Project 22195-15

Hetronic
HH-TC-1A

Wireless Certification Report
FCC 15.247
RSS-247

Prepared for:

Hetronic
3905 NW 36th St.
Oklahoma City, OK 73112
USA

By

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

25 February 2022

Reviewed by

Larry Finn
Chief Technical Officer

Written by

Eric Lifsey
EMC Engineer

Revision History

Revision Number	Description	Date
Final 01	Release to agency	3 Feb 2022
Final 02	Corrections from review	18 Feb 2022
Final 03	Corrections from review	25 Feb 2022

Errata:

None

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Compliance Certificate

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

Applicant	Device & Test Identification	
Hetronic	FCC ID:	LW9-TXMFSTC1A
3905 NW 36th St.	Industry Canada ID:	2119B-TXMFSTC1A
Oklahoma City, OK 73112 USA	Model(s):	HH-TC-1A
Certificate Date: 25 Feb 2022	Laboratory Project ID:	22195-15

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
FCC OET Bulletin 65*	Edition 97-01, supplemented by KDB 447498	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, with supplements
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	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.

NVLAP 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**
Hetronic Model: TC1	Type H35-00017 Production DD1120173126 System DD1120135027	Industrial wireless remote controller using 2405-2475 MHz DTS transceiver

Table 1.2.2: Support Equipment		
Manufacturer / Model	**Serial #**	**Description**
None		

This device is operated in industrial environments. Typical application is control of industrial cranes. It is hand-held and presented in a pistol-grip fashion such that it can be operated by one hand.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. Firmware was employed that allowed operation on selectable test channels with or without modulation.

1.4 Modifications to Equipment

No modifications were made to the EUT during the performance of the test program.

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 776781, 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 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 5	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

Peak power is measured using radiated means and without modulation.

2.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	
15.247(a)(3) // RSS-247 5.2	Fundamental Power Conducted Limits 1 W (30dBm) Limit Restated as Field: 125.23 dBµV/m @ 3 m	

2.3 Test Results, Peak Power

The EUT was measured using radiated field strength method.

Table 2.3.1 Field Strength, Maximum

Frequency (MHz)	Polarity / Orientation	Measured Peak Power (dBµV/m)	Calculated EIRP
2405	Horizontal / Face Up	109.2	14.04dBm / 0.025W
2440	Horizontal / Face Up	108.5	13.34dBm / 0.022W
2480*	Horizontal / Face Up	108.1	12.94dBm / 0.020W

Measured in 3 MHz RBW, 3 MHz VBW.

*EIRP calculated from field strength by: $\text{EIRP (dBm)} = E(db\mu V/m) + 20\log d(m) - 104.7$

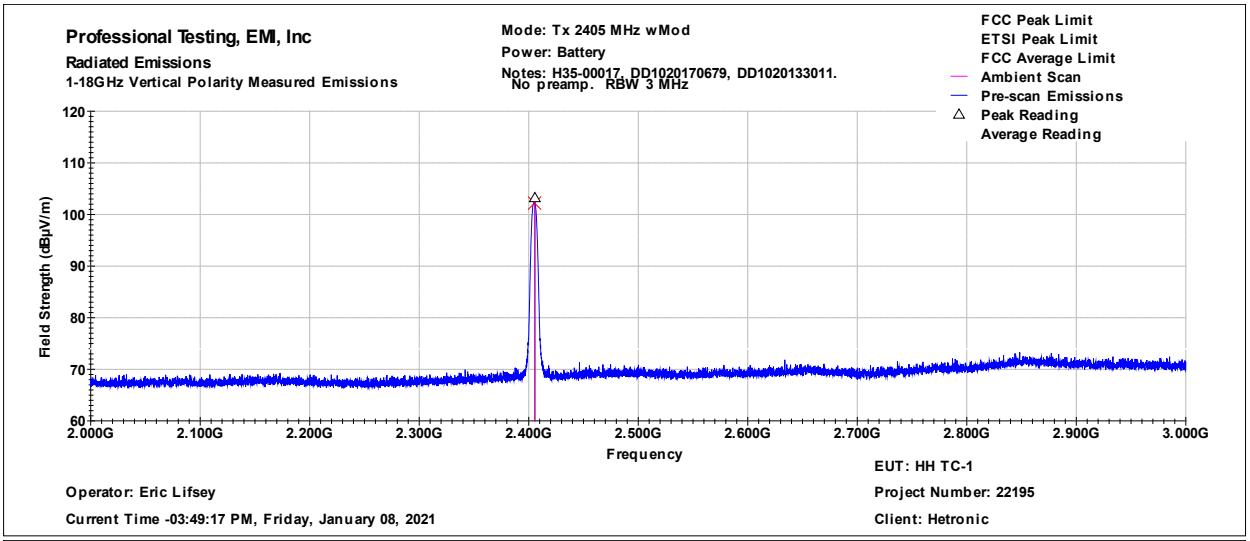
Maximum Conducted RF power = Maximum EIRP – Antenna gain = 14.04 dBm – 3 dBi = 11.04 dBm (12.71 mW)

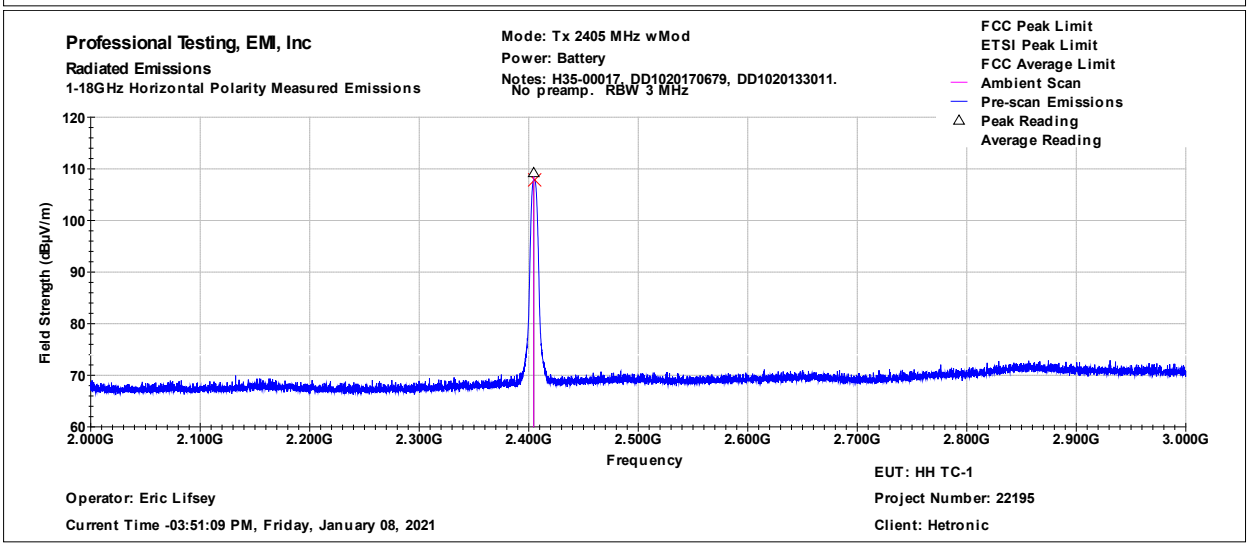
Minimum Conducted RF power = Minimum EIRP – Antenna gain = 12.94 dBm – 3 dBi = 9.94 dBm (9.86 mW)

The EUT was satisfied the requirements.

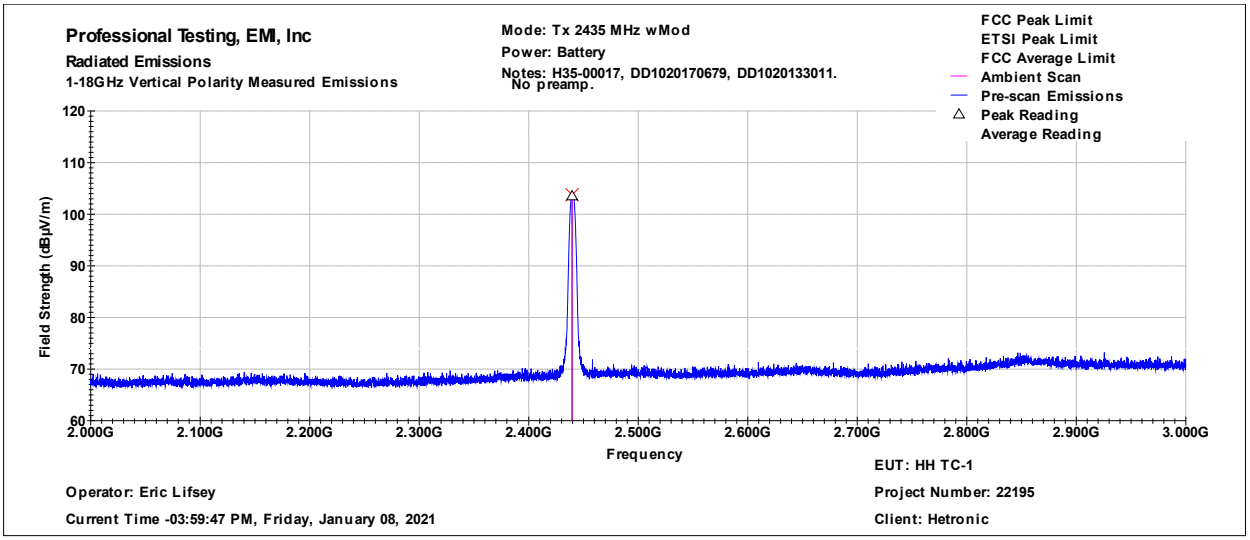
*Note that the top channel is not used to satisfy the band edge requirement. The next lower channel 2475 MHz is the top channel.

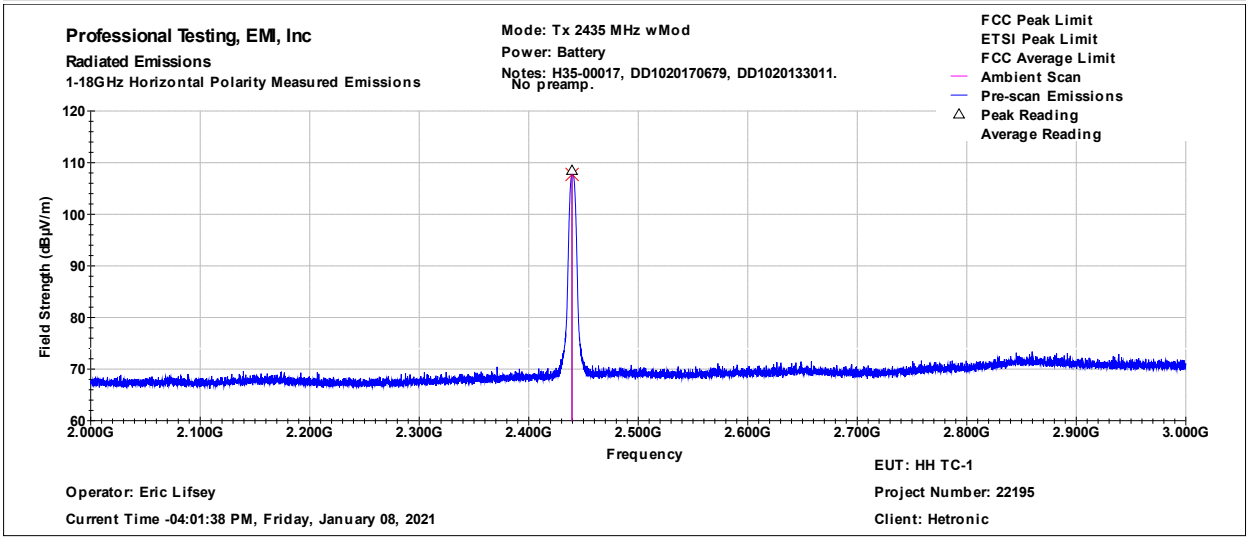
2.3.1 Measured Peak Power, Bottom Channel



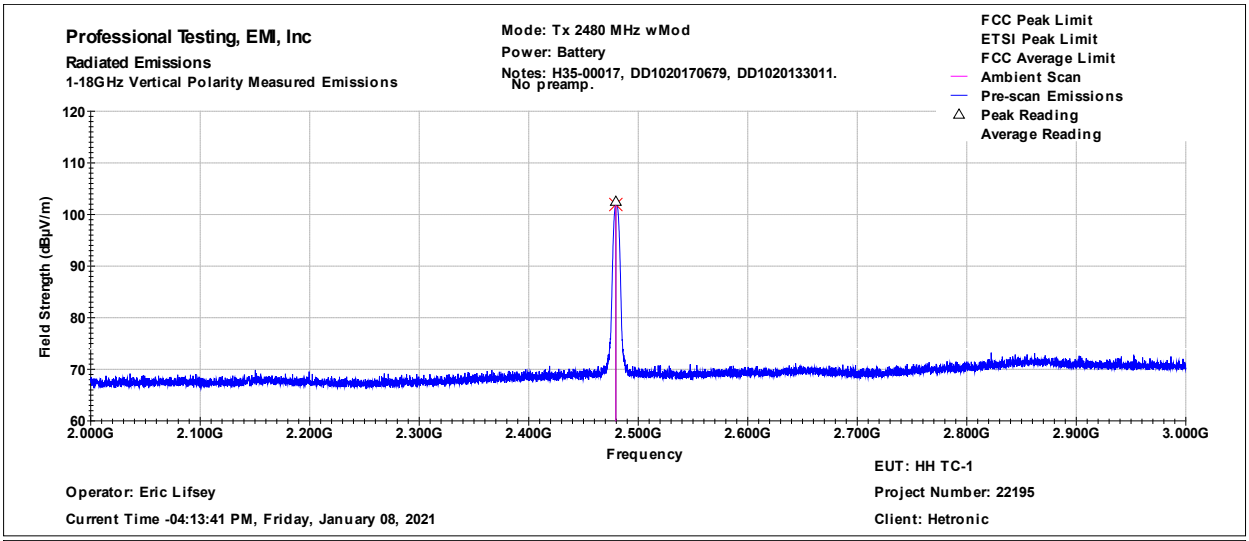


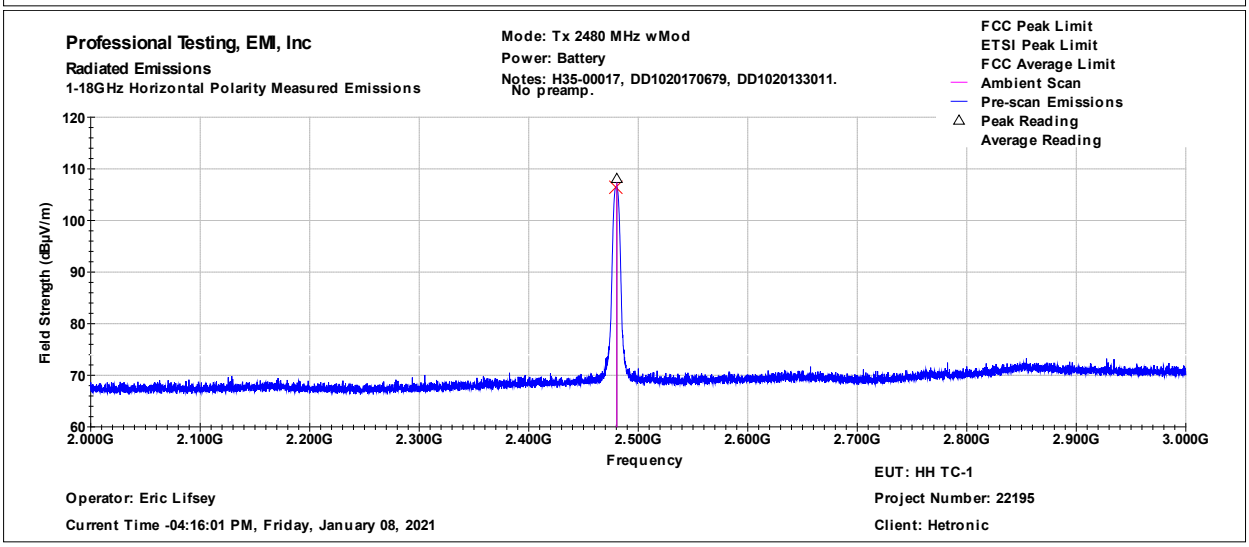
2.3.2 Measured Peak Power, Middle Channel





2.3.3 Measured Peak Power, Top Channel





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. A second calculation determines power for exposure. This is not a pass/fail measurement. These measurements were taken on the original certified sample and remain valid as the timings were not affected by the hardware changes.

Measurements taken on 9/15/2014.

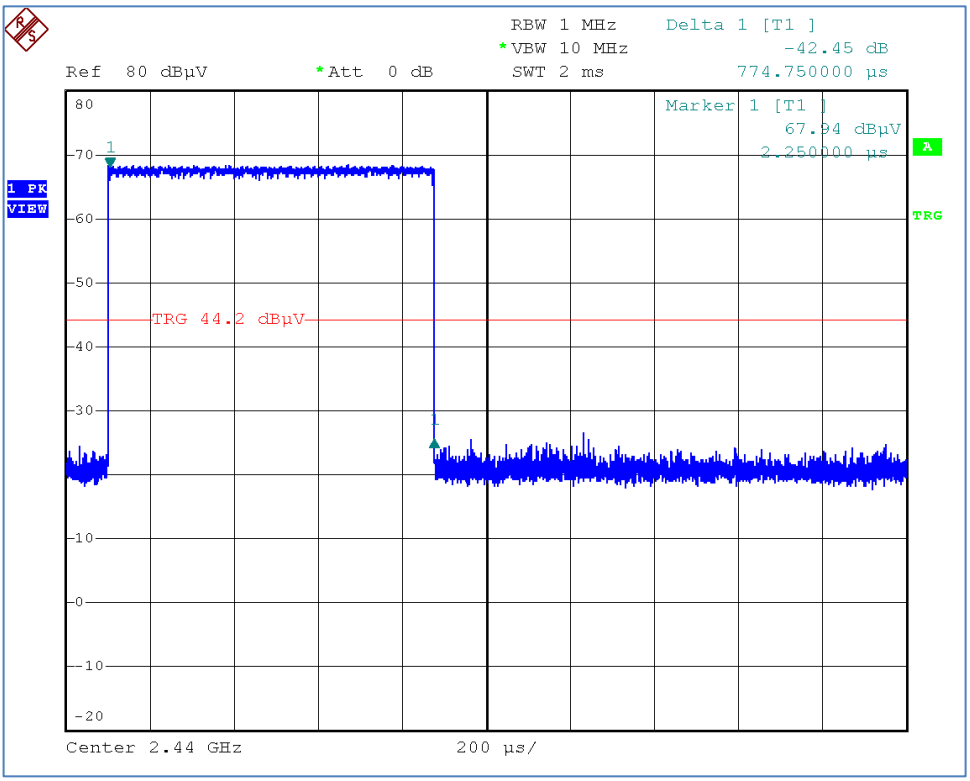
Table 4.3.1 Duty Cycle Results

Measured On Time (msec)	Measured Time Interval (msec)	Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB)
0.77475	14.88	= 20 * Log_{10} (0.77475 msec / 14.88 msec)	-25.67	-20

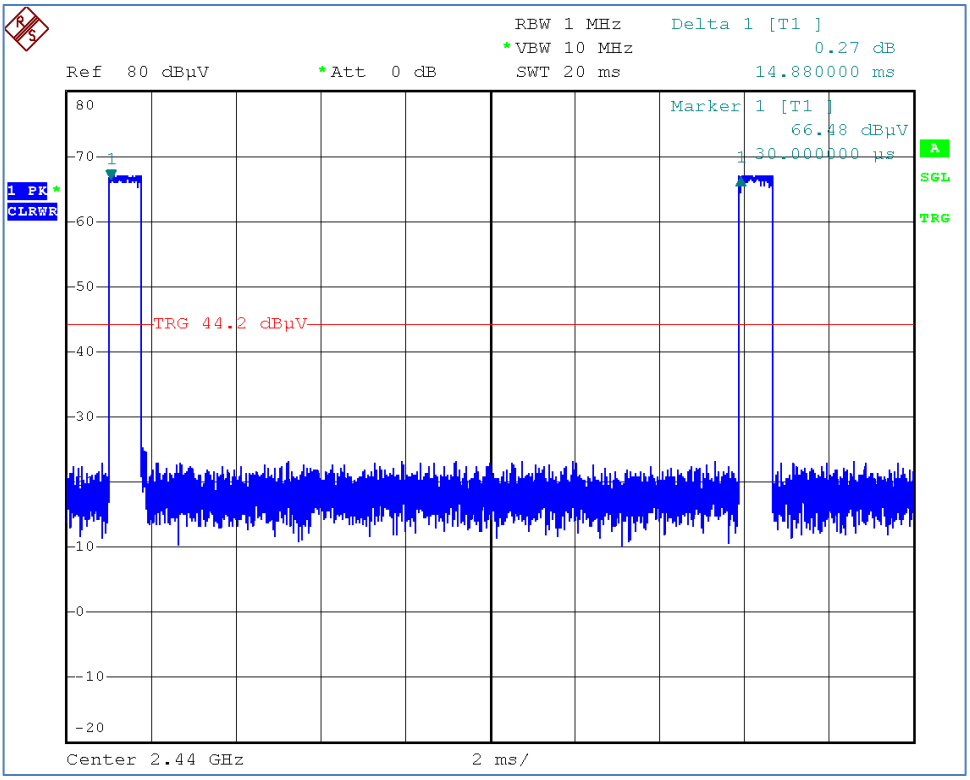
Table 4.3.2 Exposure Source Duty Cycle Results

Measured On Time (msec)	Measured Time Interval (msec)	Exposure Duty Cycle Factor Calculation	Result (dB)	Duty Cycle Factor Allowed (dB)
0.77475	14.88	= 10 * Log_{10} (0.77475 msec / 14.88 msec)	-12.83	-12.83

Plotted measurements appear below.



Transmit Time



Transmit Period

3.0 Power Spectral Density

3.1 Test Procedure

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

3.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
15.247(e) // RSS-247, 5.2	Power Spectral Density, Conducted Limit: 8 dBm / 3 kHz Restated as field strength limit: 103.23 dBµV/m at 3 m	1 Apr 2021

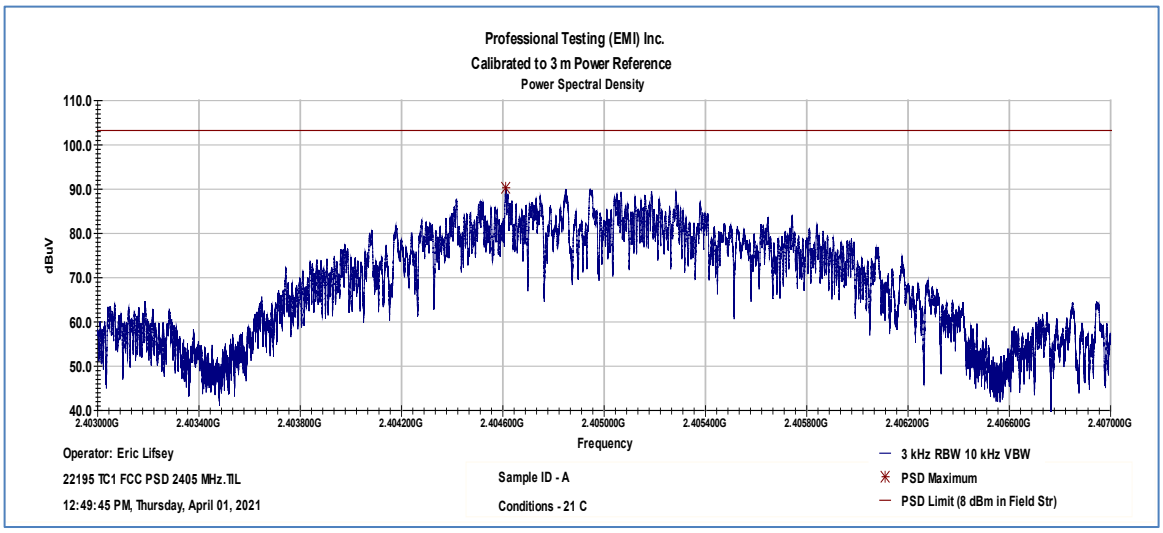
3.3 Test Results

Table 3.3.1 Power, PSD, Relative/Radiated Referenced to 3 meters	
Frequency MHz	**Measured Peak PSD Power in dBuV/m**
2405	90.3
2440	85.9
2475	87.9

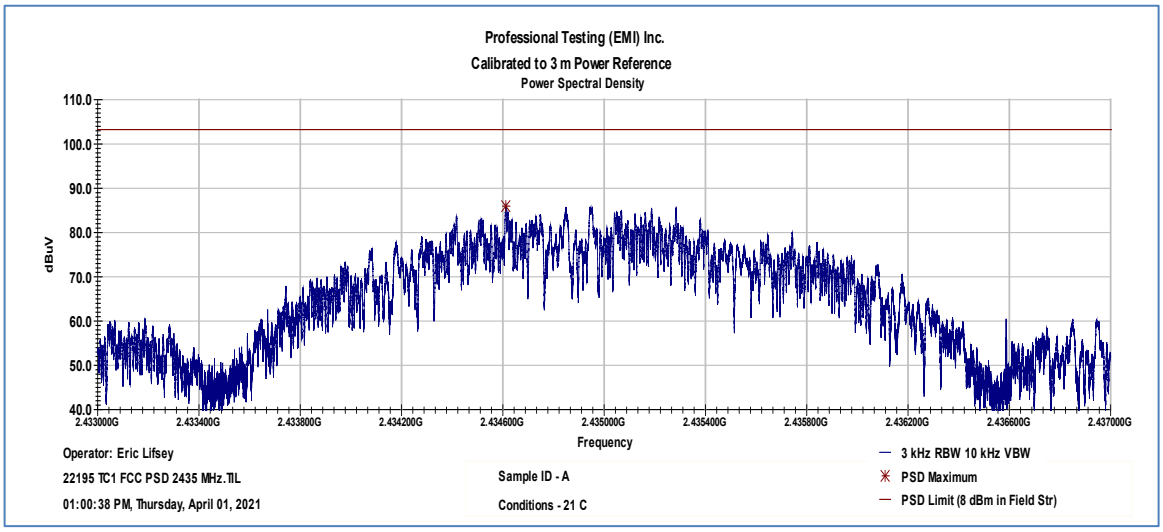
Measured in 3 kHz RBW, 10 kHz VBW.

The EUT satisfied the requirement.

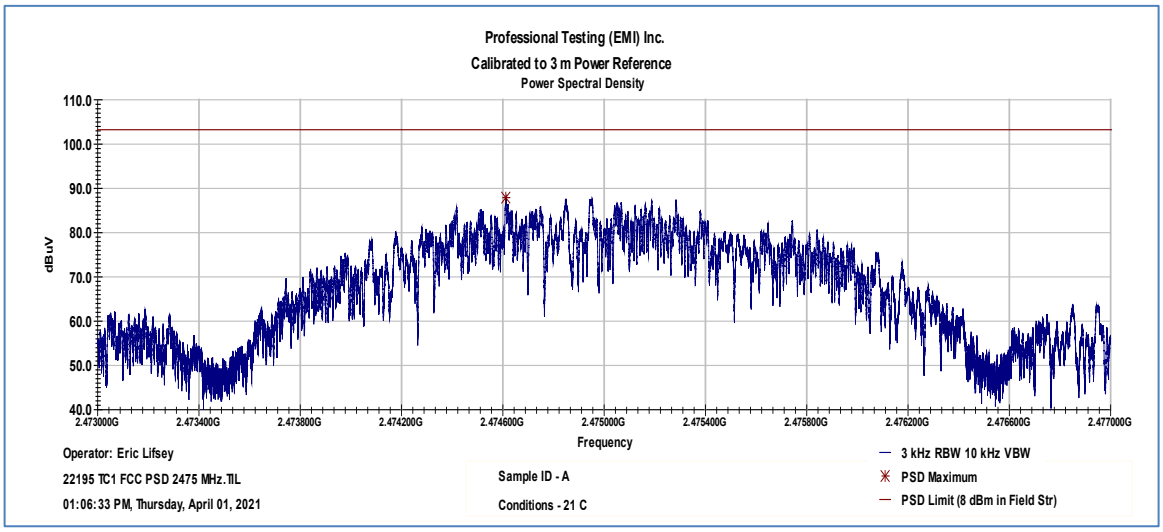
The EUT is placed next to a sense antenna, and with external preamplification, is manually adjusted in position to obtain the same peak level as recorded previously for power. The measurement is then taken with software.



Bottom Channel



Middle Channel



Top Channel

4.0 Occupied Bandwidth

4.1 Test Procedure

Bandwidth is measured by radiated means. A recording of the results is included.

4.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date
14.247(a)(2), 2.1049, KDB 558074 D01 // RSS-Gen 4.6	Bandwidth, 6 dB, 20 dB, 99%	1 Apr 2021

4.3 Test Results

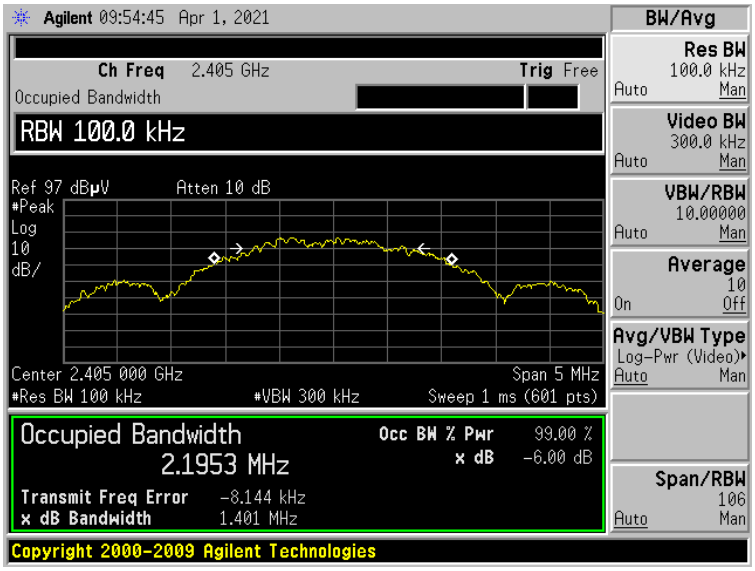
The bandwidth measurement is used to verify DTS characteristics and/or for general reporting for agency application.

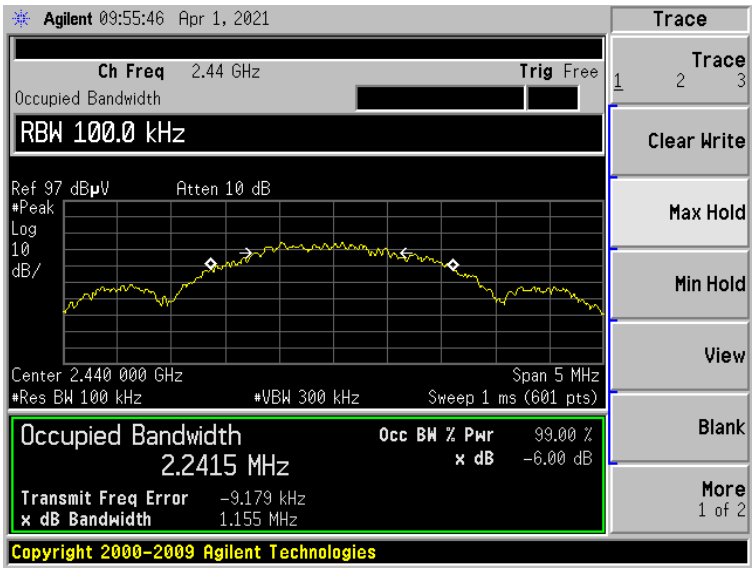
The EUT satisfied the requirements.

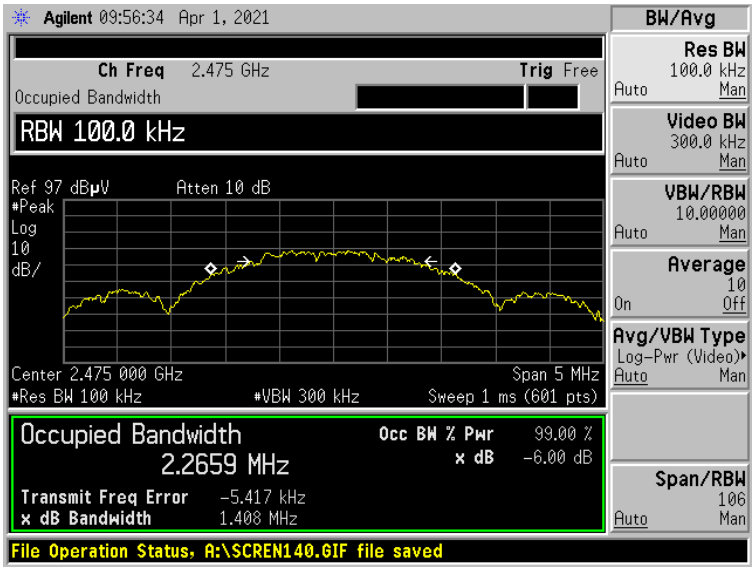
Table 4.3.1			
Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Reported Minimum BW (kHz)**
1401	1155	1404	**1155**
Bandwidth 99%, Measure and Report			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Reported Maximum BW (kHz)**
2216	2168	2207	**2216**

Plotted measurements appear on the following pages.

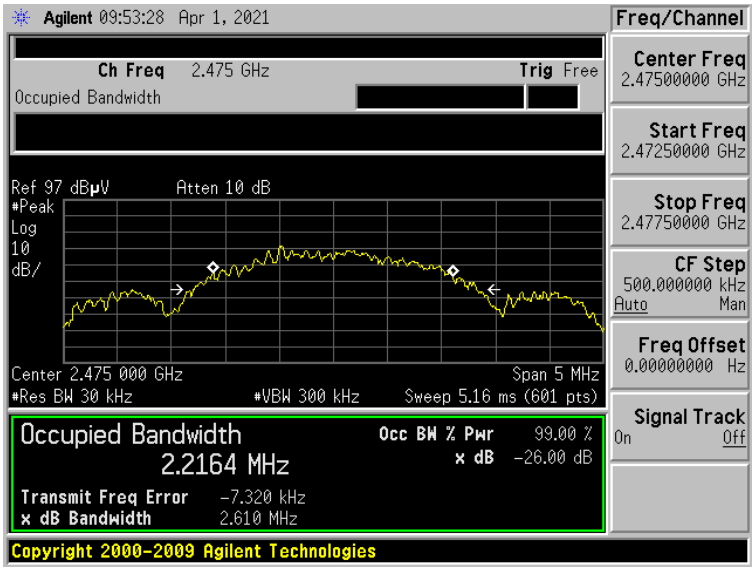
4.3.1 Bandwidth Plots, 6 dB (Only x dB Bandwidth applies)

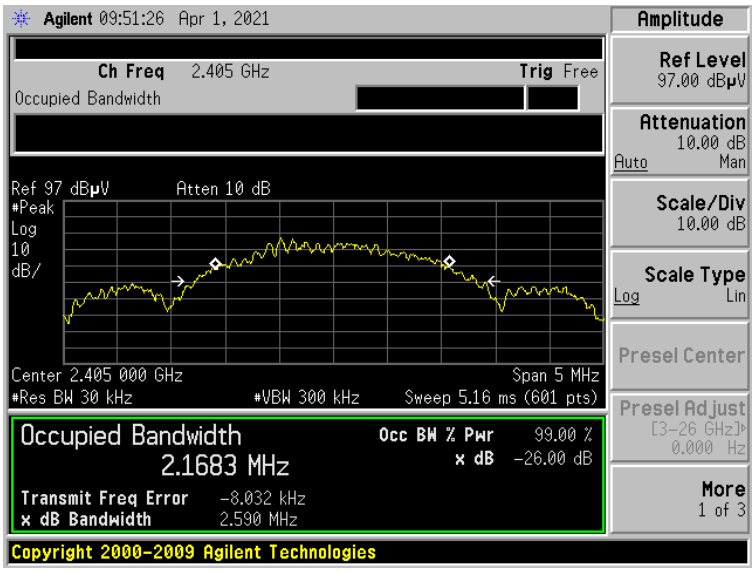


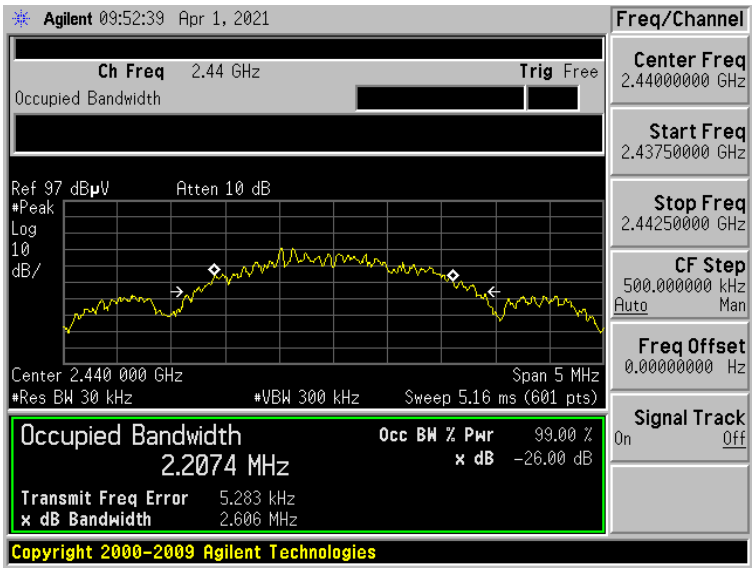




4.3.2 Bandwidth Plots, 99%







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	26 Mar 2021

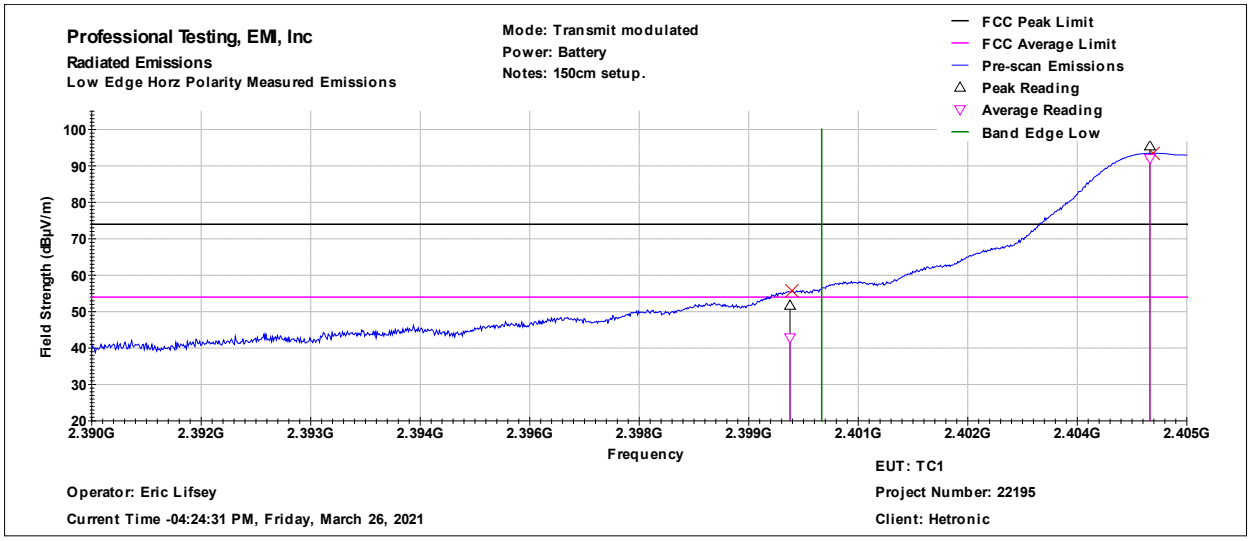
5.3 Test Results

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.

Measured in worst-case polarity.

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

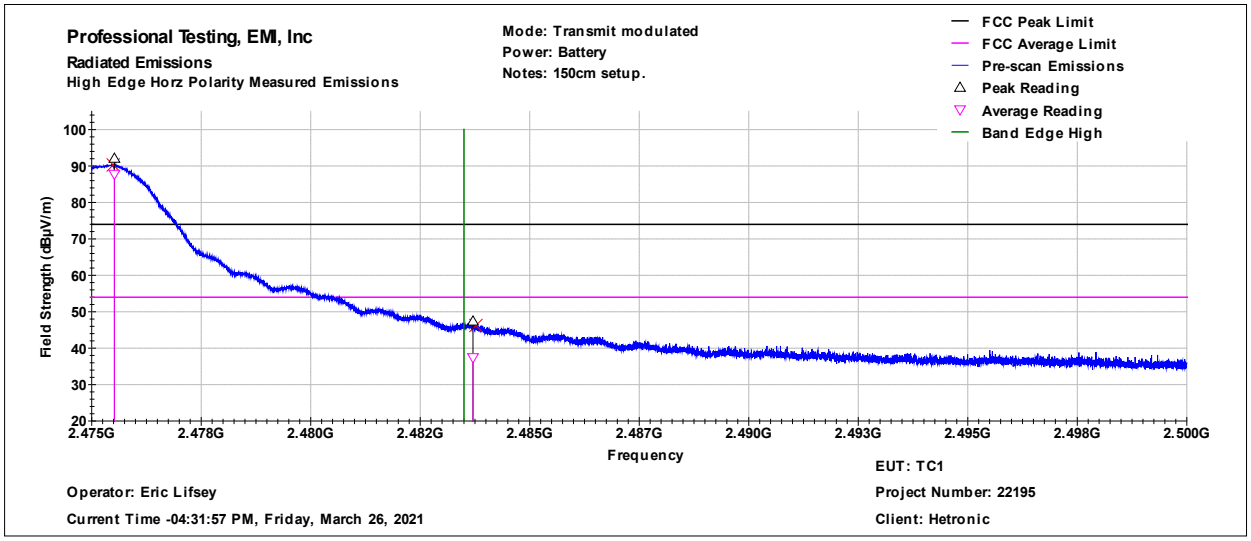
5.3.1 Low Channel Band Edge



The general emission limits are shown.

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)
2399.57	360	331	51.666	73.958	-22.292	PASS	42.808	53.958	-11.150	PASS
2404.50	325	140	95.411	73.958	21.453	N/A	92.009	53.958	38.051	N/A

5.3.2 High Channel Band Edge



The general emission limits are shown.

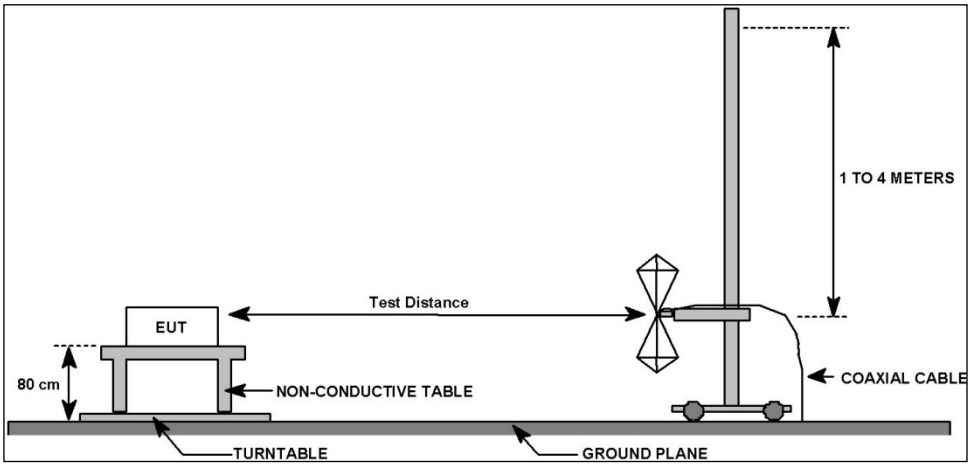
Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
2475.52	133	142	92.063	73.958	18.105	N/A	87.745	53.958	33.787	N/A
2483.71	154	156	47.367	73.958	-26.591	PASS	37.420	53.958	-16.538	PASS

6.0 Radiated Spurious Emissions, Receive Mode

6.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane. The EUT was centered on a rotating turntable. Measurements below 1 GHz were taken at a test distance of 10 meters from the measurement antenna. Above 1 GHz the measurement distance was 3 meters.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken in 1 MHz resolution bandwidth and the video average measured where appropriate.



6.2 Test Criteria

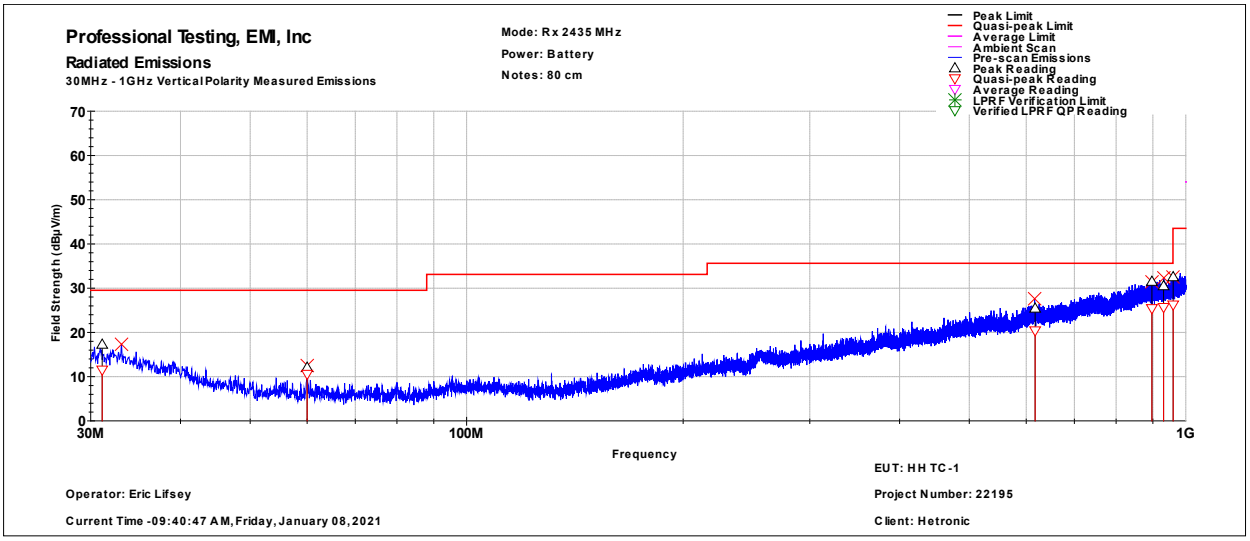
47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247, 15.209 // RSS-247 5.5, RSS-Gen 4.9 & 4.10	Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode	8 Jan 2021

6.3 Test Results

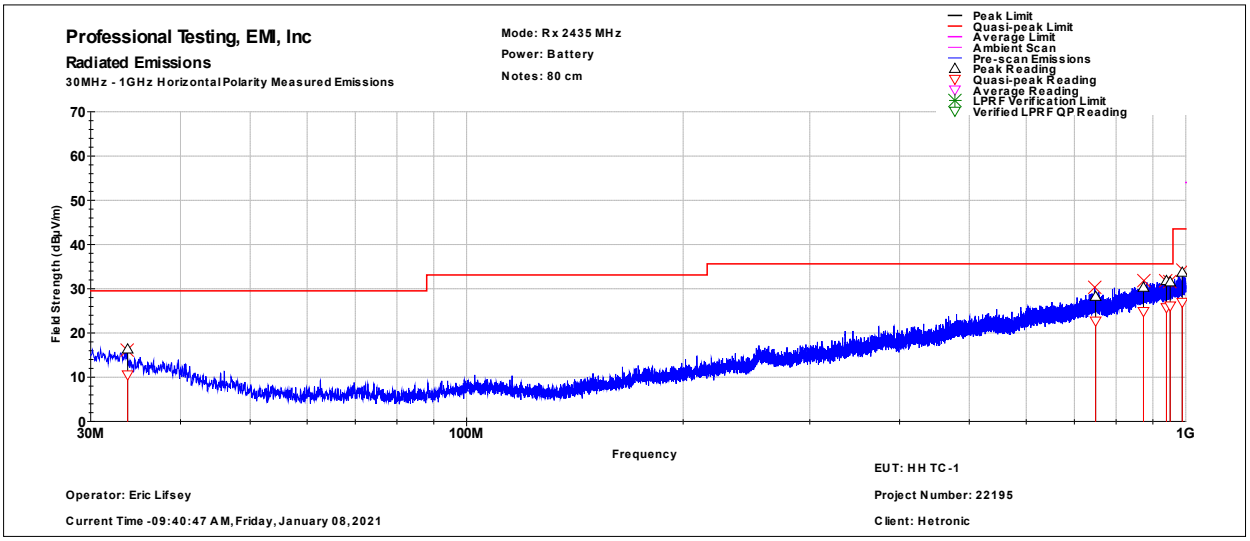
The EUT was tuned to the middle channel and placed in receive mode.

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

6.3.1 Up to 1 GHz

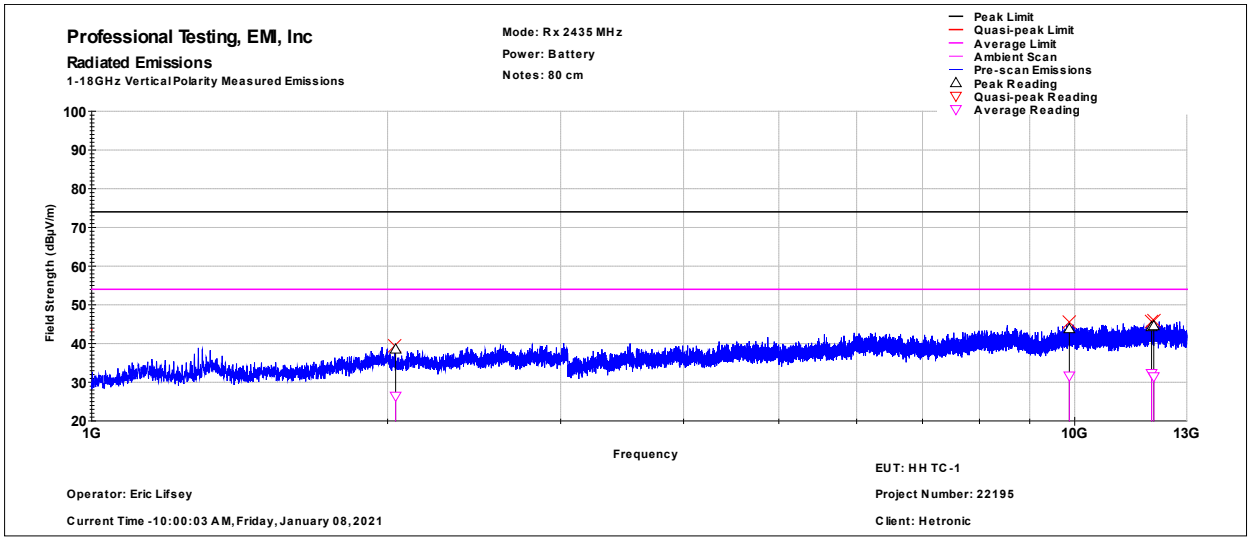


Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
MHz	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
31.130	254.000	266.000	11.497	29.500	-18.003	PASS	17.277
59.995	304.000	357.000	10.558	29.500	-18.942	PASS	12.074
617.350	110.000	181.000	20.369	35.600	-15.231	PASS	25.446
897.357	95.000	178.000	25.390	35.600	-10.210	PASS	31.505
931.517	294.000	412.000	25.662	35.600	-9.938	PASS	30.498
960.617	119.000	264.000	26.215	43.500	-17.285	PASS	32.531

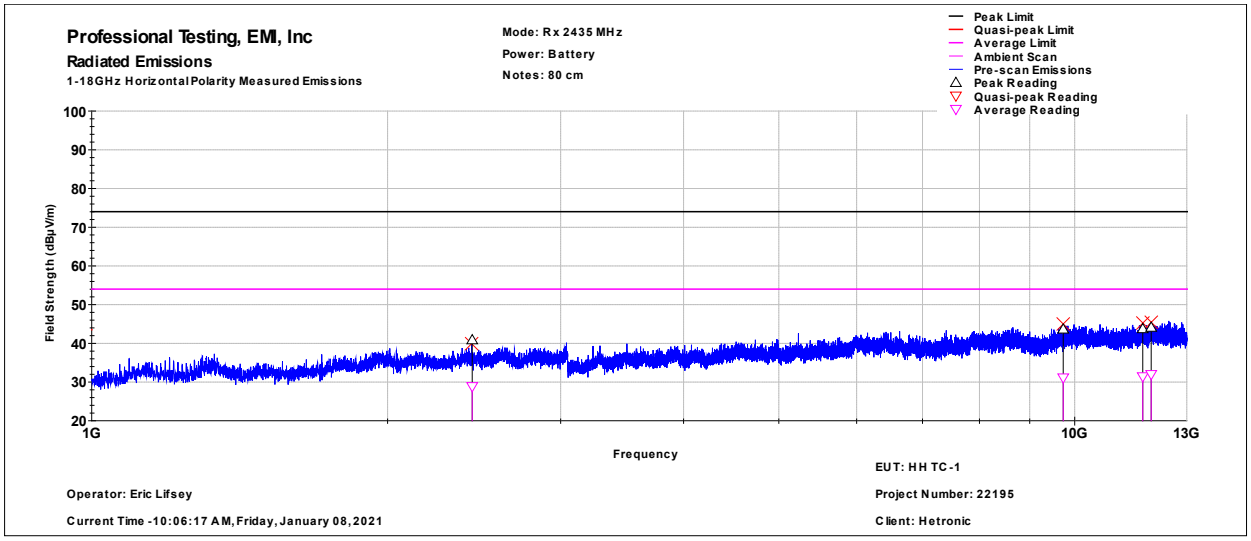


Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
(MHz)	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
33.771	32.000	108.000	10.551	29.500	-18.949	PASS	16.327
749.254	278.000	141.000	22.719	35.600	-12.881	PASS	28.235
873.362	93.000	253.000	24.868	35.600	-10.732	PASS	30.276
940.048	142.000	359.000	25.740	35.600	-9.860	PASS	31.804
951.488	8.000	103.000	26.133	35.600	-9.467	PASS	31.488
988.947	112.000	125.000	26.952	43.500	-16.548	PASS	33.679

6.3.2 Up to 13 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)
2038.20	133	162	38.517	74.000	-35.483	PASS	26.411	54.000	-27.589	PASS
9875.22	212	371	43.765	74.000	-30.235	PASS	31.623	54.000	-22.377	PASS
11972.59	177	291	44.296	74.000	-29.704	PASS	32.277	54.000	-21.723	PASS
12034.04	321	305	44.544	74.000	-29.456	PASS	31.444	54.000	-22.556	PASS



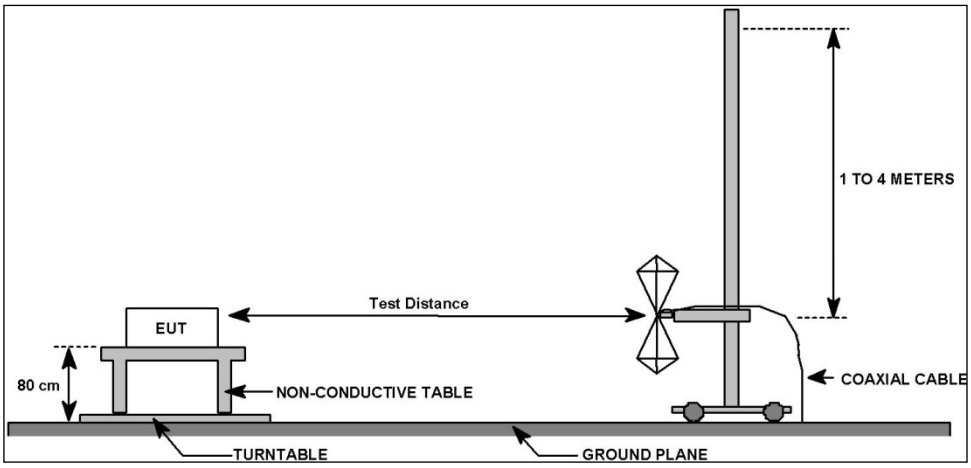
Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
2438.30	294	120	40.849	74.000	-33.151	PASS	28.850	54.000	-25.150	PASS
9733.81	321	259	43.628	74.000	-30.372	PASS	31.092	54.000	-22.908	PASS
11728.37	67	183	43.722	74.000	-30.278	PASS	31.390	54.000	-22.610	PASS
11960.68	94	102	44.096	74.000	-29.904	PASS	31.953	54.000	-22.047	PASS

7.0 Radiated Spurious Emissions, Transmit Mode

7.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the ground plane for 30MHz to 1GHz measurements and 1.5 meters above the ground plane for 1GHz to 26.5GHz measurements. The EUT was centered on a rotating turntable. Measurements below 1 GHz were taken at a test distance of 10 meters from the measurement antenna. Above 1 GHz the measurement distance was 3 meters. Absorber was placed between antenna and EUT for measurements above 1GHz.

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken and average measured where appropriate using 1 MHz resolution bandwidth.



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	8 Jan 2021 12 Jan 2021

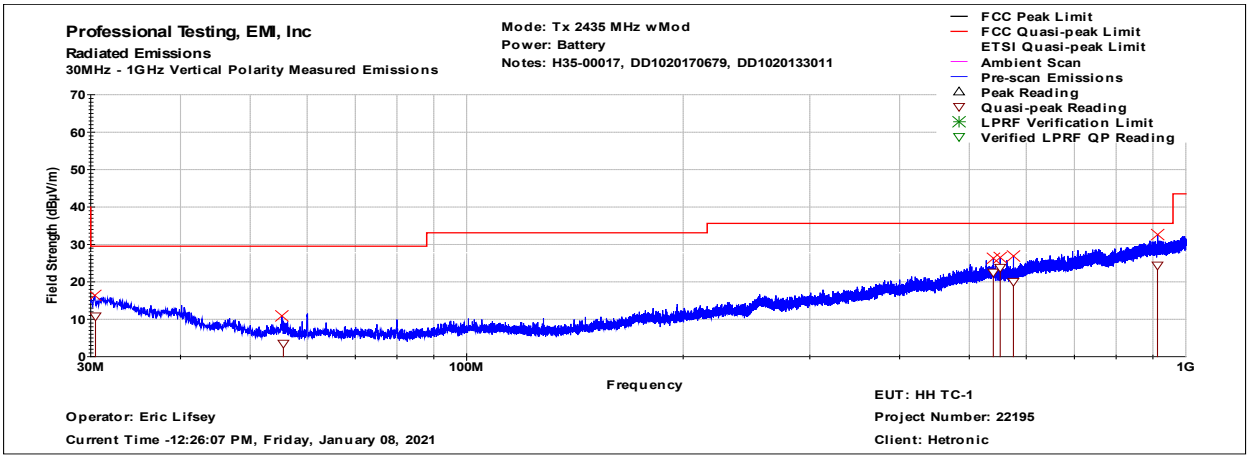
7.3 Test Results

The EUT was tuned to the each of the three test channels and placed in unmodulated transmit mode.

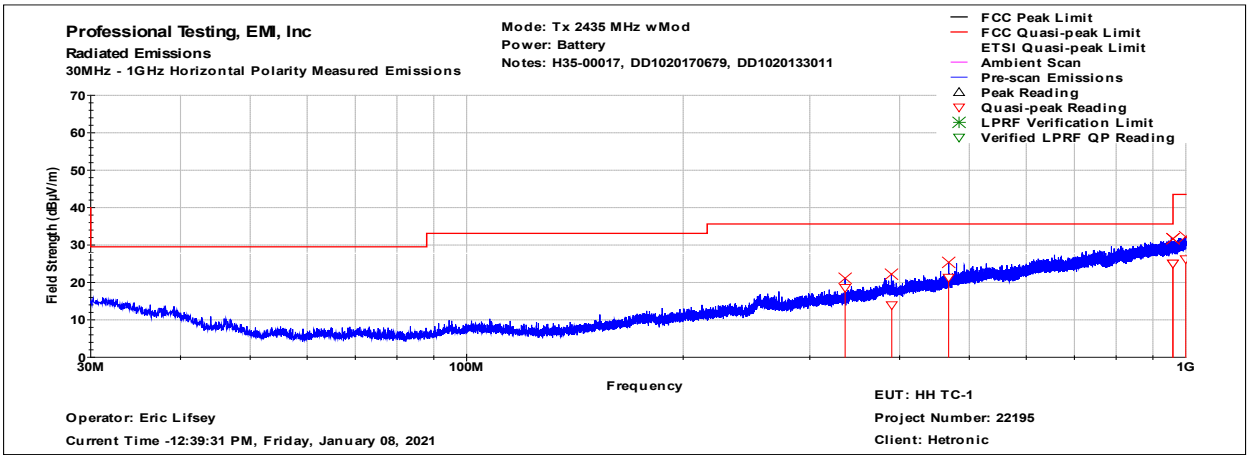
Duty cycle factor applicable to all spurious peak measurement is -20 dB such that all spurious satisfying the peak limit also satisfy the average limit.

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

7.3.1 Middle Channel, Up to 1 GHz

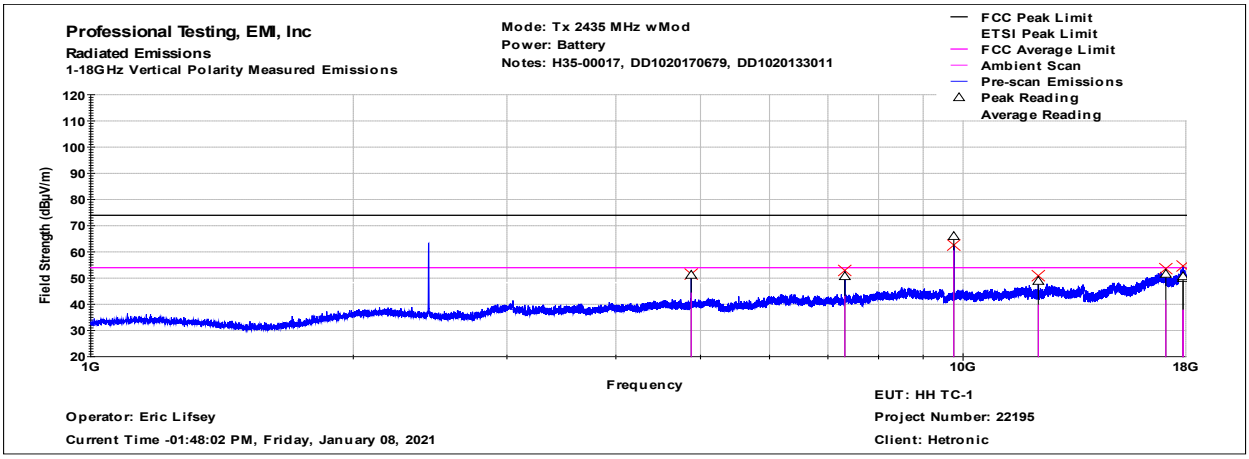


Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results
MHz	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)
30.470	181.000	142.000	10.798	29.500	-18.702	PASS
55.605	204.000	366.000	3.518	29.500	-25.982	PASS
539.981	199.000	362.000	22.520	35.600	-13.080	PASS
552.004	64.000	363.000	23.792	35.600	-11.808	PASS
575.946	5.000	124.000	20.056	35.600	-15.544	PASS
913.492	313.000	384.000	24.401	35.600	-11.199	PASS



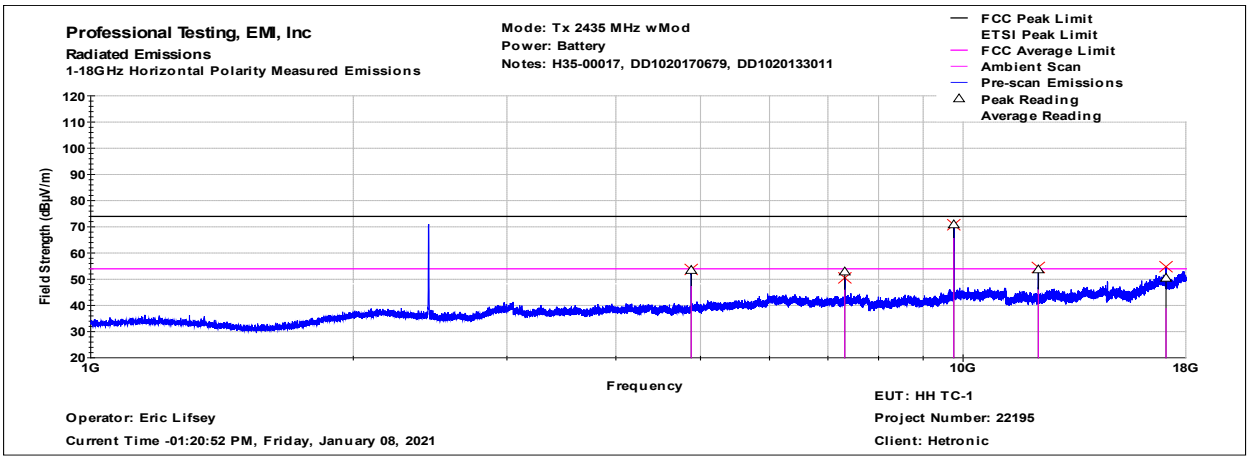
Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results
(MHz)	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)
335.980	246.000	248.000	18.580	35.600	-17.020	PASS
390.006	291.000	253.000	13.946	35.600	-21.654	PASS
468.003	68.000	248.000	21.296	35.600	-14.304	PASS
959.665	31.000	103.000	25.078	35.600	-10.522	PASS
959.723	343.000	232.000	25.075	35.600	-10.525	PASS
999.905	275.000	253.000	26.234	43.500	-17.266	PASS

7.3.2 Middle Channel, Up 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)
4879.08	240	360	51.183	73.958	-22.775	PASS	44.272	53.958	-9.686	PASS
7318.72	45	126	50.660	73.958	-23.298	PASS	43.058	53.958	-10.900	PASS
9758.05	76	100	65.992	73.958	-7.966	PASS	45.992	53.958	-7.996	PASS*
12197.48	2	100	48.868	73.958	-25.090	PASS	39.663	53.958	-14.295	PASS
17076.78	56	100	51.547	73.958	-22.411	PASS	41.458	53.958	-12.500	PASS
17869.06	2	283	49.980	73.958	-23.978	PASS	37.692	53.958	-16.266	PASS

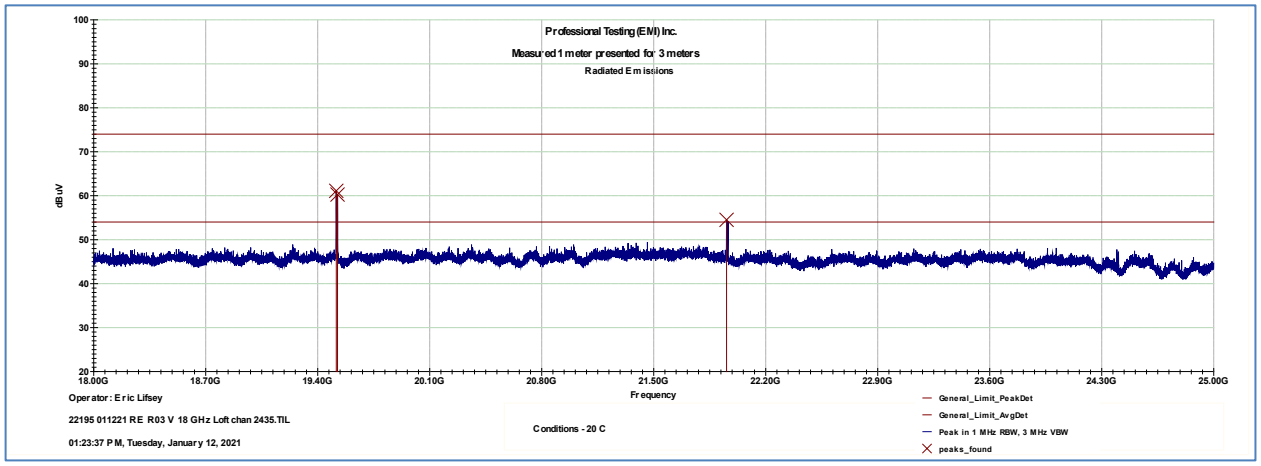
*-20dB DCCF applied to 4th transmitter harmonic



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)
4879.24	135	152	53.467	73.958	-20.491	PASS	47.231	53.958	-6.727	PASS
7318.57	16	210	52.871	73.958	-21.087	PASS	45.802	53.958	-8.156	PASS
9758.05	53	126	70.875	73.958	-3.083	PASS	50.875	53.958	-3.083	PASS*
12197.78	38	124	53.691	73.958	-20.267	PASS	45.899	53.958	-8.059	PASS
17083.40	20	148	50.459	73.958	-23.499	PASS	38.791	53.958	-15.167	PASS

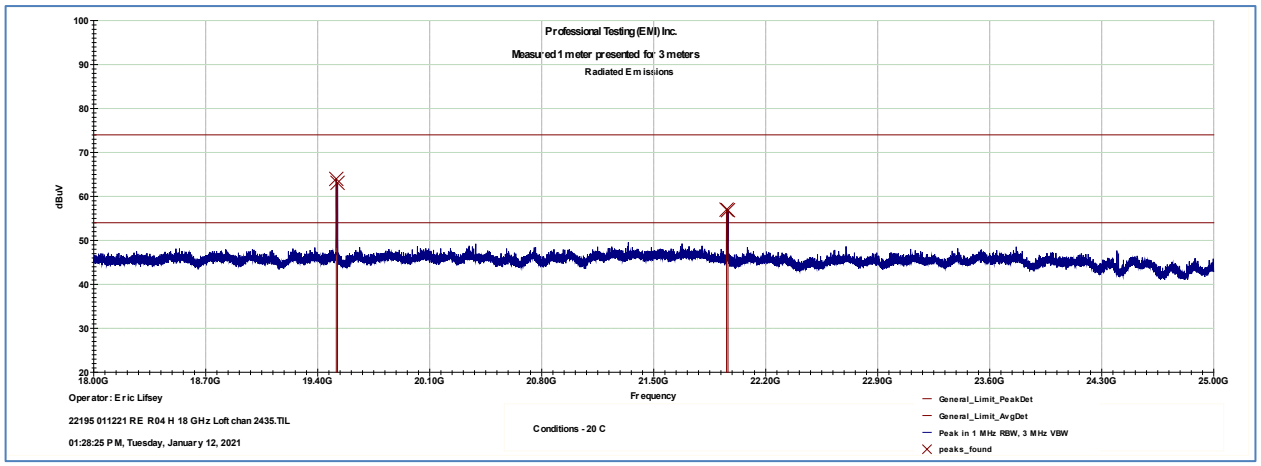
*-20dB DCCF applied to 4th transmitter harmonic

7.3.3 Middle Channel, Up to 25 GHz



Peaks Found		Average Limit	Average Measurement*	Avg Result
Frequency	dBuV	dBuV	dbuV	P/F
19.5164	61.109	53.958	41.109	Pass
19.5242	60.260	53.958	40.260	Pass
21.9559	54.495	53.958	34.495	Pass

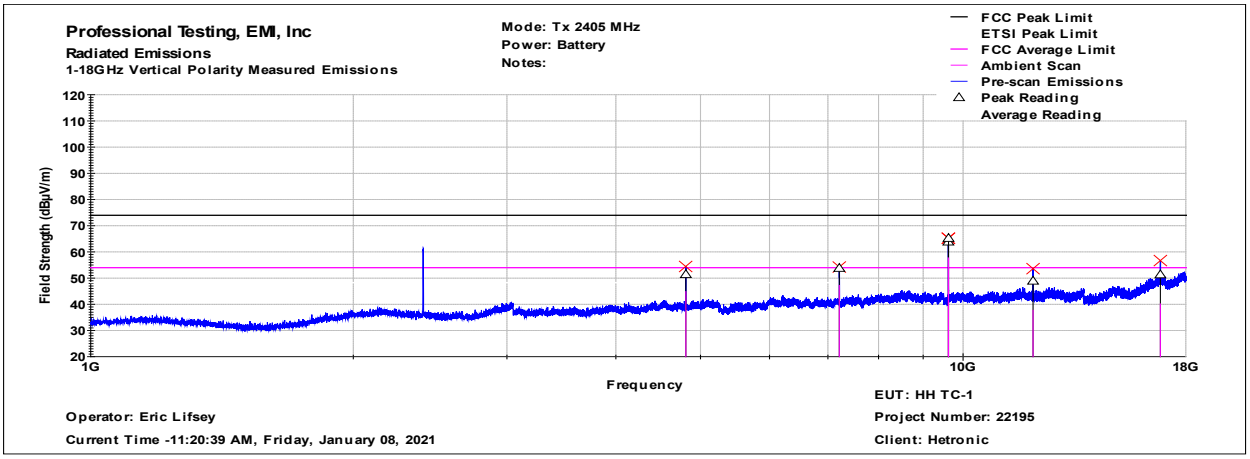
*-20dB DCCF applied to harmonics



Peaks Found		Average Limit	Average Measurement*	Avg Result
Frequency	dBuV	dbuV	dBuV	P/F
19.5164	63.974	53.958	43.974	Pass
19.5242	63.071	53.958	43.071	Pass
21.9559	56.985	53.958	36.985	Pass
21.9646	56.857	53.958	36.857	Pass

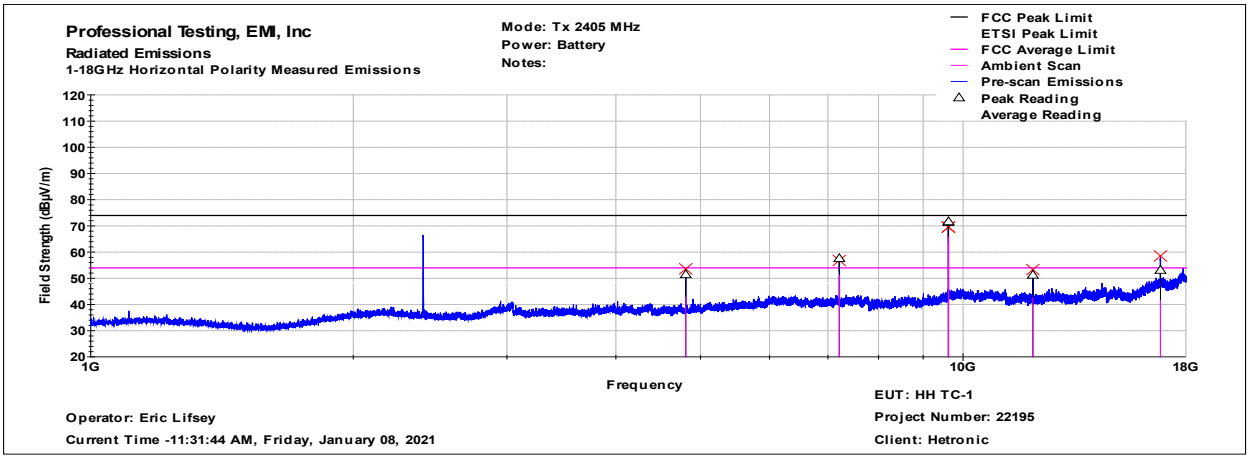
*-20dB DCCF applied to harmonics

7.3.4 Bottom Channel, 1 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)
4811.13	271	102	51.428	73.958	-22.530	PASS	44.831	53.958	-9.127	PASS
7213.53	39	102	53.798	73.958	-20.160	PASS	47.190	53.958	-6.768	PASS
9618.31	224	126	63.853	73.958	-10.105	PASS	43.853	53.958	-10.105	PASS*
9622.25	217	163	65.239	73.958	-8.719	PASS	45.239	53.958	-8.719	PASS*
12027.72	362	137	48.908	73.958	-25.050	PASS	37.697	53.958	-16.261	PASS
16831.54	23	125	51.336	73.958	-22.622	PASS	40.133	53.958	-13.825	PASS

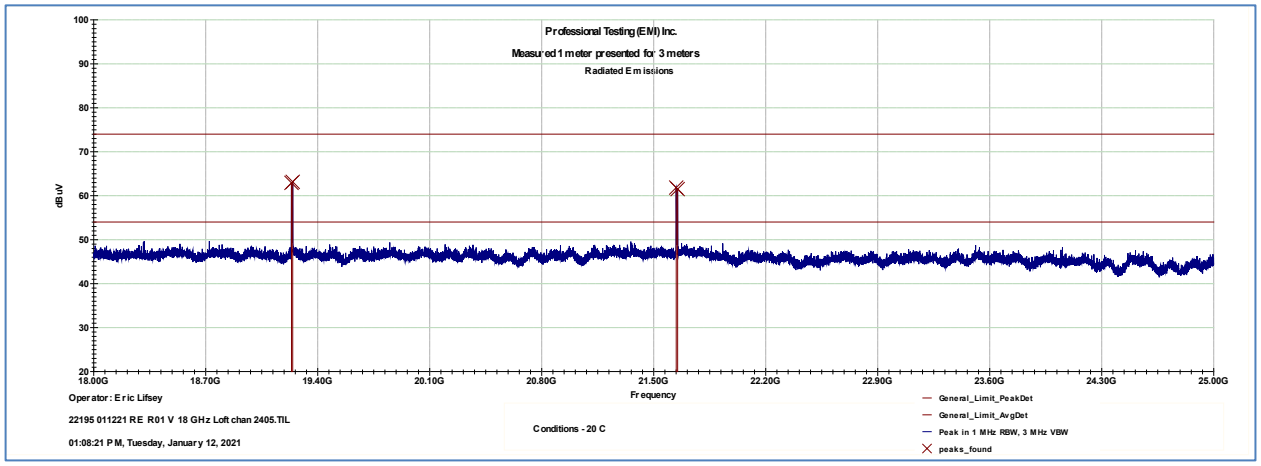
*-20dB DCCF applied to 4th transmitter harmonic



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)
4809.10	16	125	51.438	73.958	-22.520	PASS	42.866	53.958	-11.092	PASS
7213.64	15	329	57.598	73.958	-16.360	PASS	51.183	53.958	-2.775	PASS
9618.25	53	138	71.412	73.958	-2.546	PASS	51.412	53.958	-2.546	PASS*
9622.05	51	137	71.656	73.958	-2.302	PASS	51.656	53.958	-2.302	PASS*
12022.66	42	125	51.256	73.958	-22.702	PASS	42.483	53.958	-11.475	PASS
16838.38	21	149	53.117	73.958	-20.841	PASS	41.586	53.958	-12.372	PASS

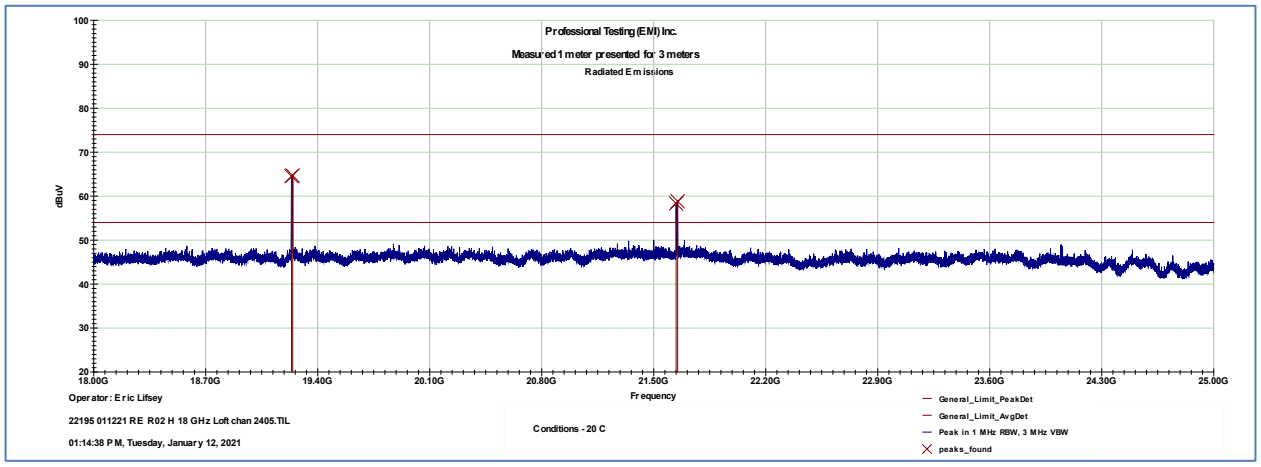
*-20dB DCCF applied to 4th transmitter harmonic

7.3.5 Bottom Channel, 18 to 25 GHz



Peaks Found		Average Limit	Average Measurement*	Avg Result
Frequency	dBuV	dbuV	dBuV	P/F
19.2364	62.918	53.958	42.918	Pass
19.2443	63.146	53.958	43.146	Pass
21.6409	61.833	53.958	41.833	Pass
21.6496	61.496	53.958	41.496	Pass

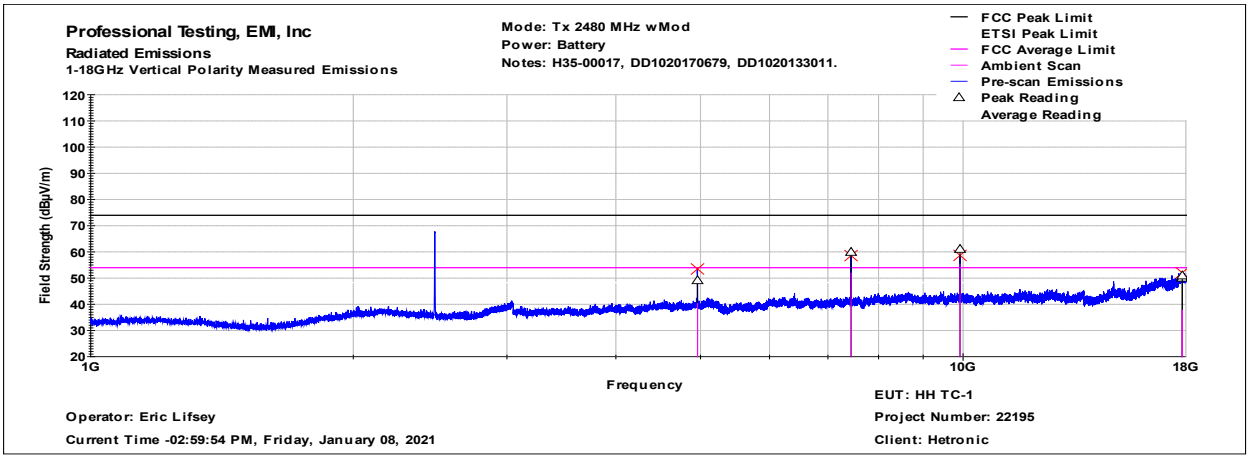
*-20dB DCCF applied to harmonics



Peaks Found		Average Limit	Average Measurement*	Avg Result
Frequency	dBuV	dbuV	dBuV	P/F
19.2364	64.548	53.958	44.548	Pass
19.2443	64.677	53.958	44.677	Pass
21.6404	58.309	53.958	38.309	Pass
21.6496	58.821	53.958	38.821	Pass

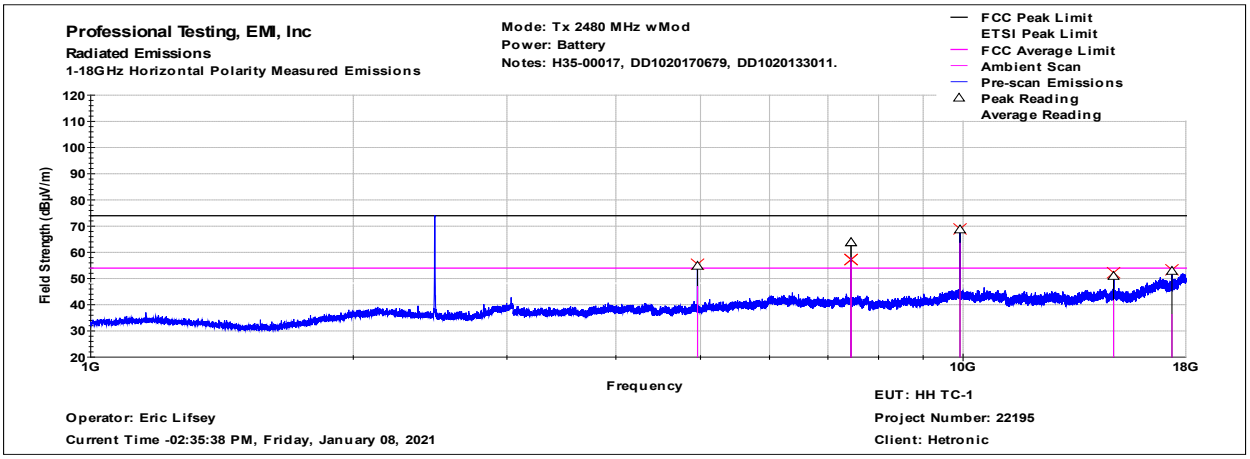
*-20dB DCCF applied to harmonics

7.3.6 Top Channel, 1 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)
4960.91	336	224	49.104	73.958	-24.854	PASS	40.311	53.958	-13.647	PASS
7441.59	50	154	59.932	73.958	-14.026	PASS	51.832	53.958	-2.126	PASS
9918.11	201	146	61.057	73.958	-12.901	PASS	41.057	53.958	-12.901	PASS*
17832.37	357	160	50.062	73.958	-23.896	PASS	37.540	53.958	-16.418	PASS

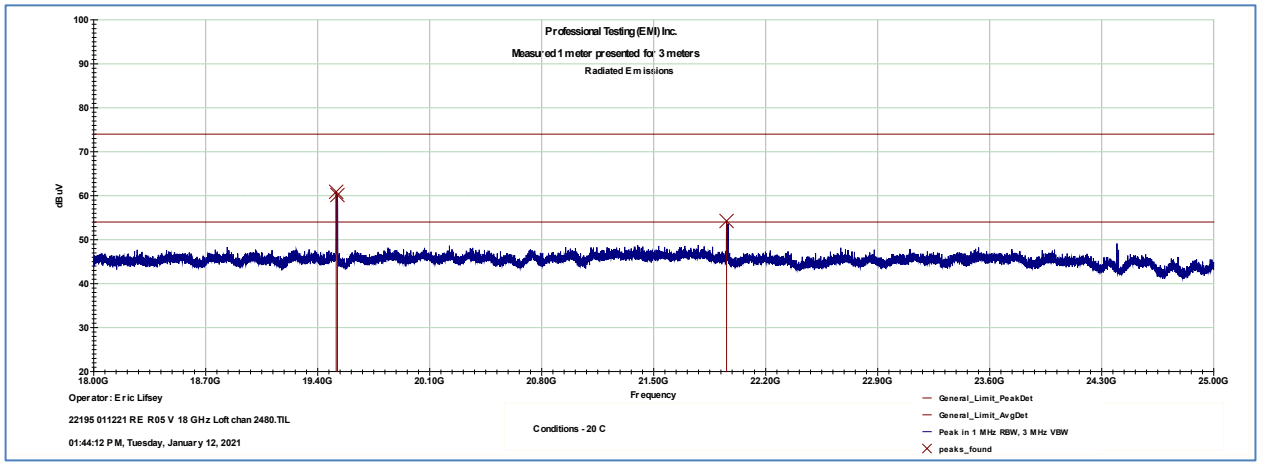
*-20dB DCCF applied to 4th transmitter harmonic



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)
4961.07	17	160	54.785	73.958	-19.173	PASS	46.948	53.958	-7.010	PASS
7438.52	16	287	63.699	73.958	-10.259	PASS	43.699	53.958	-10.259	PASS*
7441.44	15	288	63.826	73.958	-10.132	PASS	43.826	53.958	-10.132	PASS*
9918.13	53	182	68.683	73.958	-5.275	PASS	48.683	53.958	-5.275	PASS*
14877.20	17	126	50.913	73.958	-23.045	PASS	41.539	53.958	-12.419	PASS
17356.52	53	152	52.835	73.958	-21.123	PASS	36.267	53.958	-17.691	PASS

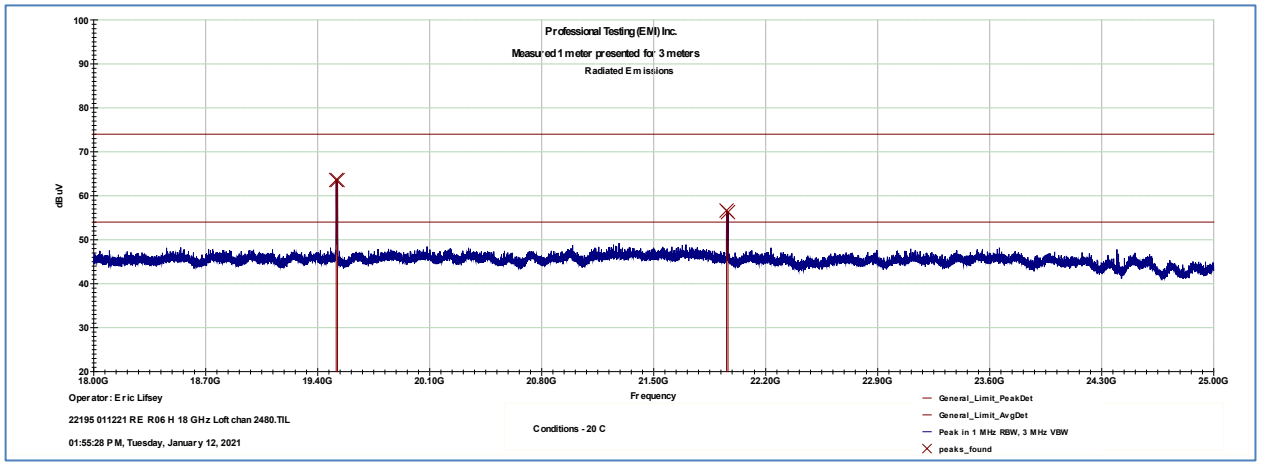
*-20dB DCCF applied to 3rd and 4th transmitter harmonic

7.3.7 Top Channel, 18 to 25 GHz



Peaks Found		Average Limit	Average Measurement*	Avg Result
Frequency	dbuV	dBuV	dBuV	P/F
19.5159	60.885	53.958	40.885	Pass
19.5238	60.140	53.958	40.140	Pass
21.9554	54.251	53.958	34.251	Pass

*-20dB DCCF applied to harmonics



Peaks Found		Average Limit	Average Measurement*	Avg Result
Frequency	dbuV	dBuV	dBuV	P/F
19.5159	63.590	53.958	43.590	Pass
19.5242	63.570	53.958	43.570	Pass
21.9559	56.625	53.958	36.625	Pass
21.9646	56.257	53.958	36.257	Pass

*-20dB DCCF applied to harmonics

8.0 Antenna Construction Requirements

8.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevent wireless device antennas from being modified by end users and satisfy any limits on gain.

8.2 Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.203, 15.247 // RSS-Gen 8.3	Antenna Construction	1 Apr 2021

8.3 Results

Table 8.3.1 Antenna Construction Details
Internal Inverted-F Antenna
Manufacturer: Hetronic Model/PN: N/A 2.4 GHz Inverted-F Etched on circuit board. Antenna Gain = 3 dBi.

The antenna design above satisfies the requirements of the rules.

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_v2.7.til**		
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	11/10/2021
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	9/8/2021
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
0942	HP	6448B	Power Supply, DC, 600V	2952A05001	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
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	9/8/2021
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

9.2 Bandwidth

Asset #	Manufacturer	Model #	Description	Calibration Due
1937	Agilent	E4440A	Spectrum Analyzer	11 Dec 2021
None	PTI	None	Sense Antenna, Sleeve Dipole	CNR

9.3 Radiated Spurious Emissions 18-25 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
1937	Agilent	E4440A	Spectrum Analyzer	11 Dec 2021
1542	AH Systems	SAS-572	Standard Gain Horn	Reference CNR
1973	Agilent	83017A	Preamp	7 Nov 2021
0524	EMCO	1060	Turntable	CIU

9.4 Duty Cycle

Asset #	Manufacturer	Model #	Description	Calibration Due
ALN-077	Rohde & Schwarz	FSP-30	Spectrum Analyzer	29 Jan 2015

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