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Project 18900-15

**Hetronic  
WFA-1**

**Wireless Certification Report**

Prepared for:

Hetronic Malta  
A Division of Methode Electronics Malta Ltd.  
Mrieהל Industrial Estate  
Mrieהל BKR3000, Malta

By

Professional Testing (EMI), Inc.  
1601 North A.W. Grimes Blvd., Suite B  
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19 Mar 2019

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Reviewed by

A handwritten signature in black ink, appearing to read 'Larry Finn'.

Larry Finn  
Chief Technical Officer

Written by

A handwritten signature in black ink, appearing to read 'Eric Lifsey'.

Eric Lifsey  
EMC Engineer

**Revision History**

<b>Revision Number</b>	<b>Description</b>	<b>Date</b>
Final 01		21 Mar 2019

Errata:

None.

## Table of Contents

Revision History.....	2
Compliance Certificate.....	5
1.0 Introduction.....	6
1.1 Scope.....	6
1.2 EUT Description .....	6
1.3 EUT Test Configuration.....	6
1.4 Modifications to Equipment.....	6
1.5 Test Site .....	7
1.6 Radiated Measurements .....	7
1.7 Applicable Documents and Clauses.....	7
2.0 Fundamental Power .....	8
2.1 Test Procedure .....	8
2.2 Test Criteria .....	8
2.3 Test Results, Peak Power.....	8
2.3.1 Antenna Port 1 .....	9
2.3.2 Antenna Port 2.....	10
2.4 Test Results, Duty Cycle.....	11
3.0 Power Spectral Density.....	12
3.1 Test Procedure .....	12
3.2 Test Criteria .....	12
3.3 Test Results, Tabular.....	12
3.4 Test Results, Recorded, Port 1 .....	13
3.5 Test Results, Recorded, Port 2 .....	17
4.0 Occupied Bandwidth.....	22
4.1 Test Procedure .....	22
4.2 Test Criteria .....	22
4.3 Test Results.....	22
4.3.1 Antenna Port 1, Mode b.....	23
4.3.2 Antenna Port 1, Mode g.....	26
4.3.3 Antenna Port 1, Mode n, MCS7 .....	29
4.3.4 Antenna Port 2, Mode b.....	32
4.3.5 Antenna Port 2, Mode g.....	35
4.3.6 Antenna Port 2, Mode n, MCS15 .....	38
5.0 Band Edge.....	41
5.1 Test Procedure .....	41
5.2 Test Criteria .....	41
5.3 Test Results.....	41
5.3.1 Antenna Port 1, Mode b.....	42
5.3.2 Antenna Port 1, Mode g.....	42
5.3.3 Antenna Port 1, Mode n, MCS7, 20 MHz .....	43
5.3.4 Antenna Port 1, Mode n, MCS7, 40 MHz .....	44
5.3.5 Antenna Port 2, Mode b.....	44
5.3.6 Antenna Port 2, Mode g.....	45
5.3.7 Antenna Port 2, Mode n, MCS7, 20 MHz .....	46
5.3.8 Antenna Port 2, Mode n, MCS15, 20 MHz .....	46
6.0 Radiated Spurious Emissions, Transmit Mode .....	48
6.1 Test Procedure .....	48
6.2 Test Criteria .....	48
6.3 Test Results.....	48
6.3.1 Middle Channel, 30 MHz to 25 GHz.....	49
6.3.2 Bottom, Middle, and Top Channel, 1 GHz to 18 GHz .....	51
6.3.3 Bottom Channel, 18 GHz to 25 GHz.....	53
6.3.4 Middle Channel, 18 GHz to 25 GHz .....	54
6.3.5 Top Channel, 18 GHz to 25 GHz .....	55
7.0 Radiated Spurious Emissions, Receive Mode.....	56
7.1 Test Procedure .....	56
7.2 Test Criteria .....	56
7.3 Test Results.....	56

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8.0	Antenna Construction .....	61
8.1	Procedure .....	61
8.2	Criteria .....	61
8.3	Results.....	61
9.0	Equipment.....	62
9.1	Radiated Emissions 30 MHz to 25 GHz .....	62
9.2	Fundamental Power, Bandwidth, Duty Cycle, Band Edge .....	63
10.0	Measurement Bandwidths.....	64
	Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty .....	65
	End of Report .....	65

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# Compliance Certificate

FCC MRA Designation Number: US5270 NVLAP Accreditation Number: 200062-0

Applicant	Device & Test Identification
Hetronic Malta A Division of Methode Electronics Malta Ltd. Mriehel Industrial Estate Mriehel BKR3000, Malta Certificate Date: 19 Mar 2019	FCC ID: LW9-WFA1 Industry Canada ID: 2119B-WFA1 Model(s): WFA-1 Laboratory Project ID: 18900-15

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	15.205	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
Hetronic Model: WFA-1	none	2400-2483.5 MHz DTS amplifier module paired with pre-approved WiFi module listed in the table below.

Table 1.2.2: Support Equipment		
Manufacturer / Model	Serial #	Description
Texas Instruments Model: WL18MODGI	none	WiFi Module FCC ID: Z64-WL18DBMOD IC: 451I-WL18DBMOD

### 1.3 EUT Test Configuration

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

The device is modular and intended for use internally in systems built by the manufacturer. For this test the module is installed into an unshielded sample of the manufacturer's remote control product line. This also provided battery power and a processor and LCD display to facilitate test firmware to place the WiFi module into the desired operating modes.

This setup operated two EUT samples driven by the approved WiFi module's available two RF ports. It was configured with two amplifier modules to represent the typical use of the device in the manufacturer's product line. More than 20 cm of power wiring was attached to the modules per modular test setup requirements. Each module uses 1 DC power input and 2 RF ports; antenna and WiFi module. There is no digital control or data lines attached the EUT as the module senses RF to switch into the required transmit/receive mode.

For this test each amplifier was driving a monopole antenna to represent maximum gain in the final application. Measurements were made at each antenna port.

### 1.4 Modifications to Equipment

The EUT was adjusted in firmware for a reduced power setting of "+6.0 dBm" drive for the desired power level on the 2<sup>nd</sup> highest WiFi channel. The highest WiFi channel is disabled. The end user has no control over power settings.

## 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

Table 1.6 1 Measurement Corrections	
Parameter	From Sums Of
Radiated Field Strength	Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain
Conducted Antenna Port	Raw Measured Level + Attenuator Factor + Cable Losses
Conducted Mains Port	Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses

Additionally, measurement distance extrapolation factors (such as  $1/d$  above 30 MHz) 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	15.247, 15.203	RSS-Gen 8.3

## 2.0 Fundamental Power

### 2.1 Test Procedure

A spectrum analyzer is used to measure the fundamental emission. It is adjusted to measure the full bandwidth power if modulated or unmodulated.

### 2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(a)(3) // RSS-247 5.2	Fundamental Power	18 Feb 2019
	Conducted Limits 1 W Limit Restated as Field: 125.23 dB $\mu$ V/m @ 3 m	7 Mar 2019

### 2.3 Test Results, Peak Power

Table 2.3.1 Power, Peak, Unmodulated, Measured Conducted Port 1		
Frequency MHz	Measured Peak Power dBm	Measured Peak Power Restated mW
2412	27.1	513
2437	27.1	513
2457	17.4	55

Measured in 3 MHz RBW, 8 MHz VBW.

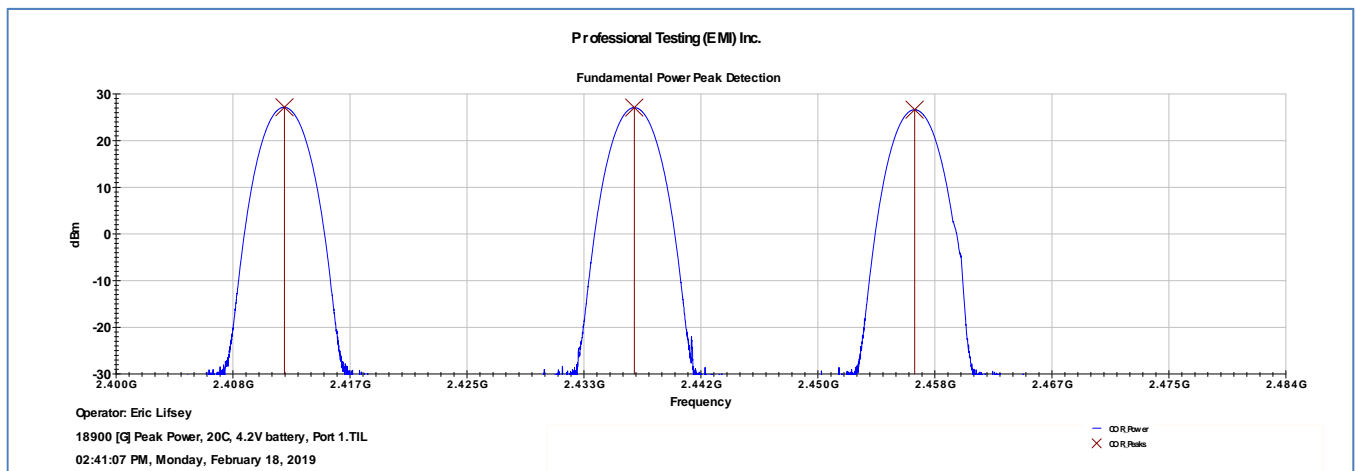
Table 2.3.2 Power, Peak, Unmodulated, Measured Conducted Port 2		
Frequency MHz	Measured Peak Power dBm	Measured Peak Power Restated mW
2412	27.8	603
2437	27.2	525
2457	19.6	91.2

Measured in 3 MHz RBW, 8 MHz VBW.

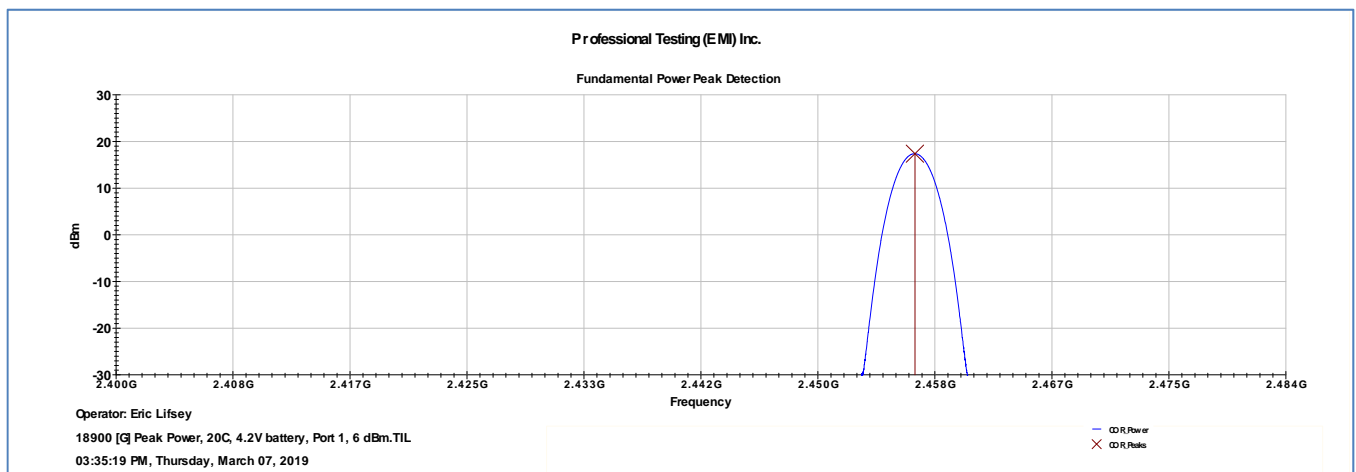
The requirements were satisfied.



### 2.3.1 Antenna Port 1

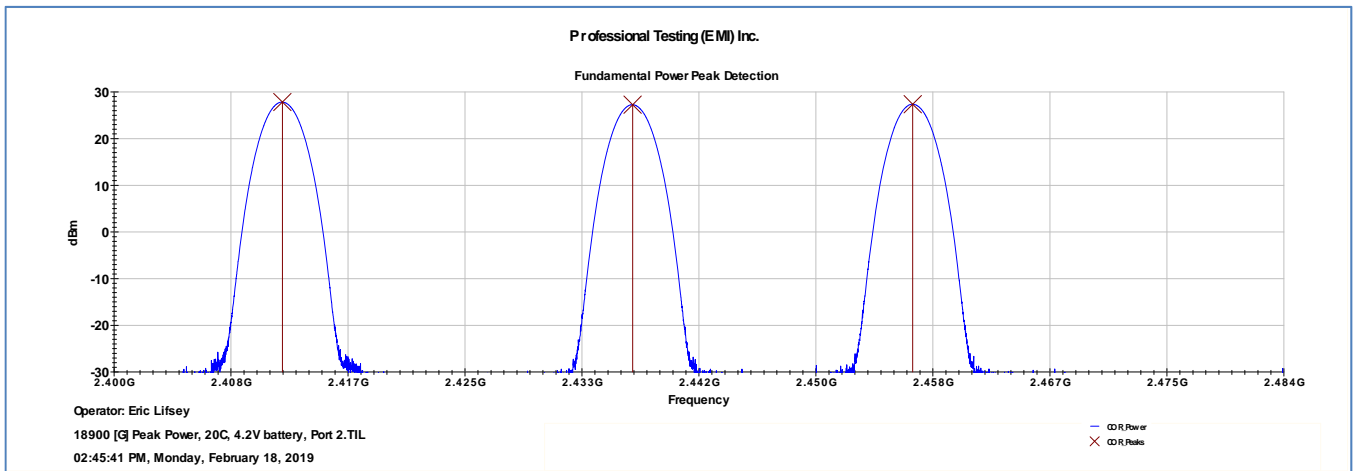


**Port 1, Bottom and Middle Channels (Disregard top channel peak.)**

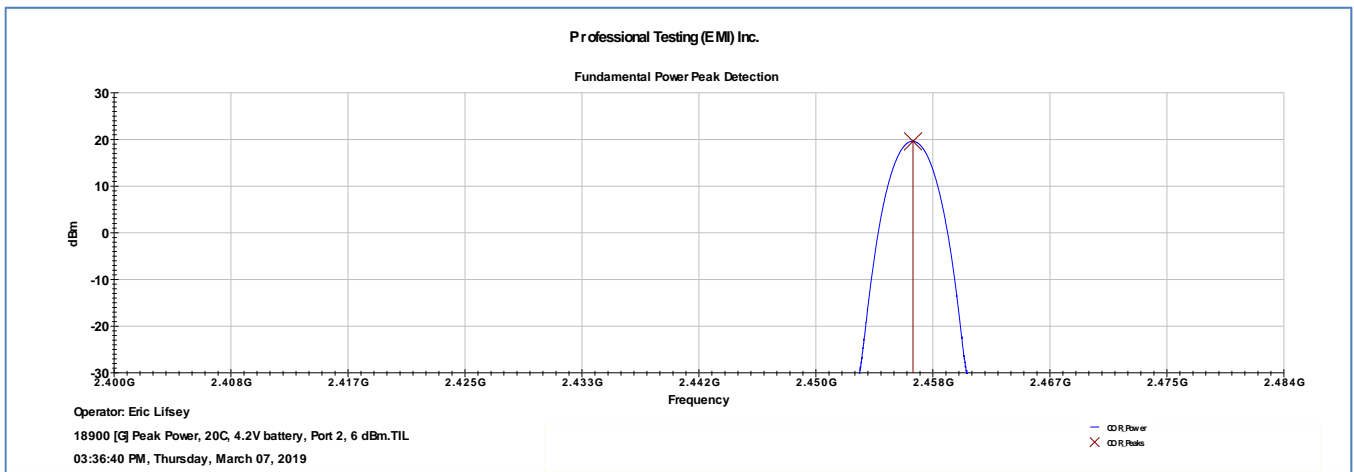


**Port 1, Top Channel (6 dBm drive)**

### 2.3.2 Antenna Port 2



**Port 2, Bottom and Middle Channels (Disregard top channel peak.)**



**Port 2, Top Channel (6 dBm drive)**

## 2.4 Test Results, Duty Cycle

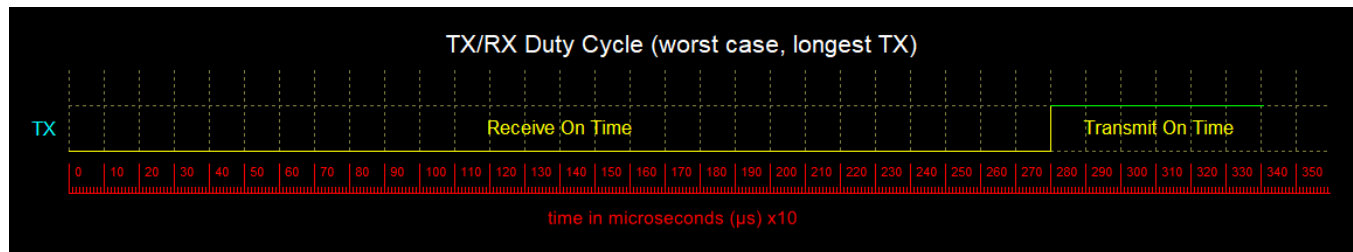
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power.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

**Table 2.4.1 Duty Cycle with Average Duty Cycle Factor**

Total Measured On Time msec	Measured Time Interval msec	Duty Cycle Factor Calculation	Result dB	Duty Cycle Factor Allowed dB
0.6	3.4	$= 20 * \log_{10} (0.6 \text{ msec} / 3.4 \text{ msec})$	-15.1	-15.1

**Table 2.4.2 Duty Cycle with Weighted Averaging Factor for Exposure**

Total Measured On Time msec	Measured Time Interval msec	Averaging Factor Calculation	Result for Averaging Factor dB
0.6	3.4	$= 10 * \log_{10} (0.6 \text{ msec} / 3.4 \text{ msec})$	-7.5



**Duty Cycle Timing Diagram**

### 3.0 Power Spectral Density

#### 3.1 Test Procedure

A spectrum analyzer is used to measure the power spectral density.

#### 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 $\mu$ V/m at 3 m	15 Jan 2019 8 Mar 2019

#### 3.3 Test Results, Tabular

Measurement method was conducted with 3 kHz RBW and 10 kHz VBW. The requirements were satisfied.

Table 3.3.1 Power Spectral Density, Measured Conducted Frequency: 2412 MHz		
Mode	Port 1 dBm	Port 2 dBm
B	1.2	1.3
G	-0.2	0.3
MCS7, 20 MHz	-1.2	-0.6
MCS15, 20 MHz	NA	-4.2

Table 3.3.2 Power Spectral Density, Measured Conducted Frequency: 2437 MHz		
Mode	Port 1 dBm	Port 2 dBm
B	1.0	1.6
G	0.3	-0.1
MCS7, 20 MHz	-1.1	-0.6
MCS15, 20 MHz	NA	-3.6

Table 3.3.3 Power Spectral Density, Measured Conducted Frequency: 2457 MHz (6 dBm drive)		
Mode	Port 1 dBm	Port 2 dBm
B	-14.4	-11.7
G	-14.8	-12.3
MCS7, 20 MHz	-16.1	-14.1
MCS15, 20 MHz	NA	-17.6

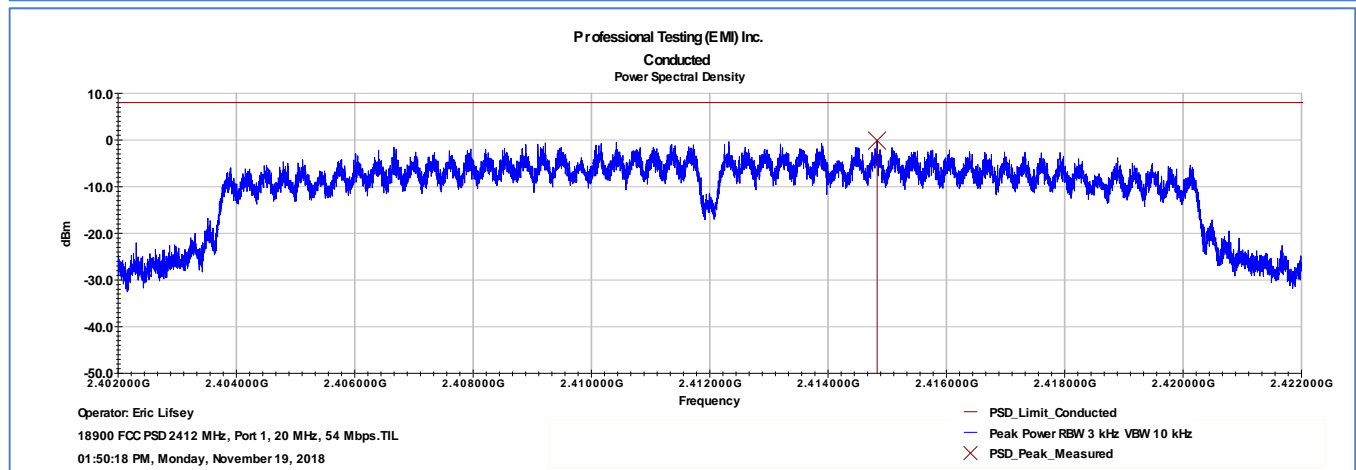
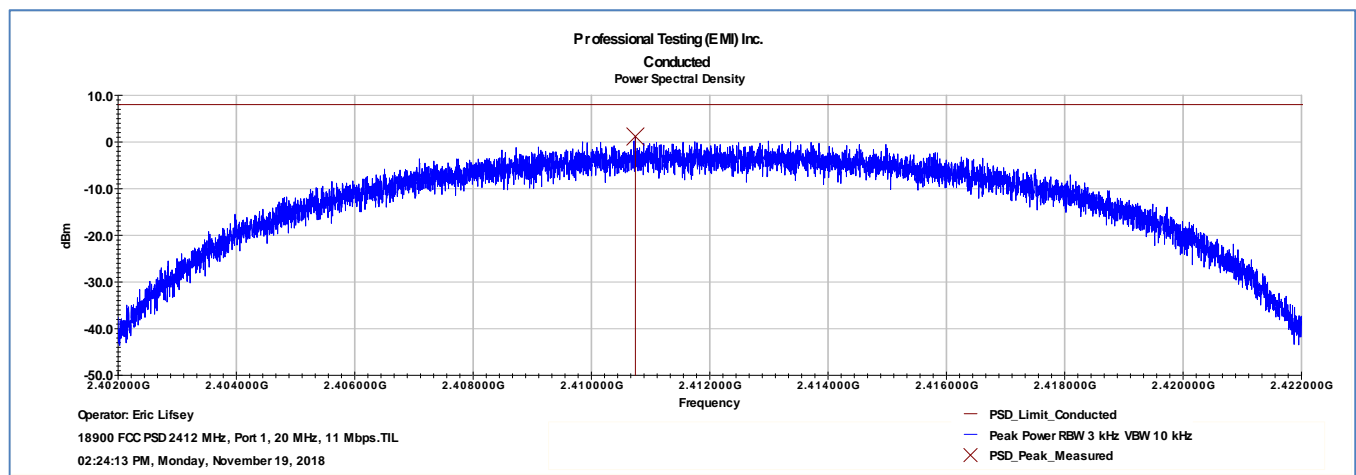
**Table 3.3.4 Power Spectral Density, Measured Conducted**  
**Frequency: 2422 MHz**

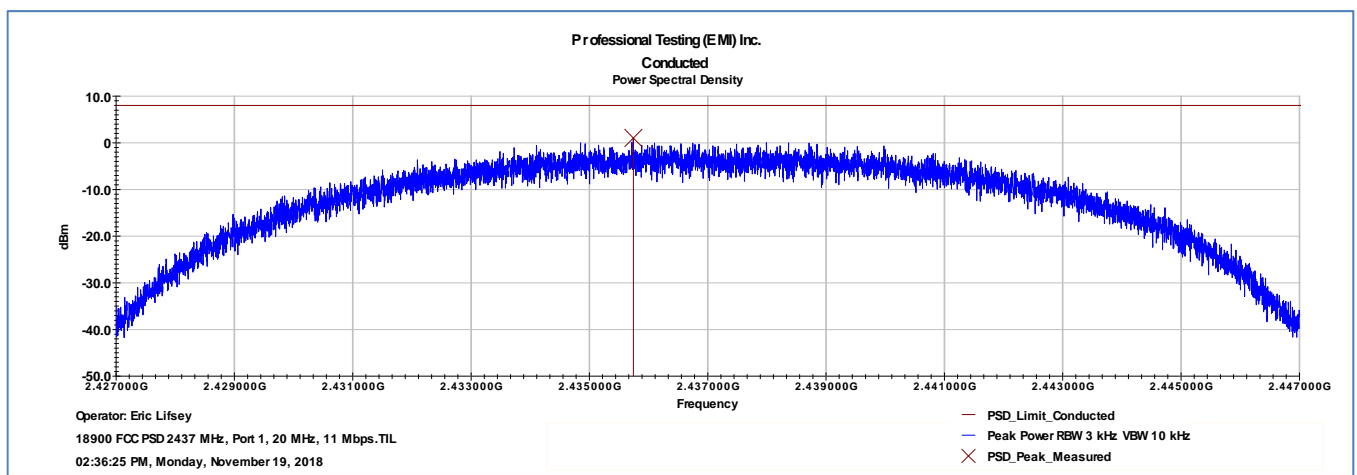
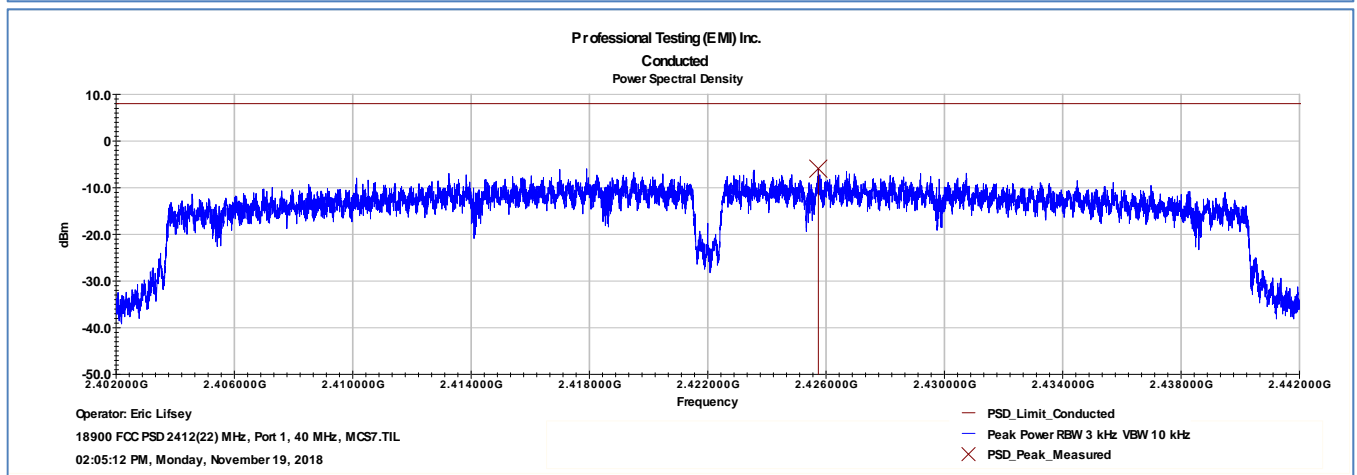
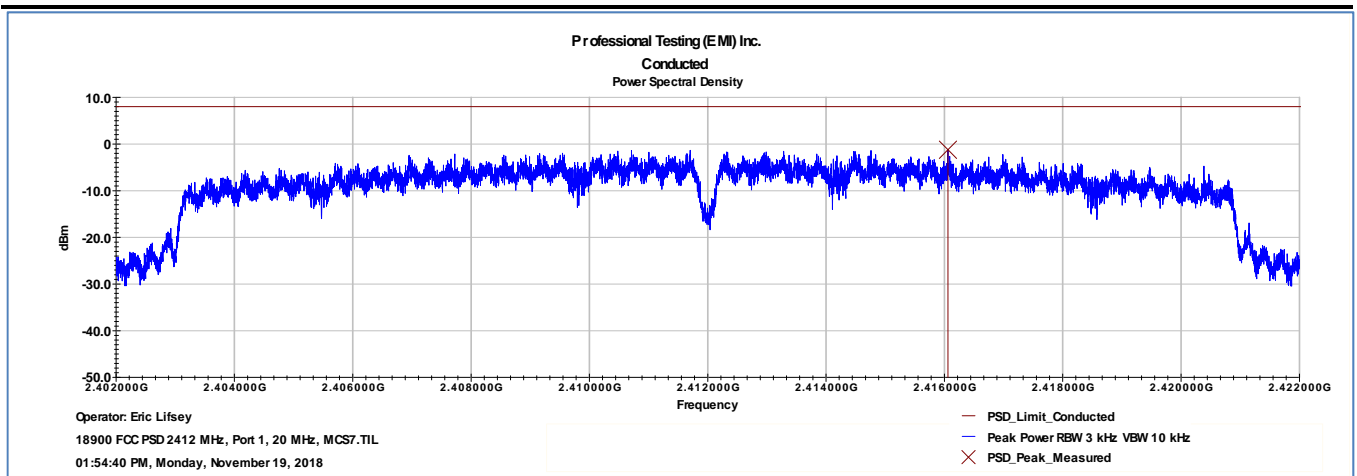
Mode	Port 1 dBm	Port 2 dBm
MCS7, 40 MHz	-5.9	NA

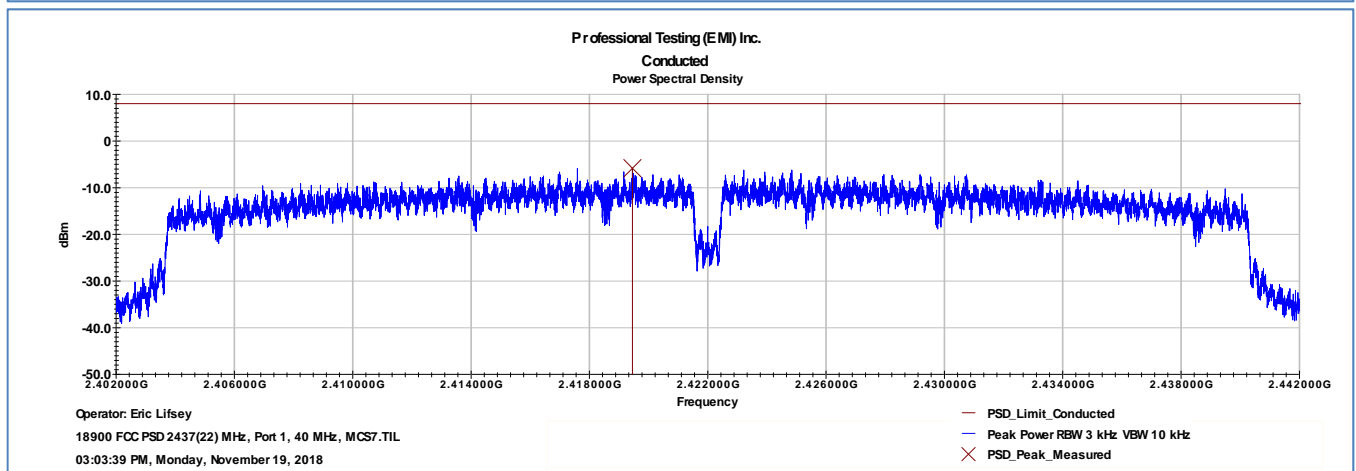
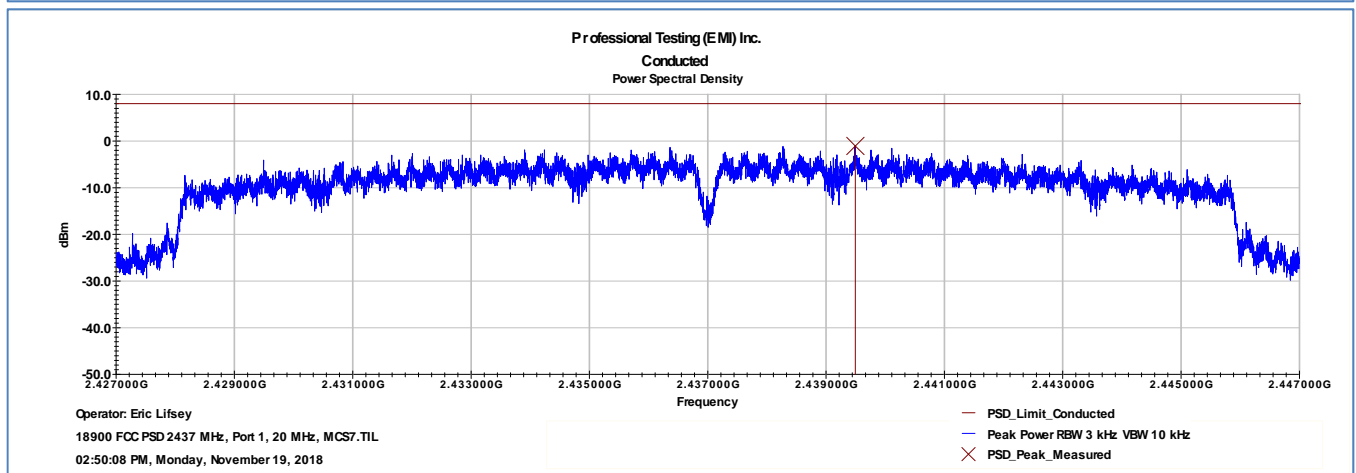
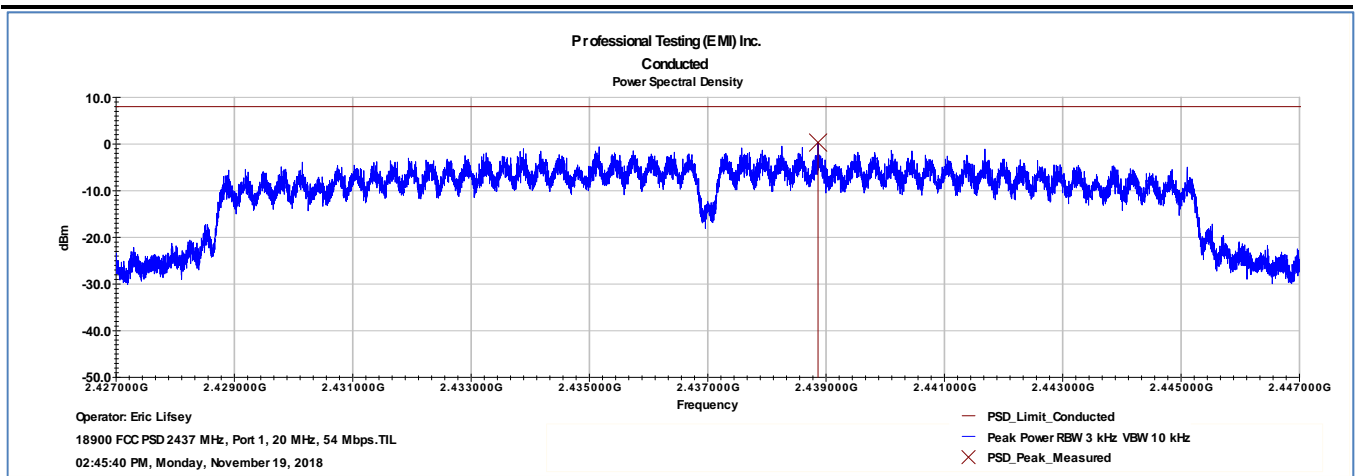
**Table 3.3.5 Power Spectral Density, Measured Conducted**  
**Frequency: 2447 MHz (6 dBm drive)**

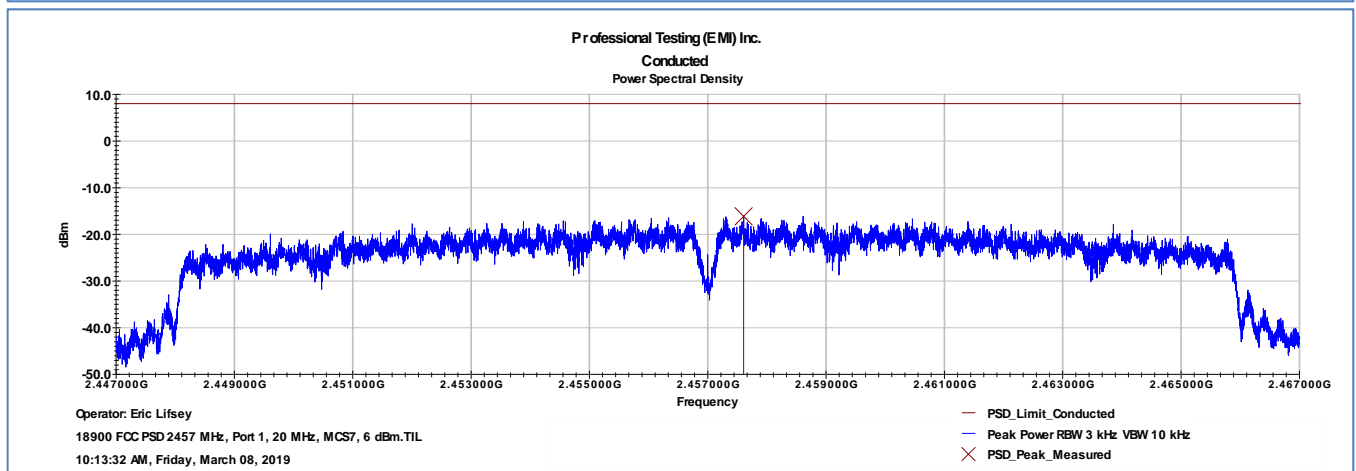
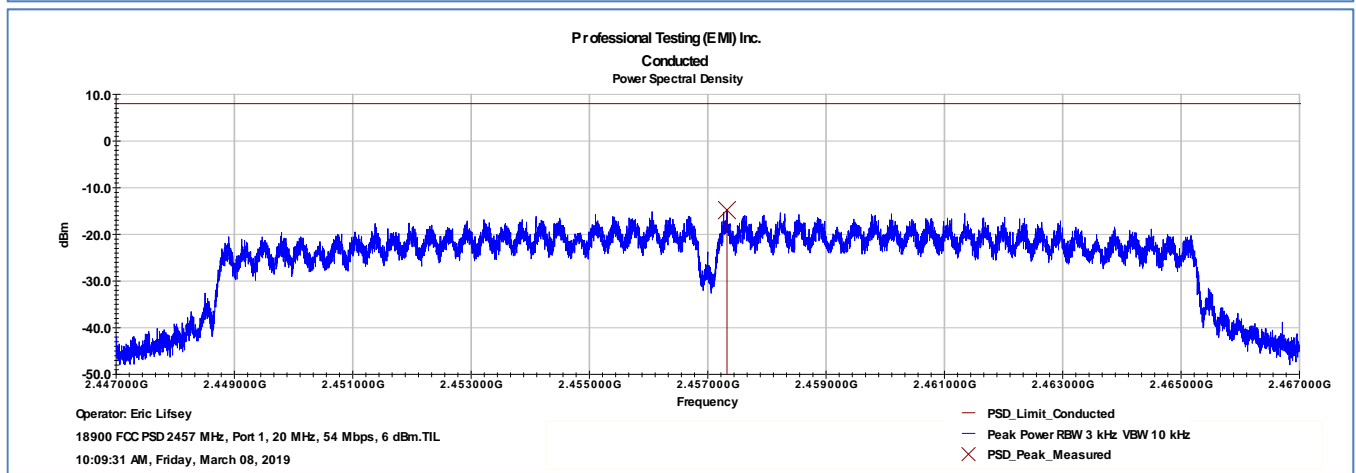
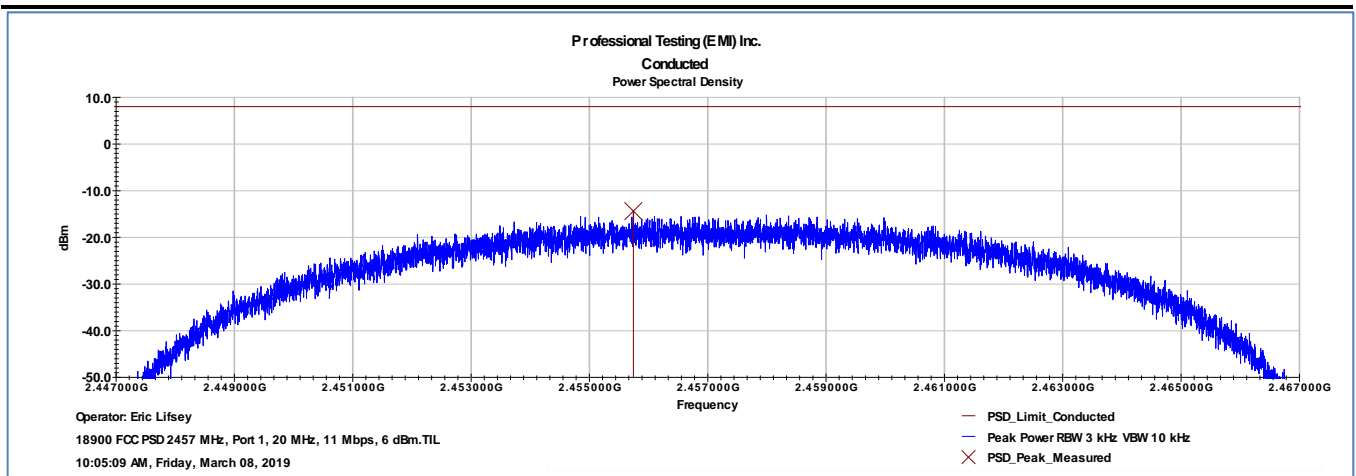
Mode	Port 1 dBm	Port 2 dBm
MCS7, 40 MHz	-19.0	NA

### 3.4 Test Results, Recorded, Port 1

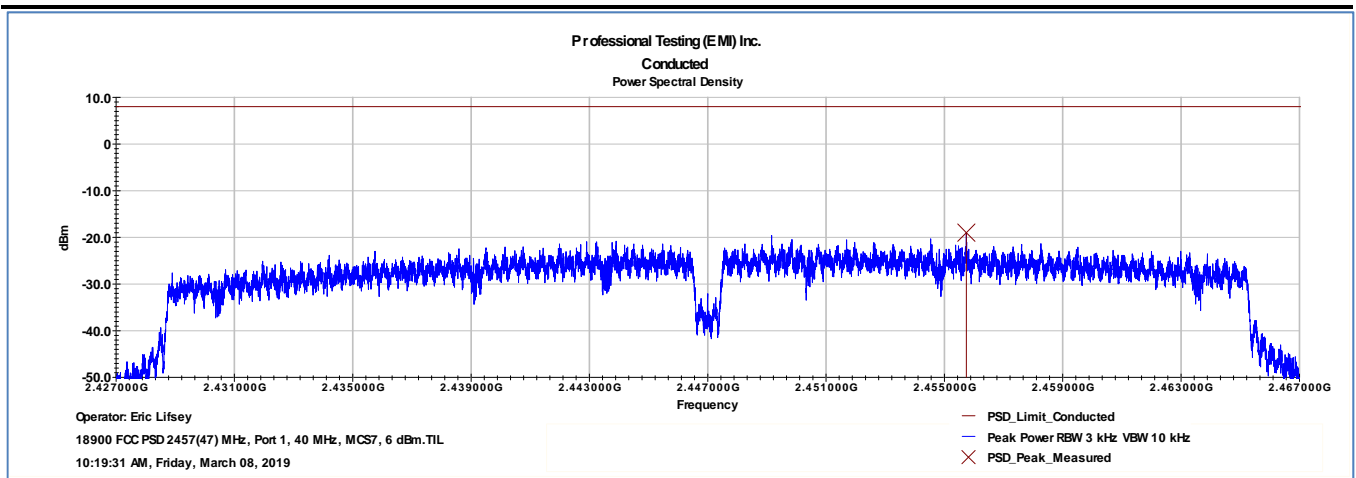




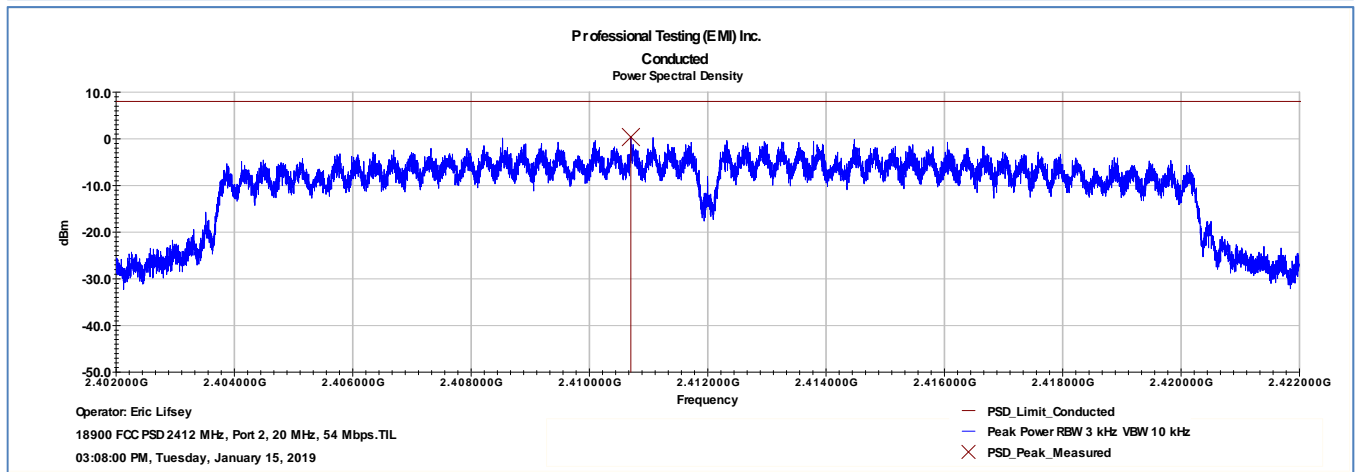
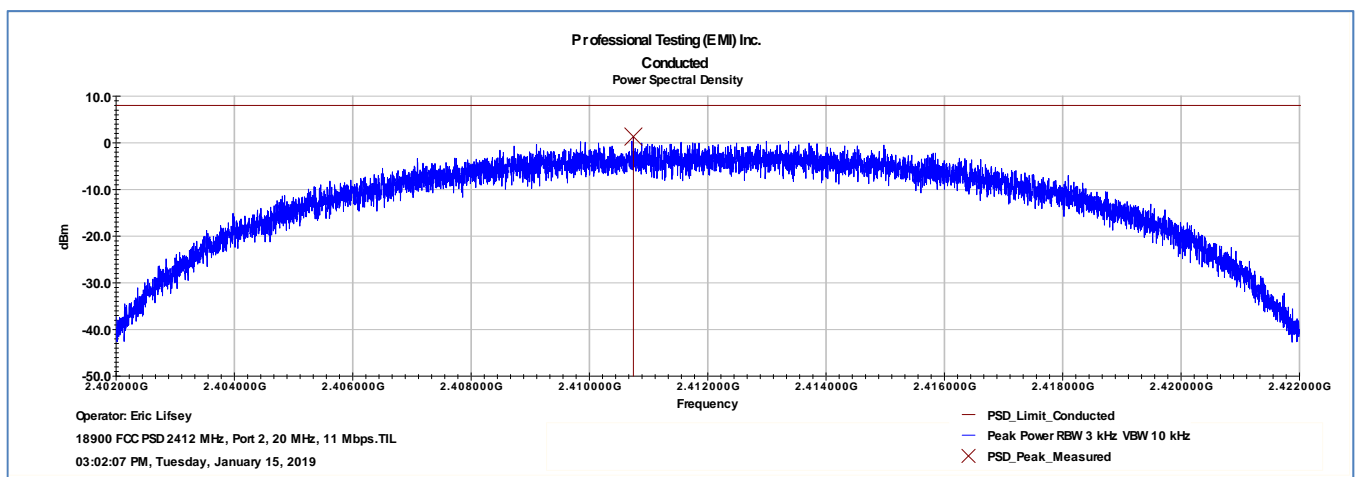


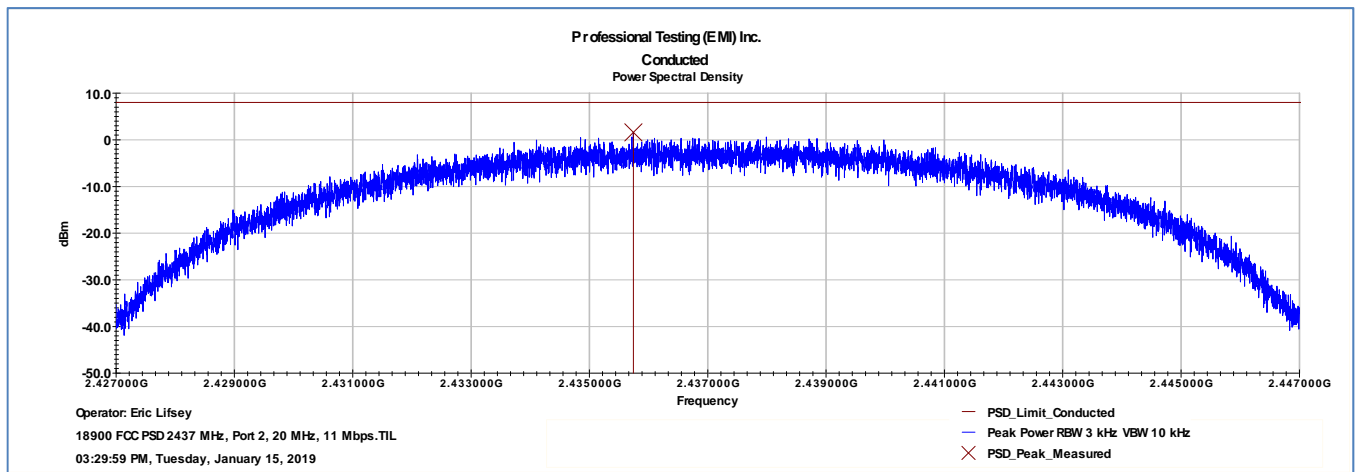
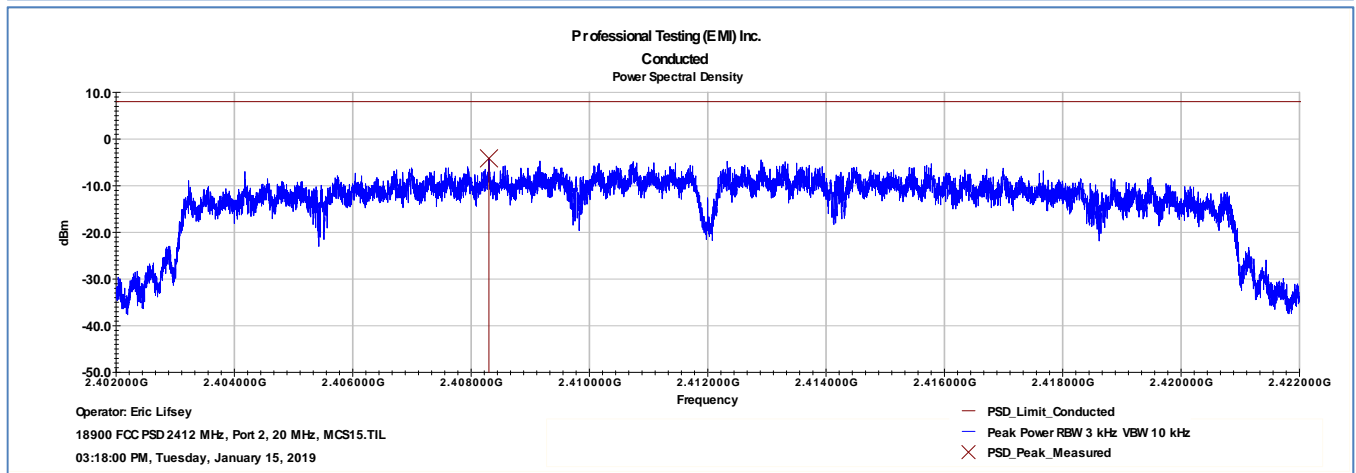
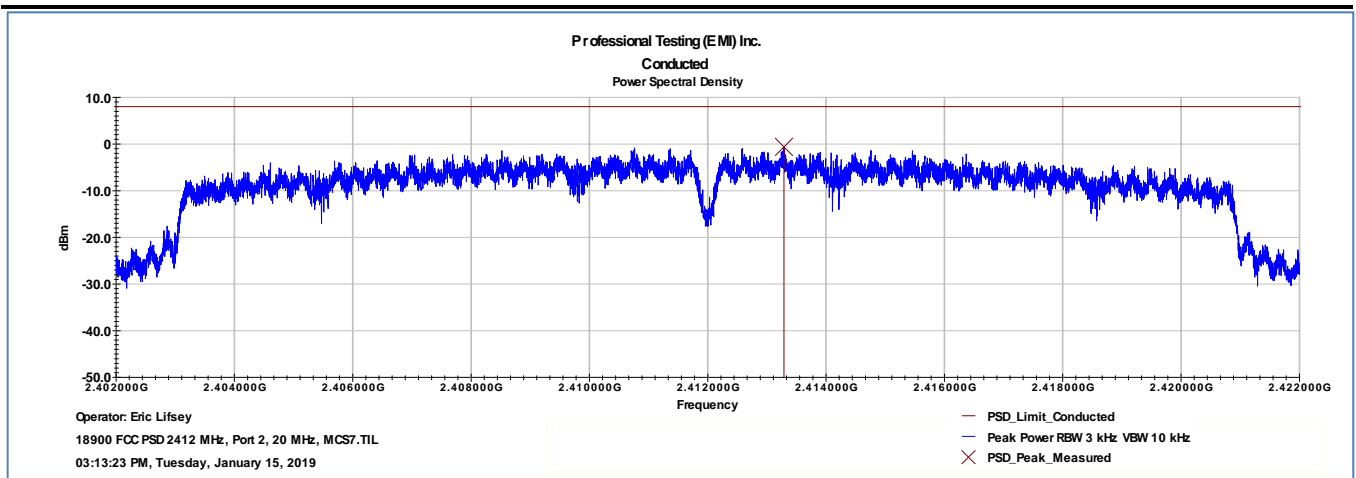


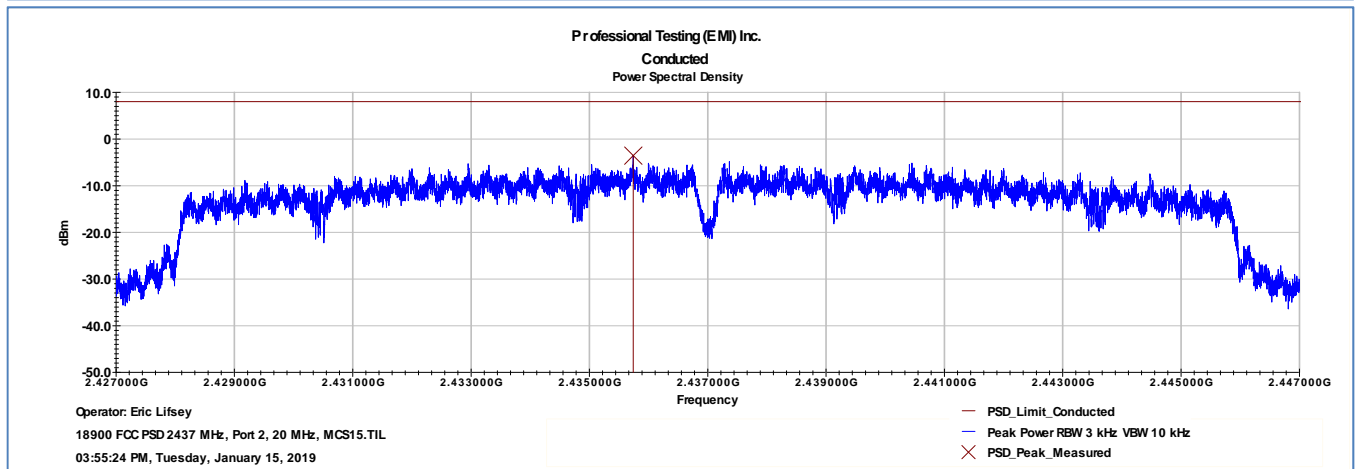
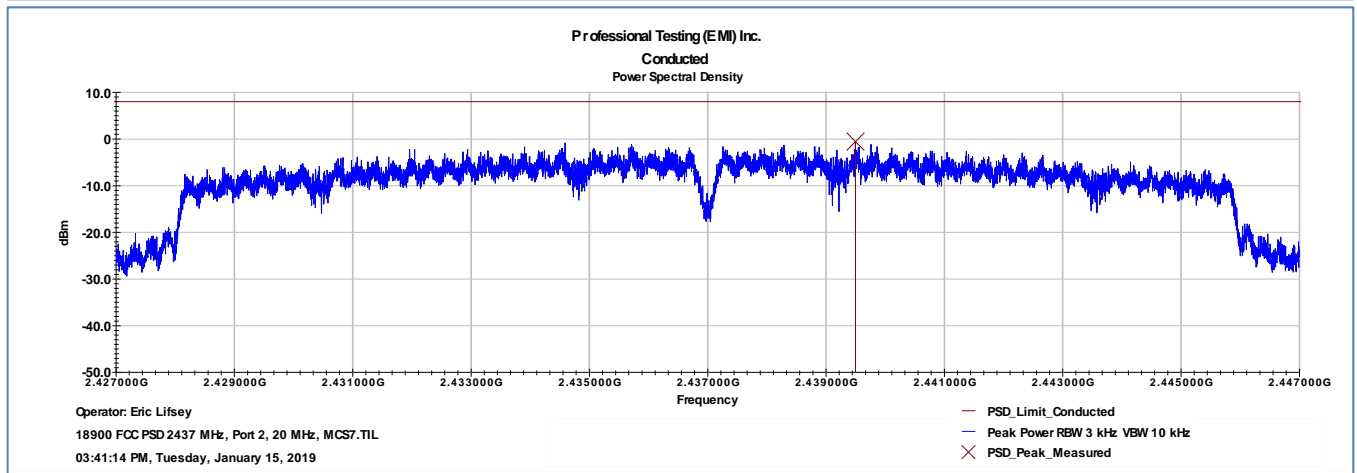
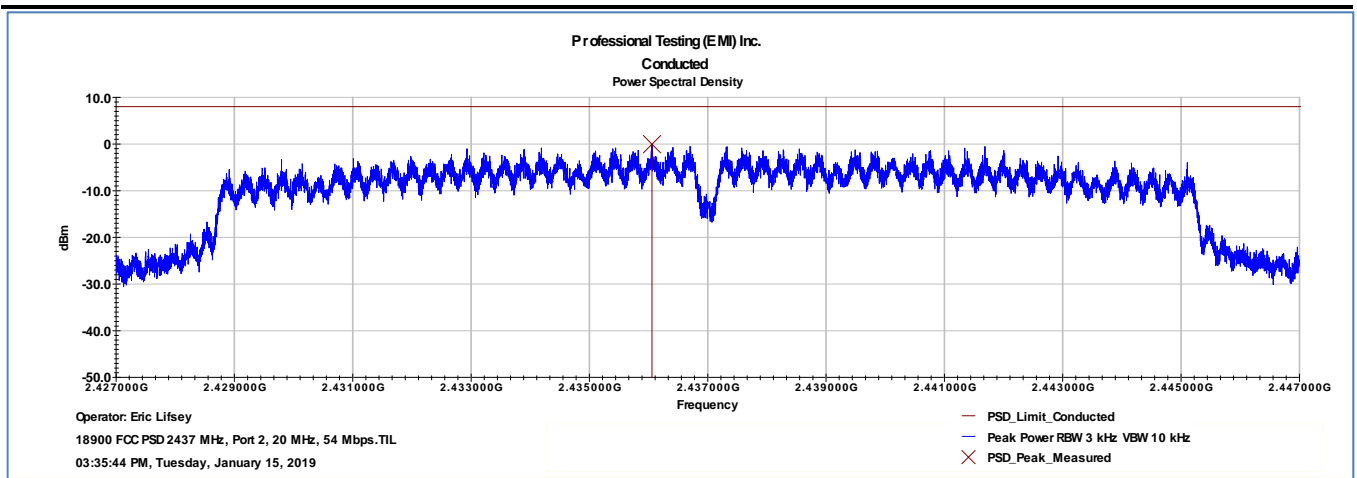


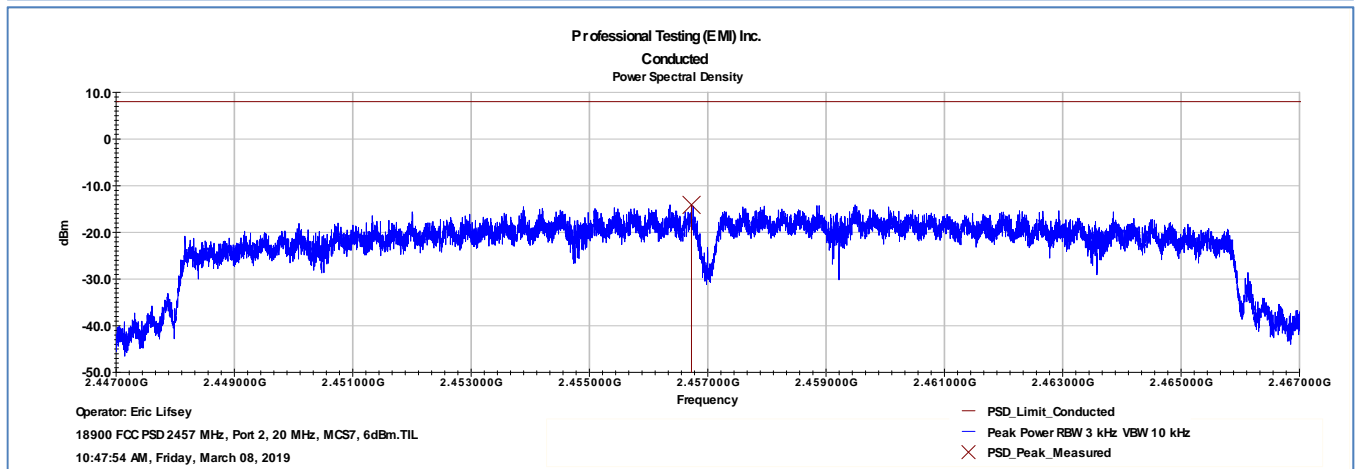
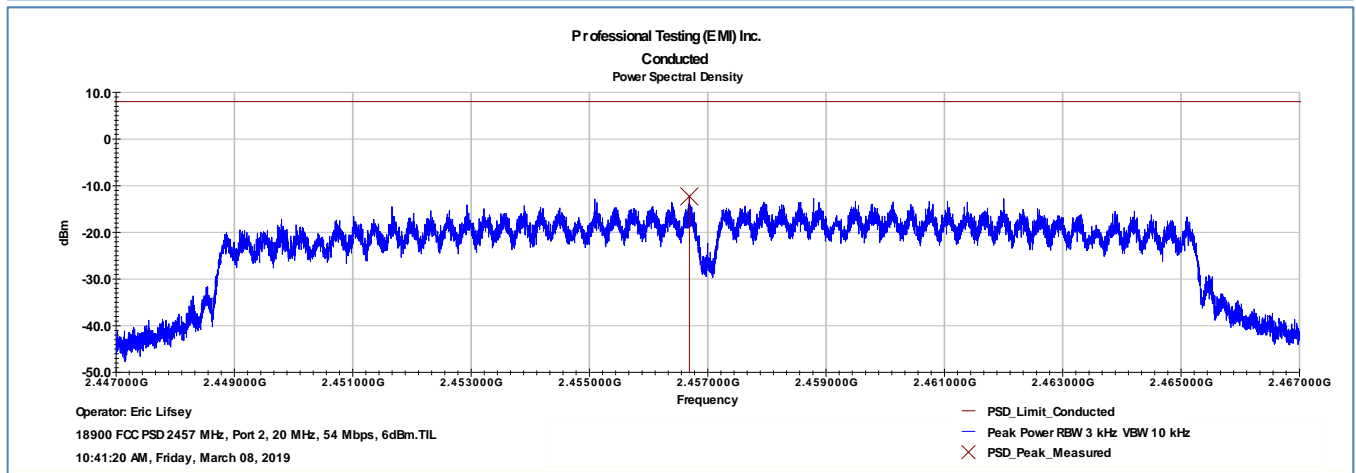
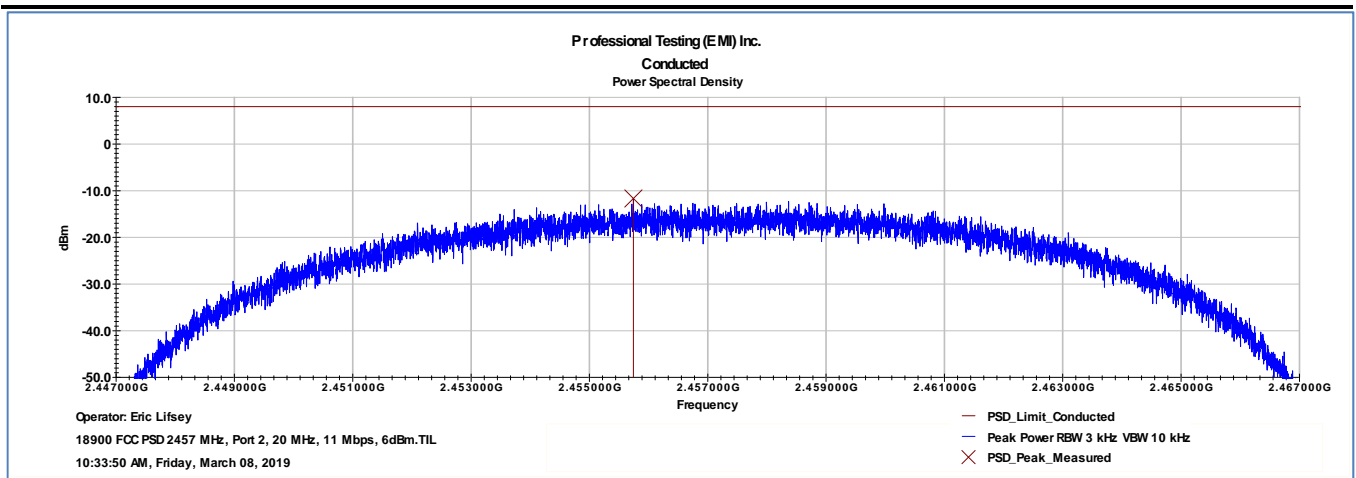


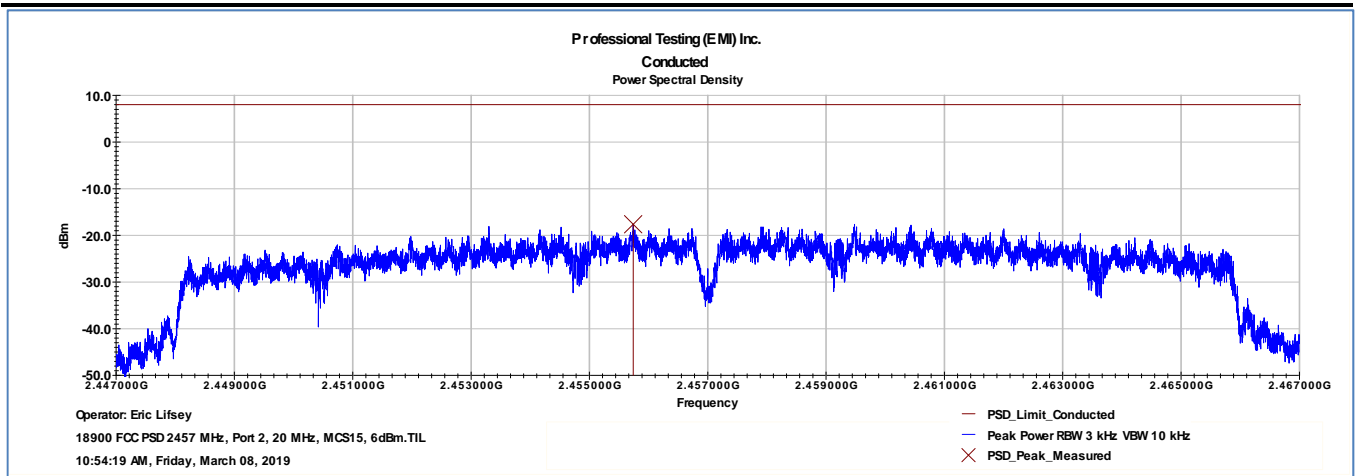
### 3.5 Test Results, Recorded, Port 2











## 4.0 Occupied Bandwidth

### 4.1 Test Procedure

Bandwidth is measured and recorded.

### 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, 99%	16 Jan 2019 8 Mar 2019

### 4.3 Test Results

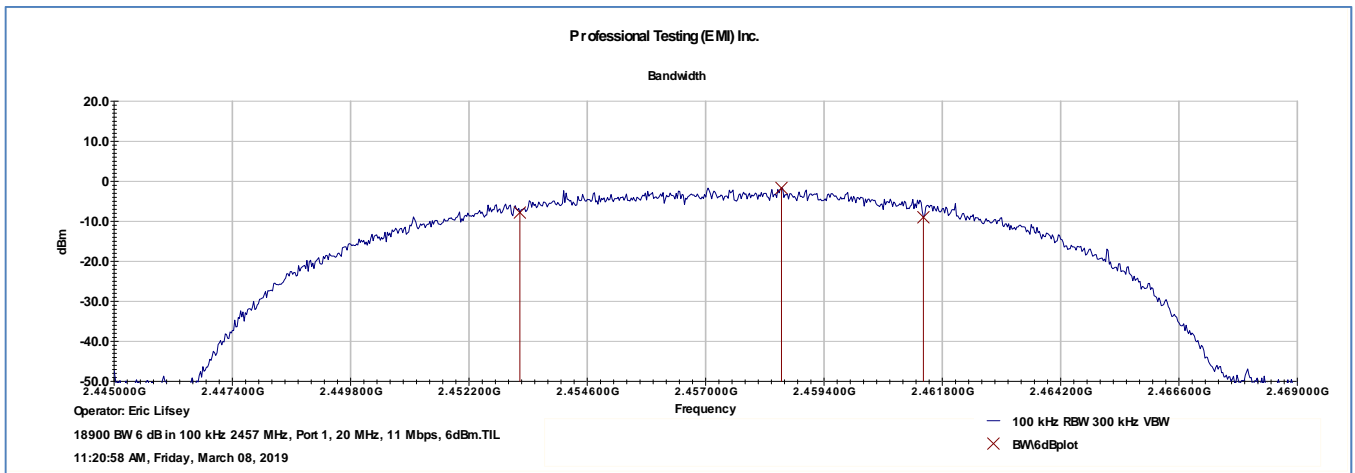
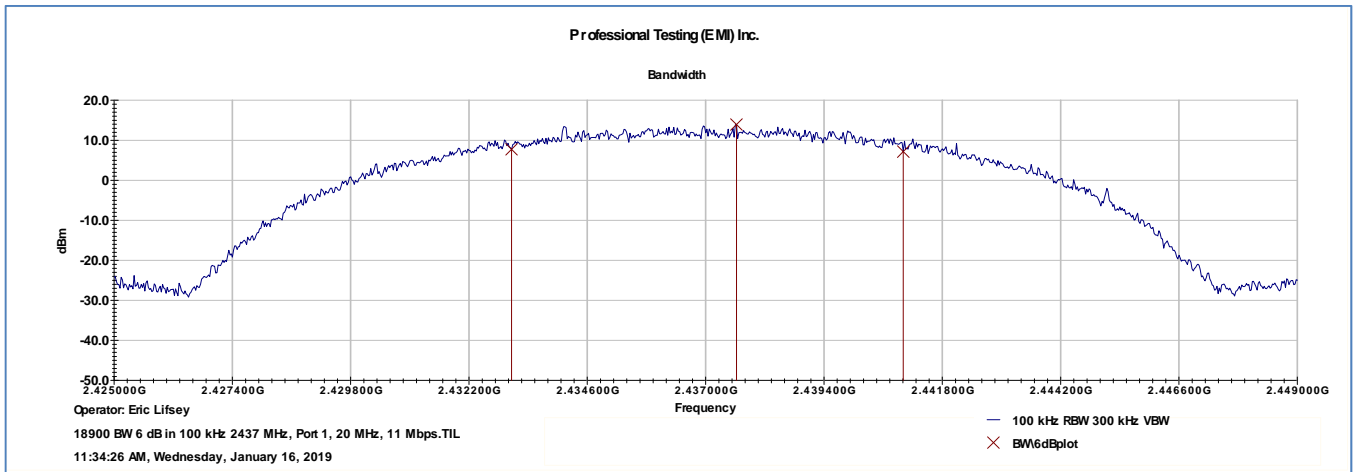
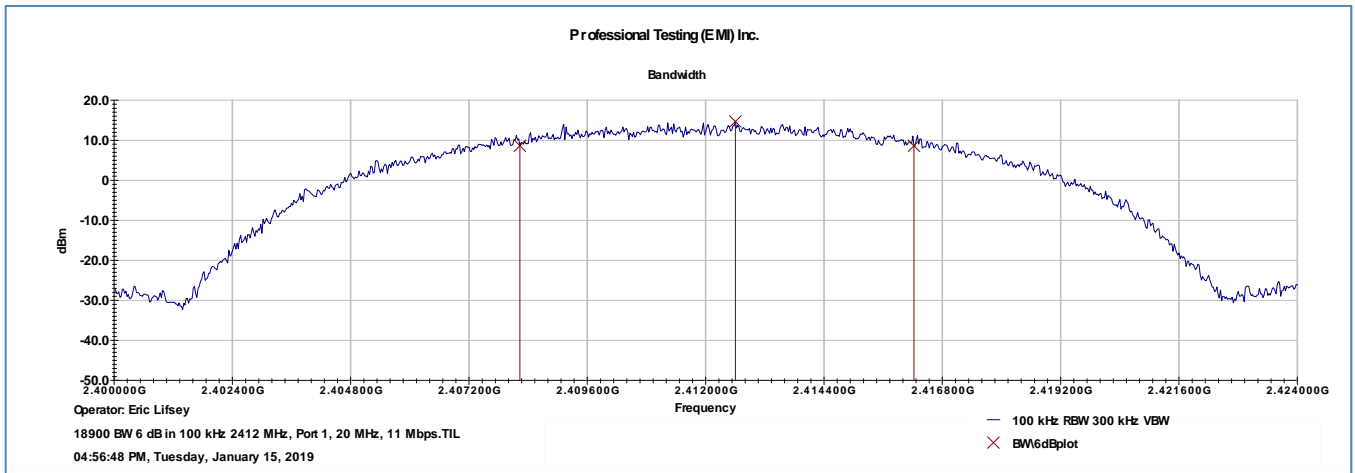
The bandwidth measurement is used to verify DTS characteristics and/or for general reporting for agency application.

The requirements were satisfied.

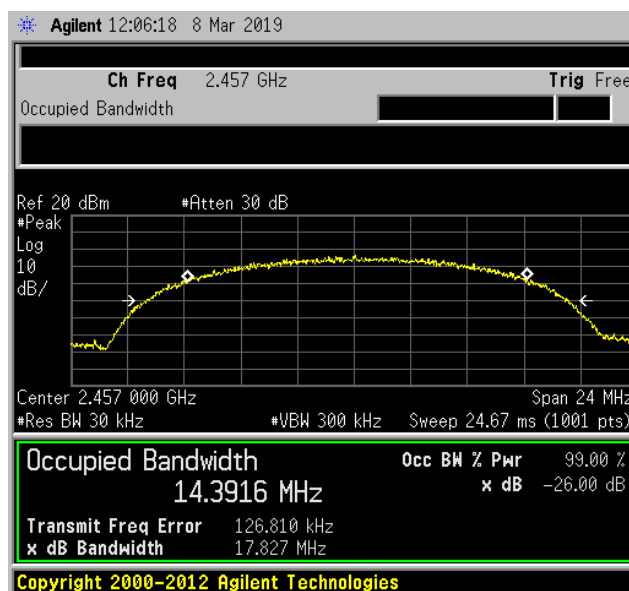
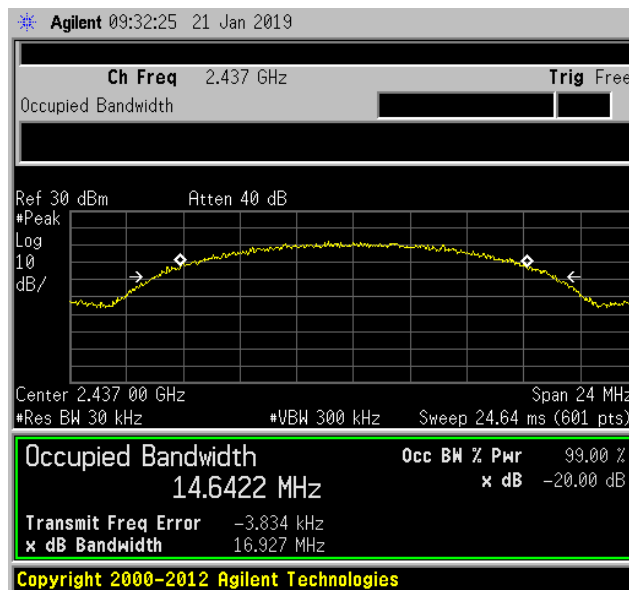
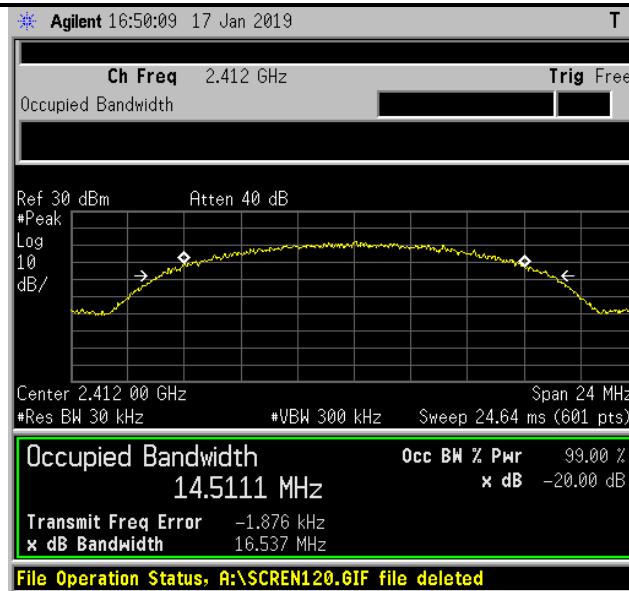
In cases where the software function failed to find/mark the correct edge of the modulated envelope, a manual measurement (marker-delta over display line) was taken with the same spectrum analyzer settings.

### 4.3.1 Antenna Port 1, Mode b

<b>Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Minimum BW (kHz)</b>
7992	7944	8184	<b>7992</b>
<b>Bandwidth 99%, Measure and Report</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Maximum BW (kHz)</b>
14511	14642	14392	<b>14642</b>

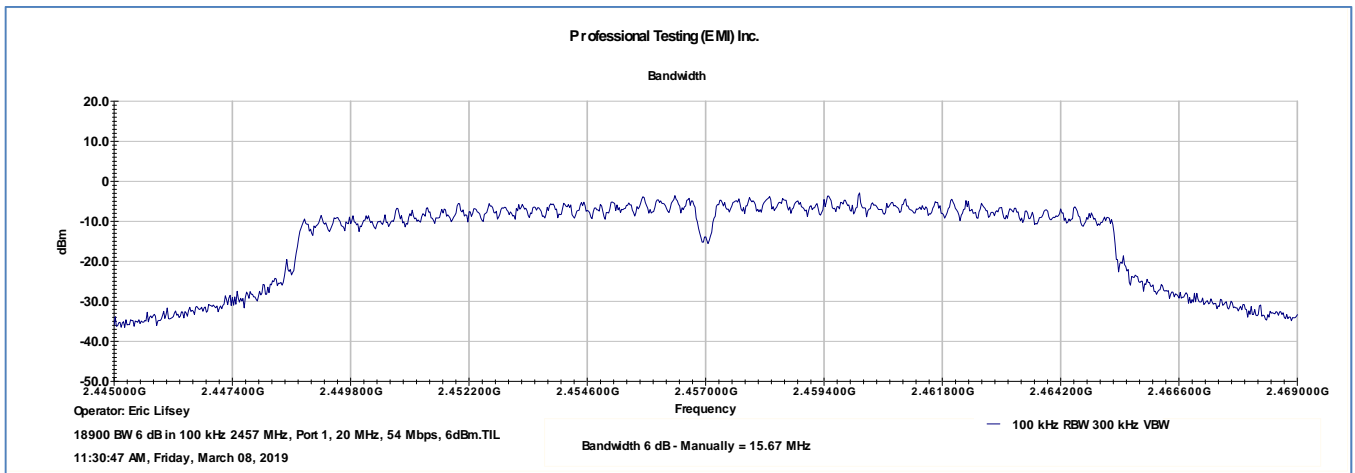
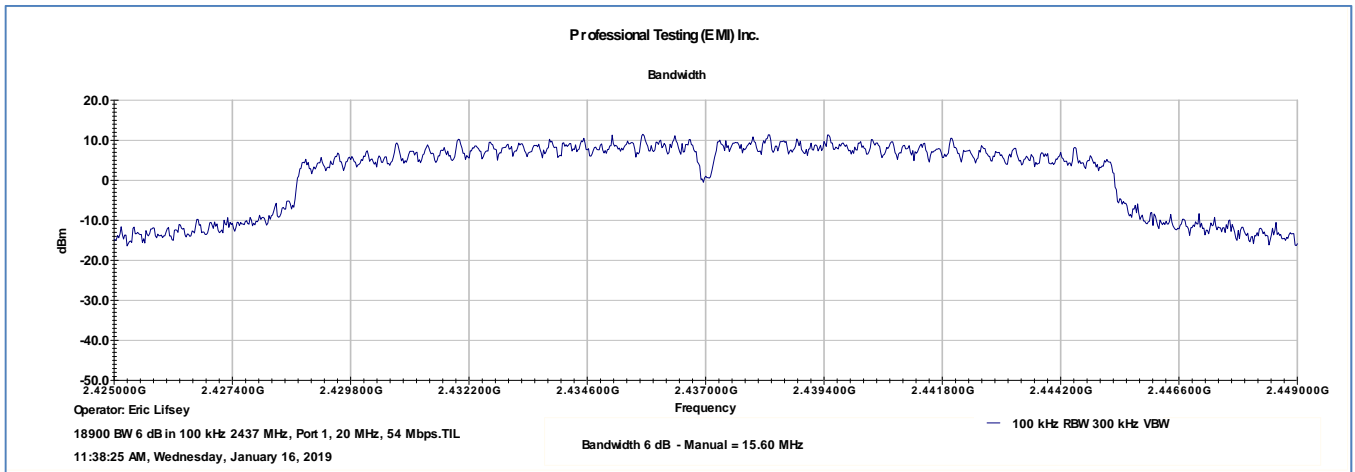
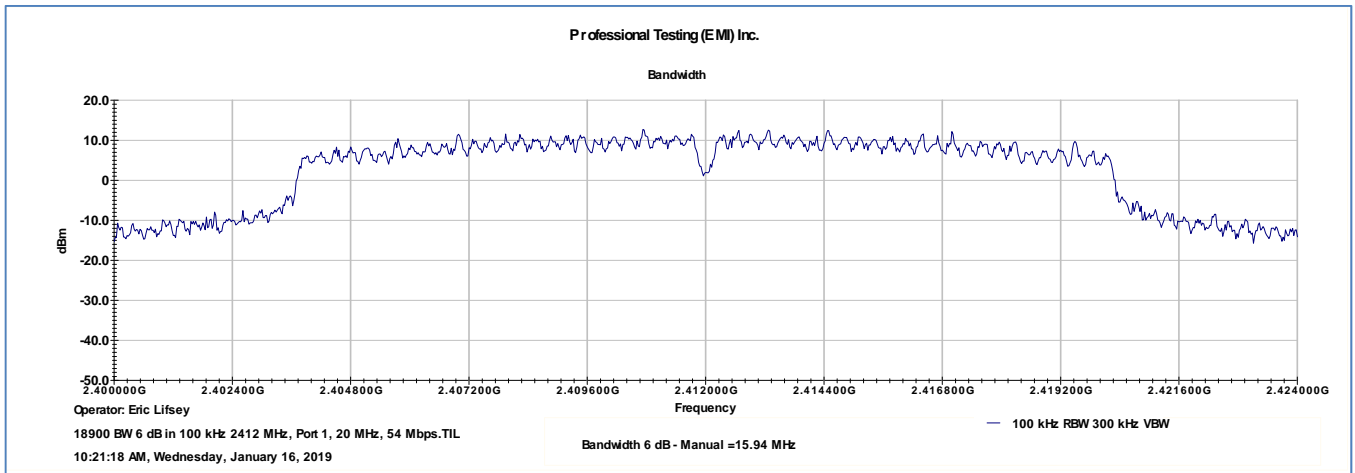


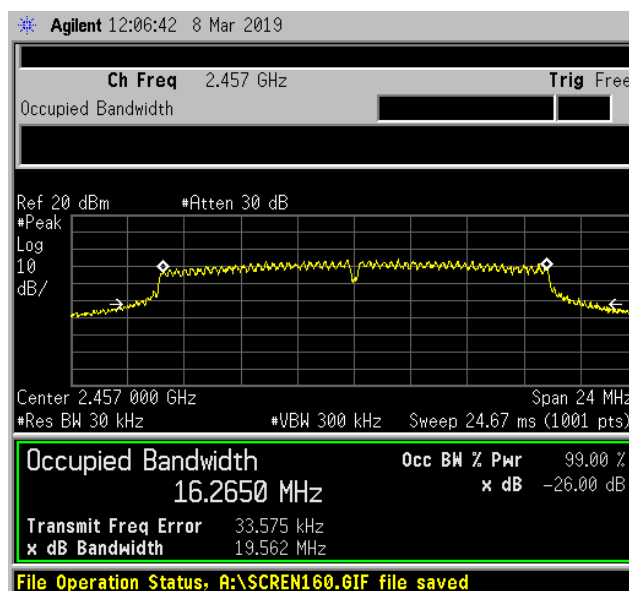
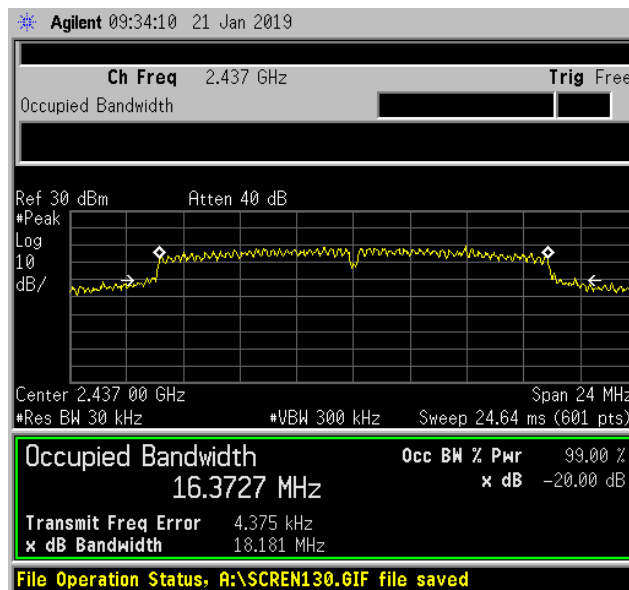
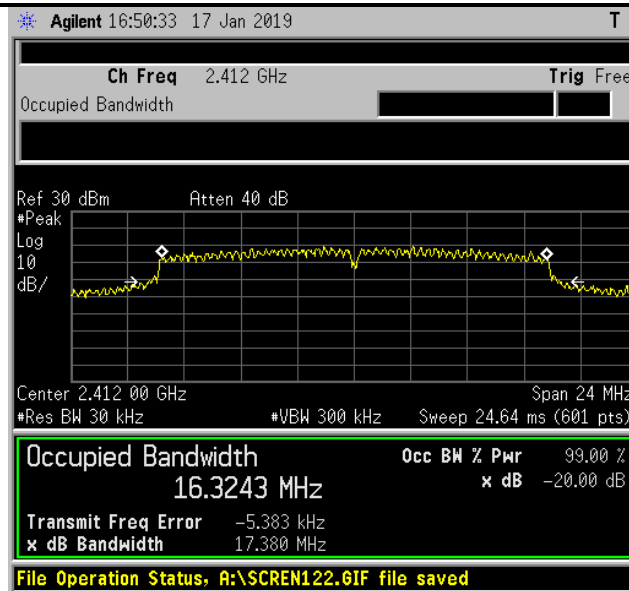




### 4.3.2 Antenna Port 1, Mode g

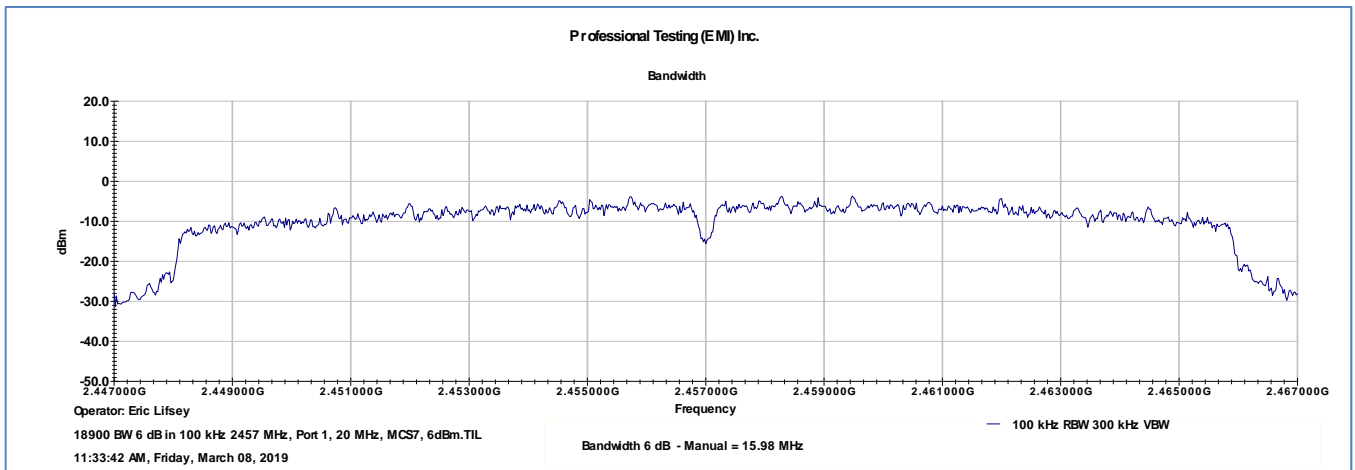
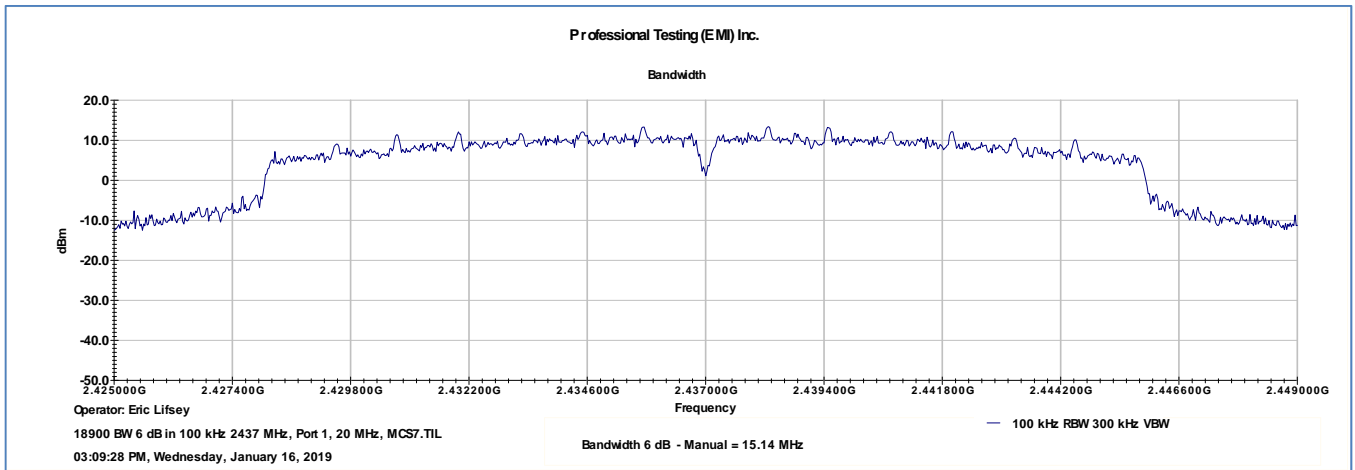
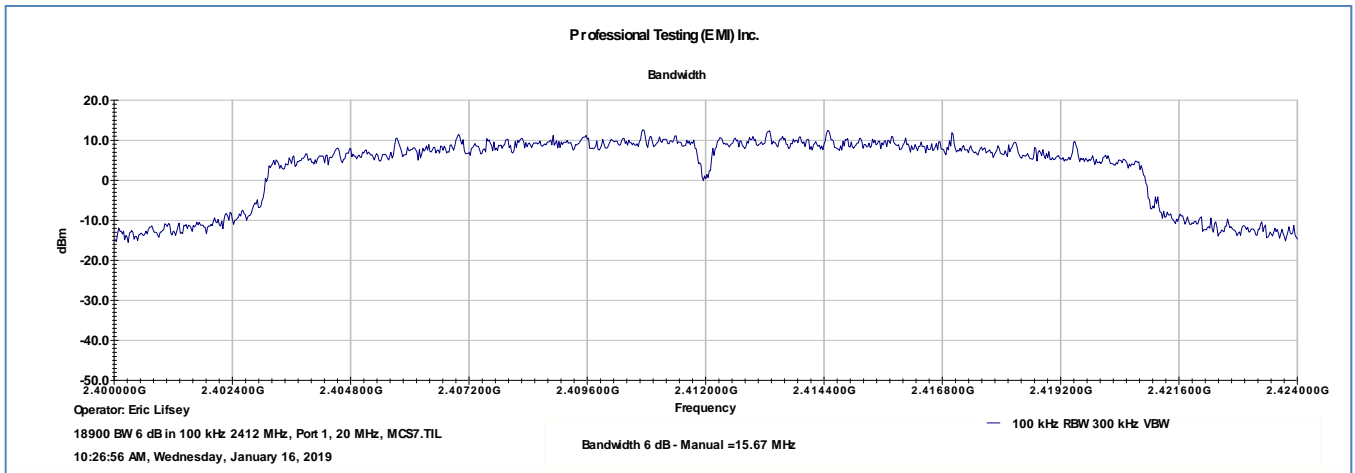
<b>Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Minimum BW (kHz)</b>
15940	15600	15670	<b>15600</b>
<b>Bandwidth 99%, Measure and Report</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Maximum BW (kHz)</b>
16324	16373	16265	<b>16373</b>

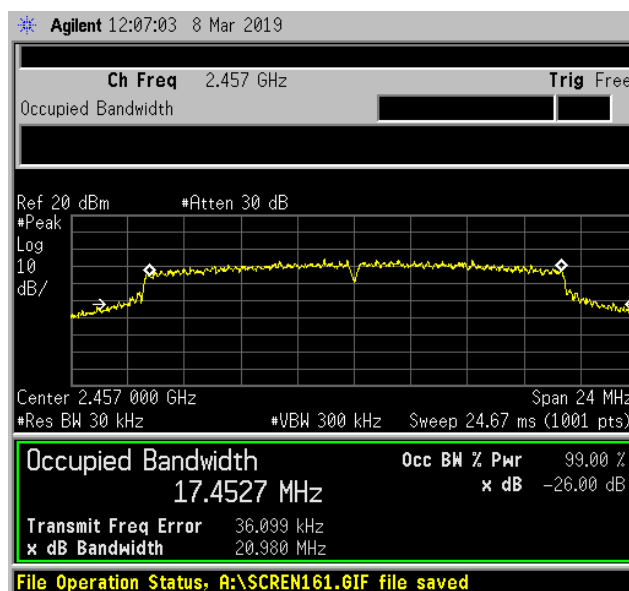
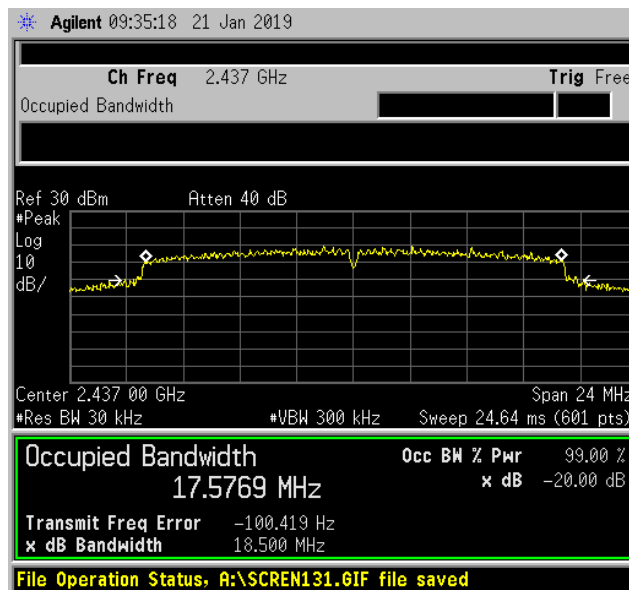
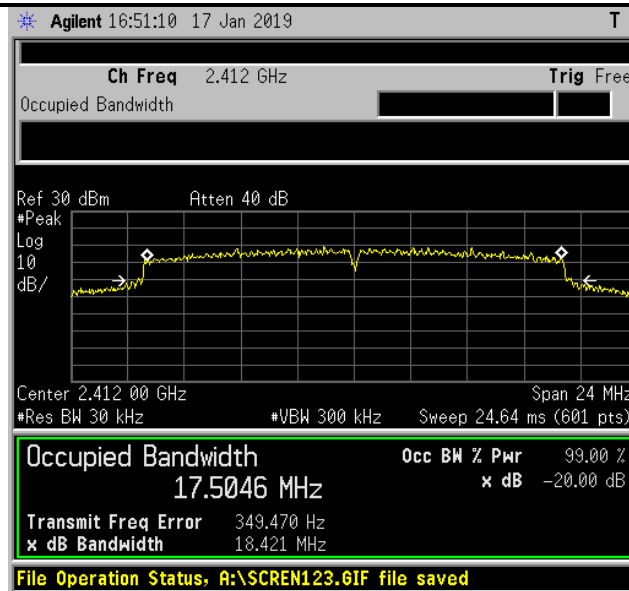




### 4.3.3 Antenna Port 1, Mode n, MCS7

<b>Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Minimum BW (kHz)</b>
15670	15140	15980	<b>15140</b>
<b>Bandwidth 99%, Measure and Report</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Maximum BW (kHz)</b>
17505	17577	17453	<b>17577</b>

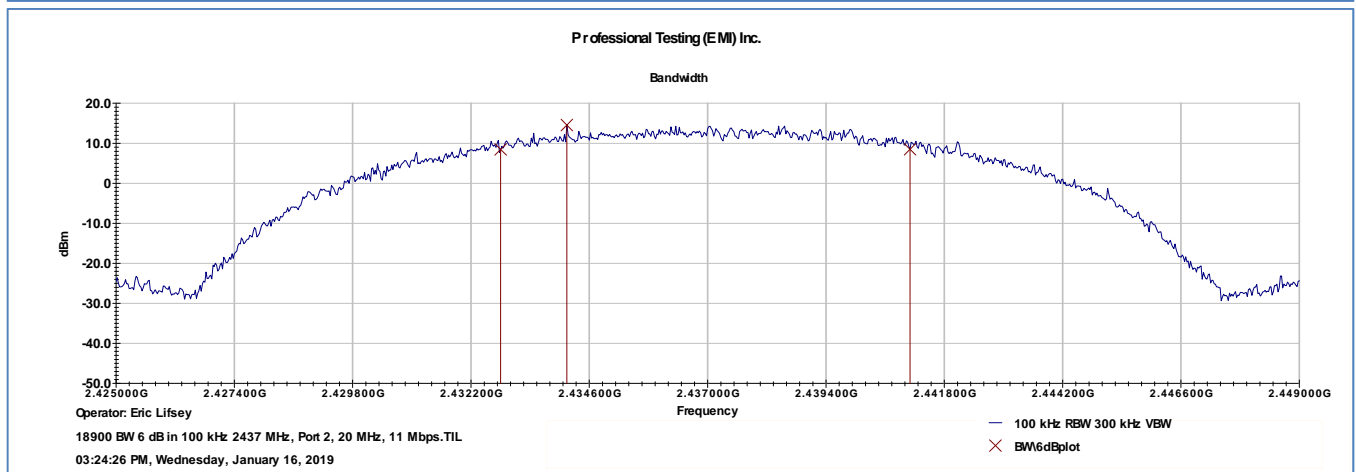
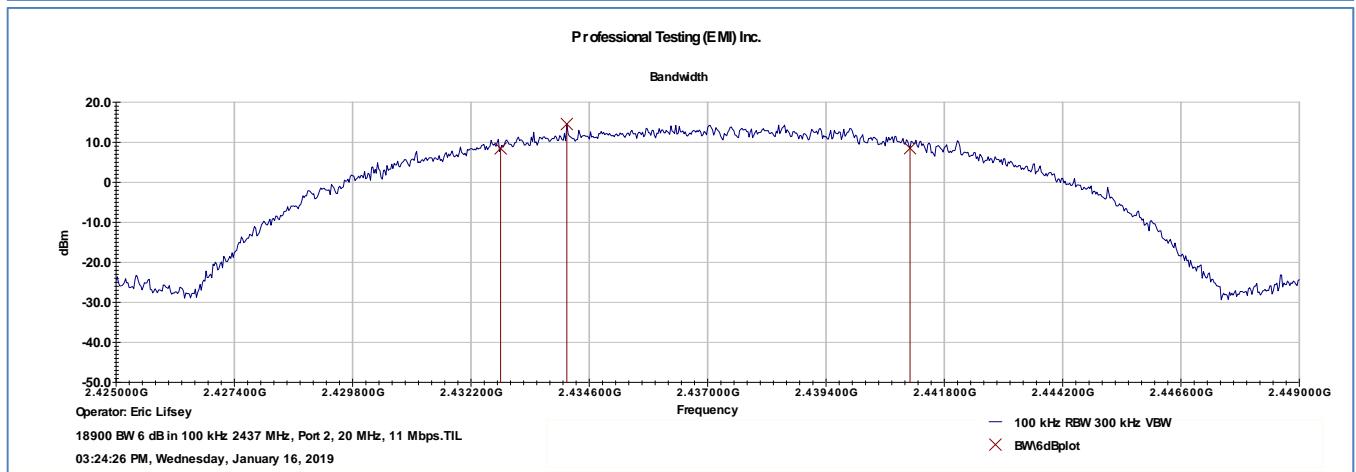
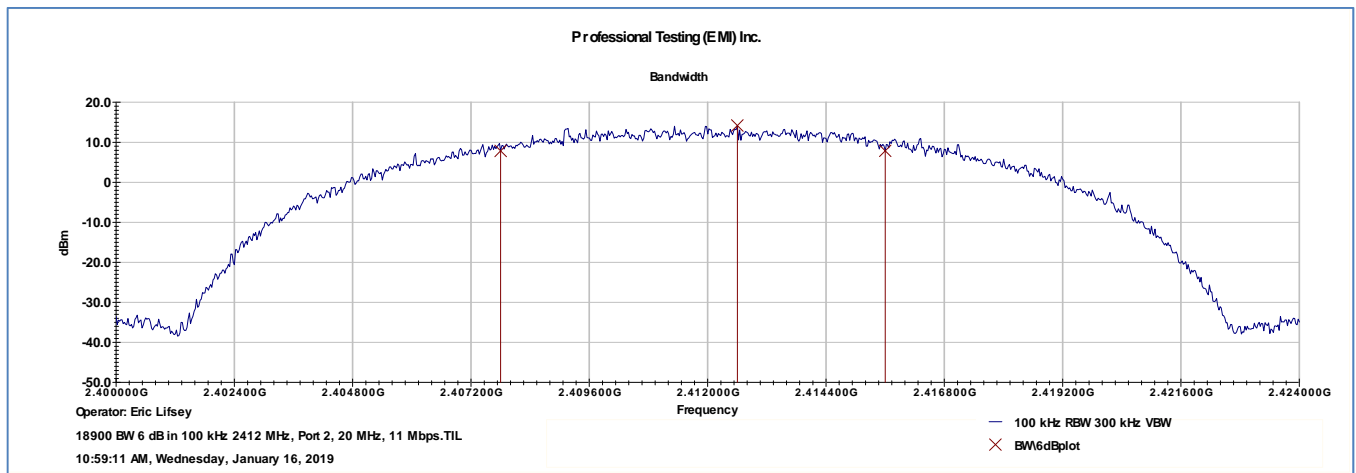


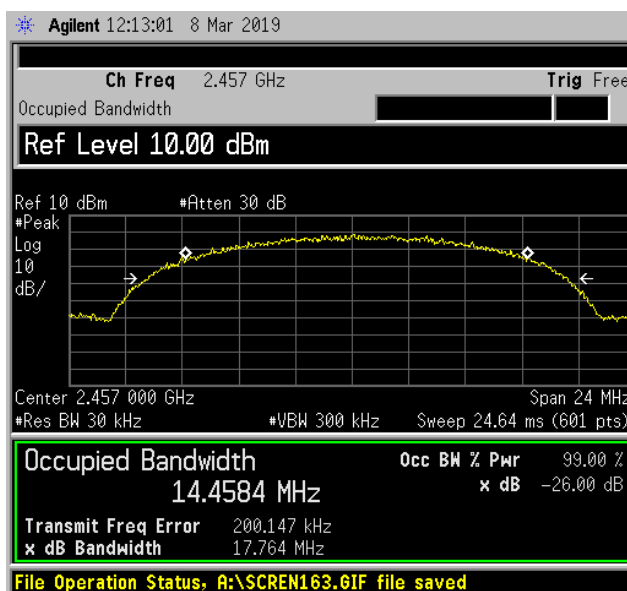
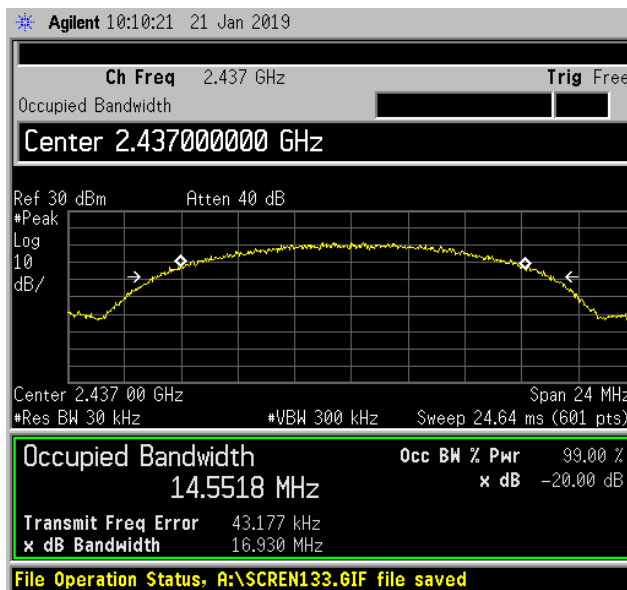
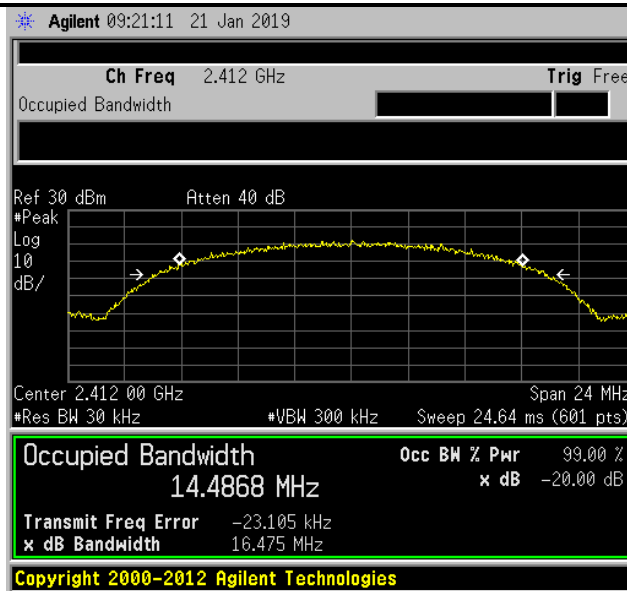


#### 4.3.4 Antenna Port 2, Mode b

<b>Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Minimum BW (kHz)</b>
7800	8304	8304	<b>7800</b>
<b>Bandwidth 99%, Measure and Report</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Maximum BW (kHz)</b>
14487	14552	14458	<b>14552</b>

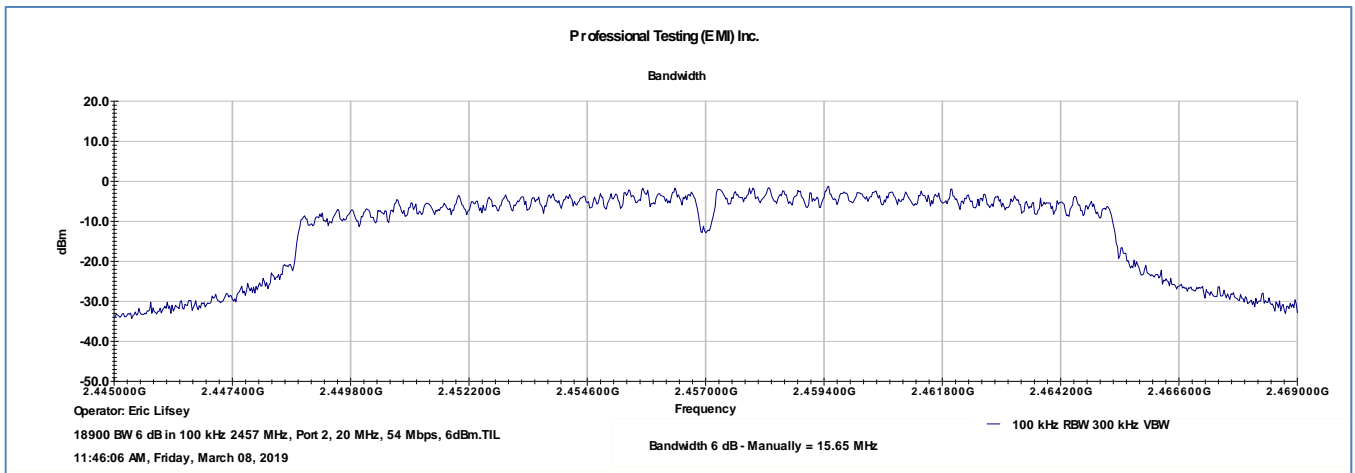
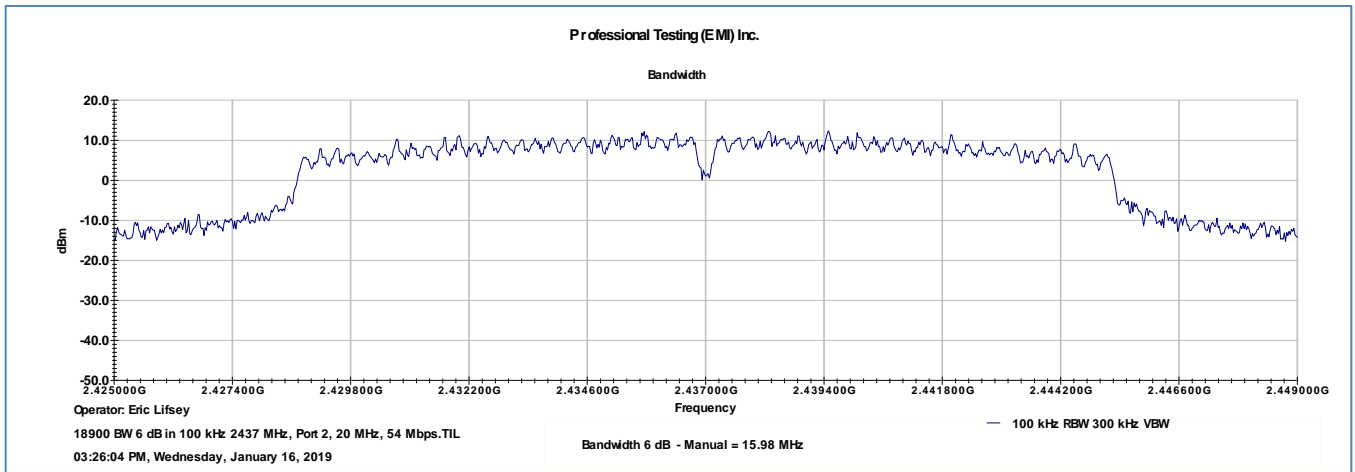
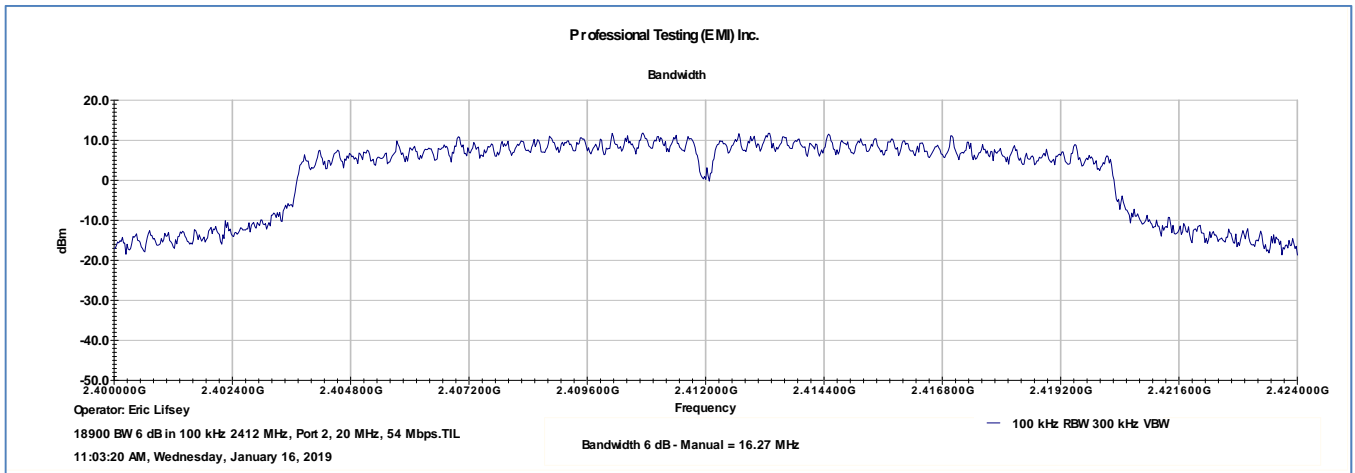


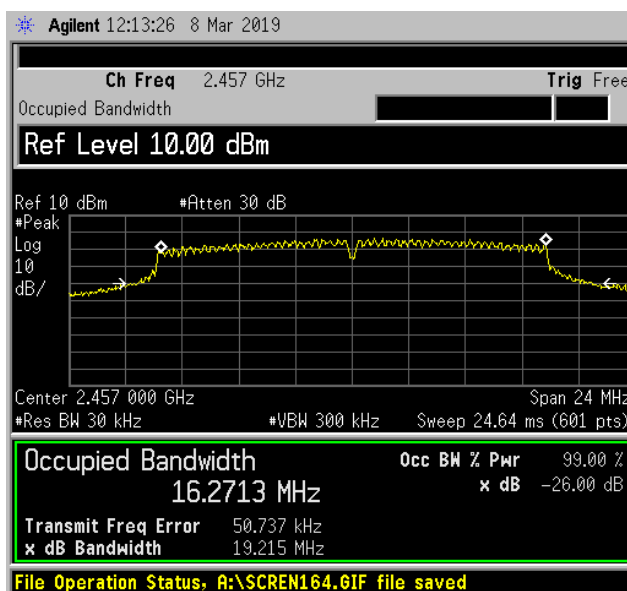
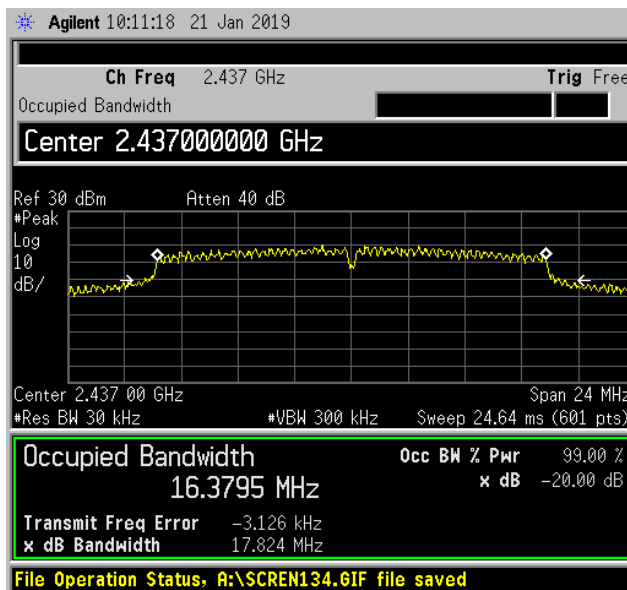
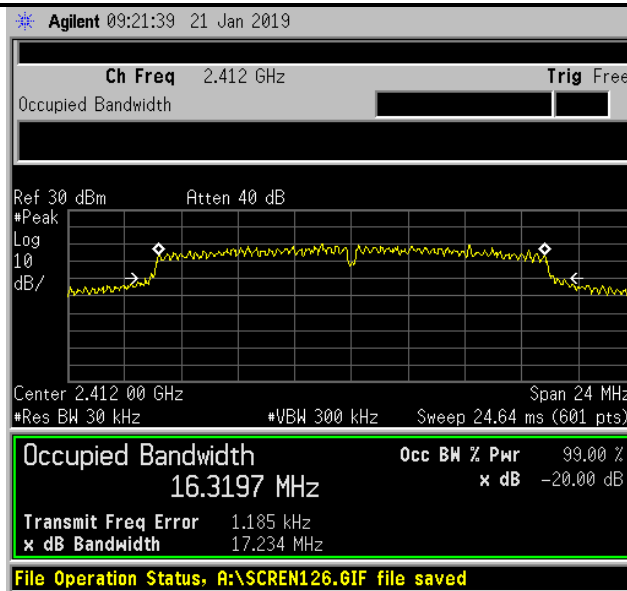




### 4.3.5 Antenna Port 2, Mode g

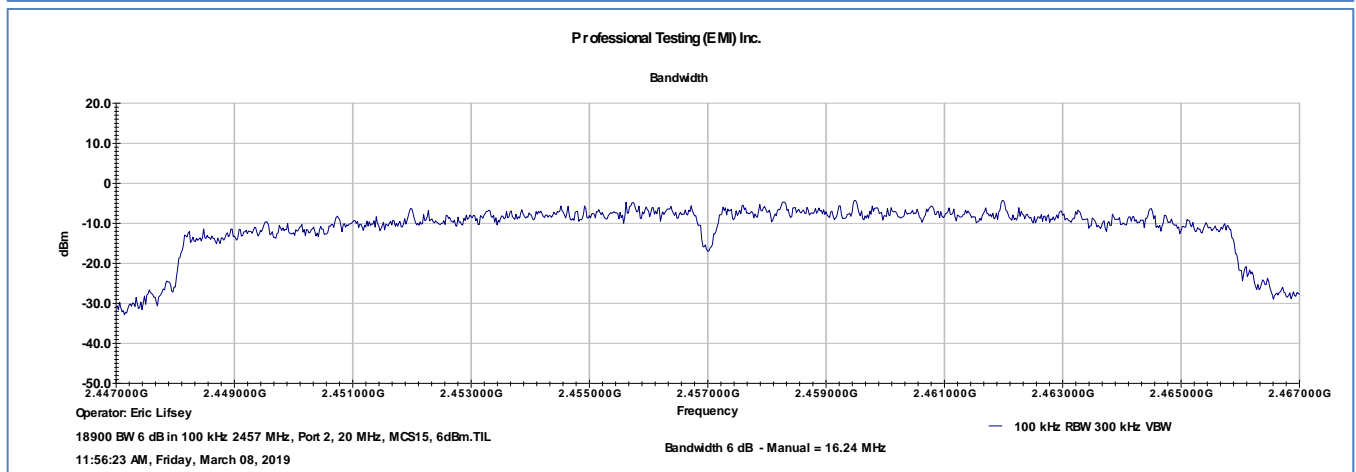
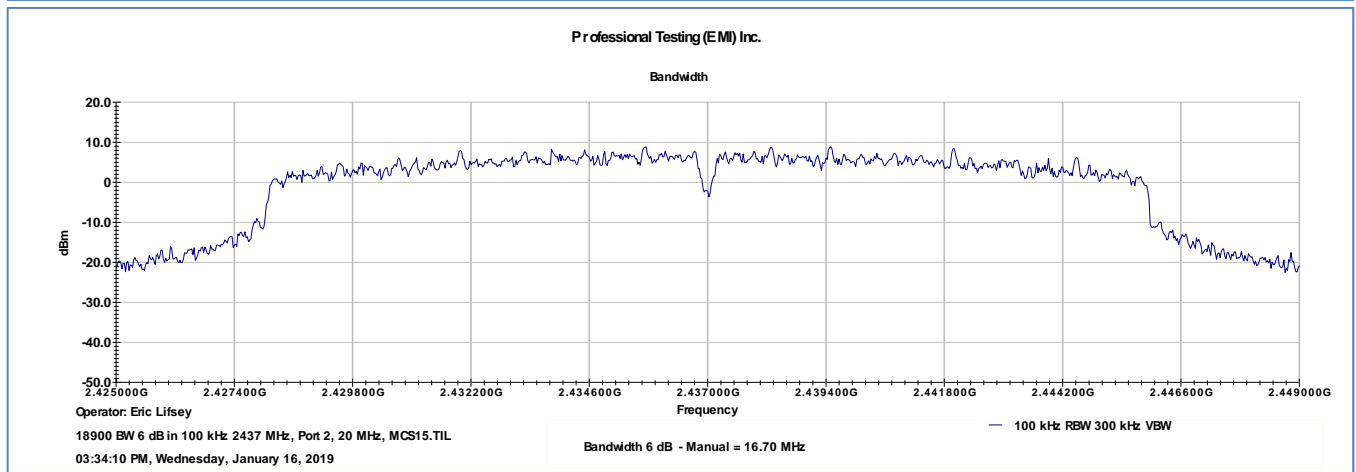
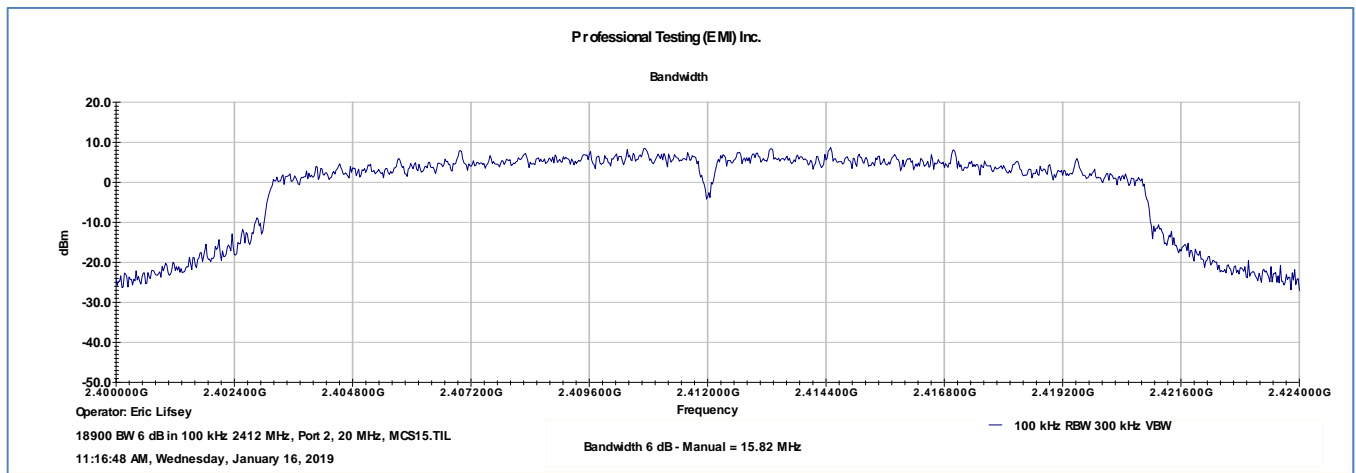
<b>Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Minimum BW (kHz)</b>
16270	15980	15650	<b>15650</b>
<b>Bandwidth 99%, Measure and Report</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Maximum BW (kHz)</b>
16320	16380	16271	<b>16380</b>

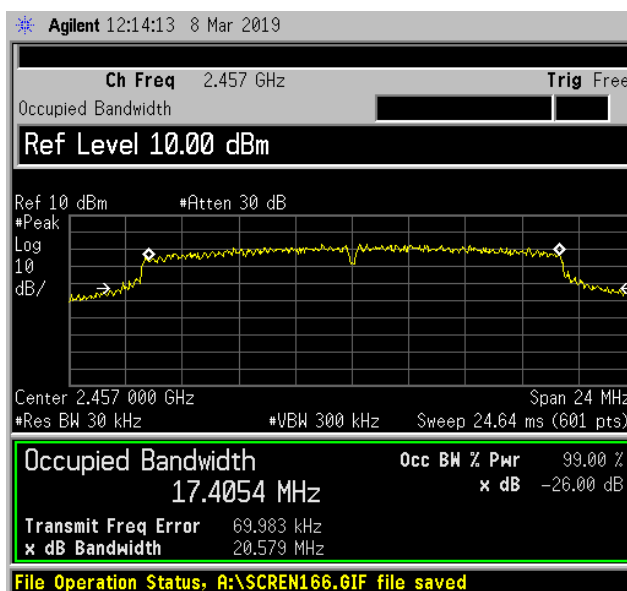
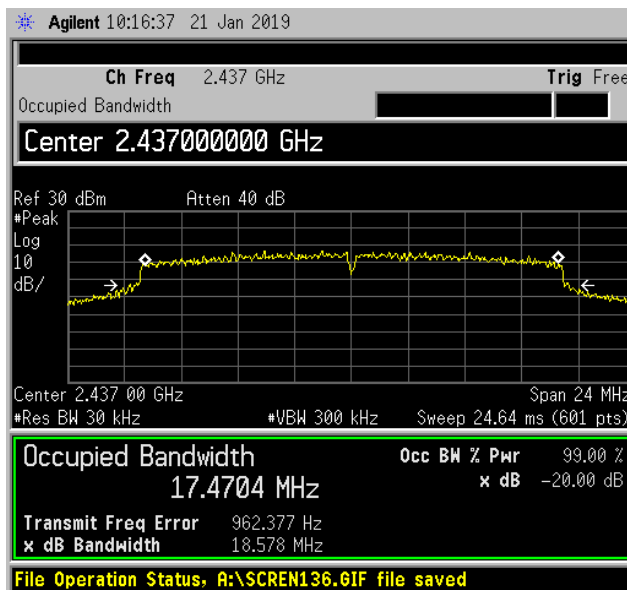
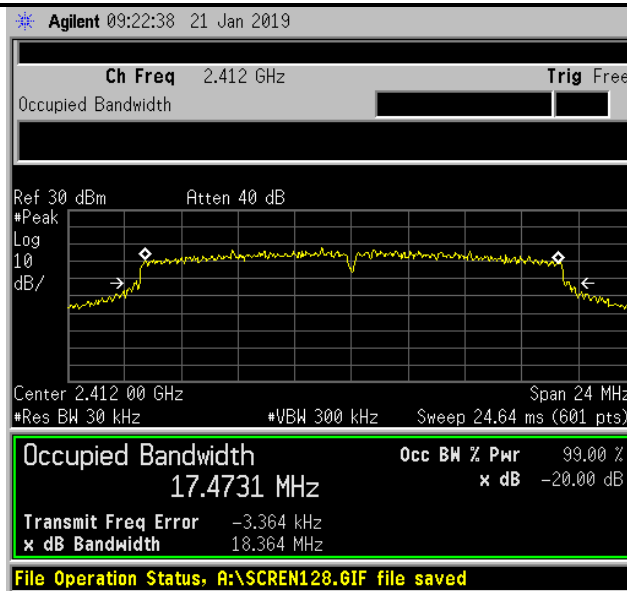




### 4.3.6 Antenna Port 2, Mode n, MCS15

<b>Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Minimum BW (kHz)</b>
15820	16700	16240	<b>15820</b>
<b>Bandwidth 99%, Measure and Report</b>			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	<b>Reported Maximum BW (kHz)</b>
17473	17470	17405	<b>17473</b>







## 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	21 Jan 2019 7 Mar 2019

### 5.3 Test Results

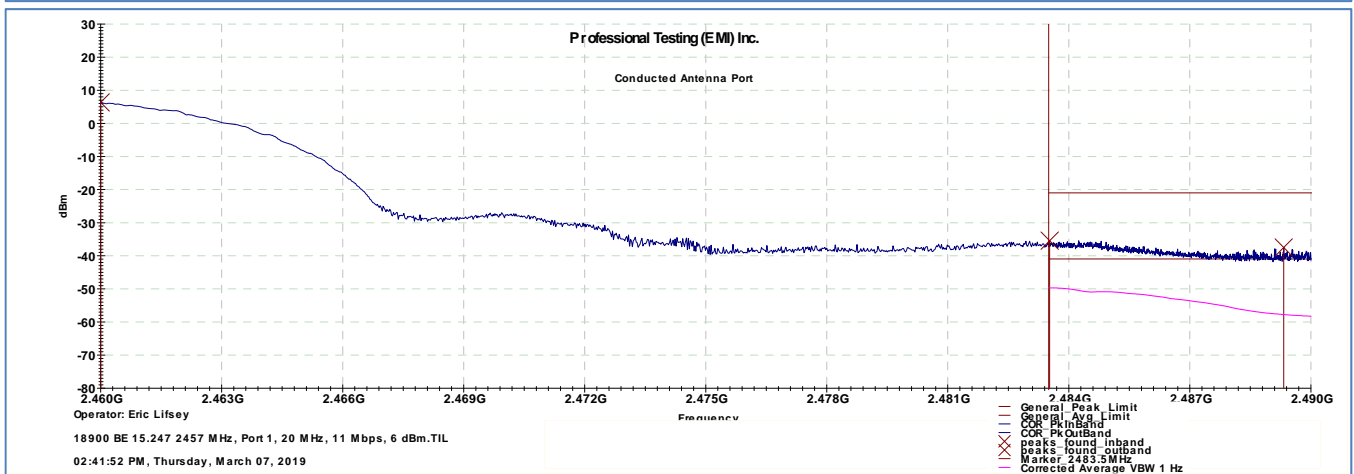
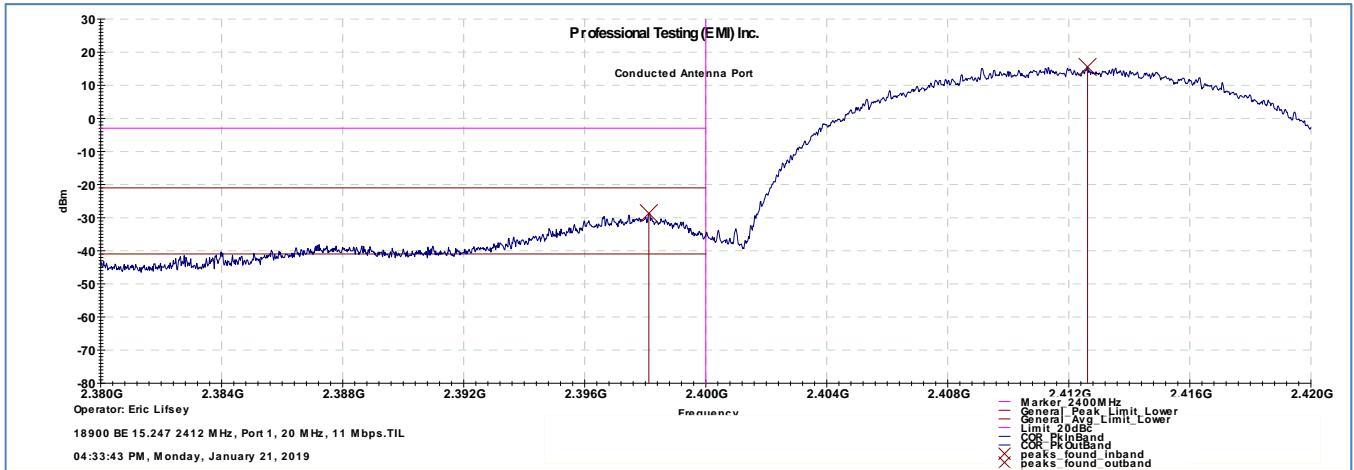
Measurements included fundamental and more than 2 standard bandwidths (standard bandwidth 1 MHz) beyond the band edges to provide a clear view of the fundamental and the declining emission levels.

Emissions below band were measured with peak detection in 100 kHz RBW.

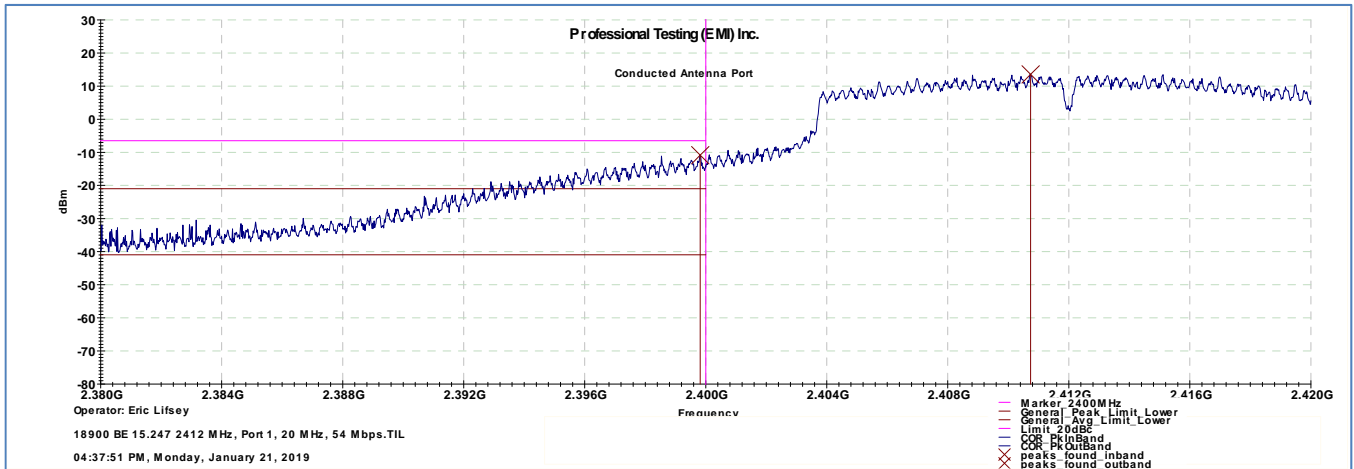
Emissions above band measured with peak detection and 1 Hz video average in 1 MHz RBW.

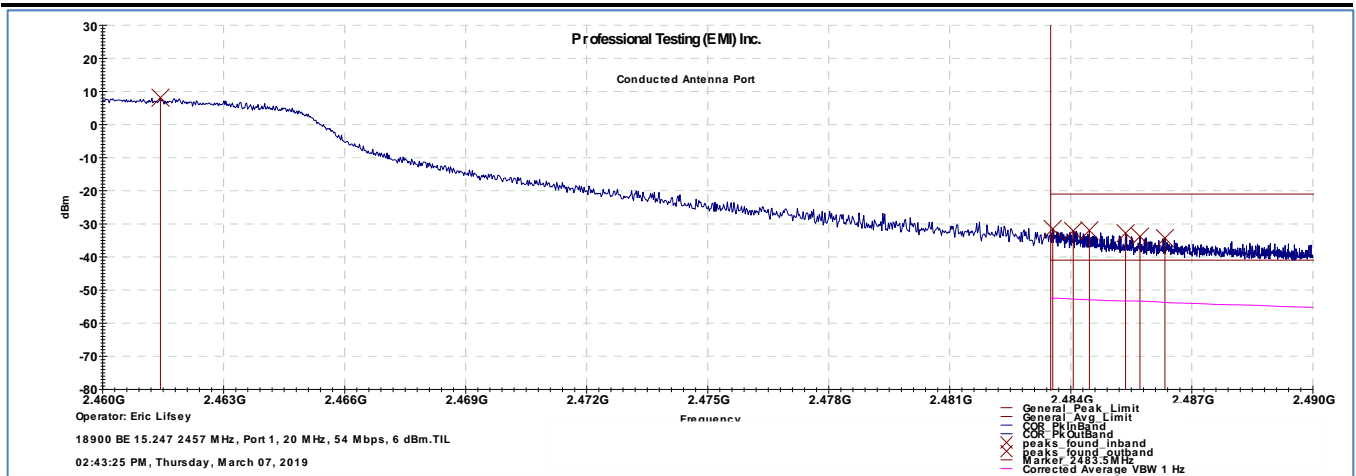
The requirement was satisfied. Plotted results appear on the following pages.

### 5.3.1 Antenna Port 1, Mode b

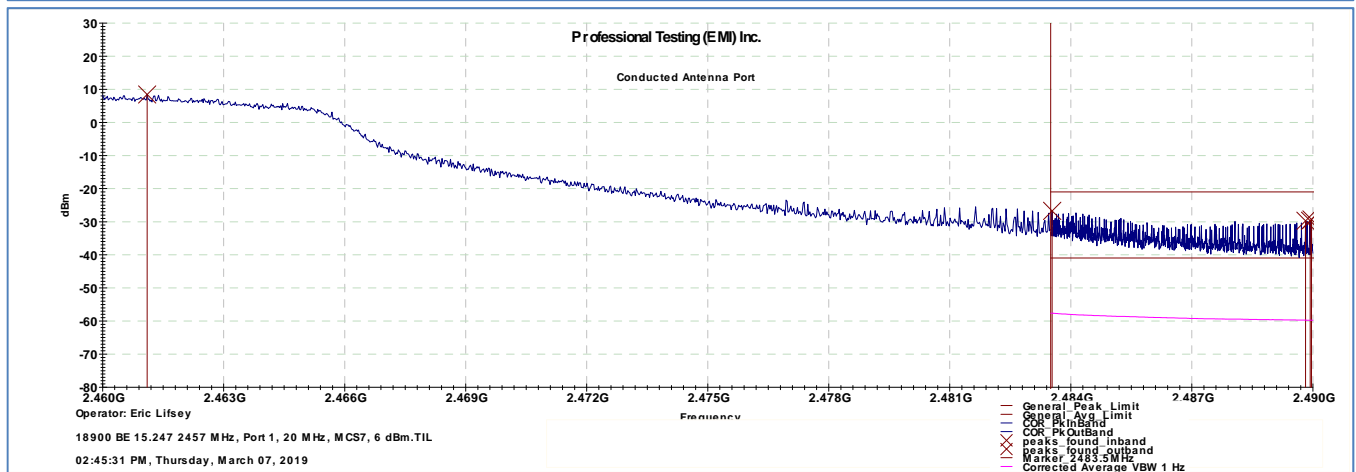
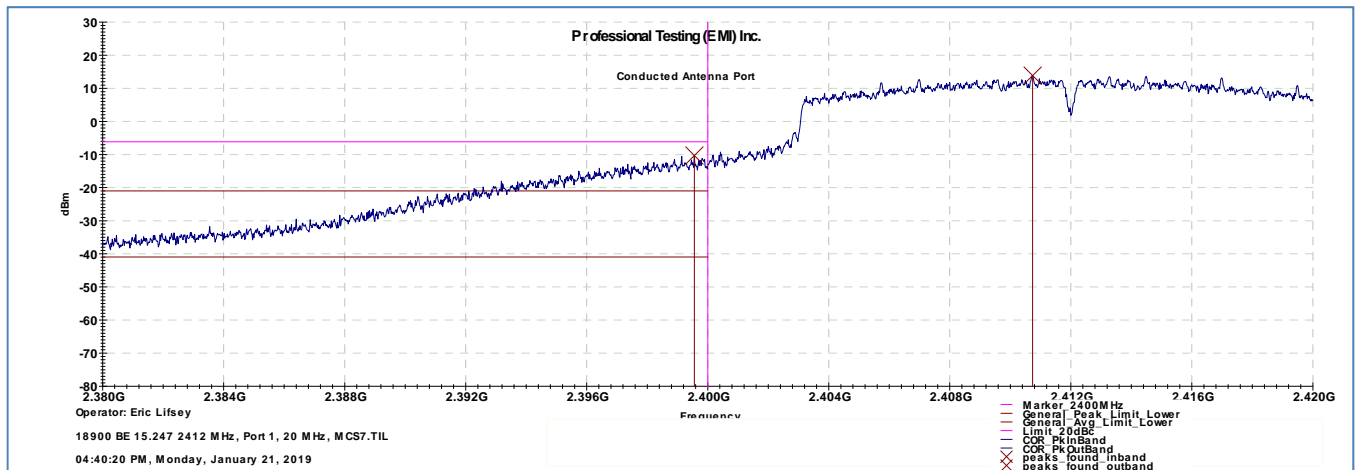


### 5.3.2 Antenna Port 1, Mode g

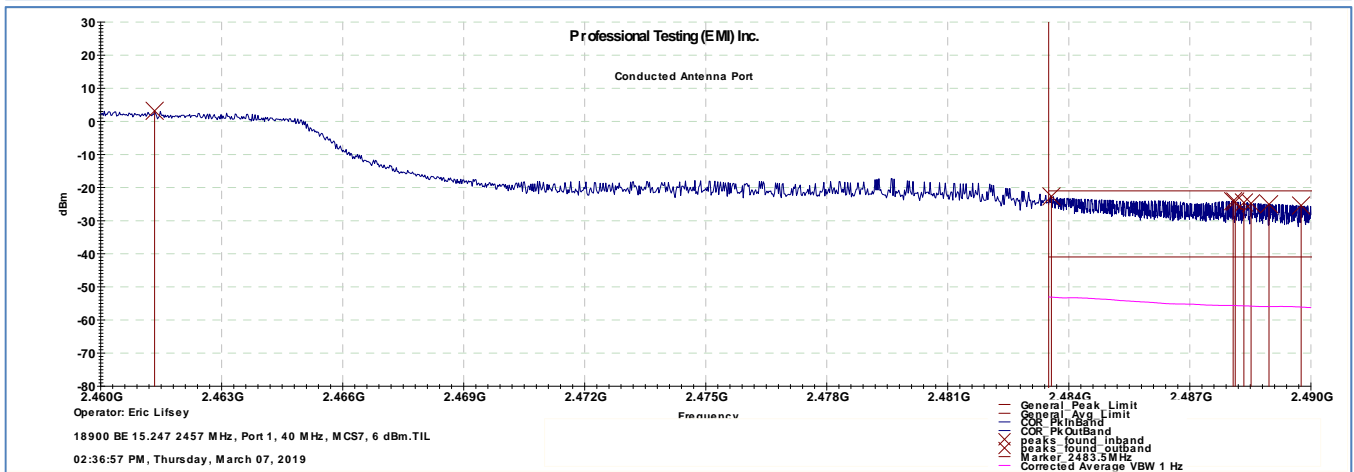
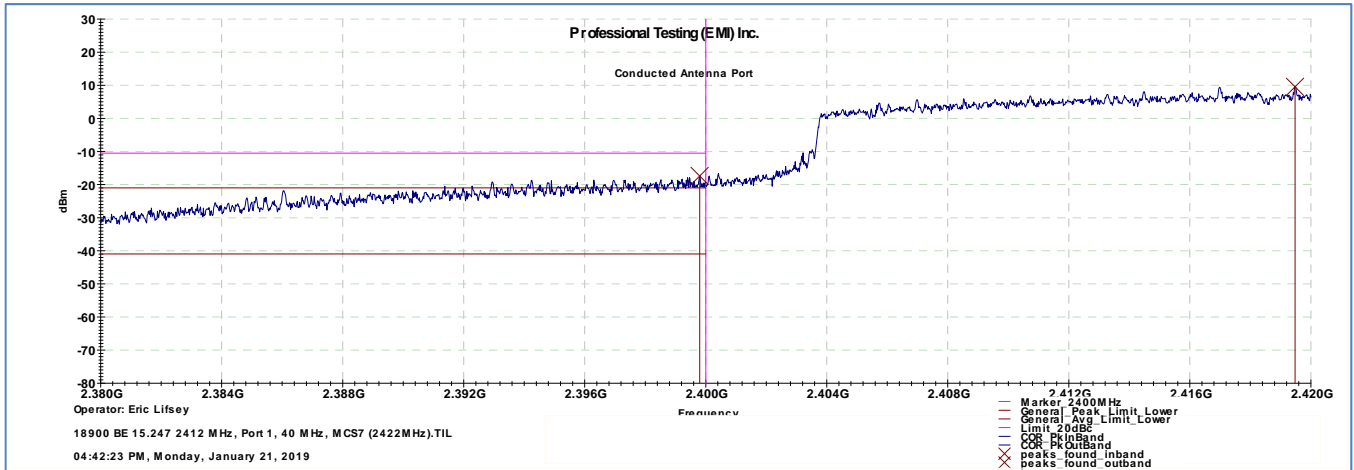




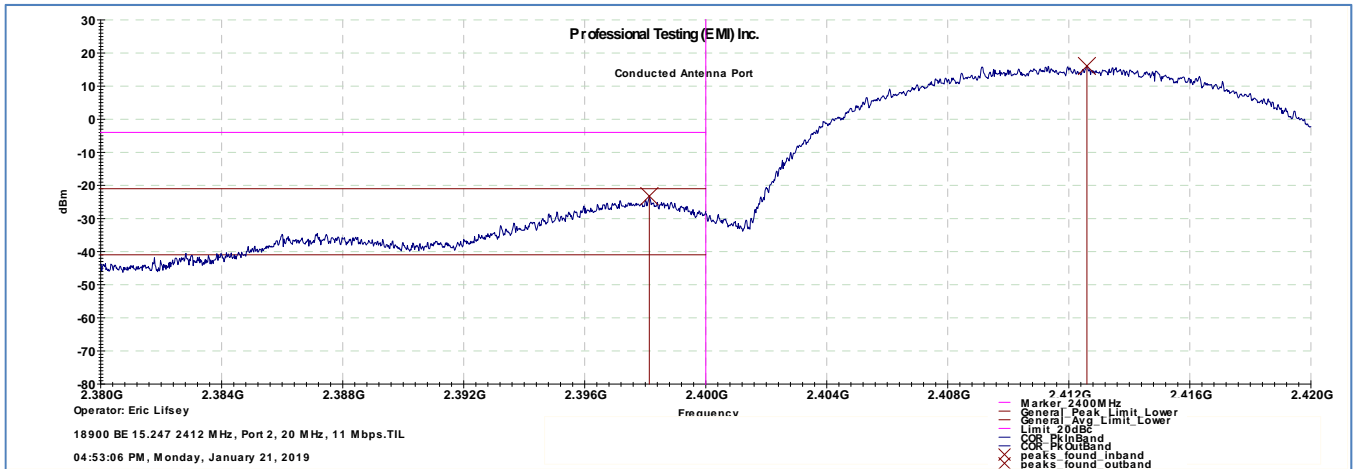
### 5.3.3 Antenna Port 1, Mode n, MCS7, 20 MHz

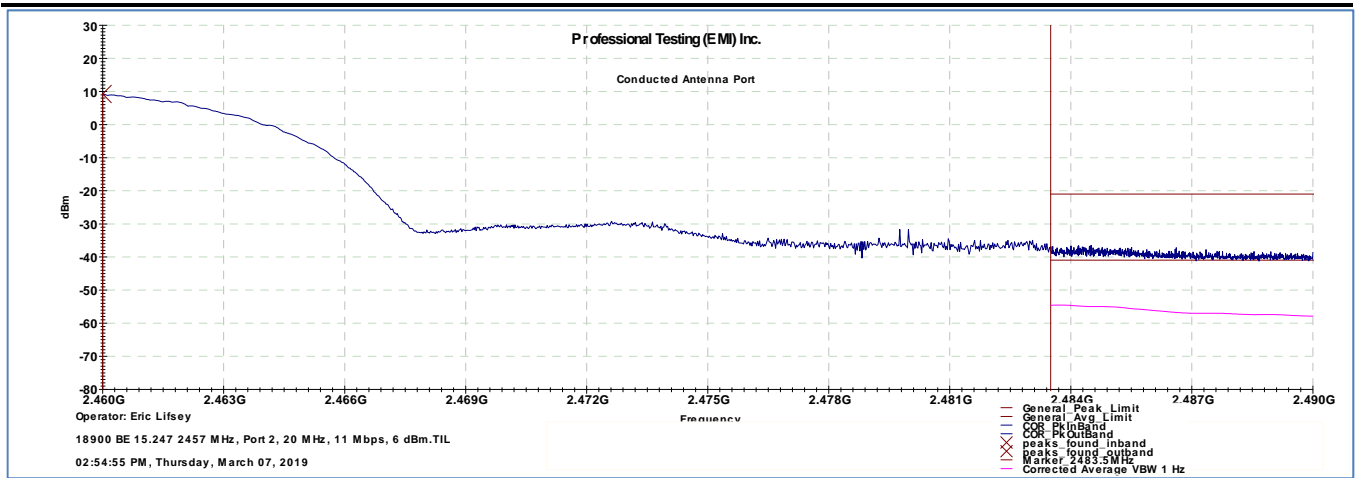


### 5.3.4 Antenna Port 1, Mode n, MCS7, 40 MHz

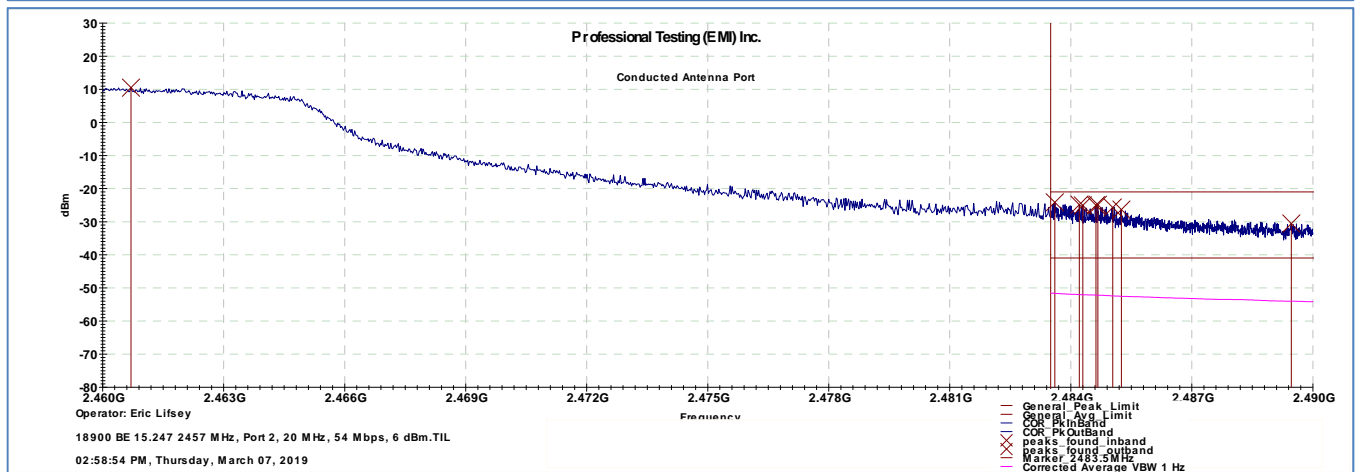
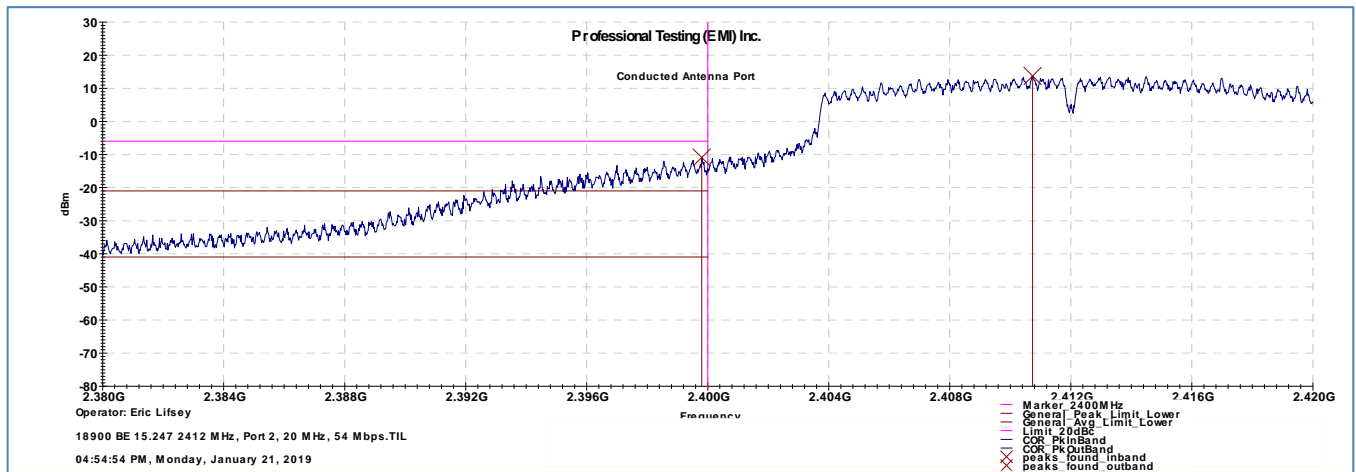


### 5.3.5 Antenna Port 2, Mode b

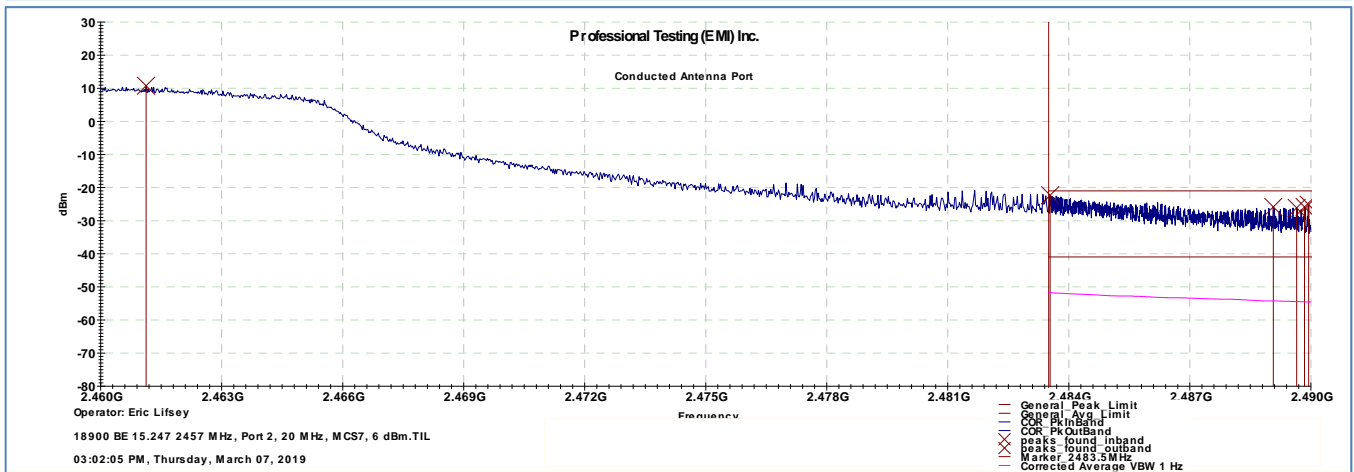
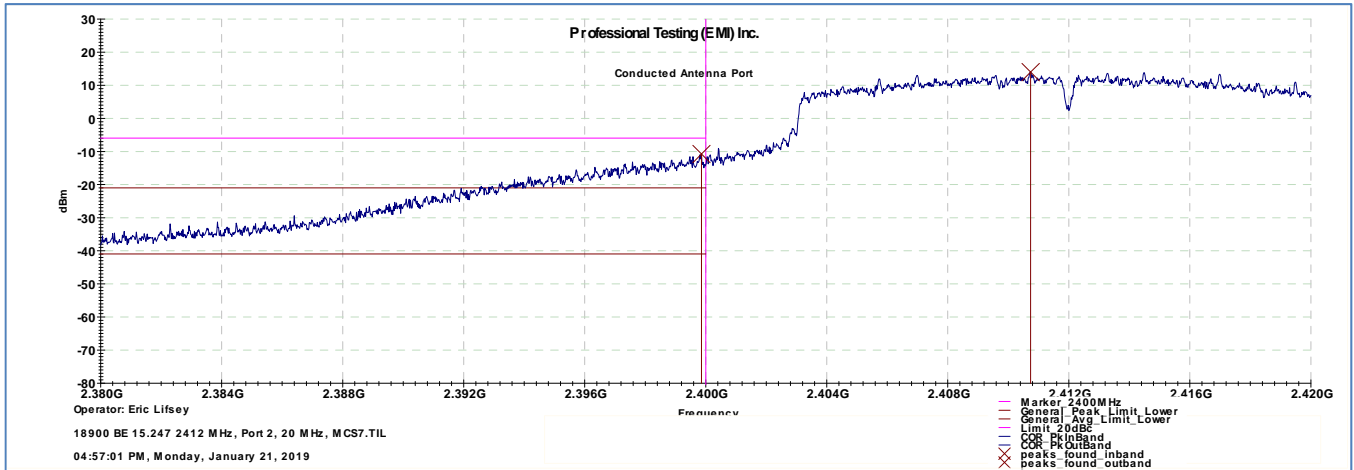




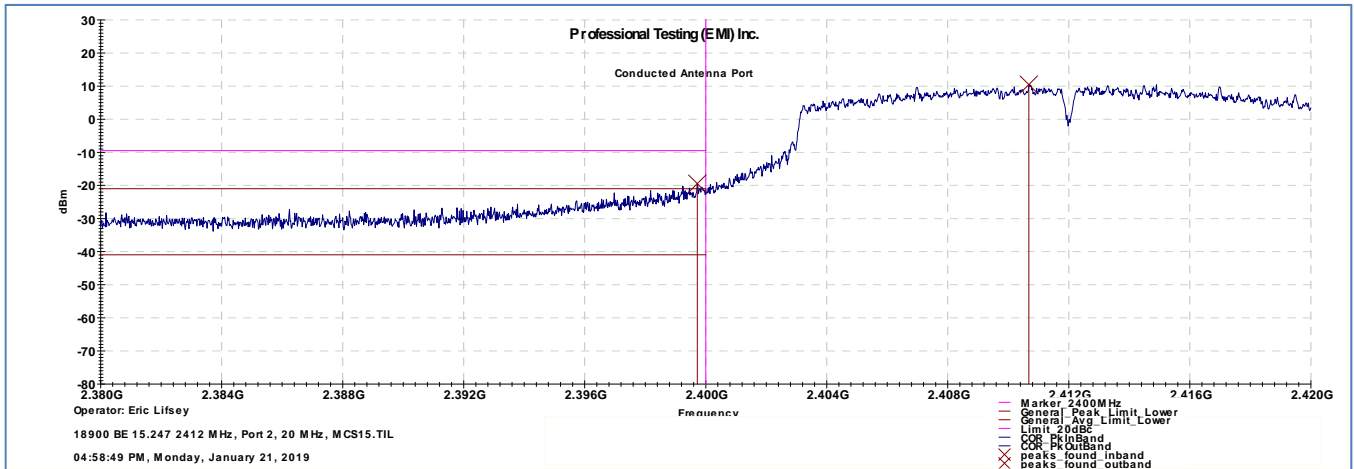
### 5.3.6 Antenna Port 2, Mode g

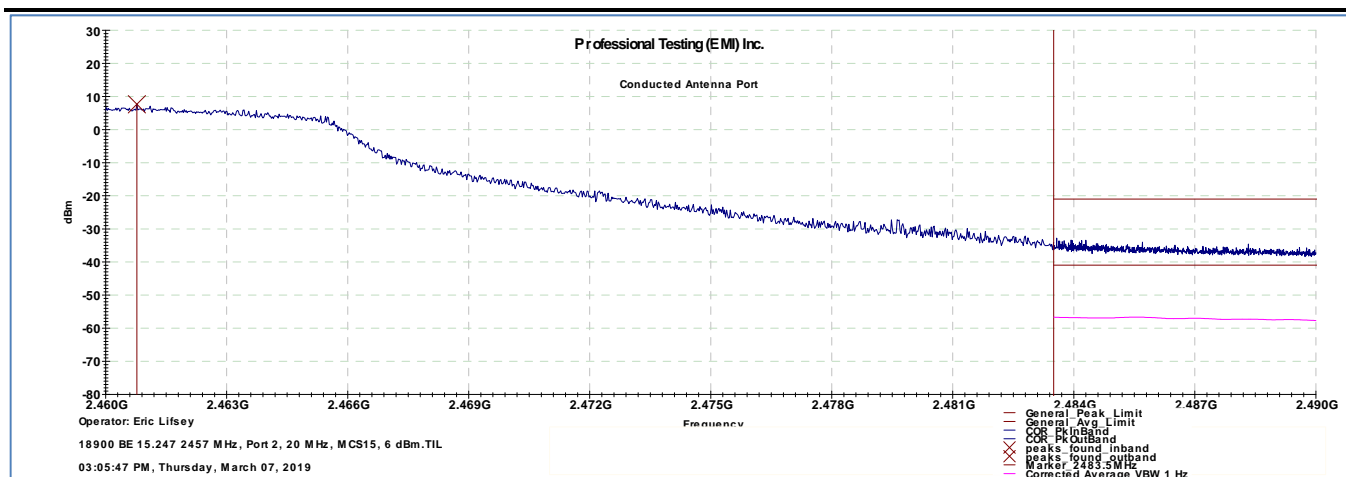


### 5.3.7 Antenna Port 2, Mode n, MCS7, 20 MHz



### 5.3.8 Antenna Port 2, Mode n, MCS15, 20 MHz

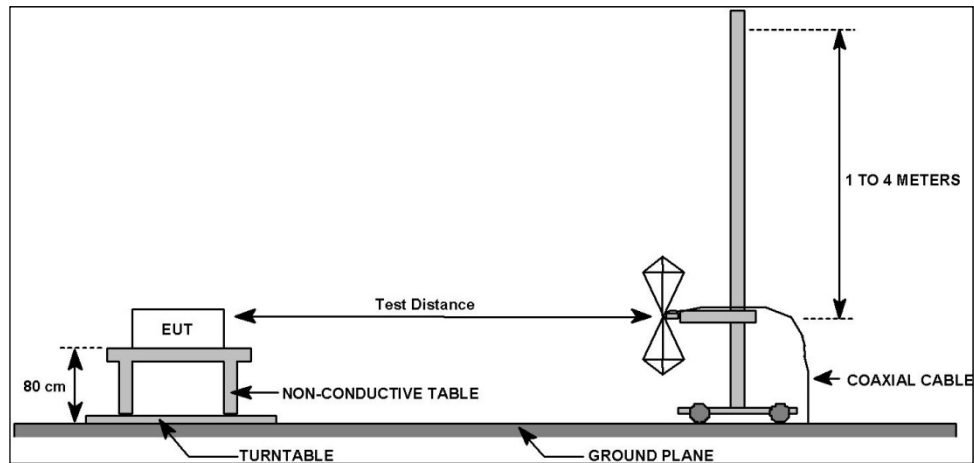




## 6.0 Radiated Spurious Emissions, Transmit Mode

### 6.1 Test Procedure

Radiated emissions are measured with the EUT transmitting on the required frequencies.



#### 6.1.1 Test Distance and Detection Method

30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 25 GHz
10 m	3 m	1 m
Quasi-peak	Peak & Average	Peak & Average

### 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 Transmit Mode	10 Dec 2018 11 Mar 2019

### 6.3 Test Results

Three channels were tested. EUT was transmitting continuously and unmodulated.

Below 1 GHz the center channel was tested. Above 1 GHz all three channels were tested using 3 EUT samples at once. The antenna port (2) with highest output was active.

The requirement was satisfied.



### 6.3.1 Middle Channel, 30 MHz to 25 GHz

Professional Testing, EMI, Inc.									
<b>Test Method:</b>		ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices							
<b>In accordance with:</b>		FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits							
<b>Section:</b>		15.209							
<b>Test Date(s):</b>		3/11/2019		<b>EUT Serial #:</b>		Sample H			
<b>Customer:</b>		Hetronic		<b>EUT Part #:</b>		0			
<b>Project Number:</b>		18900		<b>Test Technician:</b>		Eric Lifsey			
<b>Purchase Order #:</b>		0		<b>Supervisor:</b>		Lisa Arndt			
<b>Equip. Under Test:</b>		WFA-1		<b>Witness' Name:</b>		0			
Radiated Emissions Test Results Data Sheet									
Page: 1 of 1									
<b>EUT Line Voltage:</b>		3.7 VDC		<b>EUT Power Frequency:</b>		0 N/A			
<b>Antenna Orientation:</b>		Vertical		<b>Frequency Range:</b>		30MHz to 1GHz			
<b>EUT Mode of Operation:</b>					<b>Transmit Mode Chan 6</b>				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function		Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
216.001	10	133	1.42	Quasi-peak		20.681	35.6	-14.9	Pass
350.005	10	222	1.41	Quasi-peak		26.698	35.6	-8.9	Pass
385.719	10	84	1.18	Quasi-peak		24.063	35.6	-11.5	Pass
449.992	10	185	3.34	Quasi-peak		32.968	35.6	-2.6	Pass
649.999	10	174	2.62	Quasi-peak		28.583	35.6	-7.0	Pass
<div style="display: flex; justify-content: space-between;"> <div> <p><b>Professional Testing, EMI, Inc</b> Radiated Emissions 30MHz - 1GHz Vertical Polarity Measured Emissions</p> </div> <div> <p>             — FCC Peak Limit              — FCC Quasi-peak Limit              — Ambient Scan              — Pre-scan Emissions              △ Peak Reading              ▽ Quasi-peak Reading              ✱ LPRF Verification Limit              ▽ Verified LPRF QP Reading           </p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div> <p>Operator: Eric Lifsey Current Time: 11:09:11 AM, Monday, March 11, 2019</p> </div> <div> <p>Mode: Transmit Power: Batt 3.7 VDC Notes: LCD disconnected</p> </div> <div> <p>EUT: WFA Project Number: 18900 Client: Hetronic</p> </div> </div>									
≤ 1GHz Vertical Antenna Polarity Measured Emissions									

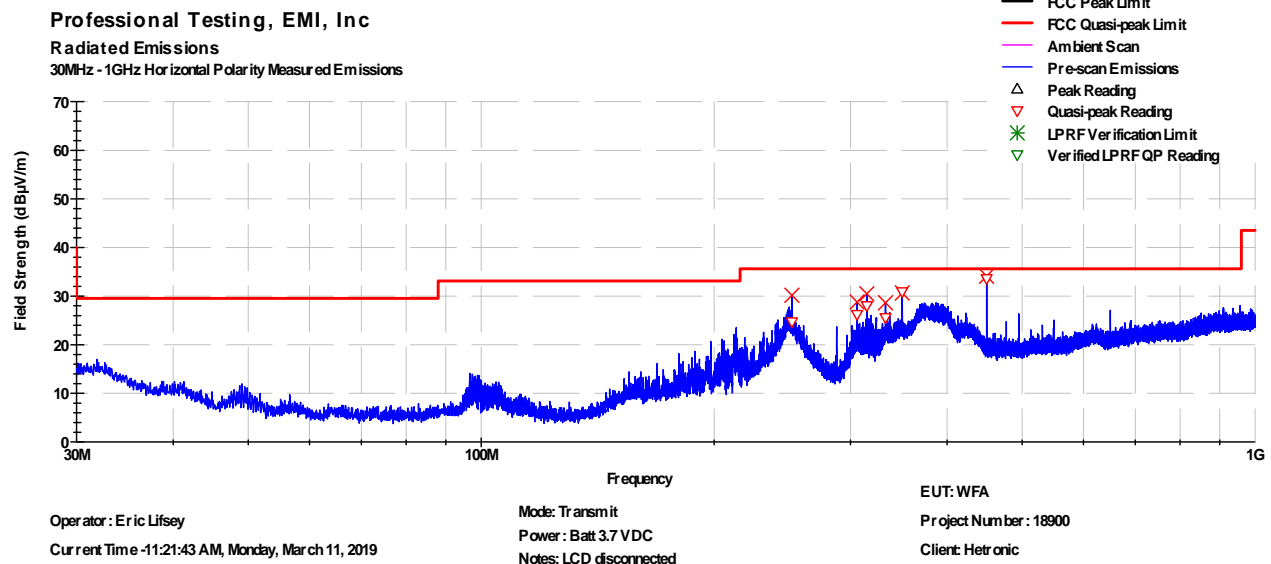
## Professional Testing, EMI, Inc.

<b>Test Method:</b>	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
<b>In accordance with:</b>	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
<b>Section:</b>	15.209		
<b>Test Date(s):</b>	3/11/2019	<b>EUT Serial #:</b>	Sample H
<b>Customer:</b>	Hetronic	<b>EUT Part #:</b>	0
<b>Project Number:</b>	18900	<b>Test Technician:</b>	Eric Lifsey
<b>Purchase Order #:</b>	0	<b>Supervisor:</b>	Lisa Arndt
<b>Equip. Under Test:</b>	WFA-1	<b>Witness' Name:</b>	0

### Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		3.7 VDC			EUT Power Frequency:		0 N/A		
Antenna Orientation:		Horizontal			Frequency Range:		30MHz to 1GHz		
EUT Mode of Operation:					Transmit Mode Chan 6				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function		Corrected Level (dBμV/m)	Limit Level (dBμV/m)	Margin (dB)	Test Results
252.014	10	38	2.52	Quasi-peak		24.681	35.6	-10.9	Pass
306.007	10	309	3.98	Quasi-peak		26.196	35.6	-9.4	Pass
315.023	10	263	3.23	Quasi-peak		27.979	35.6	-7.6	Pass
332.983	10	264	2.23	Quasi-peak		25.523	35.6	-10.1	Pass
349.996	10	65	2.16	Quasi-peak		30.858	35.6	-4.7	Pass
449.991	10	270	1.87	Quasi-peak		33.566	35.6	-2.0	Pass



**≤ 1GHz Horizontal Antenna Polarity Measured Emissions**

## 6.3.2 Bottom, Middle, and Top Channel, 1 GHz to 18 GHz

Professional Testing, EMI, Inc.									
<b>Test Method:</b>		ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices							
<b>In accordance with:</b>		FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits							
<b>Section:</b>		15.209							
<b>Test Date(s):</b>		12/10/2018			<b>EUT Serial #:</b>		Sample H		
<b>Customer:</b>		Hetronic			<b>EUT Part #:</b>		0		
<b>Project Number:</b>		18900			<b>Test Technician:</b>		Eric Lifsey		
<b>Purchase Order #:</b>		0			<b>Supervisor:</b>		Lisa Arndt		
<b>Equip. Under Test:</b>		WFA-1			<b>Witness' Name:</b>		0		
Radiated Emissions Test Results Data Sheet									
Page: 1 of 1									
<b>EUT Line Voltage:</b>		3.7 VDC			<b>EUT Power Frequency:</b>		0 N/A		
<b>Antenna Orientation:</b>		Vertical			<b>Frequency Range:</b>		Above 1GHz		
<b>EUT Mode of Operation:</b>					<b>Transmit Mode, 3 channels</b>				
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
4824.02	3	119	1.76	Peak	69.9	65.918	74.0	-8.0	Pass
7385.99	3	262	1.81	Peak	64.5	68.449	74.0	-5.5	Pass
9647.96	3	36	3.89	Peak	47	55.603	74.0	-18.4	Pass
17721.33	3	242	1.1	Peak	34.4	49.545	74.0	-24.4	Pass
<div style="display: flex; justify-content: space-between;"> <div> <p><b>Professional Testing, EMI, Inc</b> Radiated Emissions, 3m Distance 1-18GHz Vertical Polarity Measured Emissions</p> </div> <div style="border: 1px solid black; padding: 5px; background-color: #e0f2f1;"> <p>— Average Limit ▽ Average Reading — Peak Limit — Pre-scan Emissions △ Peak Reading</p> </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div> <p>Operator : Eric Lifsey Current Time -03:51:48 AM, Monday, December 10, 2018</p> </div> <div> <p>Mode: Transmit 3 channels Power: Battery</p> </div> <div> <p>EUT: WiFi Booster Project Number : 18900 Client: Hetronic</p> </div> </div>									
> 1GHz Vertical Antenna Polarity Measured Emissions									

## Professional Testing, EMI, Inc.

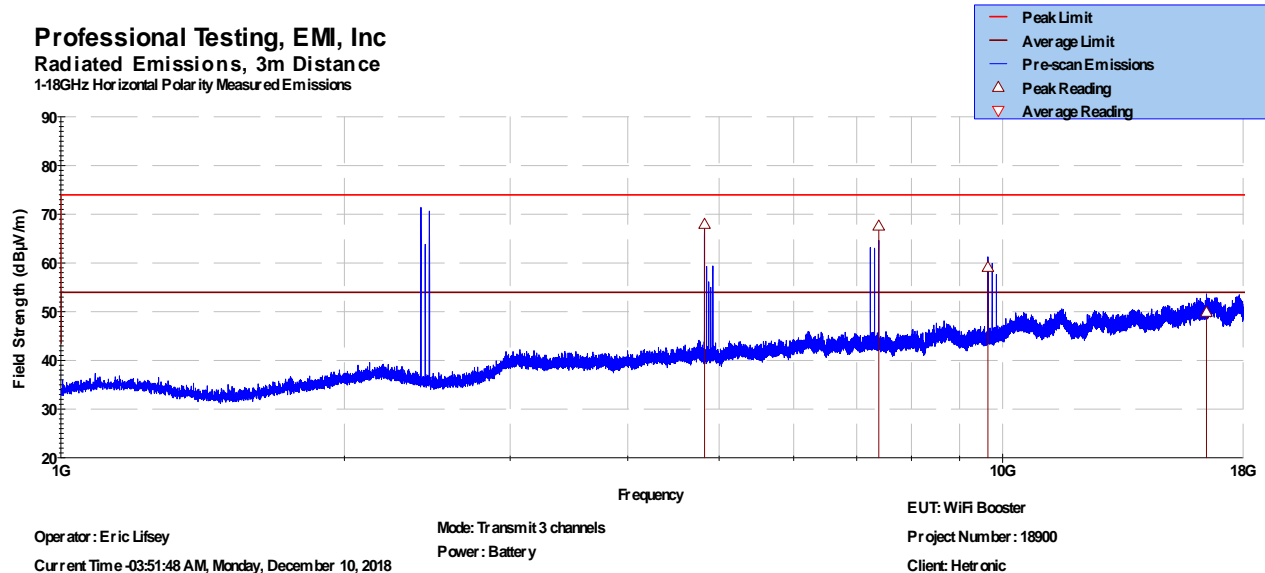
<b>Test Method:</b>	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
<b>In accordance with:</b>	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
<b>Section:</b>	15.209		
<b>Test Date(s):</b>	12/10/2018	<b>EUT Serial #:</b>	Sample H
<b>Customer:</b>	Hetronic	<b>EUT Part #:</b>	0
<b>Project Number:</b>	18900	<b>Test Technician:</b>	Eric Lifsey
<b>Purchase Order #:</b>	0	<b>Supervisor:</b>	Lisa Arndt
<b>Equip. Under Test:</b>	WFA-1	<b>Witness' Name:</b>	0

### Radiated Emissions Test Results Data Sheet

Page: 1 of 1

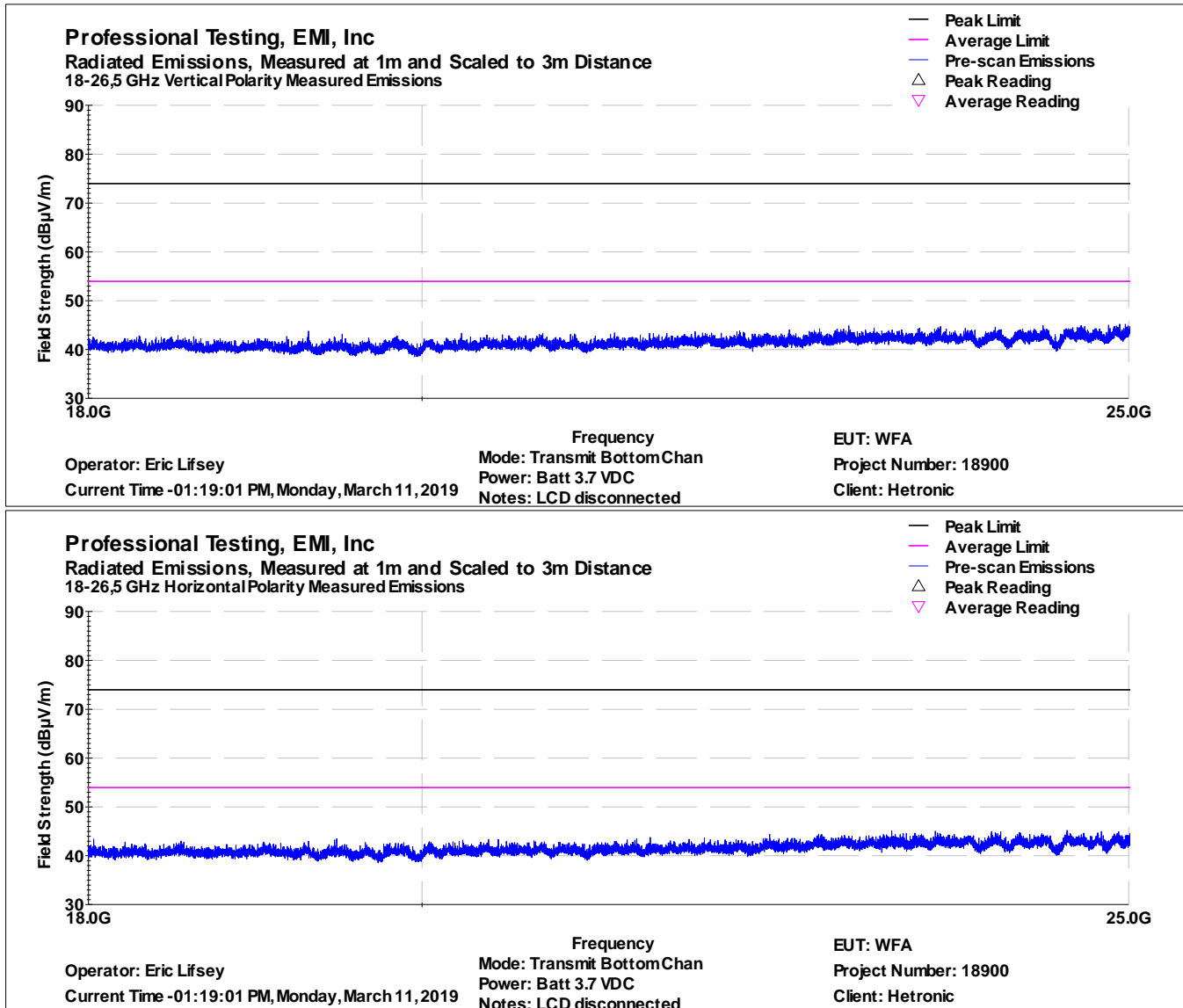
EUT Line Voltage:			3.7 VDC		EUT Power Frequency:		0 N/A		
Antenna Orientation:			Horizontal		Frequency Range:		Above 1GHz		
EUT Mode of Operation:					Transmit Mode, 3 channels				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function	Recorded Amplitude (dBµV)	Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
4823.98	3	271	1.26	Peak	71.9	67.968	74.0	-6.0	Pass
7385.99	3	272	2.4	Peak	63.7	67.584	74.0	-6.4	Pass
9648	3	228	3.64	Peak	50.6	59.134	74.0	-14.8	Pass
16460.87	3	94	1.51	Peak	35.7	49.903	74.0	-24.1	Pass

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

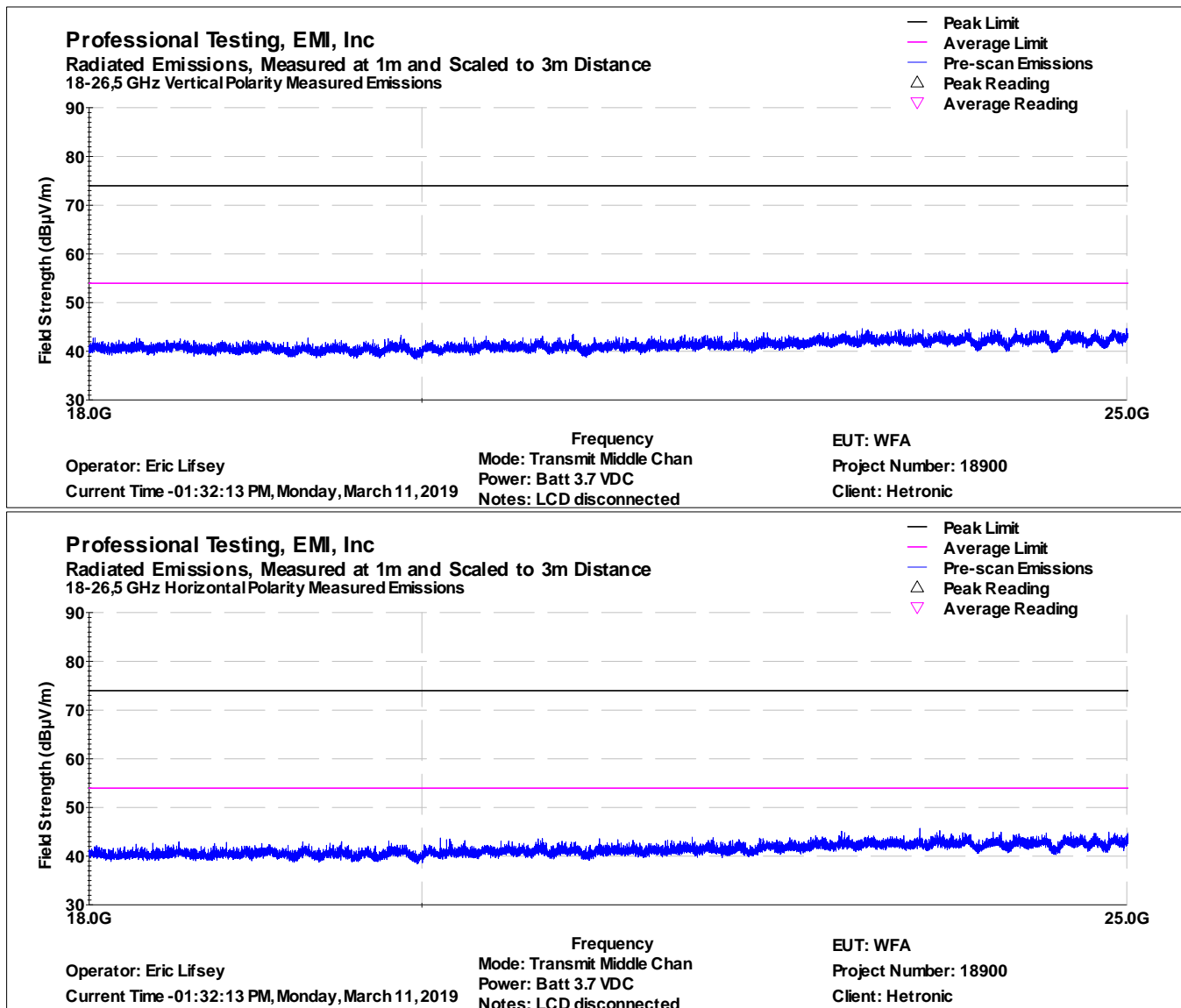


**> 1GHz Horizontal Antenna Polarity Measured Emissions**

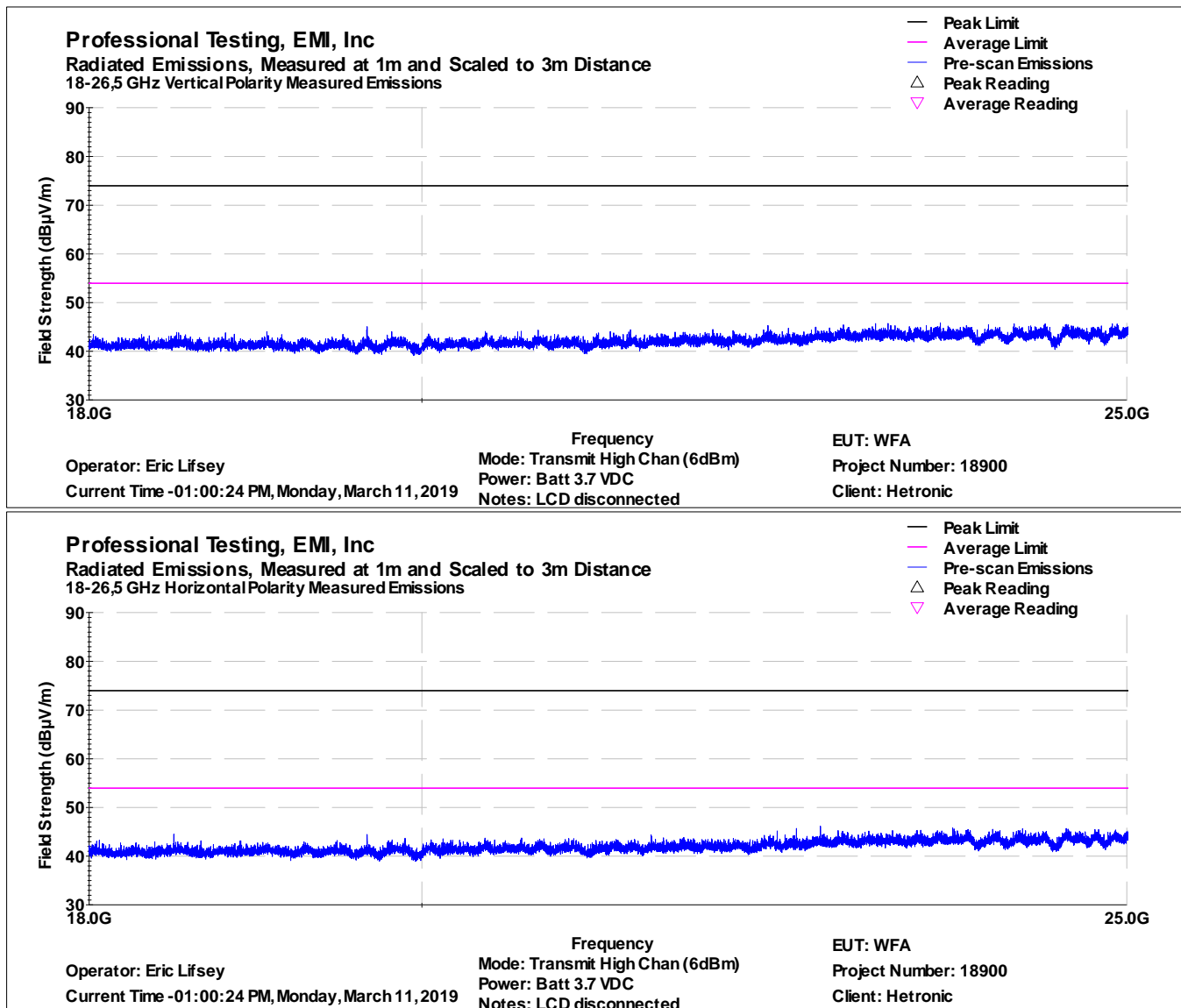
### 6.3.3 Bottom Channel, 18 GHz to 25 GHz



## 6.3.4 Middle Channel, 18 GHz to 25 GHz



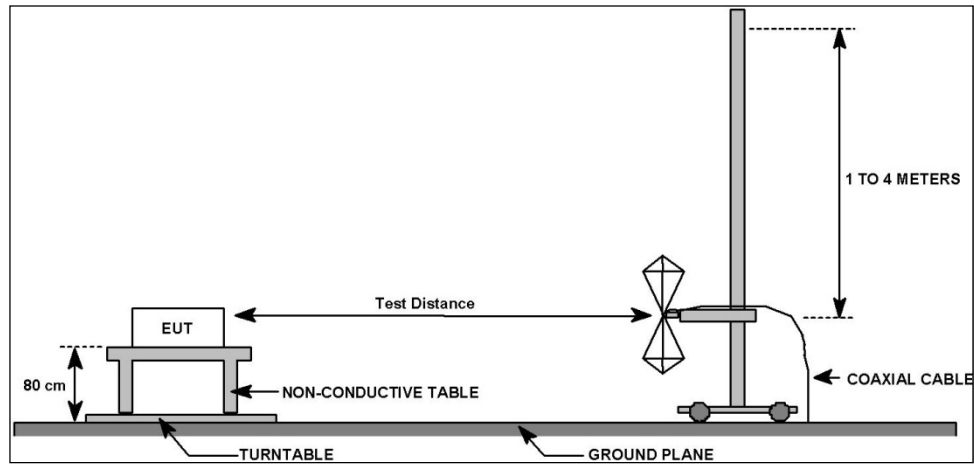
## 6.3.5 Top Channel, 18 GHz to 25 GHz



## 7.0 Radiated Spurious Emissions, Receive Mode

### 7.1 Test Procedure

Radiated emissions are measured with the EUT receiving on the center channel.



#### 7.1.1 Test Distance and Detection Method

30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 25 GHz
10 m	3 m	1 m
Quasi-peak	Peak & Average	Peak & Average

### 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	11 Mar 2019

### 7.3 Test Results

The requirement was satisfied.



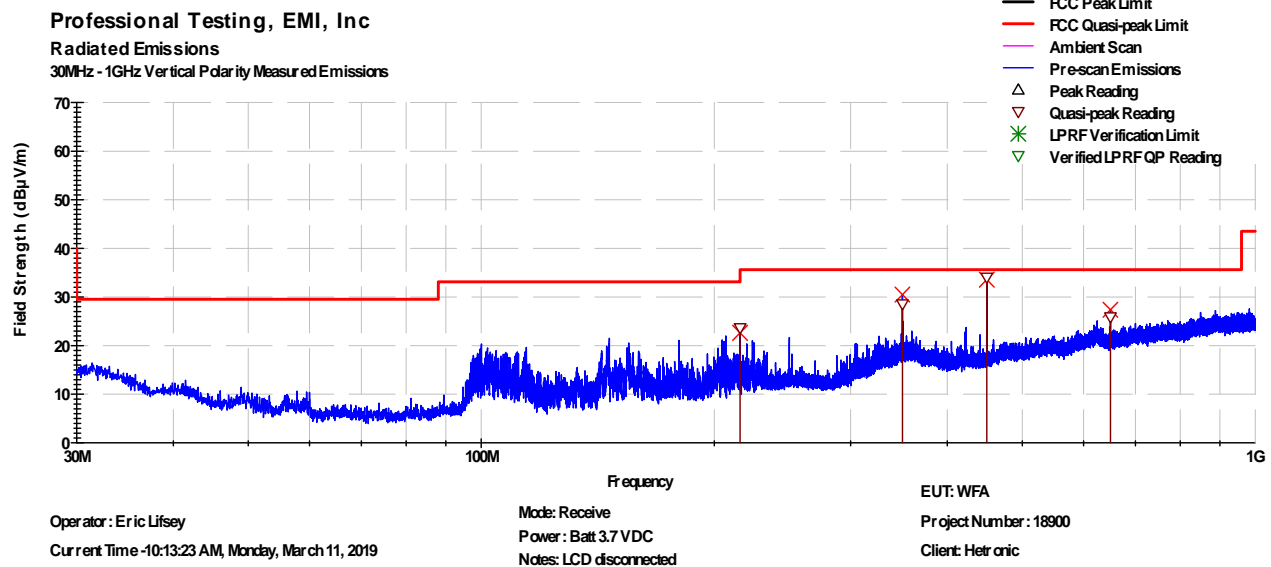
## Professional Testing, EMI, Inc.

<b>Test Method:</b>	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
<b>In accordance with:</b>	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
<b>Section:</b>	15.209		
<b>Test Date(s):</b>	3/11/2019	<b>EUT Serial #:</b>	Sample H
<b>Customer:</b>	Hetronic	<b>EUT Part #:</b>	0
<b>Project Number:</b>	18900	<b>Test Technician:</b>	Eric Lifsey
<b>Purchase Order #:</b>	0	<b>Supervisor:</b>	Lisa Arndt
<b>Equip. Under Test:</b>	WFA-1	<b>Witness' Name:</b>	0

### Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:			3.7 VDC			EUT Power Frequency:		0 N/A	
Antenna Orientation:			Vertical			Frequency Range:		30MHz to 1GHz	
EUT Mode of Operation:					Receive Mode Chan 6				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function		Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
216.023	10	322	1.42	Quasi-peak		23.623	35.6	-12.0	Pass
350.006	10	220	1.41	Quasi-peak		28.531	35.6	-7.1	Pass
450.003	10	173	3.33	Quasi-peak		34.023	35.6	-1.6	Pass
650.013	10	129	3.01	Quasi-peak		25.858	35.6	-9.7	Pass



≤ 1GHz Vertical Antenna Polarity Measured Emissions

## Professional Testing, EMI, Inc.

<b>Test Method:</b>	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
<b>In accordance with:</b>	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
<b>Section:</b>	15.209		
<b>Test Date(s):</b>	3/11/2019	<b>EUT Serial #:</b>	Sample H
<b>Customer:</b>	Hetronic	<b>EUT Part #:</b>	0
<b>Project Number:</b>	18900	<b>Test Technician:</b>	Eric Lifsey
<b>Purchase Order #:</b>	0	<b>Supervisor:</b>	Lisa Arndt
<b>Equip. Under Test:</b>	WFA-1	<b>Witness' Name:</b>	0

### Radiated Emissions Test Results Data Sheet

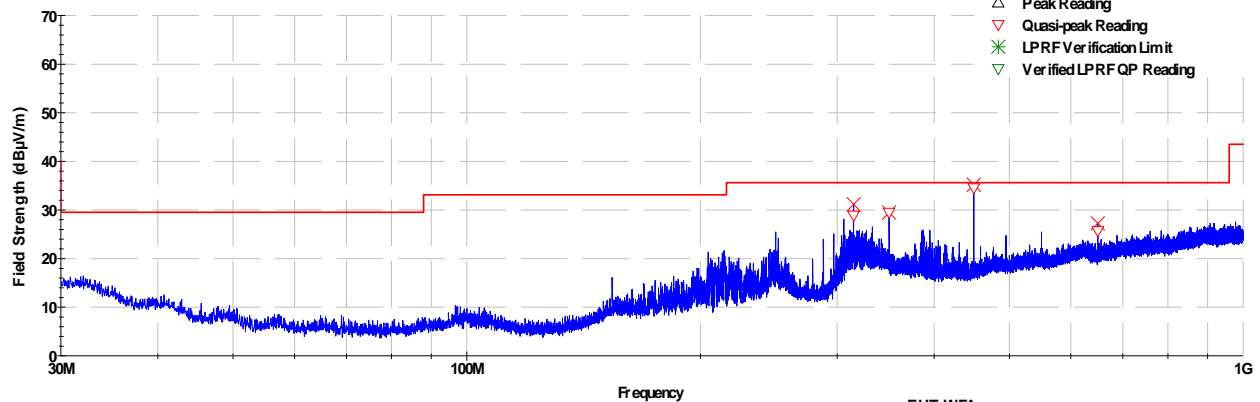
Page: 1 of 1

EUT Line Voltage:			3.7 VDC		EUT Power Frequency:		0 N/A		
Antenna Orientation:			Horizontal		Frequency Range:		30MHz to 1GHz		
EUT Mode of Operation:					Receive Mode Chan 6				
Frequency Measured (MHz)	Test Distance (Meters)	EUT Direction (Degrees)	Antenna Height (Meters)	Detector Function		Corrected Level (dBµV/m)	Limit Level (dBµV/m)	Margin (dB)	Test Results
315.015	10	133	1.86	Quasi-peak		28.887	35.6	-6.7	Pass
349.99	10	44	2.48	Quasi-peak		29.477	35.6	-6.1	Pass
449.989	10	264	1.88	Quasi-peak		34.494	35.6	-1.1	Pass
649.996	10	38	1.03	Quasi-peak		25.69	35.6	-9.9	Pass

#### Professional Testing, EMI, Inc

##### Radiated Emissions

30MHz - 1GHz Horizontal Polarity Measured Emissions



Operator : Eric Lifsey

Current Time -10:24:49 AM, Monday, March 11, 2019

Mode: Receive

Power: Batt 3.7 VDC

Notes: LCD disconnected

EUT: WFA

Project Number: 18900

Client: Hetronic

≤ 1GHz Horizontal Antenna Polarity Measured Emissions

## Professional Testing, EMI, Inc.

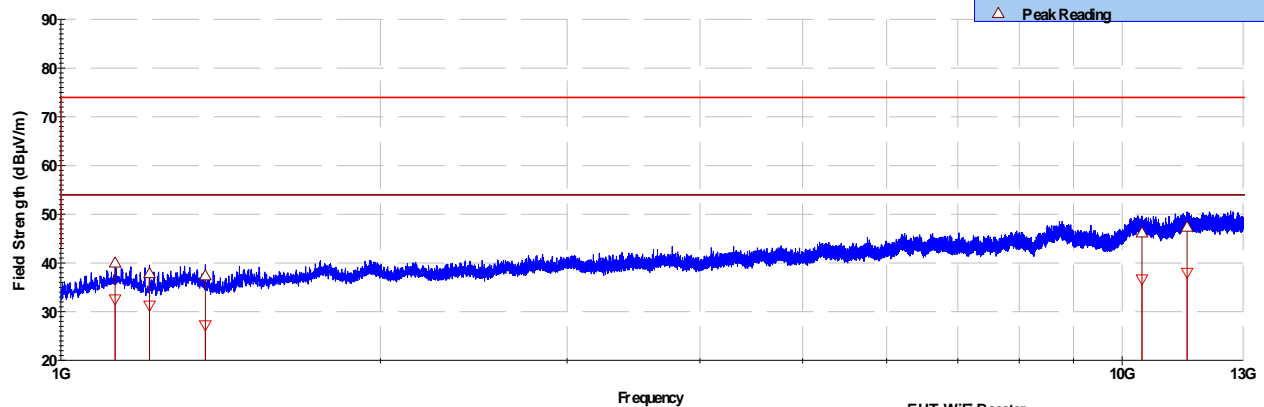
<b>Test Method:</b>	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
<b>In accordance with:</b>	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
<b>Section:</b>	15.209		
<b>Test Date(s):</b>	12/10/2018	<b>EUT Serial #:</b>	Sample H
<b>Customer:</b>	Hetronic	<b>EUT Part #:</b>	0
<b>Project Number:</b>	18900	<b>Test Technician:</b>	Eric Lifsey
<b>Purchase Order #:</b>	0	<b>Supervisor:</b>	Lisa Arndt
<b>Equip. Under Test:</b>	WFA-1	<b>Witness' Name:</b>	0

### Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		3.7 VDC			EUT Power Frequency:		0 N/A		
Antenna Orientation:		Vertical			Frequency Range:		Above 1GHz		
EUT Mode of Operation:					Receive Mode Chan 6				
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
1124.9	3	232	1.26	Average	45.1	32.561	54.0	-21.4	Pass
1212.01	3	49	1.12	Average	43.2	31.275	54.0	-22.7	Pass
1367.97	3	239	1.81	Average	39.1	27.257	54.0	-26.7	Pass
10441.8	3	223	3.3	Average	25.8	36.668	54.0	-17.3	Pass
11514.54	3	107	3.64	Average	26.9	38.009	54.0	-15.9	Pass

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



Operator: Eric Lifsey

Mode: Receive Chan6

EUT: WiFi Booster

Current Time: 03:13:23 AM, Monday, December 10, 2018

Power: Battery

Project Number: 18900

Client: Hetronic

### > 1GHz Vertical Antenna Polarity Measured Emissions

## Professional Testing, EMI, Inc.

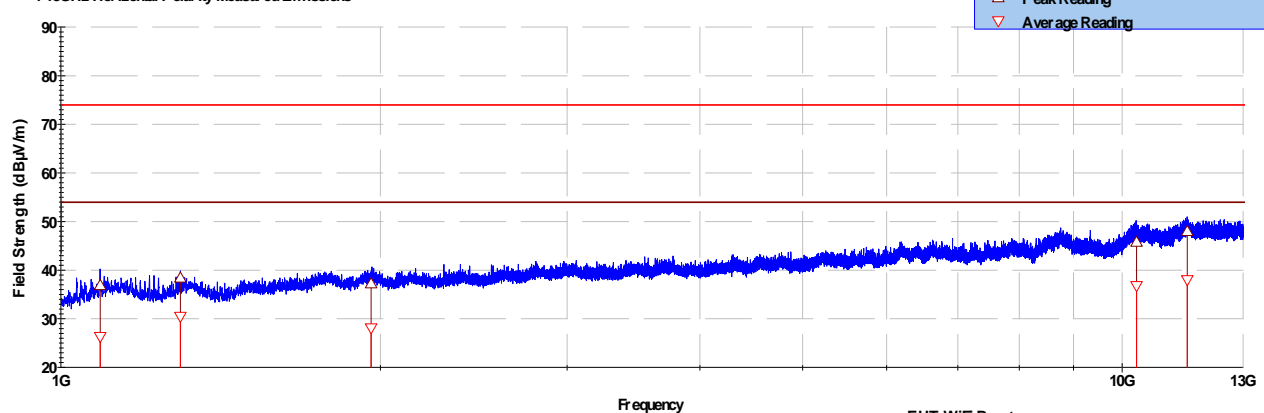
<b>Test Method:</b>	ANSI C63.10: 2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices		
<b>In accordance with:</b>	FCC Part 15.209 - Code of Federal Regulations Part 47, Subpart C - Intentional Radiators, Radiated Emissions Limits		
<b>Section:</b>	15.209		
<b>Test Date(s):</b>	12/10/2018	<b>EUT Serial #:</b>	Sample H
<b>Customer:</b>	Hetronic	<b>EUT Part #:</b>	0
<b>Project Number:</b>	18900	<b>Test Technician:</b>	Eric Lifsey
<b>Purchase Order #:</b>	0	<b>Supervisor:</b>	Lisa Arndt
<b>Equip. Under Test:</b>	WFA-1	<b>Witness' Name:</b>	0

### Radiated Emissions Test Results Data Sheet

Page: 1 of 1

EUT Line Voltage:		3.7 VDC			EUT Power Frequency:		0 N/A		
Antenna Orientation:		Horizontal			Frequency Range:		Above 1GHz		
EUT Mode of Operation:					Receive Mode Chan 6				
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
1089.07	3	60	1.72	Average	39.1	26.312	54.0	-27.6	Pass
1296.02	3	105	3.41	Average	42.2	30.437	54.0	-23.5	Pass
1960.57	3	67	3.64	Average	37.3	28.084	54.0	-25.9	Pass
10317.75	3	208	2.46	Average	25.8	36.765	54.0	-17.2	Pass
11518.23	3	81	1.25	Average	26.9	37.992	54.0	-16.0	Pass

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



Operator : Eric Lifsey

Mode: Receive Chan6

EUT: WiFi Booster

Current Time -03:13:23 AM, Monday, December 10, 2018

Power: Battery

Project Number: 18900

Client: Hetronic

**> 1GHz Horizontal Antenna Polarity Measured Emissions**

## 8.0 Antenna Construction

### 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, 15.247 // RSS-Gen 8.3	Antenna Construction	11 Mar 2019

### 8.3 Results

The module uses SMA type RF connectors. In the final application, the antenna as shown below is used with non-standard connector to prevent end-user tampering.

Table 8.3.1 Antenna Construction Details
External RP-TNC Dipole Antenna (2 used)
Manufacturer: Gainflex Model/PN: GK-442TF-R 2.4GHz TNC-Plug Rev. Polarity Length 154 mm Antenna gain 5 dBi. Uses reverse-polarized center pin to avoid user substitution.

The requirement was satisfied.

## 9.0 Equipment

### 9.1 Radiated Emissions 30 MHz to 25 GHz

Radiated Emissions Test Equipment List					
Tile! Software Version:		Version: 7.1.2.17 ( Jan 08, 2016 - 02:12:48 PM ) or 4.1.A.0, April 14, 2009, 11:01:00PM			
Test Profile:		2018_Radiated Emissions_TILE7_v1EL.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	7/10/2019
1890	HP	8447F-H64	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/10/2020
1937	Agilent	E4440A - AYZ	PSA , 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/8/2019
2172	ETS-Lindgren	3142C	Antenna, Biconilog, 26 MHz-3GHz	49383	1/23/2021
C027D	NAD	NAD 2400	Amplifier, 100W, 3Hz-100kHz	11524464	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	TDK 10M	TDK 10M Chamber,sVSWR > 1 GHz	DAC-012915-005	11/16/2019
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, .1-18GHz	0	1/10/2020
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	none	9/21/2019
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
1973	Agilent	83017A	Amplifier, Microwave 0.5-26.5 GHz	MY39500497	11/7/2020
1735	Pasternack	PE9850-20	Antenna, horn, WR28	N/A	N/A

**9.2 Fundamental Power, Bandwidth, Duty Cycle, Band Edge**

<b>Asset #</b>	<b>Manufacturer</b>	<b>Model #</b>	<b>Description</b>	<b>Calibration Due</b>
2295	Agilent	E4440A	Spectrum Analyzer	6 Nov 2019
C355	Pasternack	PE300-120	RG type coaxial cable	30 May 2019

## 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