Project 21165-15

eheat, Inc.
SE5001A Space Heater

Wireless Certification Report

Prepared for:

eheat, Inc.
22955 Tomball Parkway
Suite 17
Tomball, TX 77375

By

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

26 August 2021

Reviewed by	Written by
	
Larry Finn Chief Technical Officer	Eric Lifsey EMC Engineer

Revision History

Revision Number	Description	Date
Final02	Added average measurement plots on band edge measurements exceeding peak limits; corrected -20dBc limits on band edge plots; added power sensor information; added duty cycle measurement	26 Aug 2021

Table of Contents

Compliance Certificate

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

Applicant	Device & Test Identification	
eheat, Inc. 22955 Tomball Parkway Suite 17 Tomball, TX 77375 Certificate Date: 21 May 2021	FCC ID: Industry Canada ID: Model(s): Laboratory Project ID:	2AUA4-SE5001A 26664-SE5001A SE5001A 21165-15

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 5 Amd 1	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.

TESTING
NVLAP LAB CODE 200062-0

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**
eheat, Inc. Model: SE5001A	none	Space heater with remote control using 2400-2483.5 MHz DTS for WiFi

1.3 EUT Test Configuration

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

1.4 Modifications to Equipment

The EUT was operated at "attenuation" power setting of 20(decimal).

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. CAB Identifier: US 0123.

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 Additional Documents Applied

Table 1.7.1: Additional Documents Applied	
Document	**Title**
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.0 Fundamental Power; Clause 15.247(a)(3); RSS-247 5.2

2.1 Test Procedure

A power meter was used to measure the fundamental emission to ensure capture of full bandwidth power of the wide bandwidths utilized by the transmitter.

2.2 Test Criteria

Conducted Power Limit
1 W peak Limit Restated as Field: 125.23 dBµV/m @ 3 m

2.3 Test Results, Peak Power (dBm)

Table 2.3.1 Power, Peak, Modulated, Measured Conducted

Mode/Freq/Rate:		11b 1M	11b 2M	11b 5.5M	11B 11M				
b	2412	8.7	8.7	8.7	8.7				
	2437	8.7	8.7	8.7	8.7				
	2462	8.6	8.6	8.6	8.6				
Mode/Freq/Rate:		11g 6M	11g 9M	11g 12M	11g 18M	11G 24M	11G 36M	11G 48M	11G 54M
g	2412	7.5	7.4	7.6	7.6	4.8	4.9	3.7	2.7
	2437	7.4	7.3	7.6	7.6	4.7	4.7	3.3	2.7
	2462	7.3	7.2	7.6	7.6	4.8	4.7	3.3	2.3
Mode/Freq/Rate:		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
11n 20M	2412	6.9	7.5	7.3	4.6	4.6	3.4	2.5	1.4
	2447	6.9	7.3	7.3	4.6	4.5	3.1	2.3	1.2
	2462	6.9	7.3	7.2	4.6	4.5	3.0	2.1	1.2
Mode/Freq/Rate:		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
11n 40M	2422	7.2	7.5	7.4	4.6	4.6	3.1	2.4	1.4
	2437	6.9	7.2	7.2	4.3	4.3	2.8	2.1	1.1
	2457	6.9	7.3	7.3	4.3	4.4	2.9	2.0	1.0

Maximum power 8.7 dBm = 7.4 mW

The requirements were satisfied.

2.4 Test Results, Duty Cycle

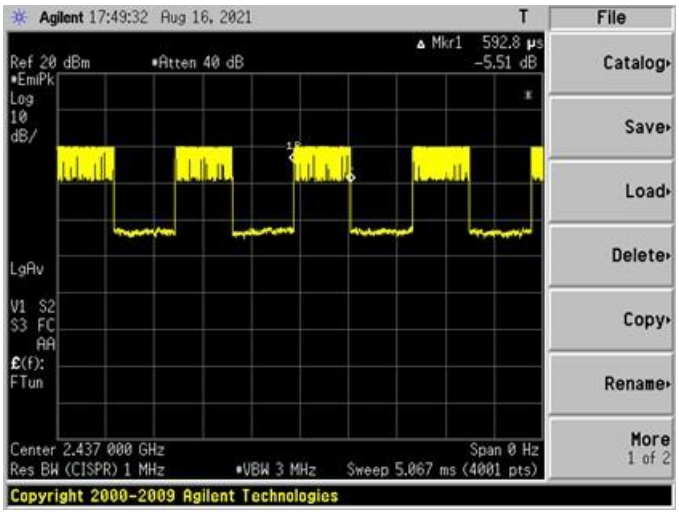
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power.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

Continuous packet transmission mode was used for the duty cycle measurement, which would represent a worst-case operating scenario. Duty Cycle measurement was performed on 25 Aug, 2021.

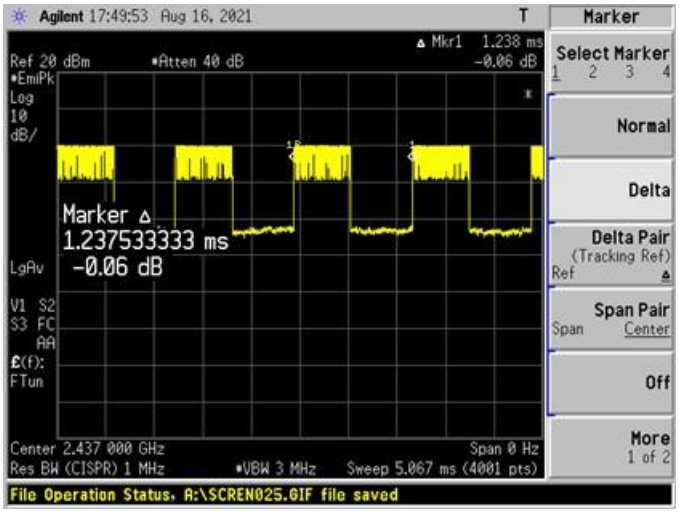
Transmitter on time: 592.8µs
Transmitter interval: 1.238ms

Duty Cycle = 592.9 / 1238 = 0.48

Duty Cycle Correction Factor (dB) = 10Log(On Time / Interval) = 10Log(592.9/1238) = -3.2dB



Transmitter On Time Measurement



Transmitter Interval Measurement

3.0 Power Spectral Density; 15.247(e); RSS-247, 5.2

3.1 Test Procedure

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

3.2 Test Criteria

Power Spectral Density, Conducted Limit
8 dBm / 3 kHz Restated as field strength: 103.23 dBµV/m at 3 m

3.3 Test Results, Tabular

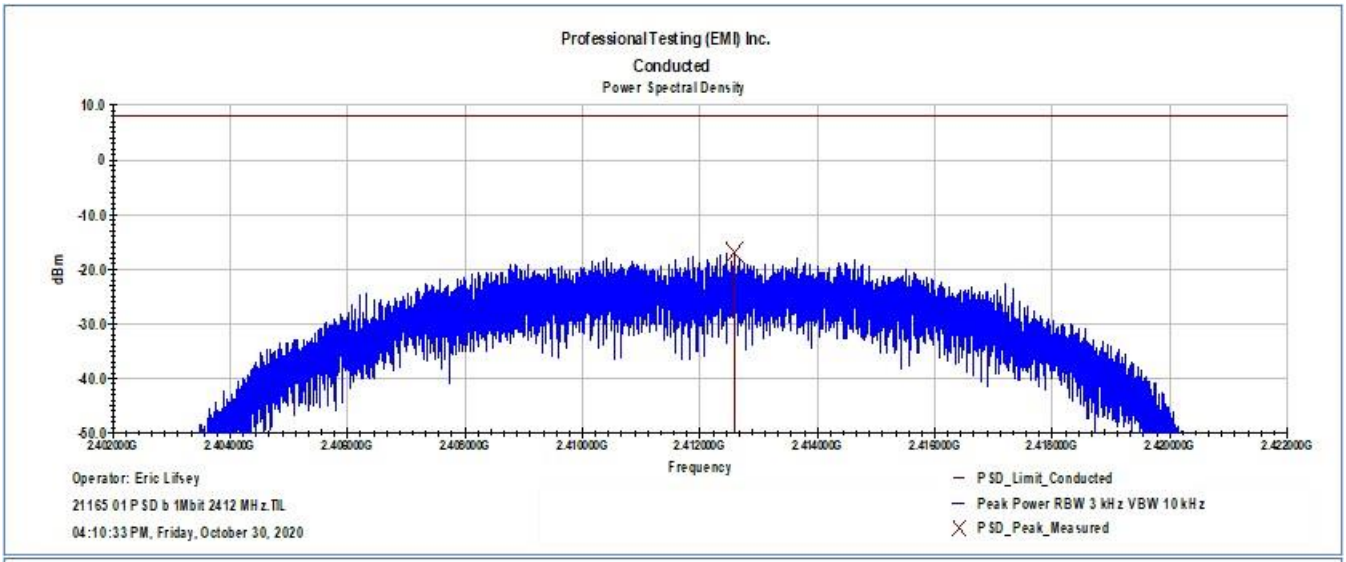
Measurement method was conducted. Measurement is only required when the full bandwidth peak power is above the 8 dBm level.

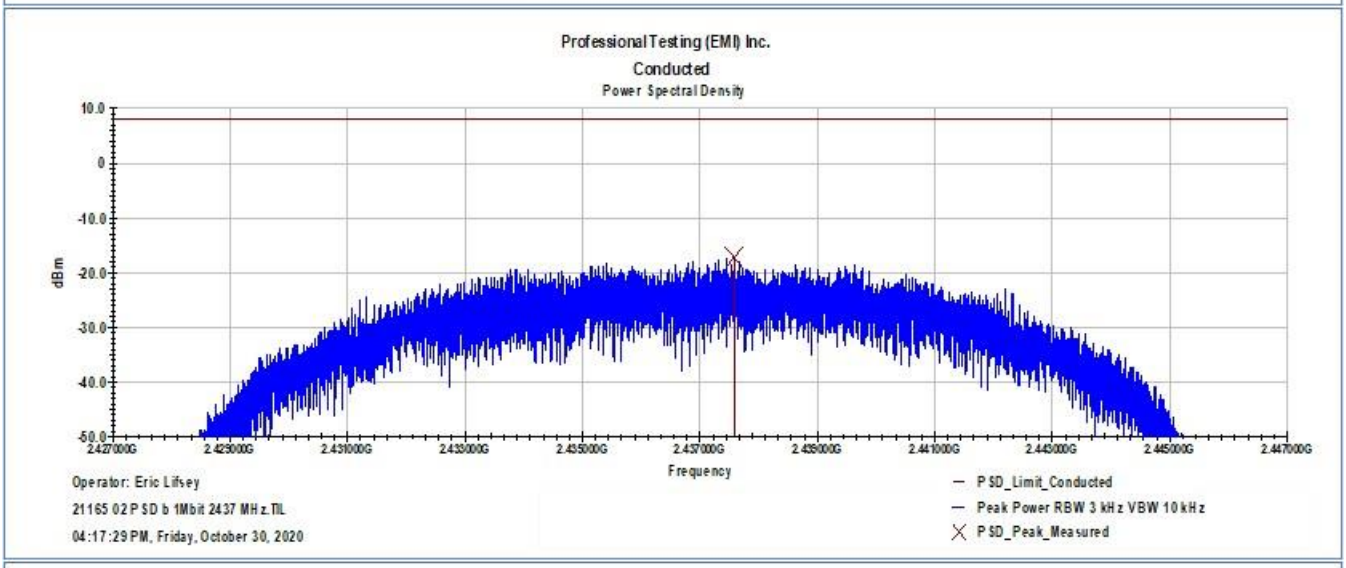
The requirements were satisfied.

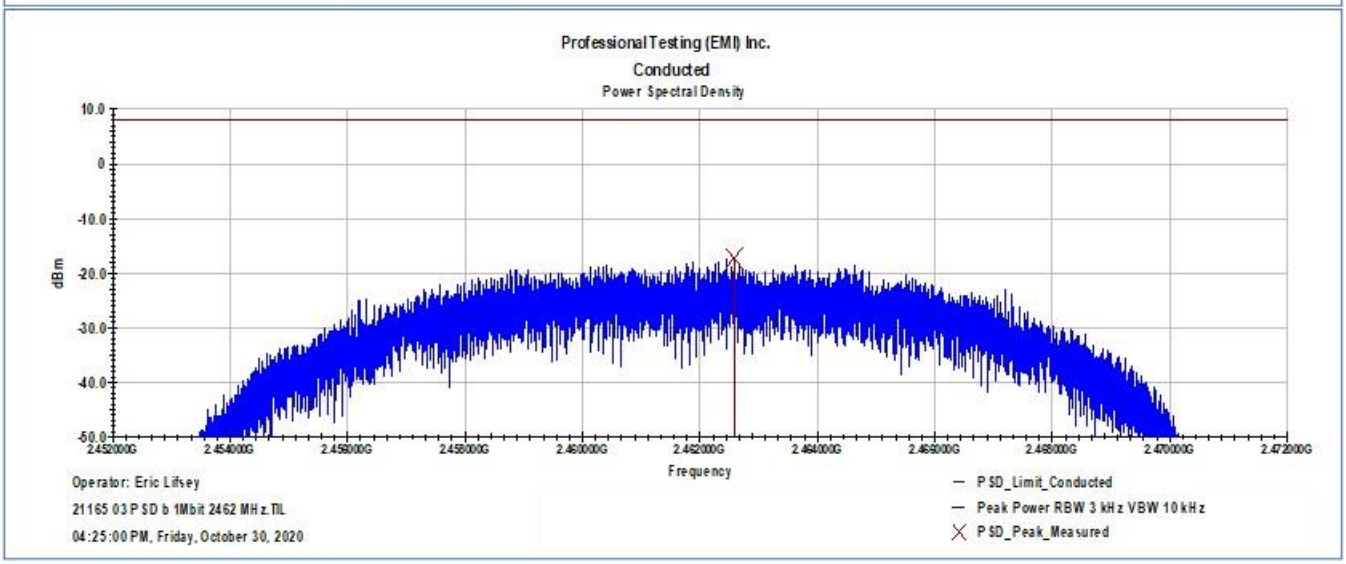
Table 2.3.1 Power Spectral Density, Peak, Modulated, Measured Conducted

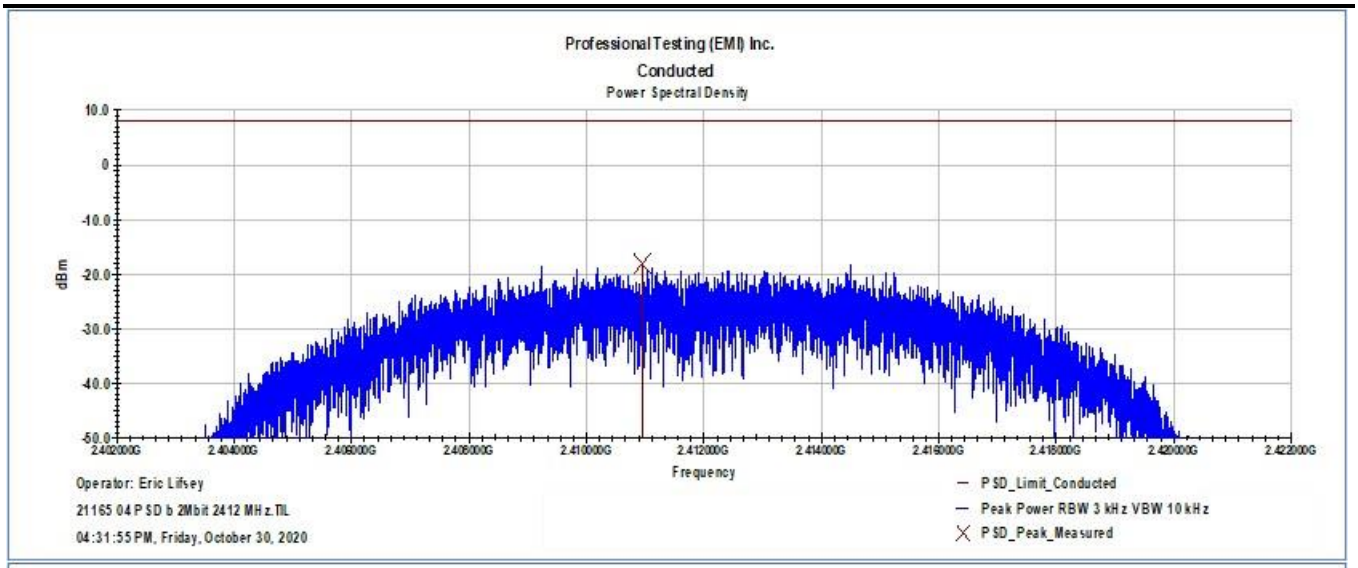
Mode/Freq/Rate:		11b 1M	11b 2M	11b 5.5M	11B 11M				
b	2412	-17.0	-18.1	-14.4	-18.1				
	2437	-17.2	-18.1	-14.5	-18.2				
	2462	-17.3	-18.1	-14.5	-18.2				
Mode/Freq/Rate:		11g 6M	11g 9M	11g 12M	11g 18M	11G 24M	11G 36M	11G 48M	11G 54M
g	Highest peak power is below PSD limit.								
Mode/Freq/Rate:		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
11n 20M	Highest peak power is below PSD limit.								
Mode/Freq/Rate:		MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
11n 40M	Highest peak power is below PSD limit.								

3.4 Test Results, Recorded








Professional Testing (EMI) Inc.
Conducted
Power Spectral Density
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-10.0
-20.0
-30.0
-40.0
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dBm
2.402000G
2.404000G
2.406000G
2.408000G
2.410000G
2.412000G
2.414000G
2.416000G
2.418000G
2.420000G
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Frequency
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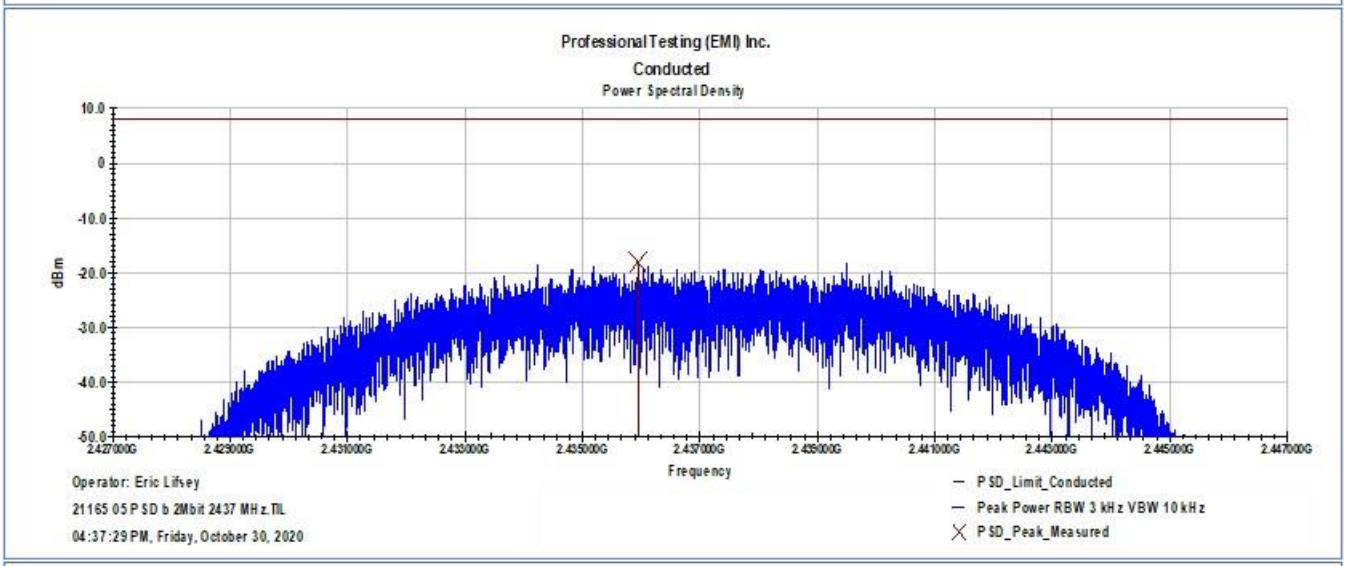
PSD_Peak_Measured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Conducted
Power Spectral Density
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dBm
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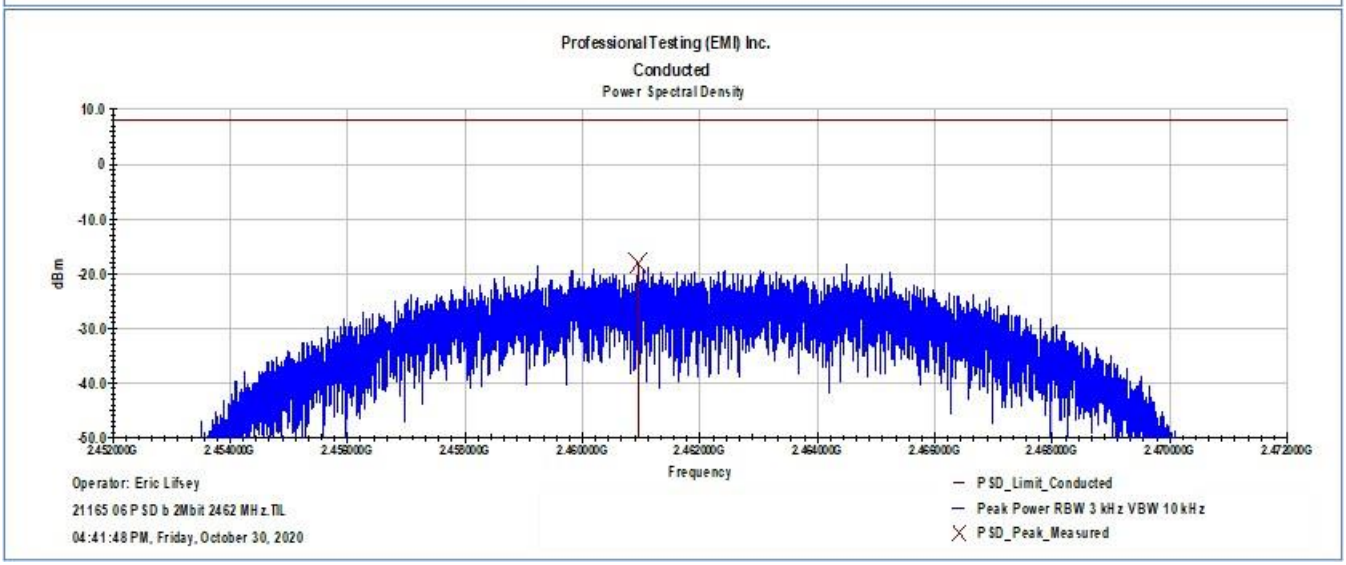
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-20.0
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dBm
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2.454000G
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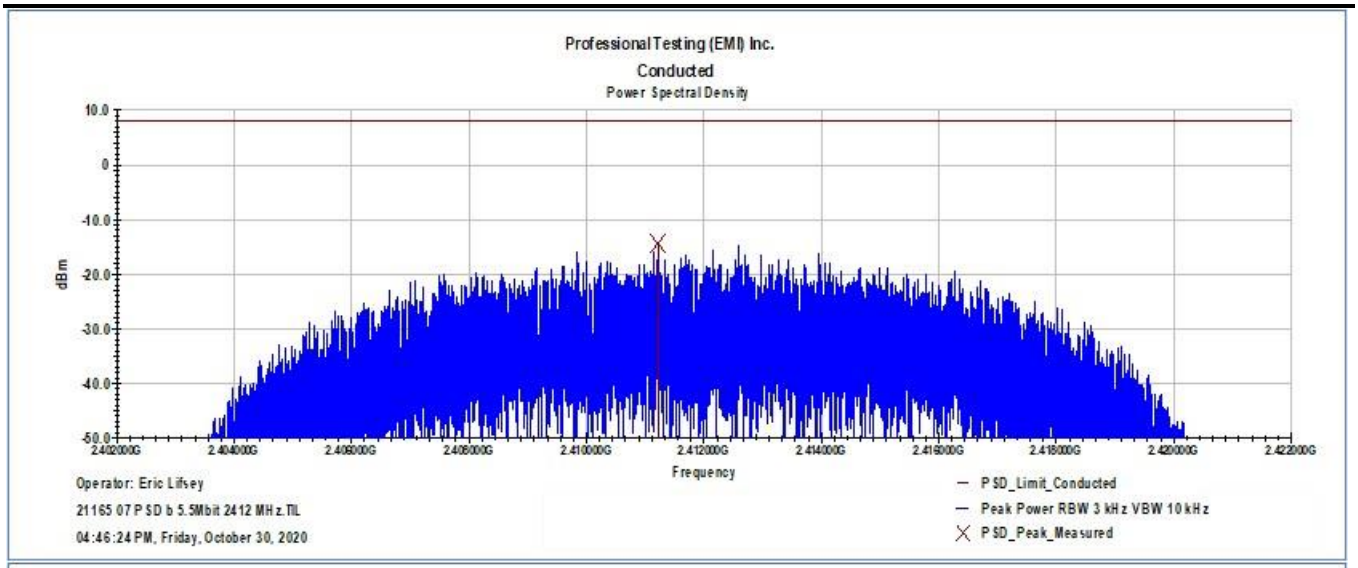
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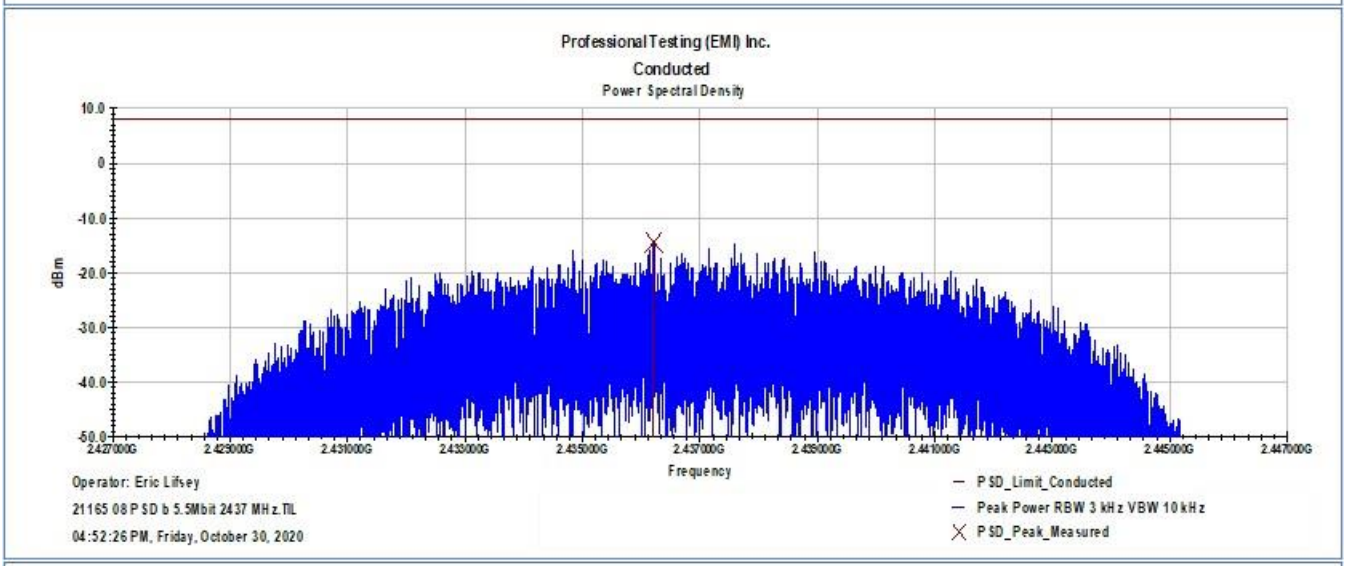
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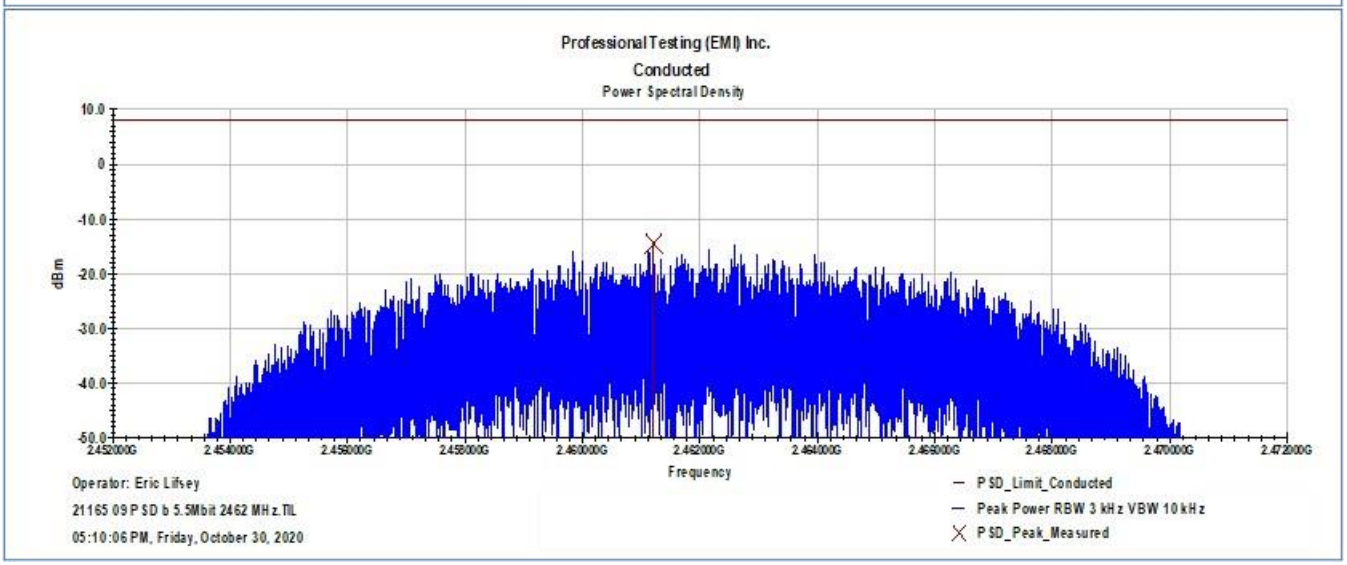
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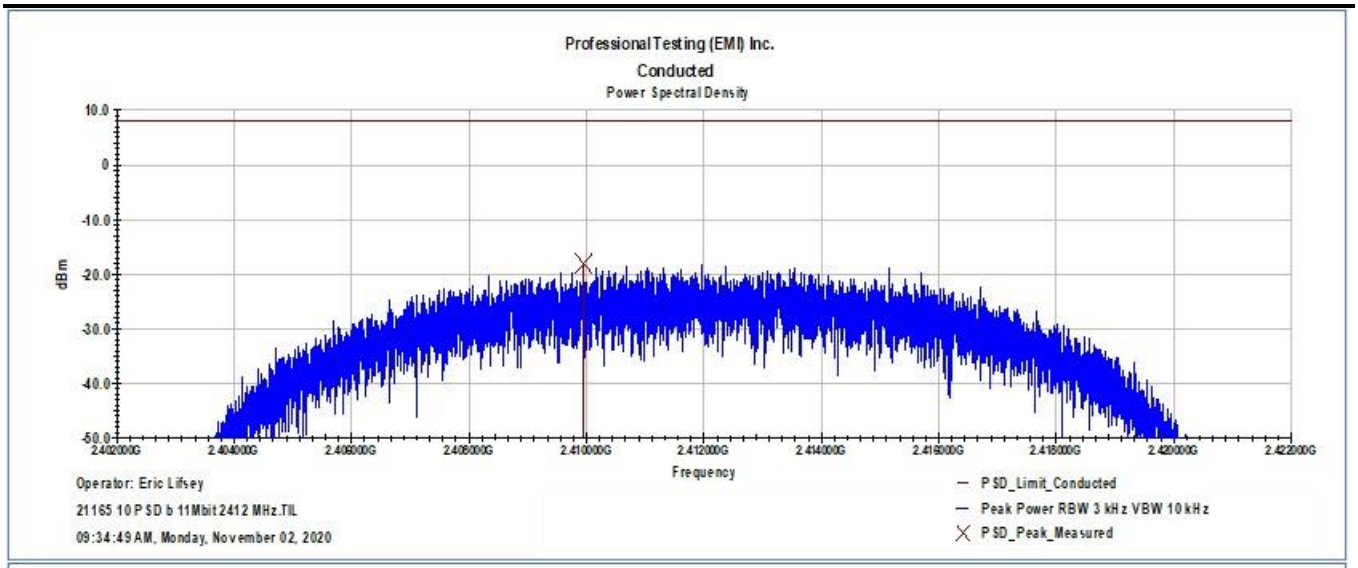
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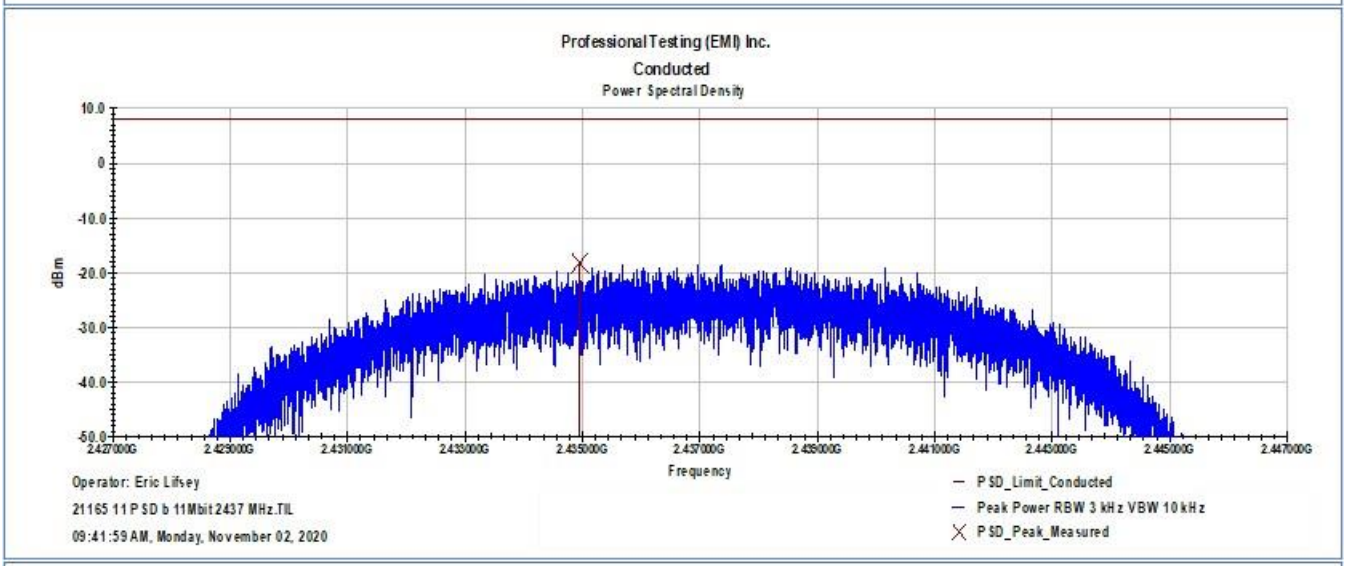
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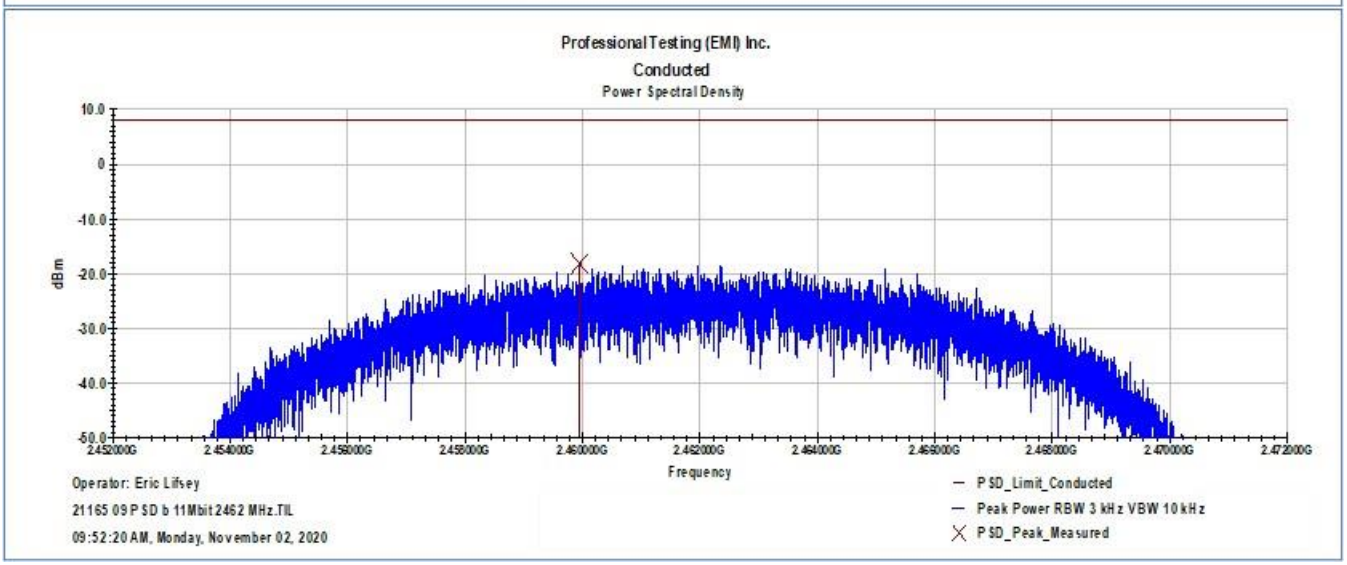
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Peak Power RBW 3 kHz VBW 10 kHz
PSD_Peak_Measured

4.0 Occupied Bandwidth; 15.247(a)(2), 2.1049; RSS-247, RSS-Gen 4.6

4.1 Test Procedure

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

4.2 Test Criteria

Bandwidth
6 dB 500 kHz minimum (non-hopping only) 20 dB (hopping only) 99% (all methods)

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

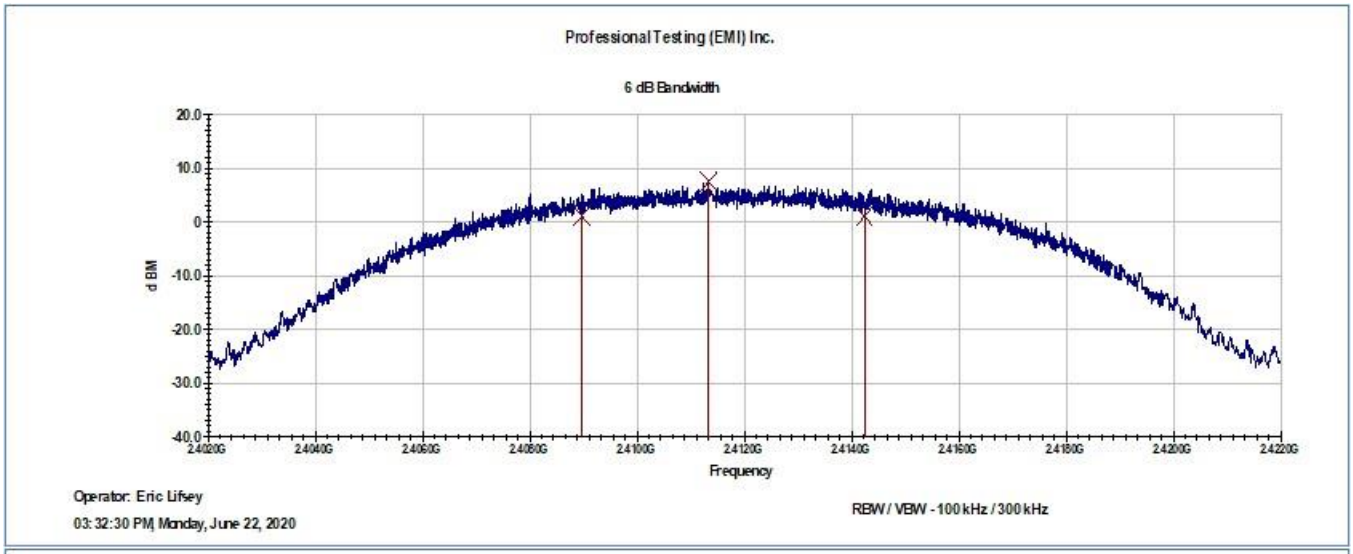
4.3 Test Results, Tabular

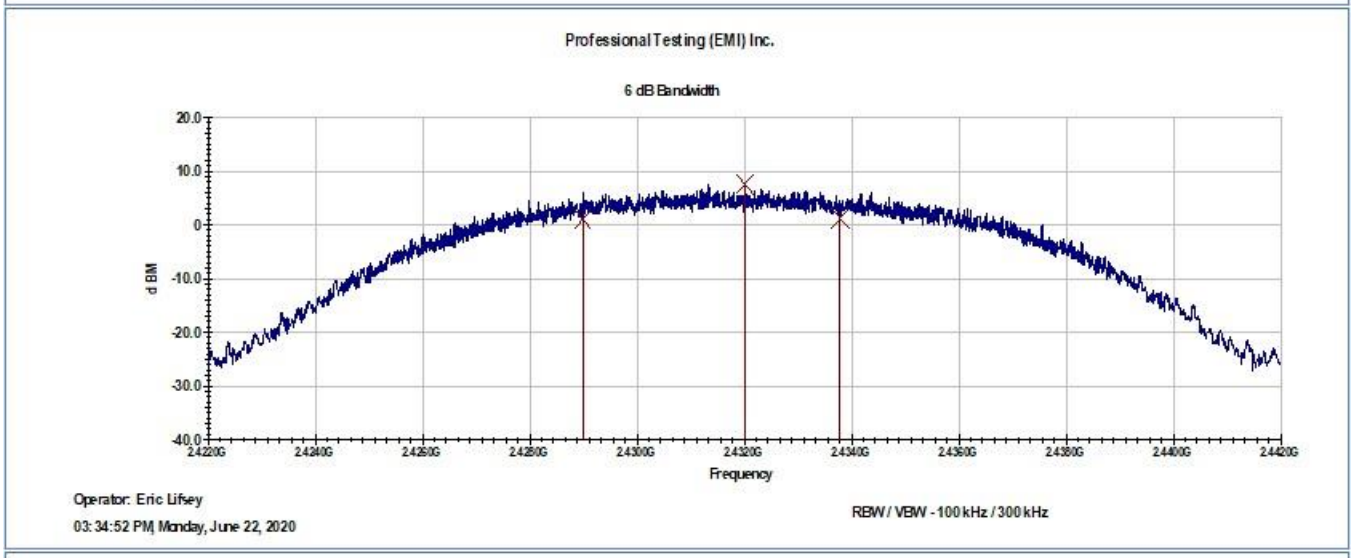
The requirements were satisfied.

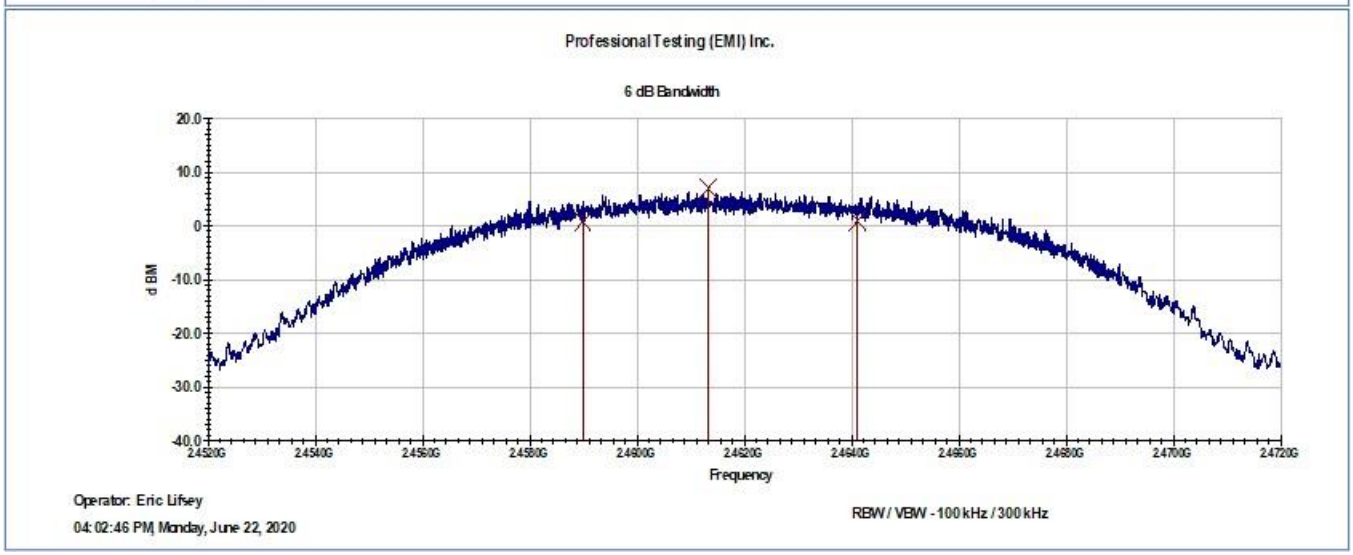
Lowest BW Modes Bandwidth 6 dB, Minimum BW 500 kHz in 100 kHz RBW				
Mode, Rate	Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Reported Minimum BW (kHz)**
b, 1 M	5270	4798	5123	**4798**
g, 6M	16413	16385	16398	**16385**
n, 20M, 0	17665	17678	17665	**17665**
n, 40M, 0	36045	35975	36040	**35975**

Highest BW Modes Bandwidth 99%				
Mode, Rate	Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Reported Maximum BW (kHz)**
b, 11M	13872	14109	14174	**14174**
g, 54M	16448	16459	16456	**16459**
n, 20M, 7	17631	17632	17634	**17634**
n, 40M, 7	36298	36305	36301	**36305**

4.4 Test Results, Recorded, 6 dB BW







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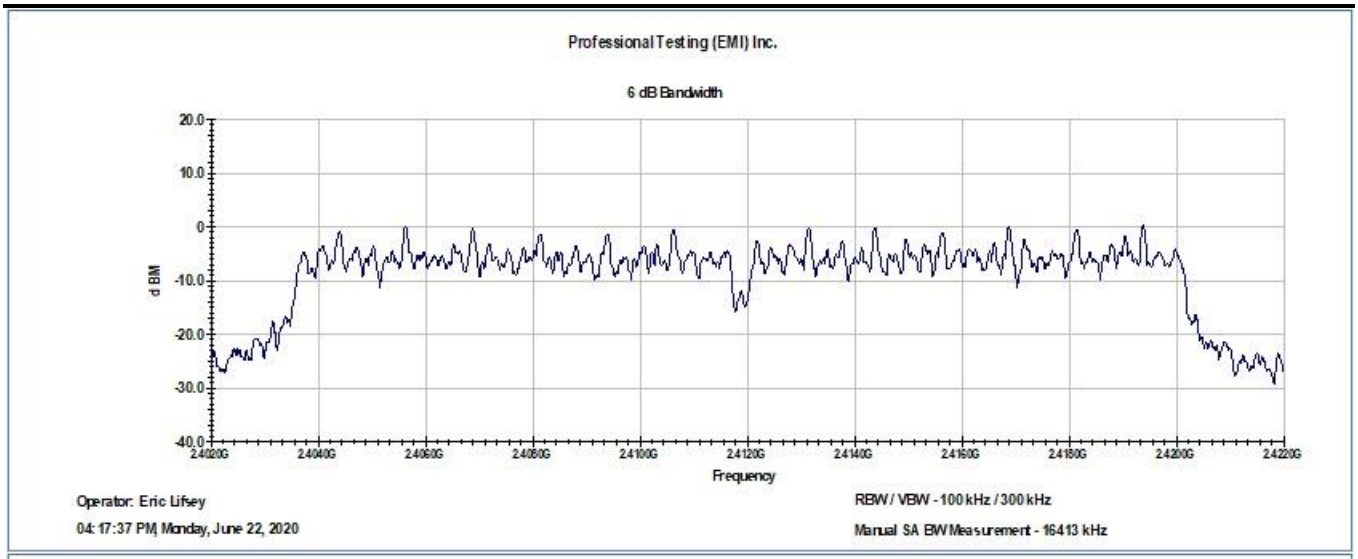
Professional Testing (EMI) Inc.
6 dB Bandwidth
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Frequency
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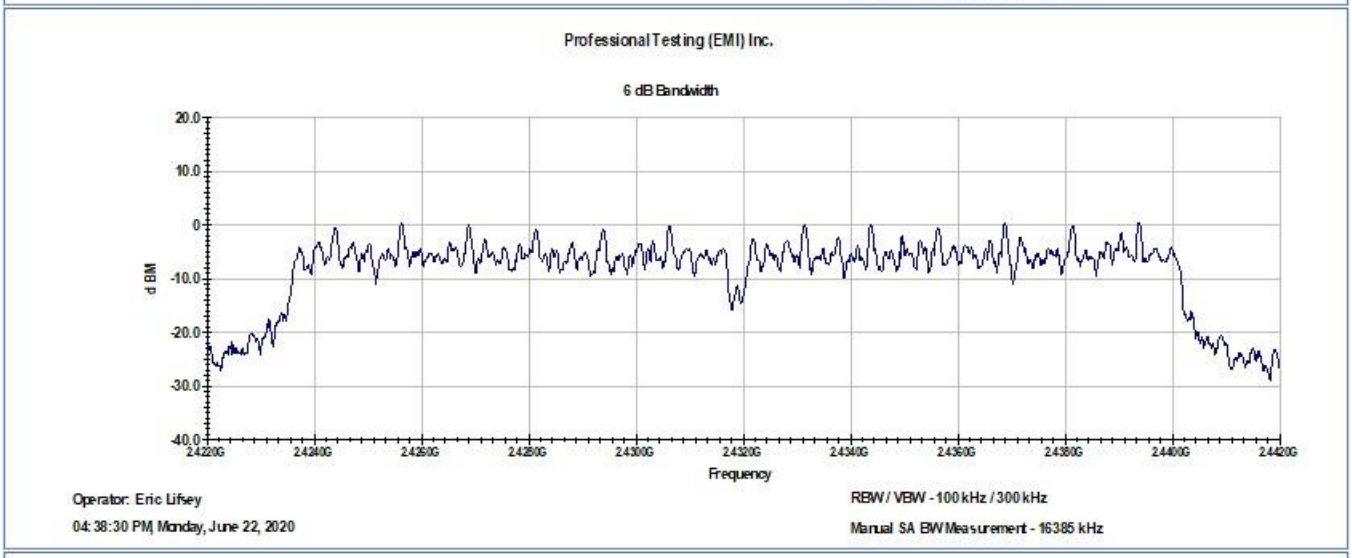
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 16413 kHz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Frequency
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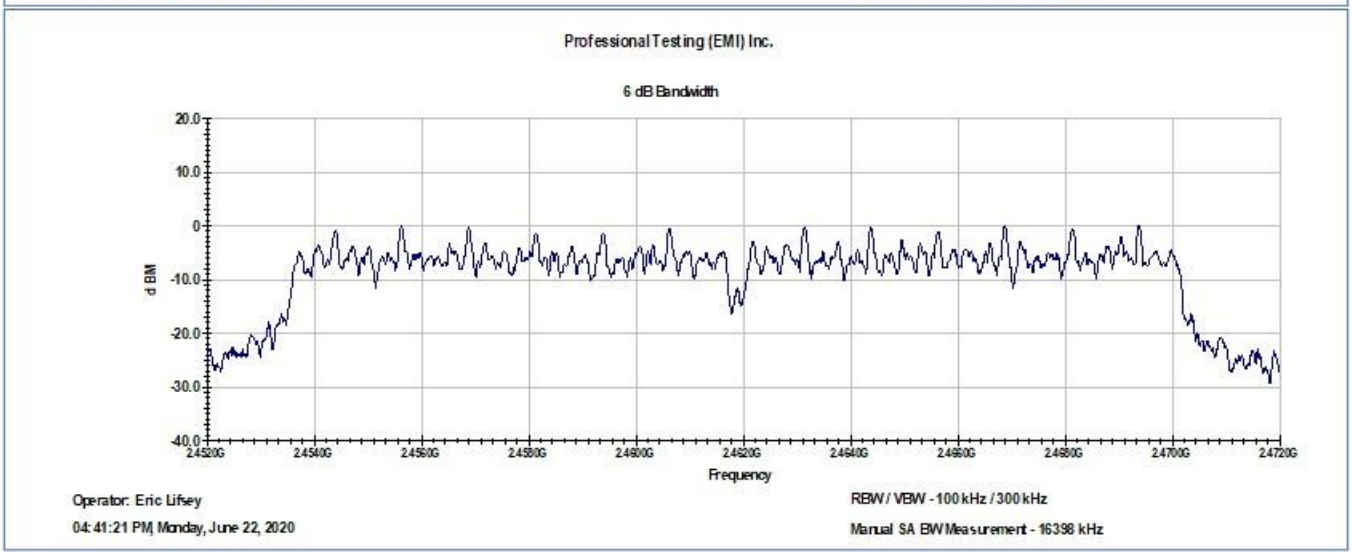
Manual SA BW Measurement - 16385 kHz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6 dB Bandwidth
d BM
Frequency
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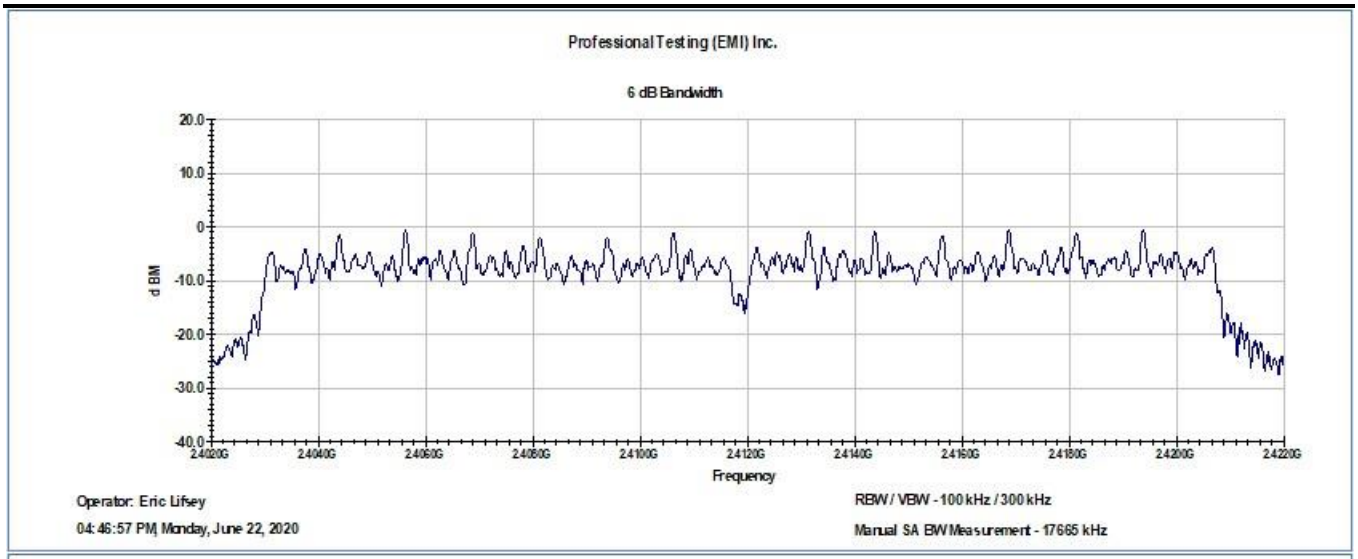
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 16398 kHz

Mode g


Professional Testing (EMI) Inc.
6 dB Bandwidth
d BM
Frequency
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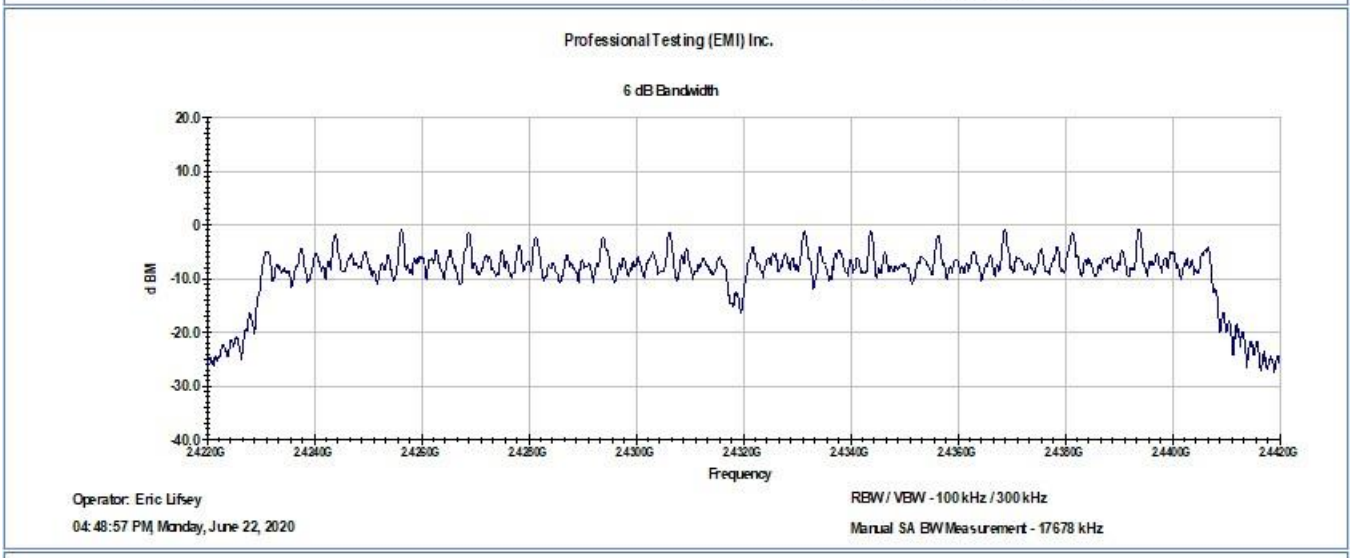
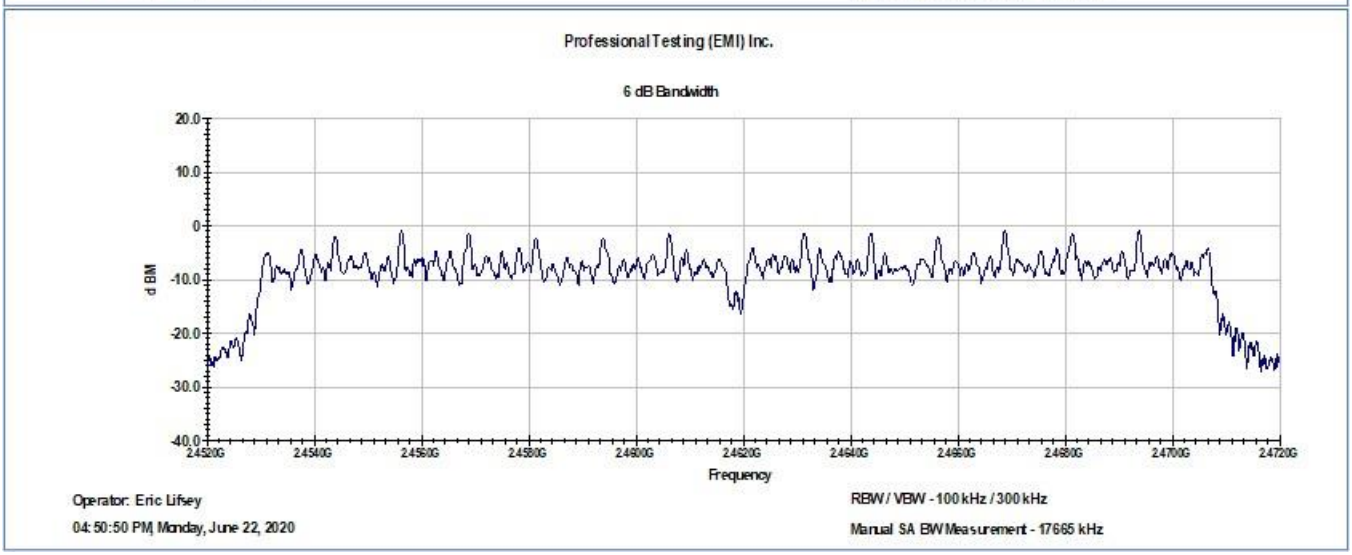
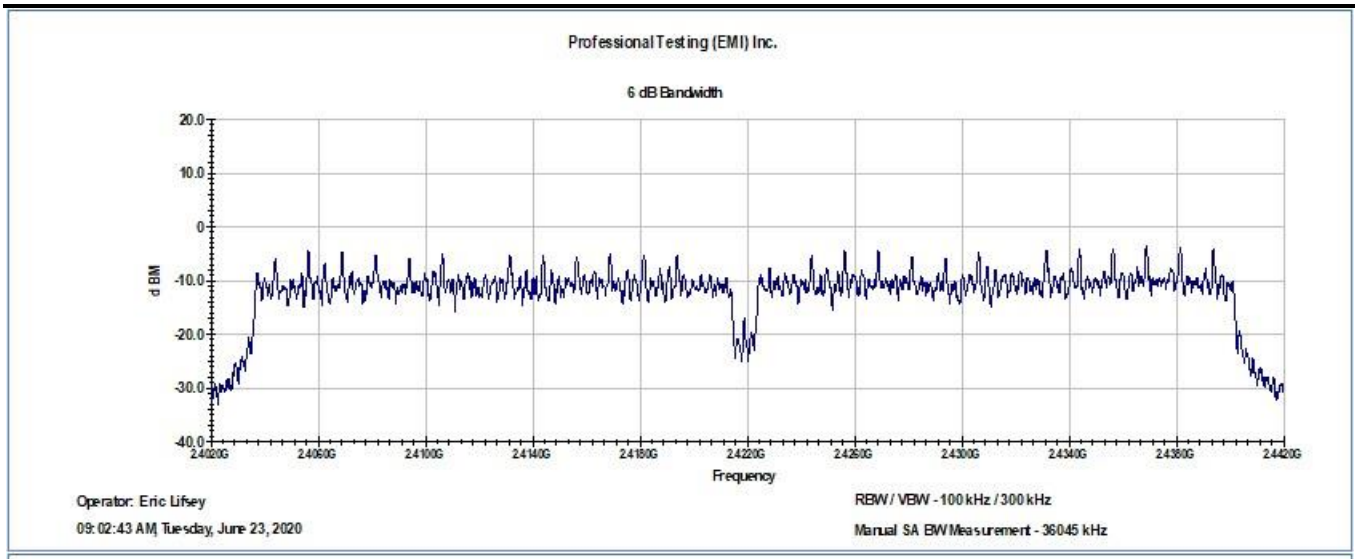
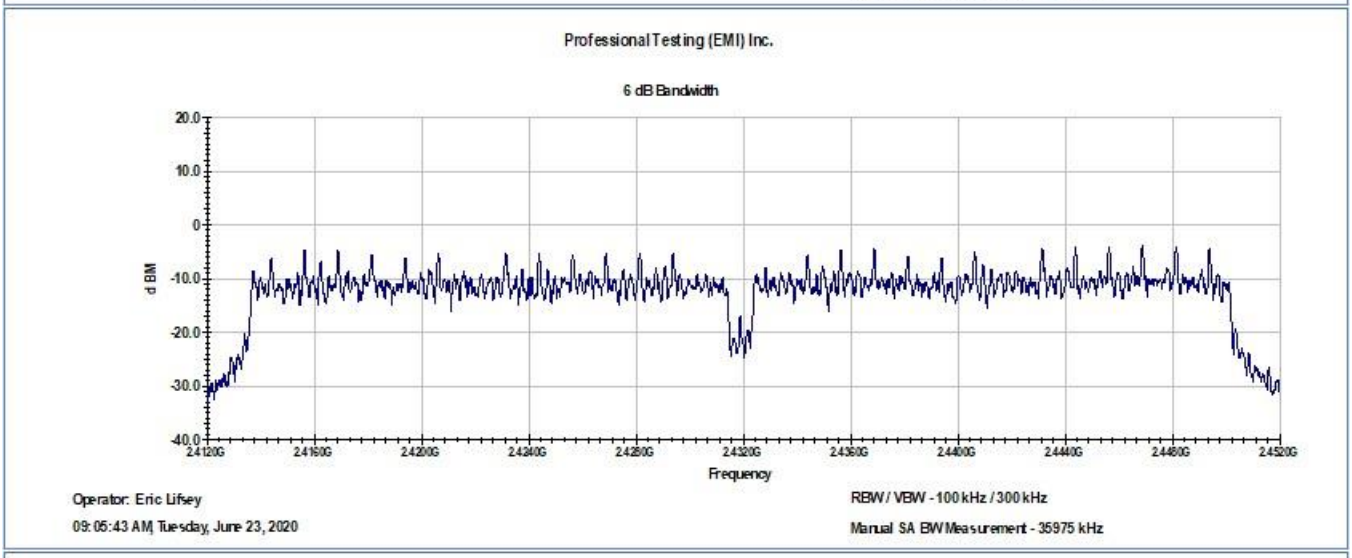
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 17665 kHz

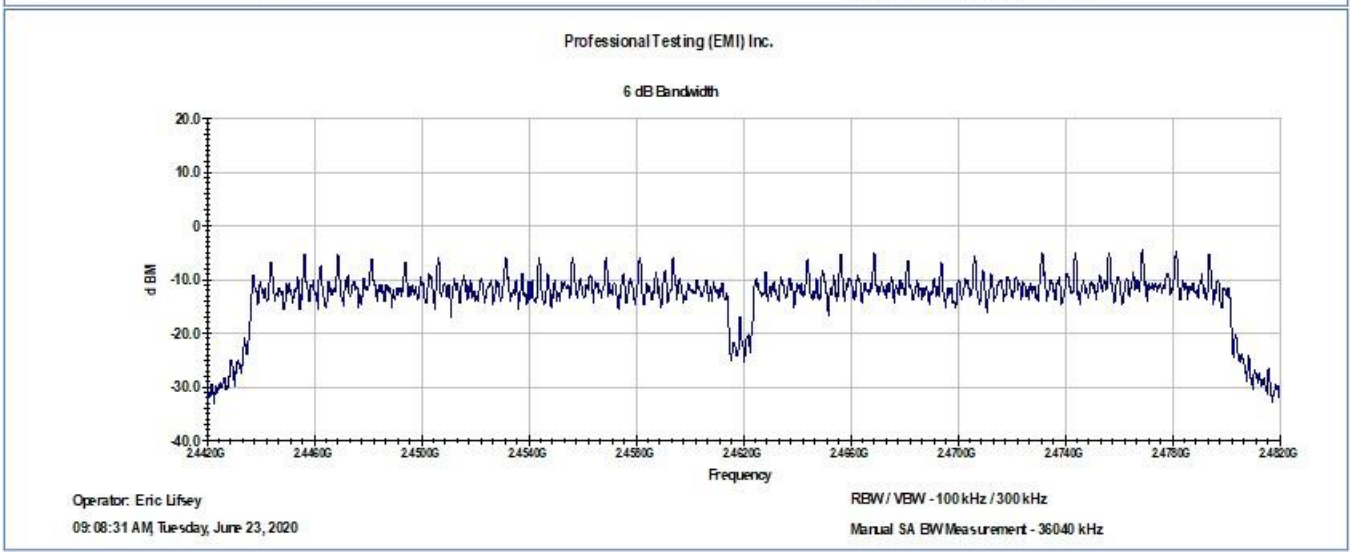

Professional Testing (EMI) Inc.
6 dB Bandwidth
d BM
Frequency
Operator: Eric Lifsey
04:48:57 PM, Monday, June 22, 2020
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 17678 kHz


Professional Testing (EMI) Inc.
6 dB Bandwidth
d BM
Frequency
Operator: Eric Lifsey
04:50:50 PM, Monday, June 22, 2020
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 17665 kHz

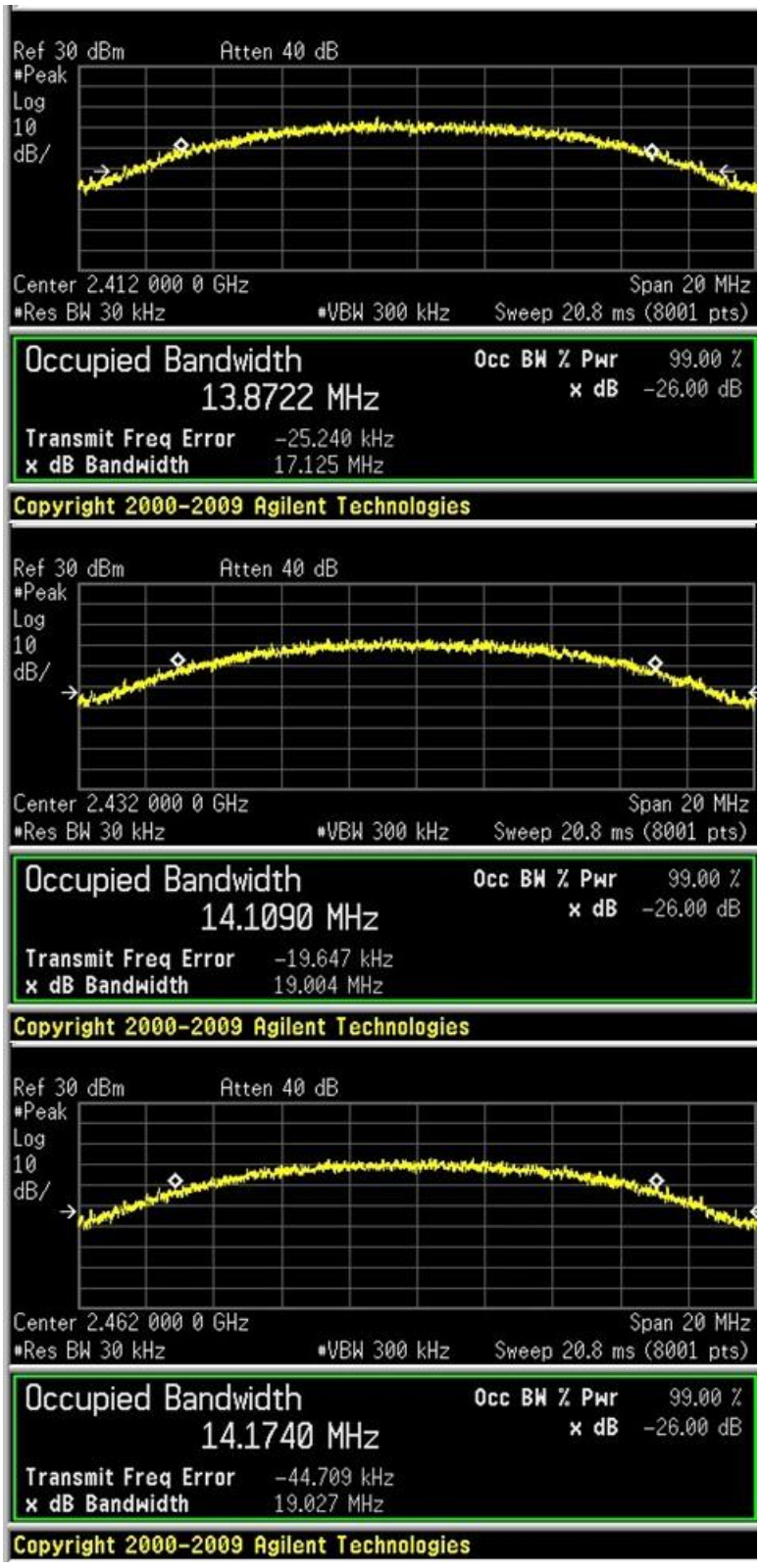
Mode n


Professional Testing (EMI) Inc.
6 dB Bandwidth
d BM
Frequency
Operator: Eric Lifsey
09:02:43 AM Tuesday, June 23, 2020
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 36045 kHz

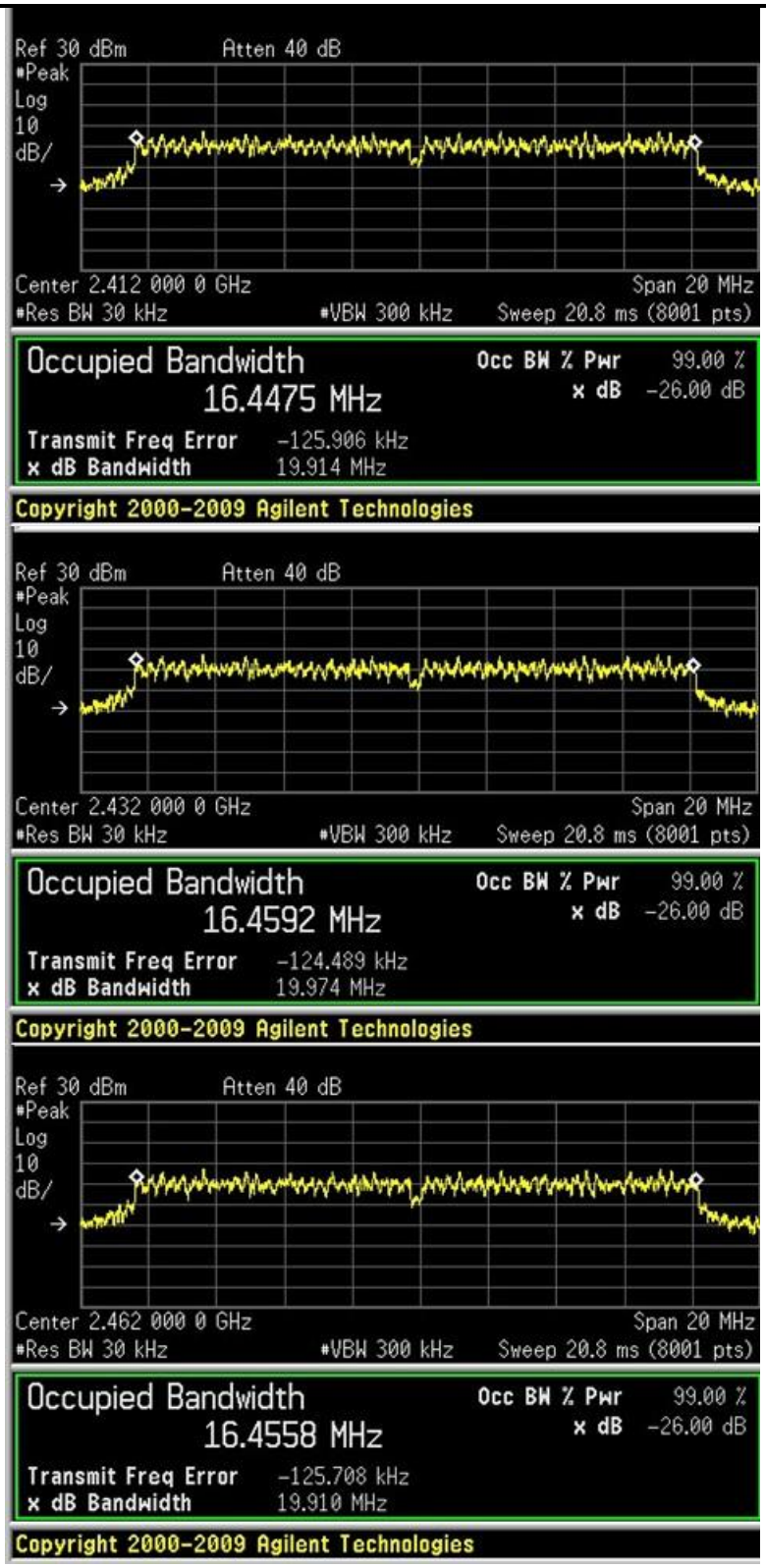

Professional Testing (EMI) Inc.
6 dB Bandwidth
d BM
Frequency
Operator: Eric Lifsey
09:05:43 AM Tuesday, June 23, 2020
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 35975 kHz


Professional Testing (EMI) Inc.
6 dB Bandwidth
d BM
Frequency
Operator: Eric Lifsey
09:08:31 AM Tuesday, June 23, 2020
RBW / VBW - 100 kHz / 300 kHz
Manual SA BW Measurement - 36040 kHz

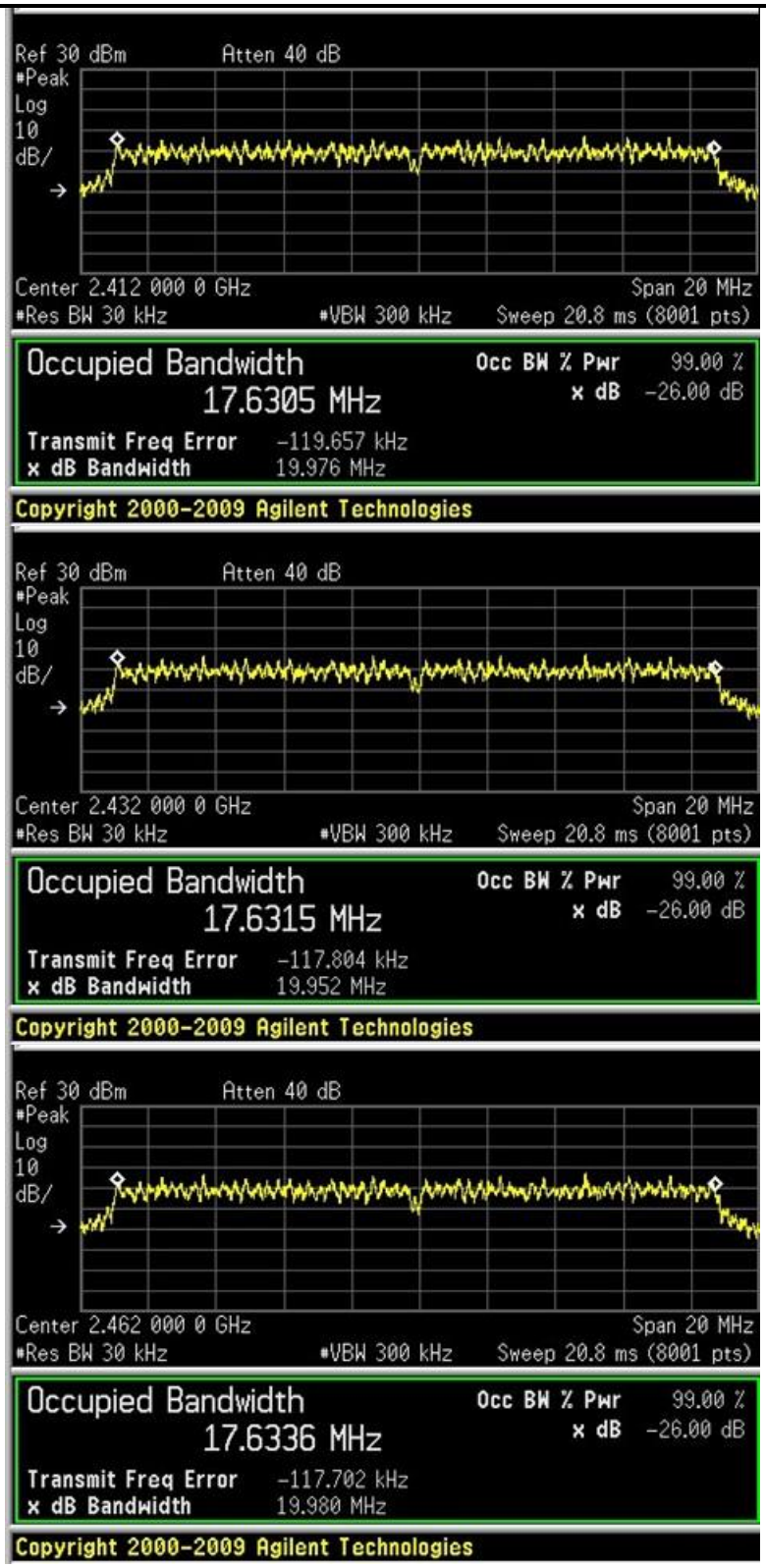
4.5 Test Results, Recorded, 99% BW



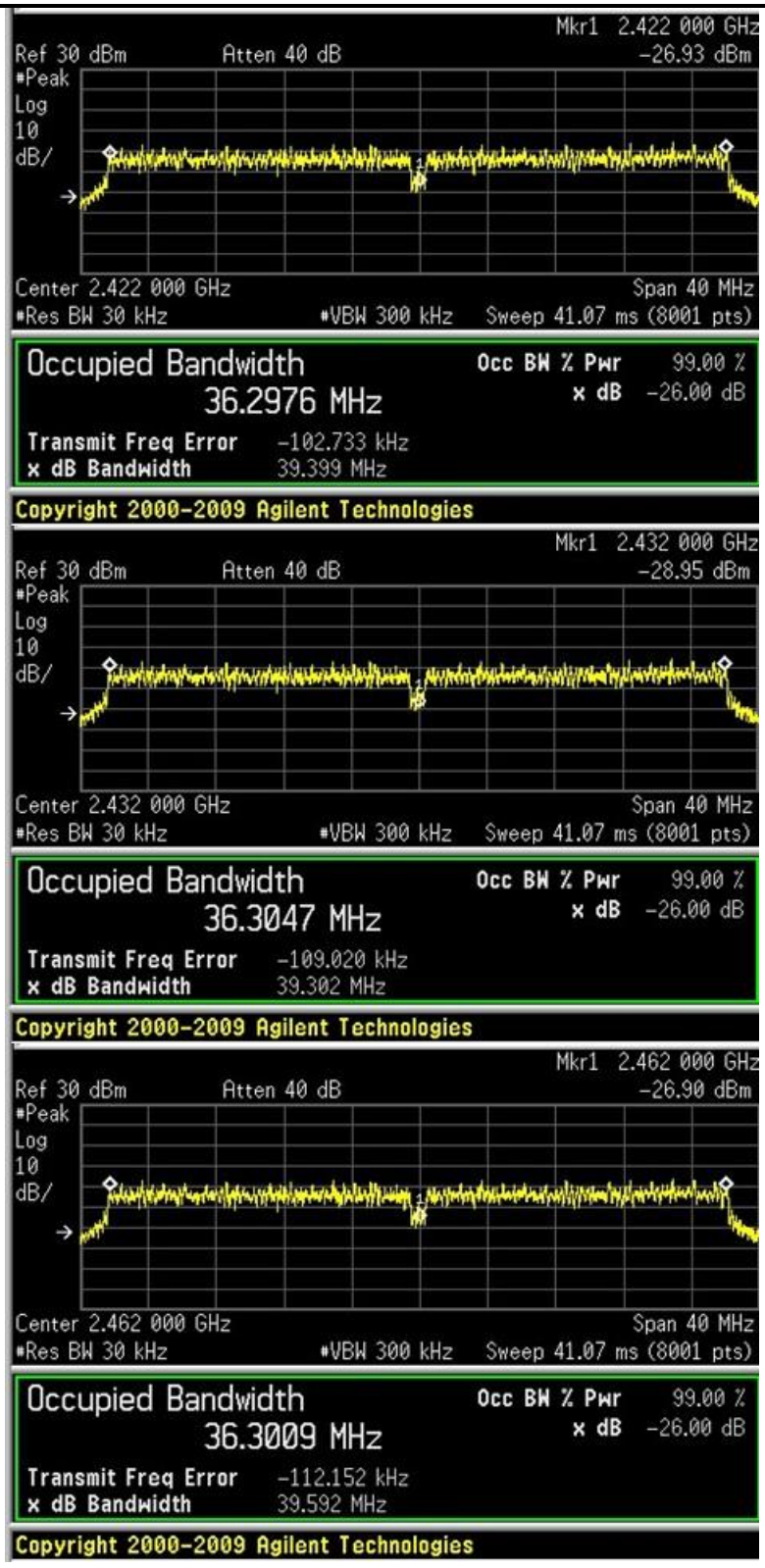
Mode b


Ref 30 dBm
Atten 40 dB
#Peak
Log
10
dB/
Center 2.412 000 0 GHz
Span 20 MHz
#Res BW 30 kHz
#VBW 300 kHz
Sweep 20.8 ms (8001 pts)
Occupied Bandwidth
16.4475 MHz
Occ BW % Pwr 99.00 %
x dB -26.00 dB
Transmit Freq Error -125.906 kHz
x dB Bandwidth 19.914 MHz
Copyright 2000-2009 Agilent Technologies
Ref 30 dBm
Atten 40 dB
#Peak
Log
10
dB/
Center 2.432 000 0 GHz
Span 20 MHz
#Res BW 30 kHz
#VBW 300 kHz
Sweep 20.8 ms (8001 pts)
Occupied Bandwidth
16.4592 MHz
Occ BW % Pwr 99.00 %
x dB -26.00 dB
Transmit Freq Error -124.489 kHz
x dB Bandwidth 19.974 MHz
Copyright 2000-2009 Agilent Technologies
Ref 30 dBm
Atten 40 dB
#Peak
Log
10
dB/
Center 2.462 000 0 GHz
Span 20 MHz
#Res BW 30 kHz
#VBW 300 kHz
Sweep 20.8 ms (8001 pts)
Occupied Bandwidth
16.4558 MHz
Occ BW % Pwr 99.00 %
x dB -26.00 dB
Transmit Freq Error -125.708 kHz
x dB Bandwidth 19.910 MHz
Copyright 2000-2009 Agilent Technologies

Mode g



Mode n, MCS7, 20MHz



Mode n, MCS7, 40MHz

5.0 Band Edge; 15.247, 15.205; RSS-247 5.5; RSS-Gen 4.9

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

Unwanted Emissions
Emissions Adjacent to Authorized Band

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. Beyond this point, the general emission limits are applied in the radiated emission tests reported elsewhere in the report.

This is a conducted measurement with limits derived from the general emission field strength limits. The far field path loss equation is utilized to convert the field strength limits to EIRP limits in dBm as follows:

Given EIRP = $E_{dB\mu V/m} + 20Log_{10}(d) - 104.8$

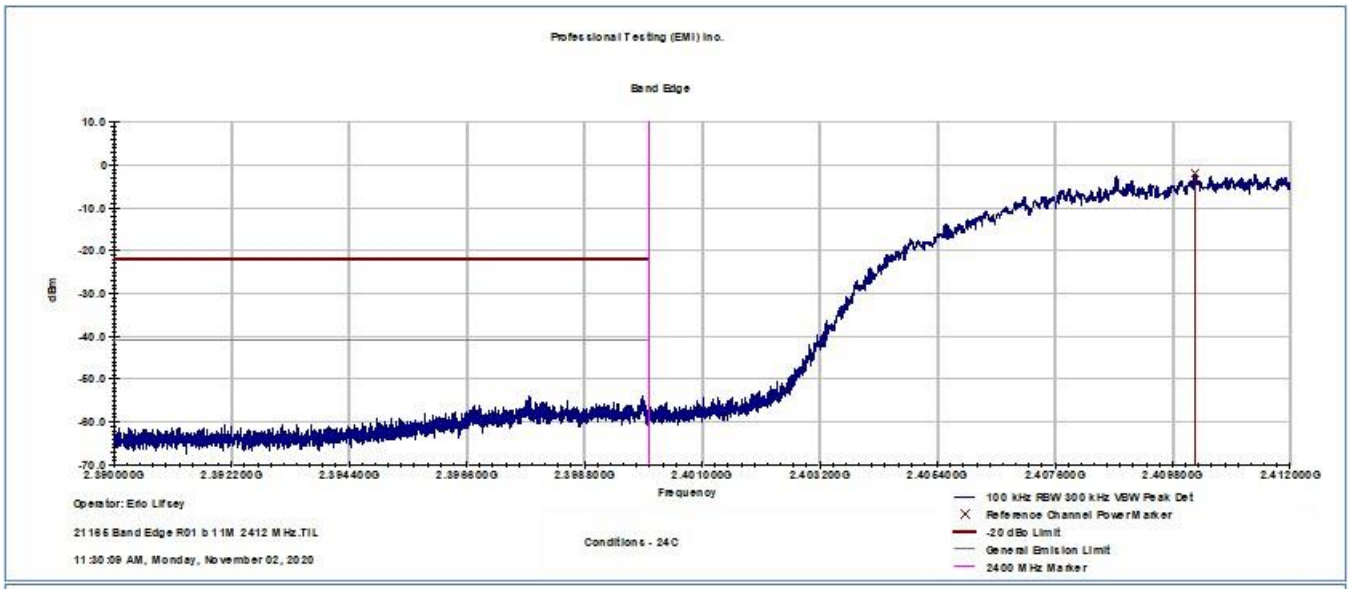
EIRP = 54 dBµV/m + $20Log_{10}$(3 m) – 104.8 dB = -41.25 dBm (commonly -41 dBm is applied)

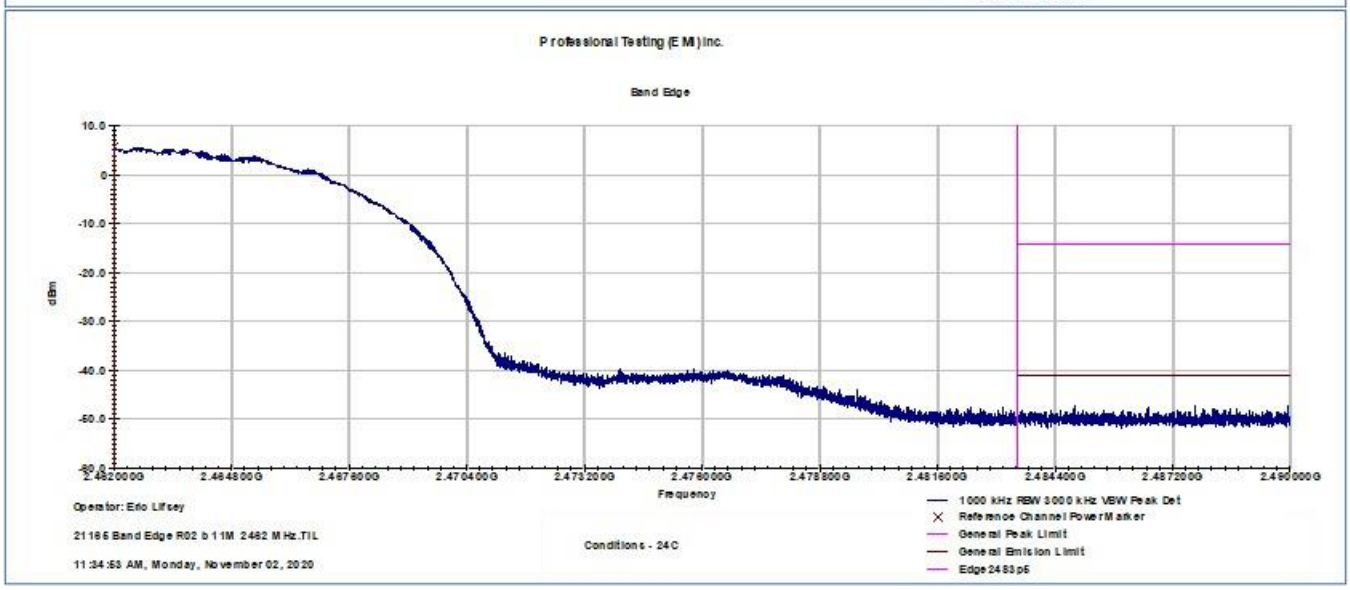
Emissions below band were measured with peak detection in 100 kHz RBW.

Emissions above band measured with peak detection and 1 Hz video average in 1 MHz RBW if the peak emission exceeds the average limit.

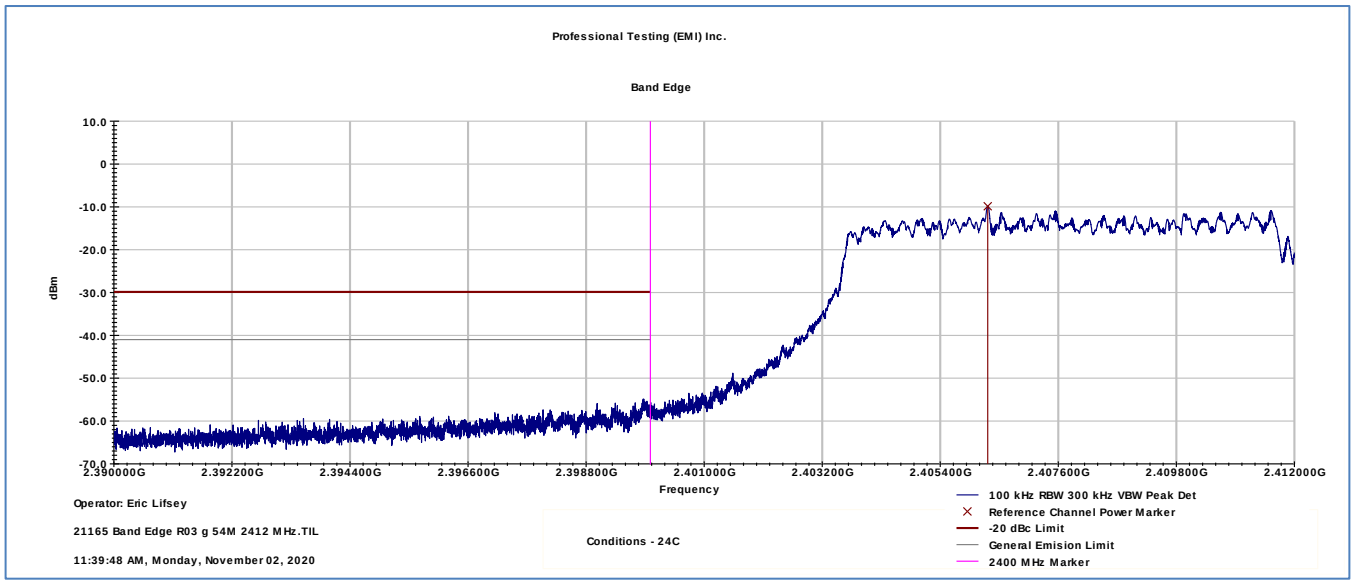
The requirement was satisfied. Plotted results appear on the following pages.

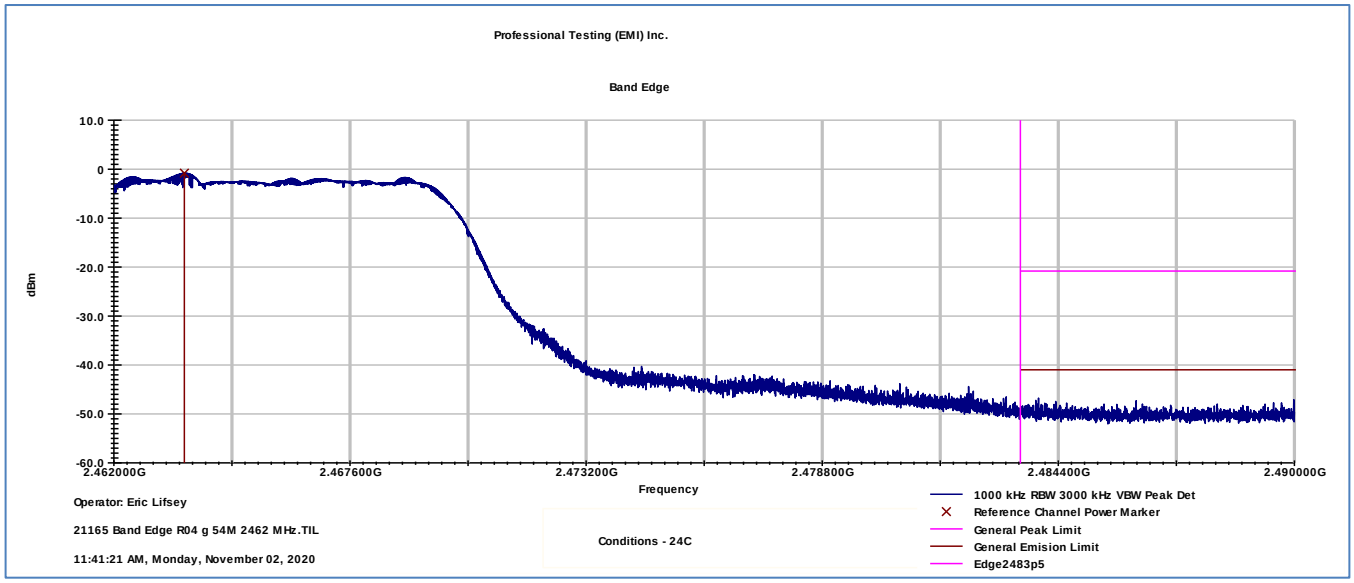
5.3.1 Mode b, 11Mbit



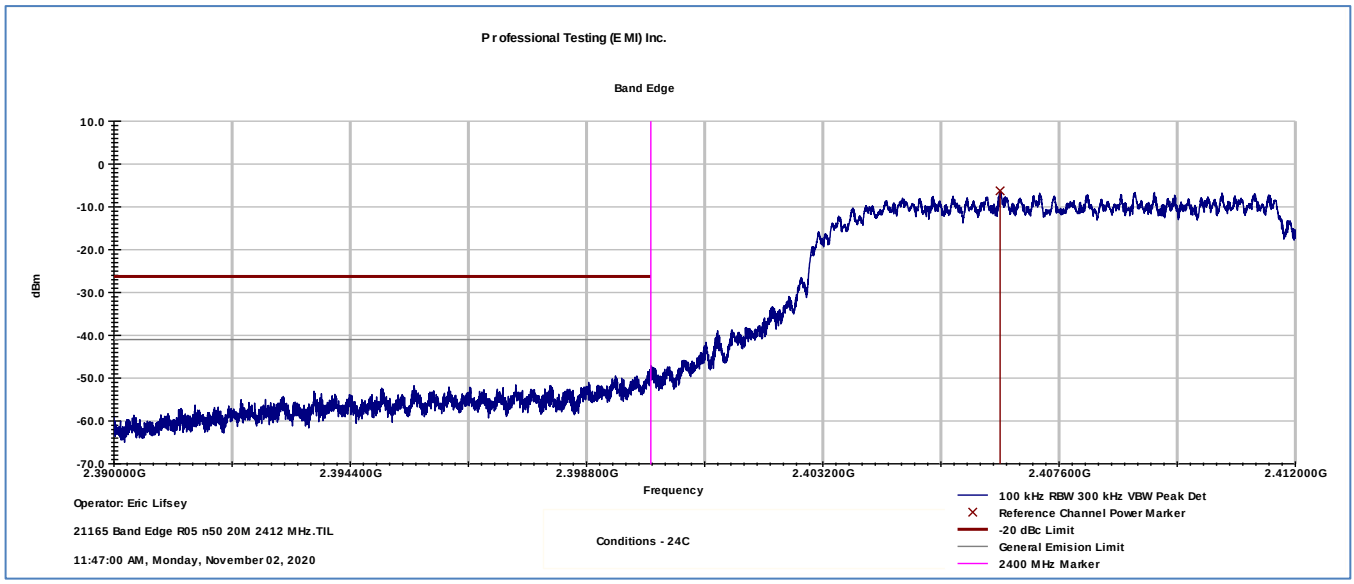


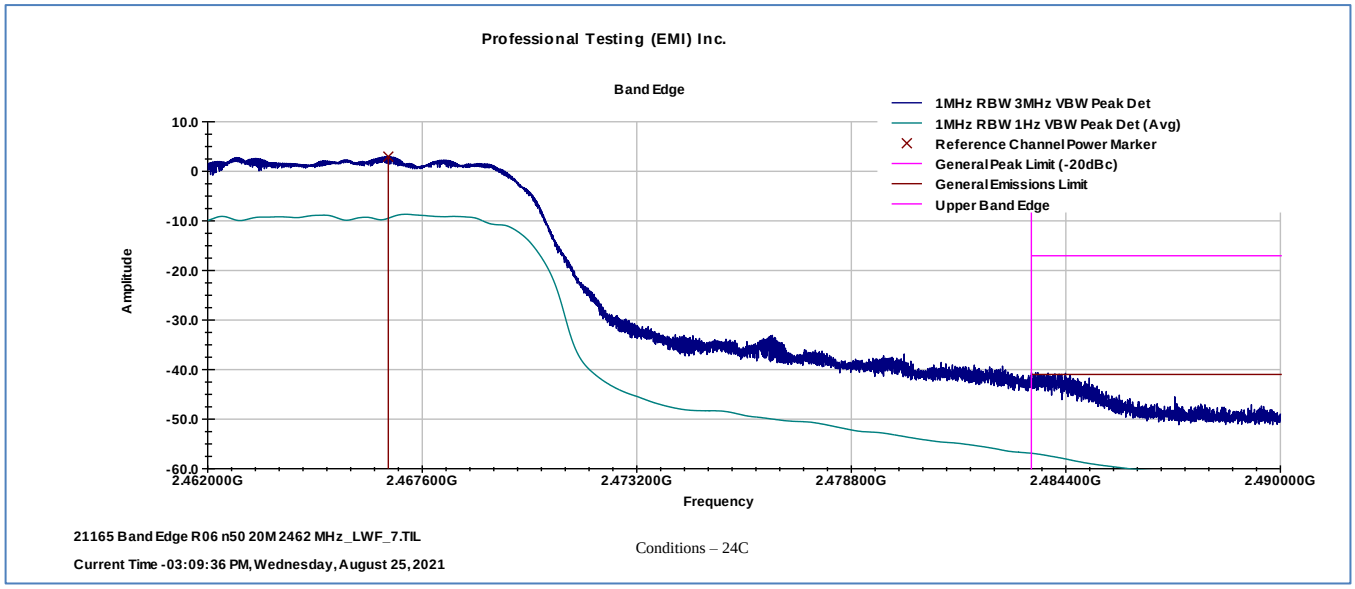
5.3.2 Mode g, 54Mbit



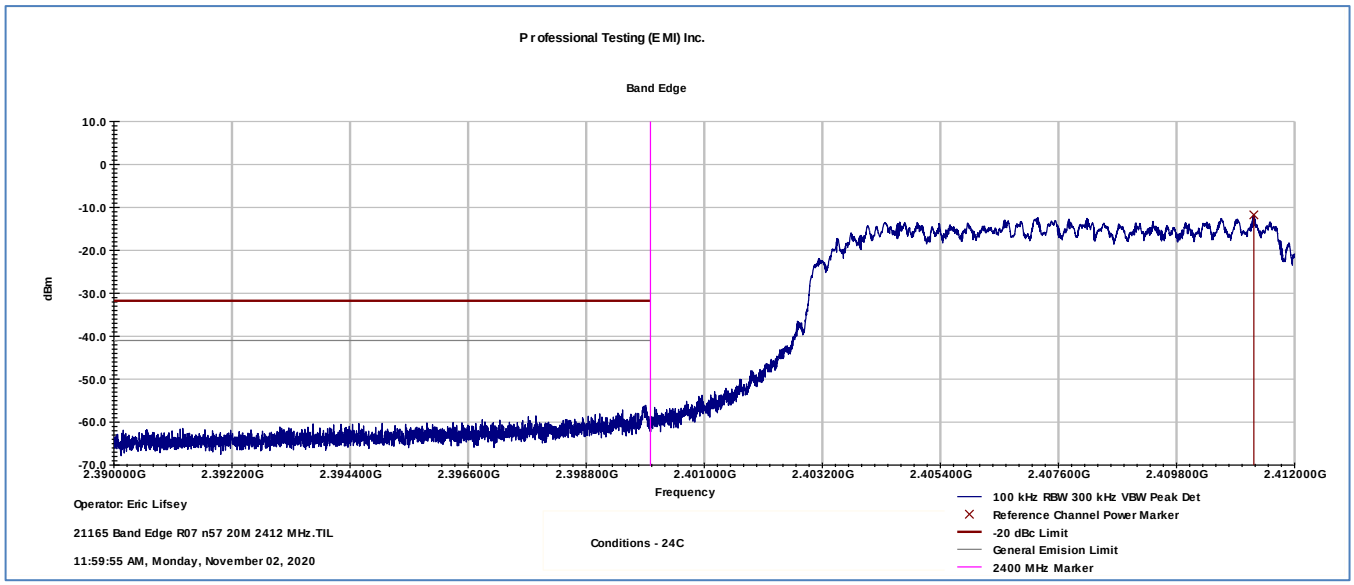


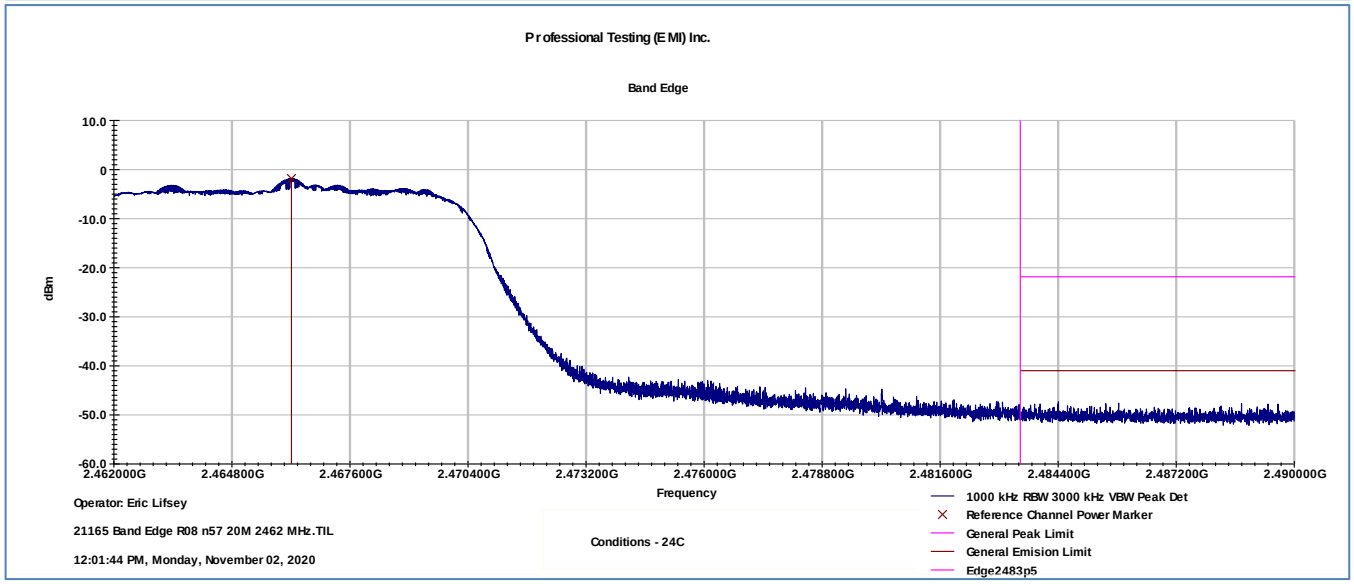
5.3.3 Mode n, MCS0, 20 MHz



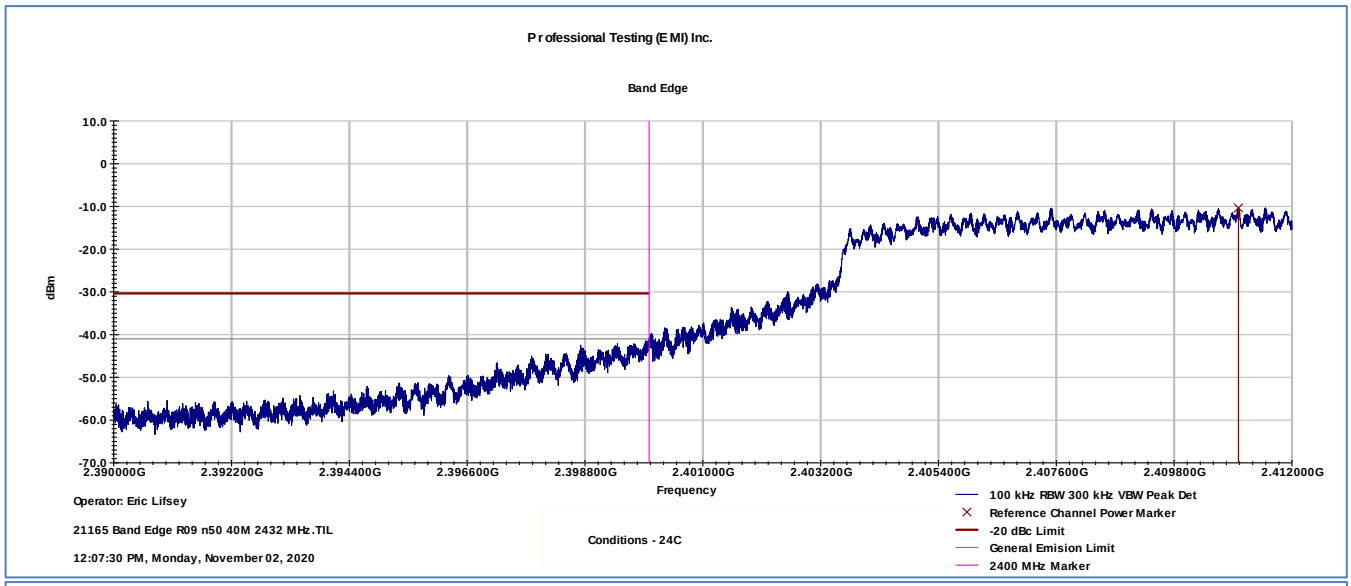


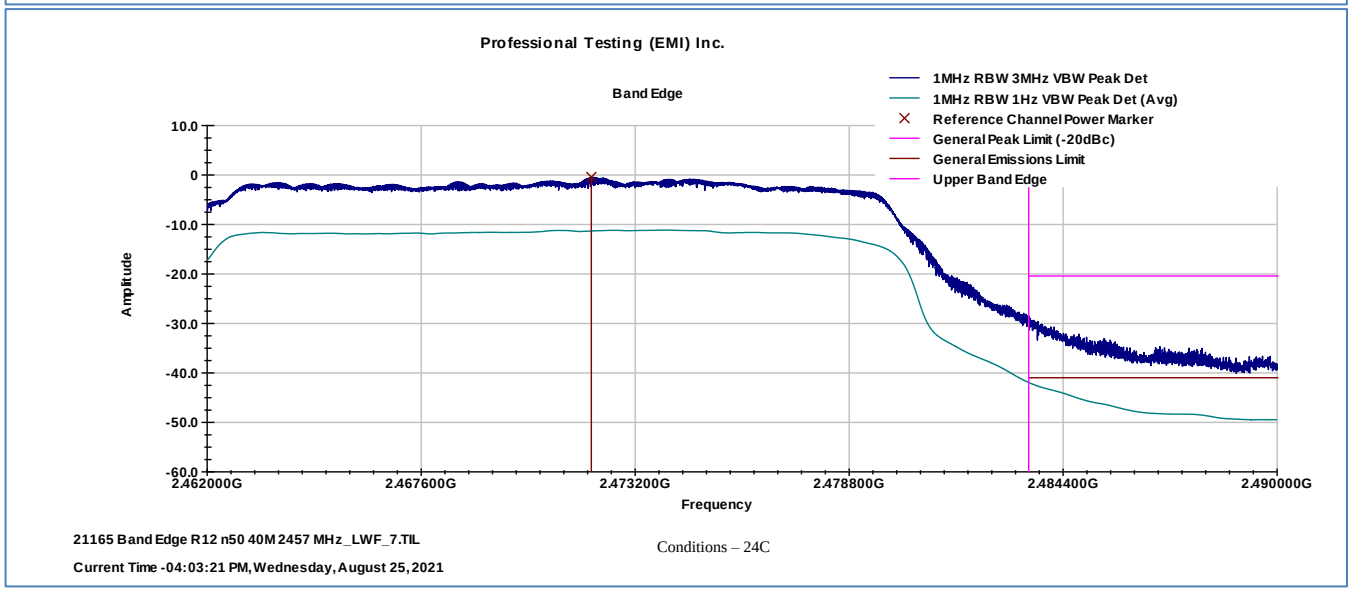
5.3.1 Mode n, MCS7, 20 MHz



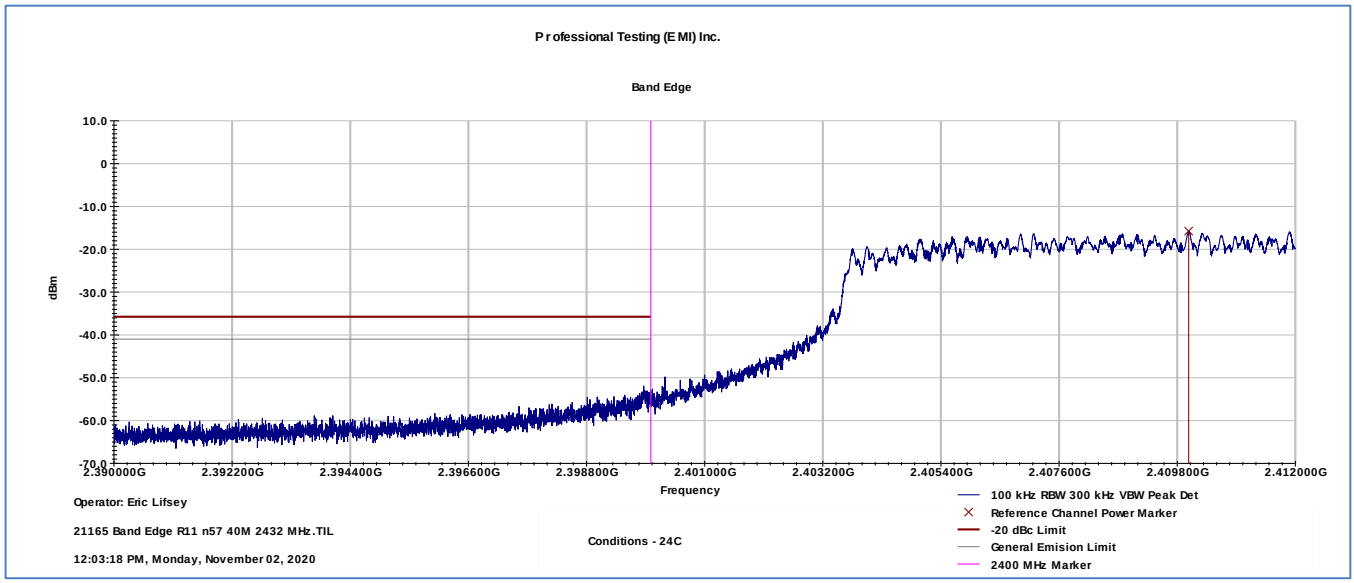


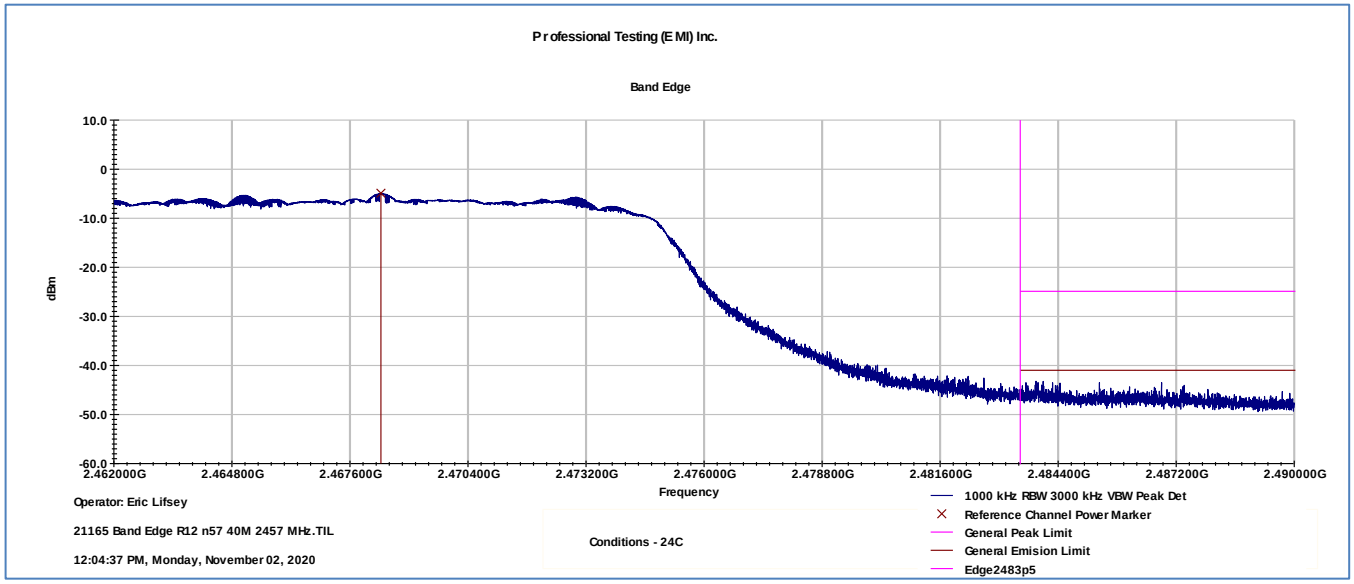
5.3.2 Mode n, MCS0, 40 MHz





5.3.1 Mode n, MCS7, 40 MHz





6.0 Radiated Spurious Emissions, Transmit Mode; 15.247, 15.209; RSS-247 5.5, RSS-Gen 4.9 & 4.10

6.1 Test Procedure

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

6.1.1 Test Distance, Table Height, and Detection Method		
30 MHz to 1 GHz	**1 GHz to 18 GHz**	**18 GHz to 25 GHz**
10 m, 80 cm	3 m, 150 cm	1 m
Quasi-peak	Peak & Average	Peak & Average

6.2 Test Criteria

Unwanted Emissions
Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode

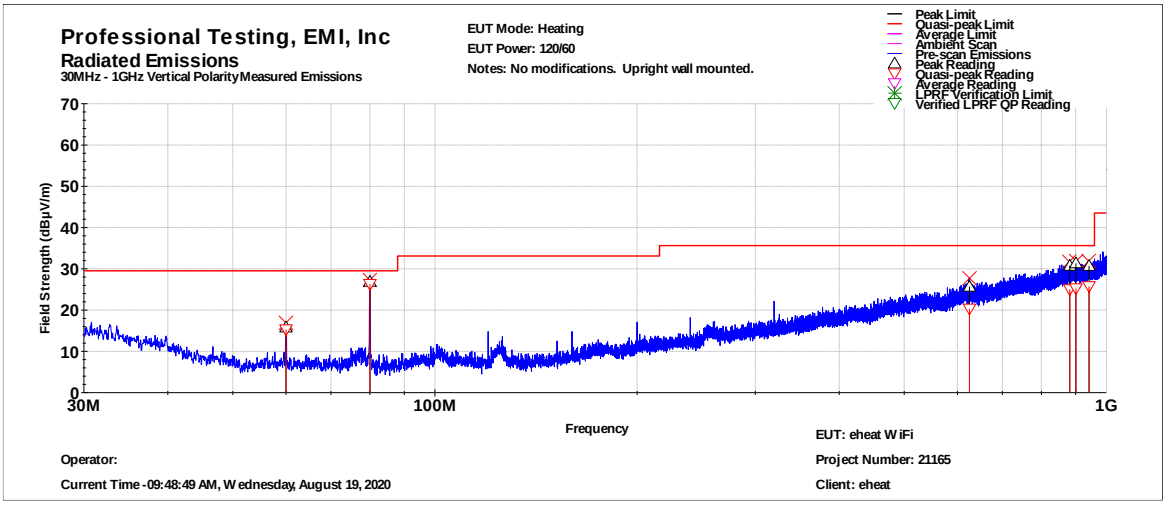
6.3 Test Results

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

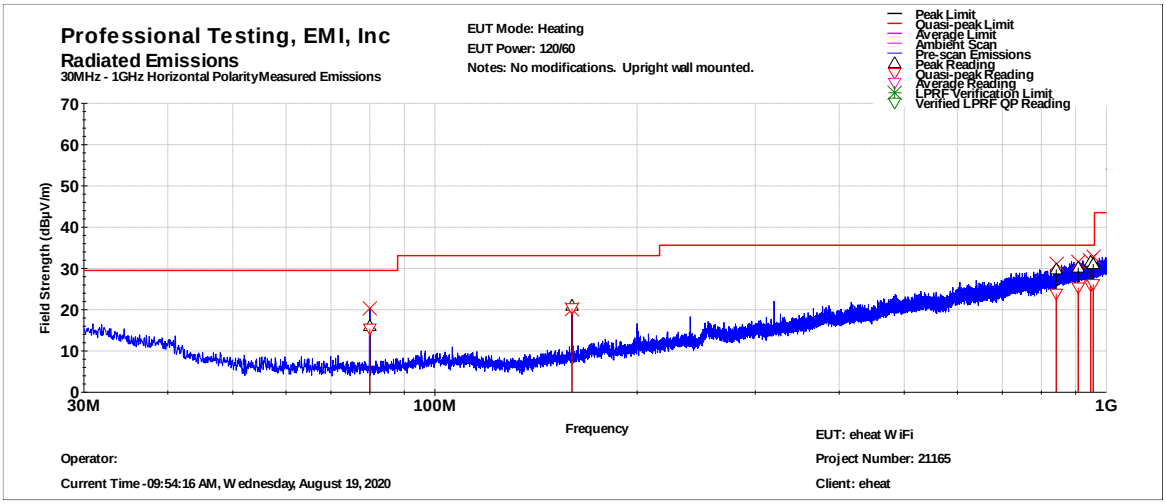
Below 1 GHz the EUT was operated in normal mode. Above 1 GHz the three channels were tested.

The requirement was satisfied.

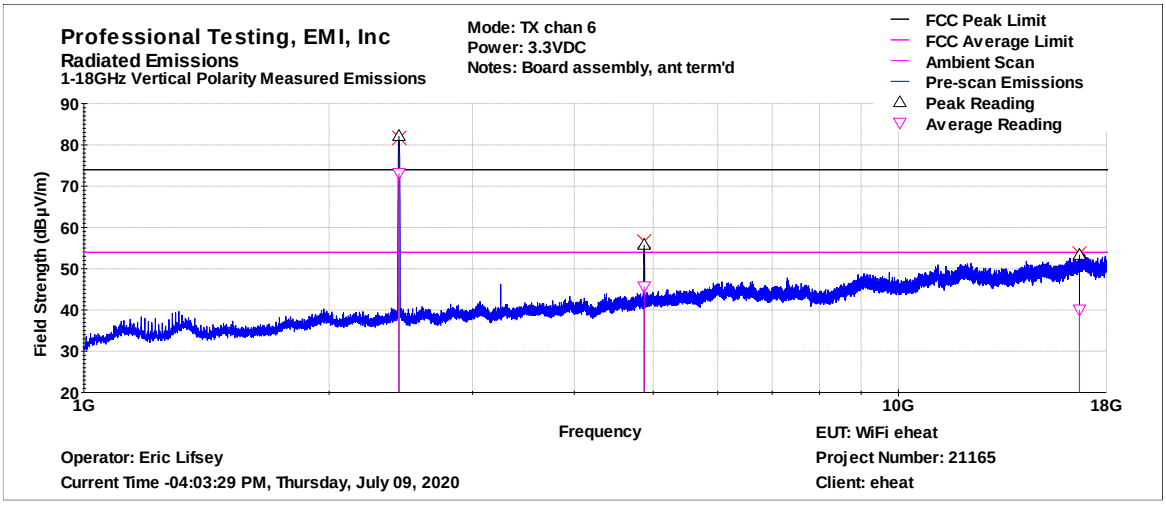
6.3.1 Middle Channel, 30 MHz to 25 GHz



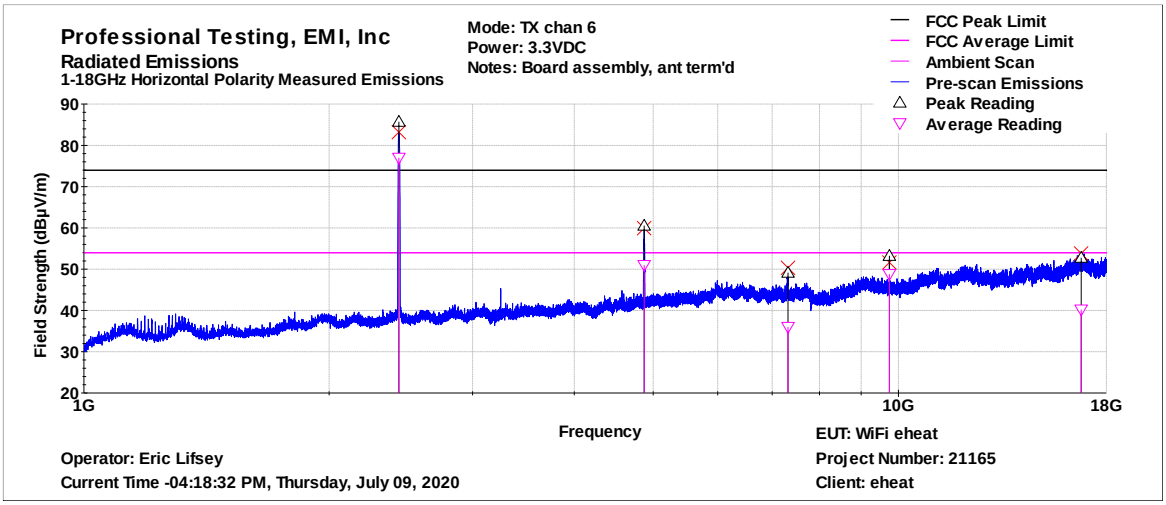
Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
MHz	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
60.009	4.000	266.000	15.309	29.500	-14.191	PASS	15.811
80.013	80.000	173.000	26.312	29.500	-3.188	PASS	26.862
625.351	133.000	366.000	20.338	35.600	-15.262	PASS	25.659
882.411	317.000	356.000	25.048	35.600	-10.552	PASS	30.733
900.901	227.000	390.000	25.247	35.600	-10.353	PASS	31.342
942.301	5.000	264.000	25.756	35.600	-9.844	PASS	30.687



Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
(MHz)	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
79.987	158.000	306.000	15.395	29.500	-14.105	PASS	16.040
159.990	170.000	352.000	20.354	33.100	-12.746	PASS	20.983
842.037	112.000	335.000	23.863	35.600	-11.737	PASS	29.761
908.014	91.000	334.000	25.365	35.600	-10.235	PASS	30.197
947.543	205.000	156.000	25.867	35.600	-9.733	PASS	31.629
956.196	111.000	356.000	26.168	35.600	-9.432	PASS	31.067

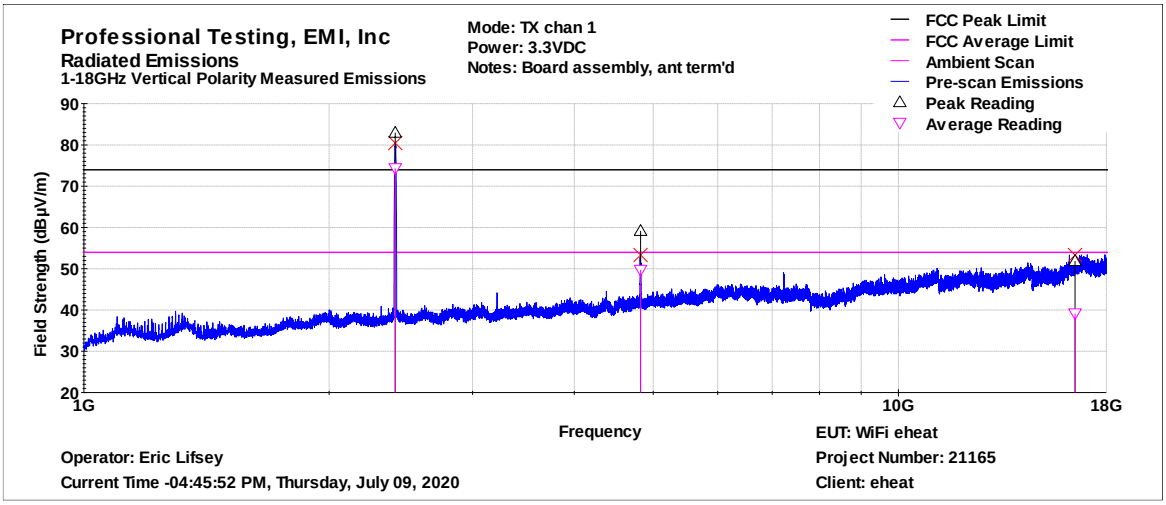


Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
4873.81	2	101	55.802	73.958	-18.156	PASS	45.675	53.958	-8.283	PASS
16682.16	258	189	53.351	73.958	-20.607	PASS	40.077	53.958	-13.881	PASS

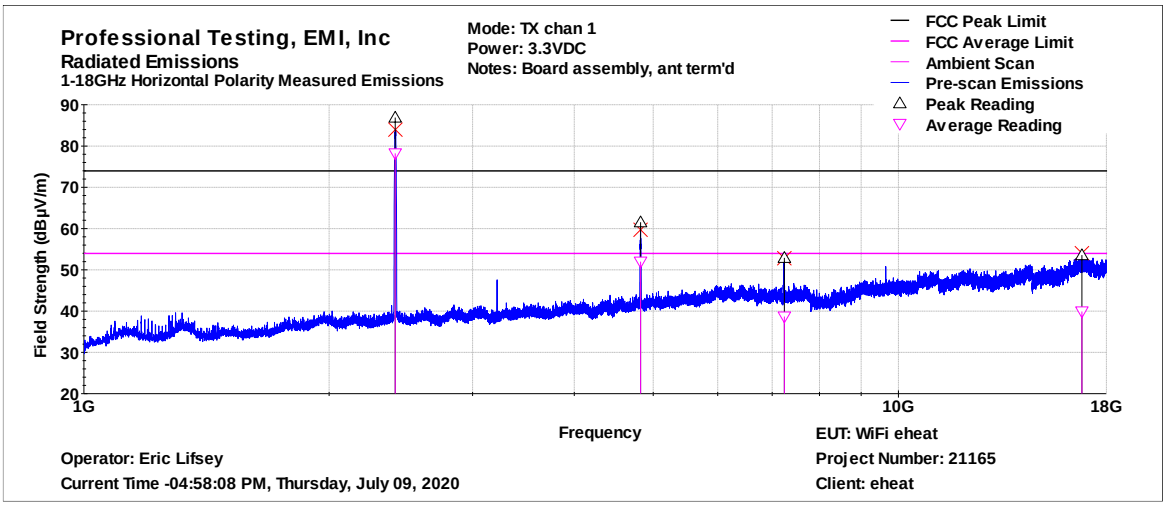


Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
4873.73	126	126	60.540	73.958	-13.418	PASS	50.976	53.958	-2.982	PASS
7318.59	2	327	49.129	73.958	-24.829	PASS	35.980	53.958	-17.978	PASS
9747.65	113	126	53.224	73.958	-20.734	PASS	48.794	53.958	-5.164	PASS
16763.70	110	138	52.745	73.958	-21.213	PASS	40.195	53.958	-13.763	PASS

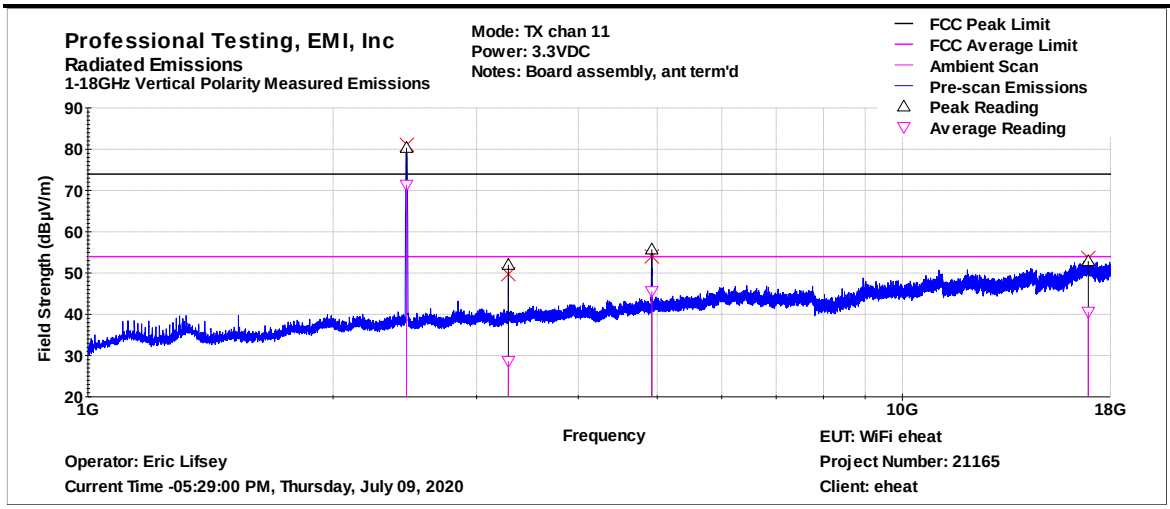
6.3.2 Bottom and Top Channel, 1 GHz to 18 GHz



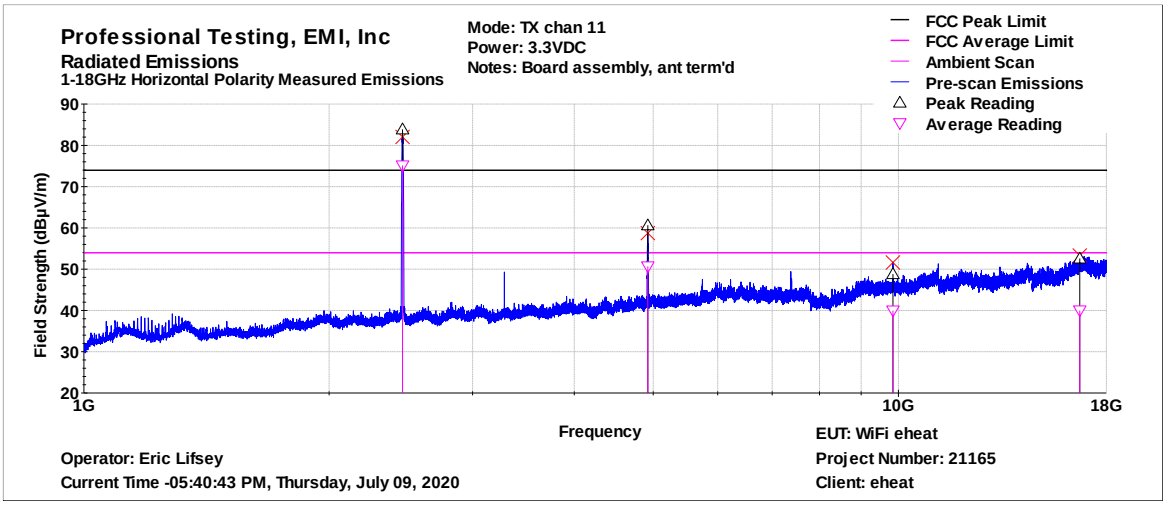
Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
4823.69	73	102	59.153	73.958	-14.805	PASS	49.689	53.958	-4.269	PASS
16475.09	3	102	51.853	73.958	-22.105	PASS	39.142	53.958	-14.816	PASS



Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
4823.79	125	126	61.508	73.958	-12.450	PASS	51.967	53.958	-1.991	PASS
7243.37	2	162	52.871	73.958	-21.087	PASS	38.659	53.958	-15.299	PASS
16797.17	19	102	53.558	73.958	-20.400	PASS	39.891	53.958	-14.067	PASS

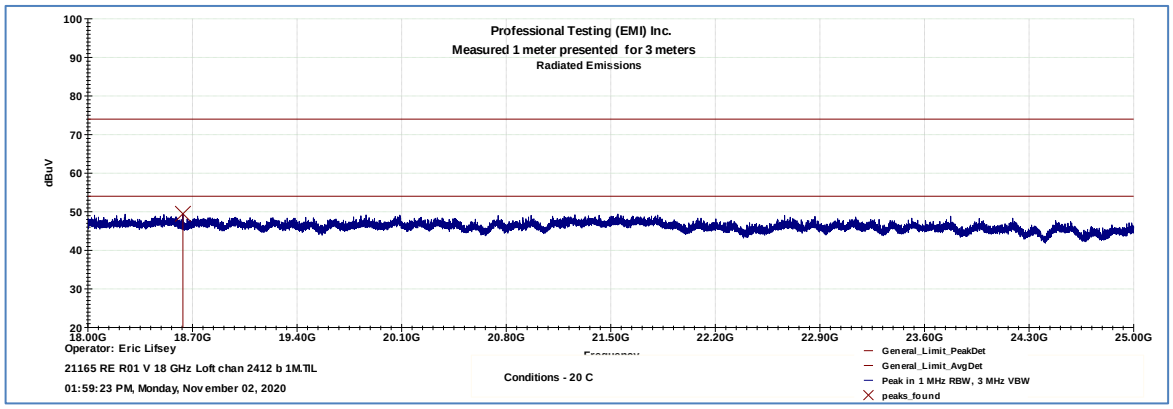


Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
3282.41	255	100	51.985	73.958	-21.973	PASS	28.654	53.958	-25.304	PASS
4923.99	65	100	55.711	73.958	-18.247	PASS	45.565	53.958	-8.393	PASS
16914.74	82	100	52.873	73.958	-21.085	PASS	40.579	53.958	-13.379	PASS

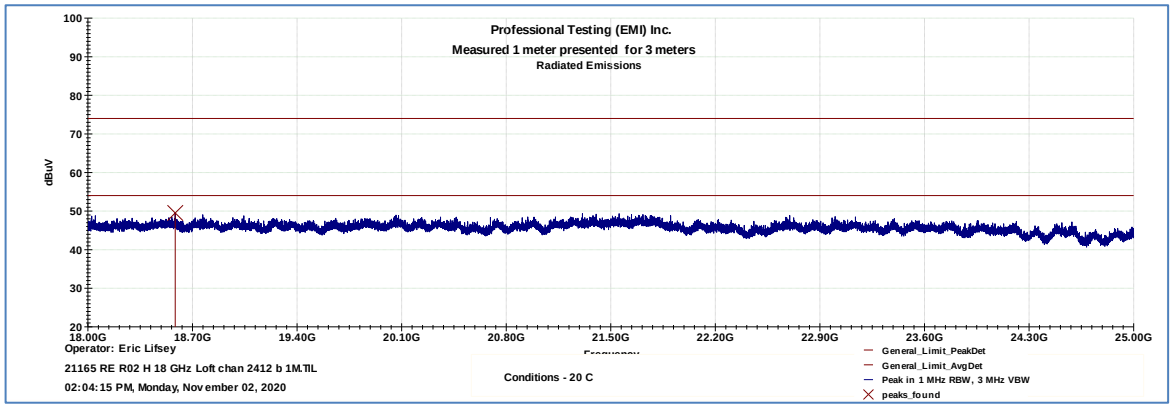


Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
4923.85	123	179	60.627	73.958	-13.331	PASS	50.644	53.958	-3.314	PASS
9847.87	1	335	48.817	73.958	-25.141	PASS	39.966	53.958	-13.992	PASS
16698.23	224	335	52.585	73.958	-21.373	PASS	39.984	53.958	-13.974	PASS

6.3.3 Bottom Channel, 18 GHz to 25 GHz

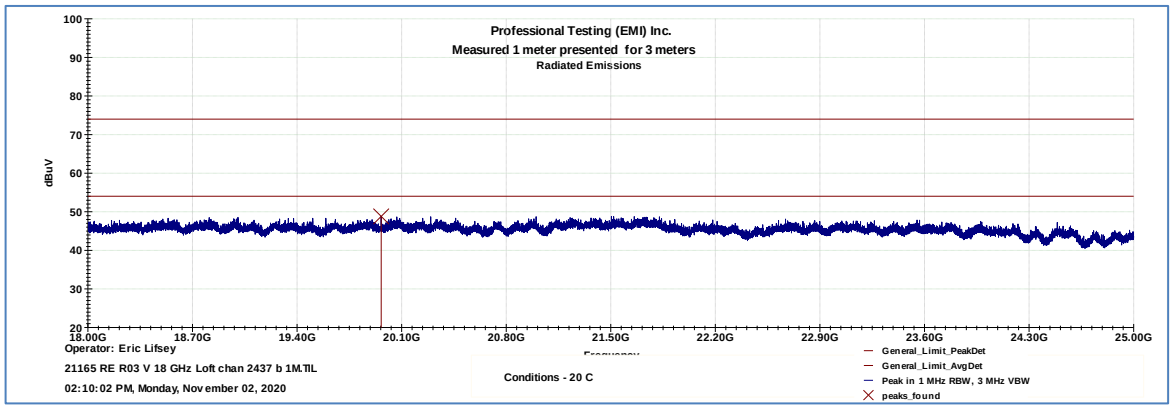


Frequency	dBuV
18.636 GHz	49.443

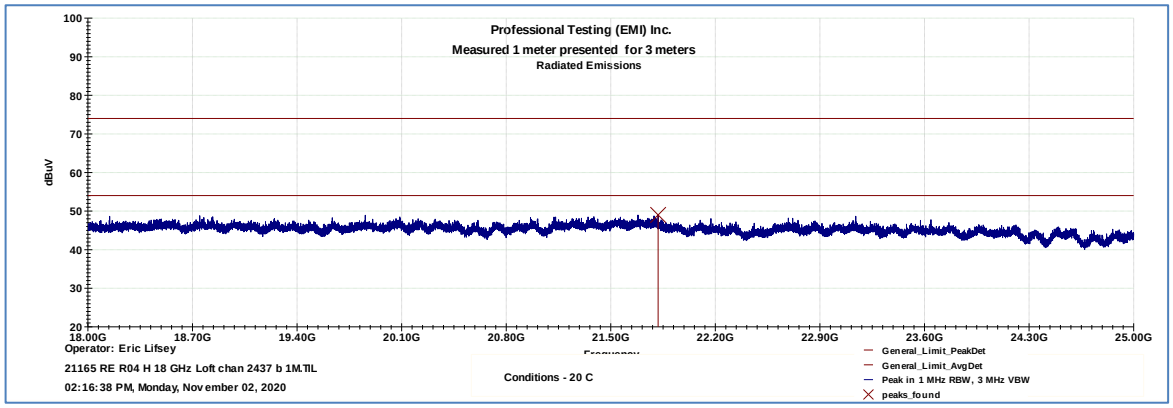


Frequency	dBuV
18.585 GHz	49.490

6.3.4 Middle Channel, 18 GHz to 25 GHz

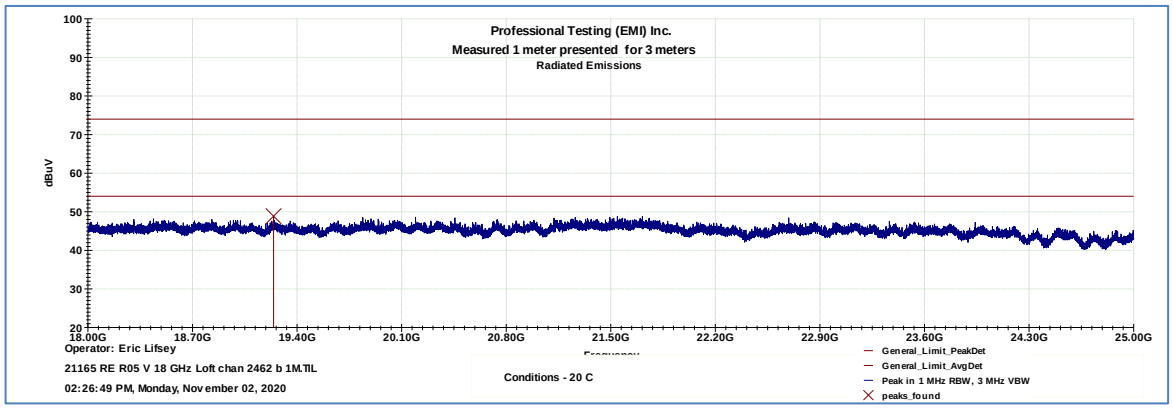


Frequency	dBuV
19.963 GHz	48.785

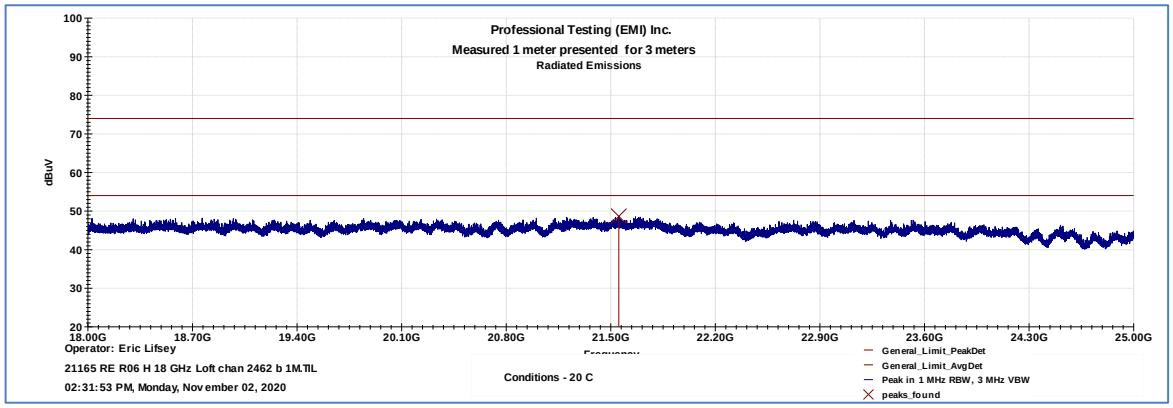


Frequency	dBuV
21.817 GHz	48.987

6.3.5 Top Channel, 18 GHz to 25 GHz



Frequency	dBuV
19.243 GHz	48.860



Frequency	dBuV
21.554 GHz	48.617

7.0 Radiated Spurious Emissions, Receive Mode; 15.247, 15.209; RSS-247 5.5, RSS-Gen 4.9 & 4.10

7.1 Test Procedure

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

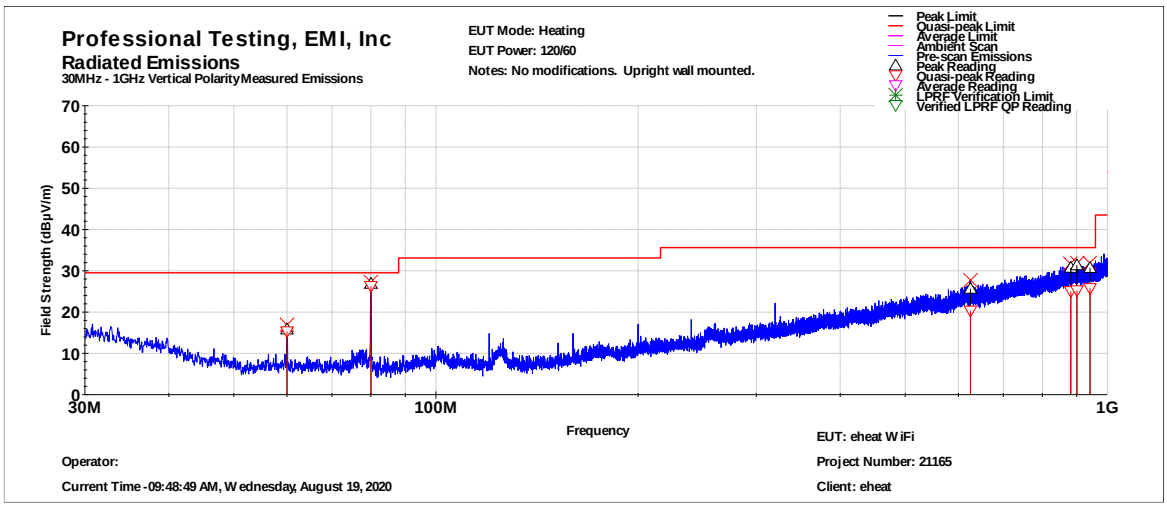
7.1.1 Test Distance, Table Height, and Detection Method		
30 MHz to 1 GHz	**1 GHz to 18 GHz**	**18 GHz to 25 GHz**
10 m, 80 cm	3 m, 80 cm	1 m, 80 cm
Quasi-peak	Peak & Average	Peak & Average

7.2 Test Criteria

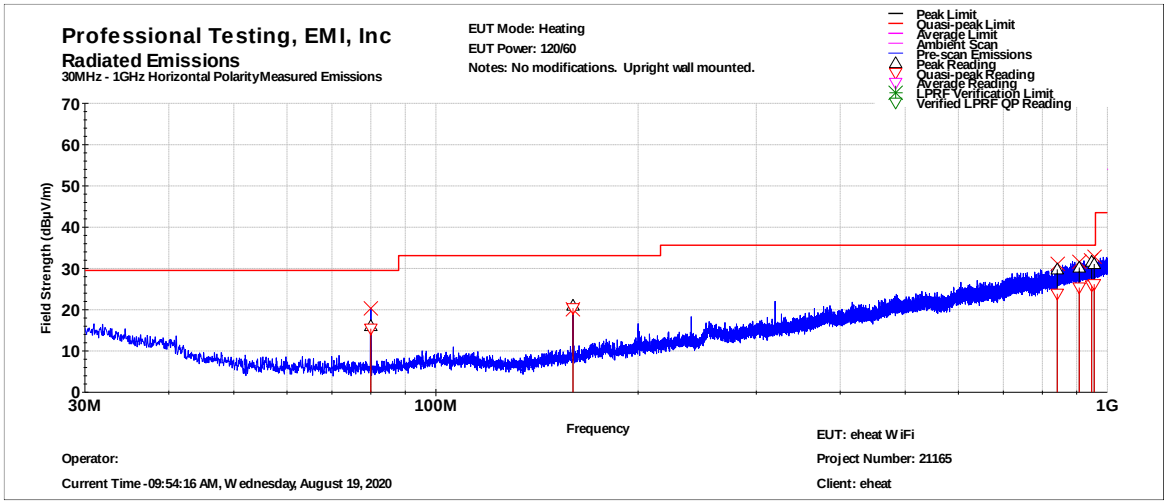
Unwanted Emissions
Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode

7.3 Test Results

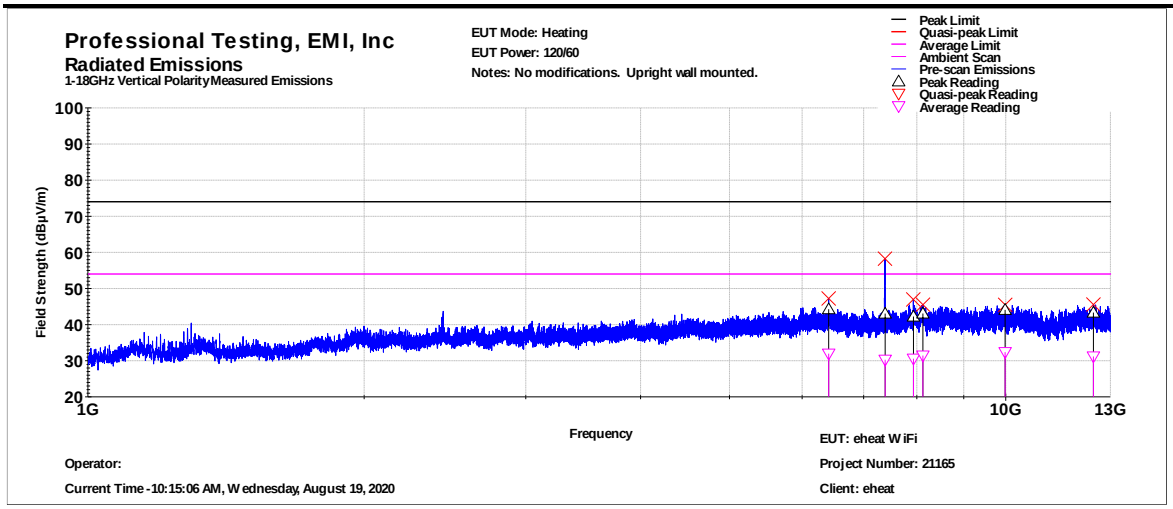
The requirement was satisfied.



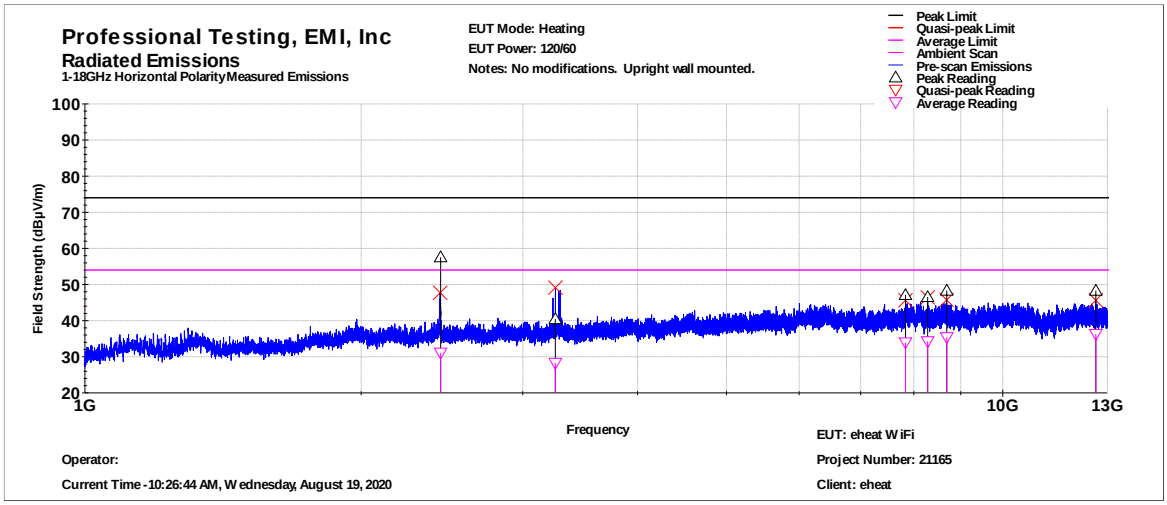
Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
MHz	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
60.009	4.000	266.000	15.309	29.500	-14.191	PASS	15.811
80.013	80.000	173.000	26.312	29.500	-3.188	PASS	26.862
625.351	133.000	366.000	20.338	35.600	-15.262	PASS	25.659
882.411	317.000	356.000	25.048	35.600	-10.552	PASS	30.733
900.901	227.000	390.000	25.247	35.600	-10.353	PASS	31.342
942.301	5.000	264.000	25.756	35.600	-9.844	PASS	30.687



Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
(MHz)	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
79.987	158.000	306.000	15.395	29.500	-14.105	PASS	16.040
159.990	170.000	352.000	20.354	33.100	-12.746	PASS	20.983
842.037	112.000	335.000	23.863	35.600	-11.737	PASS	29.761
908.014	91.000	334.000	25.365	35.600	-10.235	PASS	30.197
947.543	205.000	156.000	25.867	35.600	-9.733	PASS	31.629
956.196	111.000	356.000	26.168	35.600	-9.432	PASS	31.067



Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
6413.14	10	232	44.244	74.000	-29.756	PASS	31.931	54.000	-22.069	PASS
7389.10	216	235	43.041	74.000	-30.959	PASS	30.261	54.000	-23.739	PASS
7933.78	15	102	42.228	74.000	-31.772	PASS	30.552	54.000	-23.448	PASS
8122.94	200	347	43.070	74.000	-30.930	PASS	31.414	54.000	-22.586	PASS
9982.56	335	237	44.083	74.000	-29.917	PASS	32.362	54.000	-21.638	PASS
12458.60	93	102	43.307	74.000	-30.693	PASS	31.174	54.000	-22.826	PASS



Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
2441.09	293	115	57.544	74.000	-16.456	PASS	31.088	54.000	-22.912	PASS
3254.69	214	102	40.416	74.000	-33.584	PASS	28.274	54.000	-25.726	PASS
7834.79	103	311	47.081	74.000	-26.919	PASS	33.928	54.000	-20.072	PASS
8281.85	272	214	46.523	74.000	-27.477	PASS	34.272	54.000	-19.728	PASS
8689.56	65	130	48.300	74.000	-25.700	PASS	35.395	54.000	-18.605	PASS
12631.74	214	391	48.280	74.000	-25.720	PASS	36.269	54.000	-17.731	PASS

8.0 Antenna Construction; 15.203, 15.247; RSS-Gen 8.3

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

Antenna Construction
Type of Antenna(s)
Type of Connector
Gain

8.3 Results

Table 8.3.1 Antenna Construction Details
Chip Antenna
Manufacturer: Johanson Technology Model/PN: 2450AT18A100E Antenna peak gain 0.5 dBi. No connector. Chip is soldered to circuit board. https://www.johansontechnology.com/index.php?option=com_products&id=2450AT18A100E-AEC

User cannot substitute antenna.

Gain is under maximum limit of 6 dBi.

The requirement was satisfied.

9.0 Equipment

9.1 Radiated Emissions 30 MHz to 18 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:		**2020_RE_Unintentional_TILE7_v4**			
Asset #	**Manufacturer**	**Model**	**Equipment Nomenclature**	**Serial Number**	**Calibration Due Date**
1509A	Braden	TDK 10M	TDK 10M Chamber, NSA < 1 GHz	DAC-012915-005	9/17/2021
1890	HP	8447F-H64	Preamp/Amp, 9kHz-1300MHz, 28/25dB	3313A05298	1/9/2022
2295	Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	11/6/2020
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	3/11/2021
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/9/2020
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
1293	EMCO	6502	Antenna, Loop, Active, .01-30MHz	2040	8/13/2020
1509B	Braden	TDK 10M	TDK 10M Chamber,sVSWR > 1 GHz	DAC-012915-005	9/21/2021
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/9/2022
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/9/2020
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	3/11/2021
C233	Sucoflex	None	Cable, SMA-SMA, 7.62m, 9kHz - 1.5 GHz, Purple	None	9/24/2021

9.2 Fundamental Power, Bandwidth, Duty Cycle, Band Edge, 18-25 GHz Emissions

Asset #	Manufacturer	Model #	Description	Calibration Due
1937	Agilent	E4440A	Spectrum Analyzer	11 Nov 2021
C355	Pasternack	PE300-120	RG type coaxial cable	30 May 2020
1973	Agilent	83017A	Microwave Amplifier	10 Nov 2022
1542	A H Systems	SAS-572	18-26 GHz Standard Gain Horn	Reference
1014	Boonton	4532	RF Power Meter	7/8/2022
1503	Boonton	57318	Power Sensor, 50MHz – 18GHz	11/17/2021

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