peak	67	59.114	74.0	-14.8	Pass
3674.11	3	229	1.69	Peak	52.9	45.981	74.0	-28.0	Pass
4592.53	3	347	1.18	Peak	55.4	51.001	74.0	-23.0	Pass
5511.01	3	247	1.13	Peak	48.4	45.833	74.0	-28.1	Pass
6429.54	3	272	2.86	Peak	63.1	63.708	74.0	-10.2	Pass
8266.52	3	247	1.42	Peak	48.5	53.262	74.0	-20.7	Pass
9184.98	3	272	1.86	Peak	42.2	50.089	74.0	-23.9	Pass

Professional Testing, EMI, Inc

Radiated Emissions, 3m Distance
1-18GHz Horizontal Polarity Measured Emissions



Operator: Erik Lifsey

18980\040317\RERun01\SpuriousTX.tif

03:42:11 PM, Monday, April 03, 2017

Mode: Transmit, unmod
Power: 3.2 VDC

EUT: MB-3-C

Project Number: 18980

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	11 Jul 2017

8.3 Results

Table 10.3.1 Antenna Construction Details

Manufacturer: Shelfbucks		
		

- Antenna is a shortened linear-loaded monopole etched onto the circuit board.
- The U.F.L connector used for conducted measurements is not present in the finished product.
- Gain is 0 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	2/25/2017

9.2 Bandwidth, Power, Power Spectral Density, 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.				

Specific wireless parameter tests such as power or bandwidth may cite different settings than listed above.

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

(This page intentionally left blank.)