Project 22258-15

Compressor Products International

Proflo2

Model (HVIN): PF2

Wireless Certification Report
FCC 15.247 & RSS-247

Prepared for:

Compressor Products International
4410 Greenbriar Drive
Stafford, TX 77477

By

Nemko USA, Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

7 June 2023

Written by

Larry Finn
Lab Manager

Revision History

Revision Number	Description	Date
Draft01	Need antenna detail, mfg/PN. Need IDs assigned/selected.	12 May 2021
Final01	Initial report release	26 April 2023
Final02	Added conducted emissions and band edge data	2 May 2023
Final03	Minor changes	15 May 2023
Final04	Corrected limits; Removed conducted emissions data	7 June 2023

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 Operation 6
1.4 Modifications to Equipment 6
1.5 Test Site 6
1.6 Measurement Corrections 6
1.7 Applicable Documents, Clauses, and Uncertainty 7
2.0 Fundamental Power 8
2.1 Test Procedure 8
2.2 Test Criteria 8
2.3 Test Results, Peak Power 8
2.4 Test Results, Recorded Peak Field Strength 9
2.5 Test Results, Duty Cycle 12
3.0 Power Spectral Density 13
3.1 Test Procedure 13
3.2 Test Criteria 13
3.3 Test Results 13
4.0 Occupied Bandwidth 14
4.1 Test Procedure 14
4.2 Test Criteria 14
4.3 Test Results 14
4.3.1 Bandwidth Plots, 6 dB 15
4.3.2 Bandwidth Plots, 99% 16
5.0 Radiated Spurious Emissions, Receive Mode 17
5.1 Test Procedure 17
5.2 Test Criteria 17
5.3 Test Results 17
5.3.1 Up to 1 GHz 18
5.3.2 Up to 13 GHz 19
6.0 Radiated Spurious Emissions, Transmit Mode 20
6.1 Test Procedure 20
6.2 Test Criteria 20
6.3 Test Results 20
6.3.1 Up to 1 GHz, Middle Channel 21
6.3.2 Up to 18 GHz, Bottom Channel 22
6.3.3 Up to 18 GHz, Middle Channel 23
6.3.4 Up to 18 GHz, Top Channel 24
6.3.5 Up to 25 GHz, Bottom Channel 25
6.3.6 Up to 25 GHz, Middle Channel 26
6.3.7 Up to 25 GHz, Top Channel 27
7.0 Band Edge; 15.247, 15.205; RSS-247 5.5; RSS-Gen 4.9 28
7.1 Test Procedure 28
7.2 Test Criteria 28
7.3 Test Results 28
7.3.1 Lower Band Edge Measurement 29
7.3.2 Upper Band Edge Measurement 29
8.0 Antenna Construction Requirements 30
8.1 Procedure 30
8.2 Criteria 30
8.3 Results 30
9.0 Equipment 31
9.1 Radiated Emissions, Transmit & Receive Mode 31
9.2 Measurements of PSD, Bandwidth, and Timings 31
10.0 Measurement Bandwidths 32
Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty 33

End of Report 33

Compliance Certificate

FCC MRA Designation Number: US3166
ANAB Accreditation Number: AT-3165.01

Applicant	Device & Test Identification	
Compressor Products International	FCC ID:	2AZVT-PF2
4410 Greenbriar Drive	Industry Canada ID:	30305-PF2
Stafford, TX 77477	Model(s):	PF2
Certificate Date: 7 June 2023	Laboratory Project ID:	22258-15

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	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, Larry Finn, for Nemko USA, 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.

Lab Manager

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.

1.2 EUT Description

Table 1.2.1: Equipment Under Test		
Manufacturer / Model	**Serial #**	**Description**
CPI Model: PF2	none	2402 to 2480 MHz Bluetooth Low Energy transceiver; tested as DSSS/DTS.

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

The EUT is a wireless configuration tool for an automated pump alarm system.

1.3 EUT Operation

The EUT was exercised in a manner consistent with normal operations. Note that this device operates with unusually low power as the application is for hazardous locations.

EUT is DC powered and uses an external battery only power source.

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 Nemko USA, Inc. semi-anechoic facility designated Site 45 (FCC 905409, 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 (ANAB). 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 Measurement Corrections

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

Additionally, measurement distance extrapolation factors (such as 1/d above 30 MHz) are applied and documented where used.

1.7 Applicable Documents, Clauses, and Uncertainty

Table 1.7.1: Applicable Documents	
Document	**Title**
47 CFR	Part 15 – Radio Frequency Devices Subpart C - Intentional Radiators, Subpart B – Unintentional Radiators
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
ANSI C63.4:2014	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
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

Table 1.7.2: Applicable Clauses		
Parameter	**FCC Part 15 Rule Paragraphs**	**ISED RSS References**
Transmitter Characteristics	15.247	RSS-247 5.2 (DTS) & 5.4, RSS-Gen
Bandwidth	15.247(a)(2), 2.1049, KDB 558074 D01	RSS-247 6.2.4.1, RSS-Gen 6.7
Spurious Emission	15.247(d), 15.209, 15.205	RSS-247 5.5, RSS-GEN 6.13 & 8.10
Band Edge	15.247, 15.205	RSS-247 5.5, RSS-Gen 8.10
Antenna Requirement	15.247, 15.203	RSS-Gen 6.8

Nemko USA, Inc., follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. A copy of Nemko USA's policy for EMC Measurement Uncertainty is provided in Appendix A.

2.0 Fundamental Power

2.1 Test Procedure

Peak power is measured radiated (due to the use of an integral antenna) and without modulation. The transmitter hopping sequence is disabled to operate on a single channel for the measurement.

2.2 Test Criteria

47 CFR (USA) // ISED (Canada)		
Section Reference	Parameter	Date
15.247(b)(3) // RSS-247 5.4(d)	Fundamental Power Conducted Limits 1 W Limit Restated as Field: 125.23 dBµV/m @ 3 m	29 Mar 2021

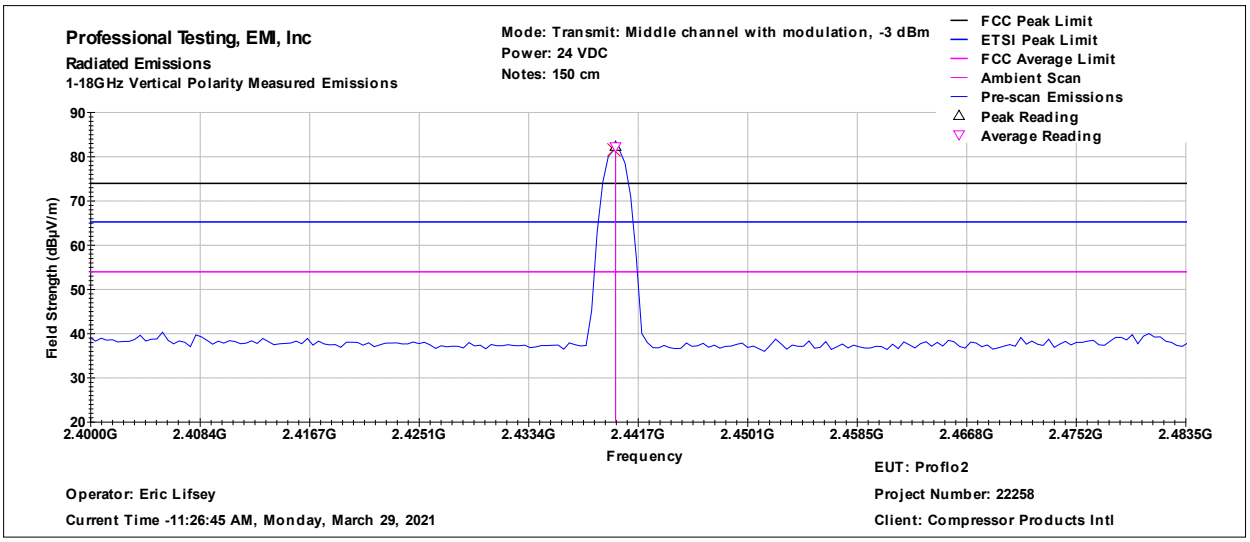
2.3 Test Results, Peak Power

Table 2.3.1 Power, Peak, Radiated, Unmodulated Vertical Polarity (highest field strength)			
Frequency MHz	**Measured Corrected Field Strength* dBµV/m @ 3 m**	**Field Strength Restated as EIRP dBm**	**Field Strength Restated as EIRP mW**
2400	82.3	-12.9	0.051
2440	82.3	-12.9	0.051
2480	80.9	-14.3	0.037

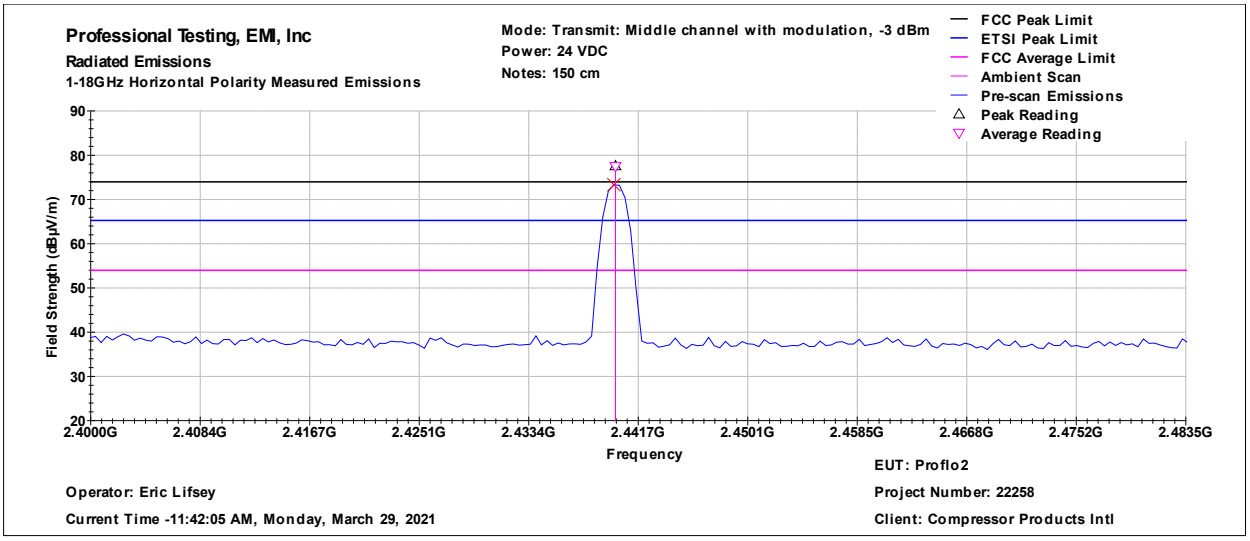
*Measured in 1 MHz RBW, 3 MHz VBW.

The EUT satisfied the requirements.

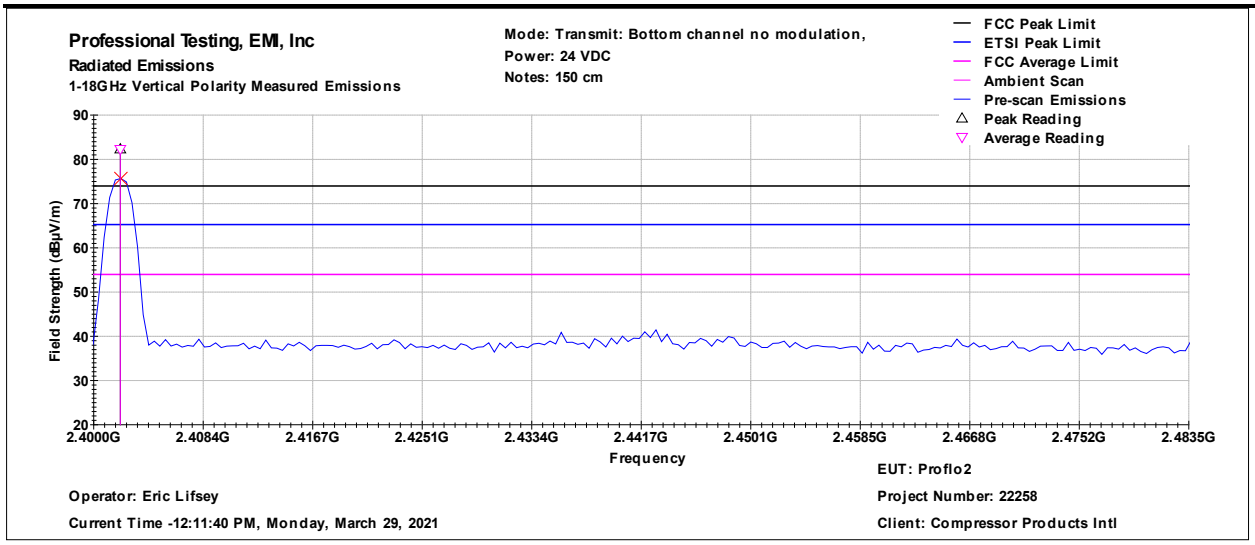
2.4 Test Results, Recorded Peak Field Strength



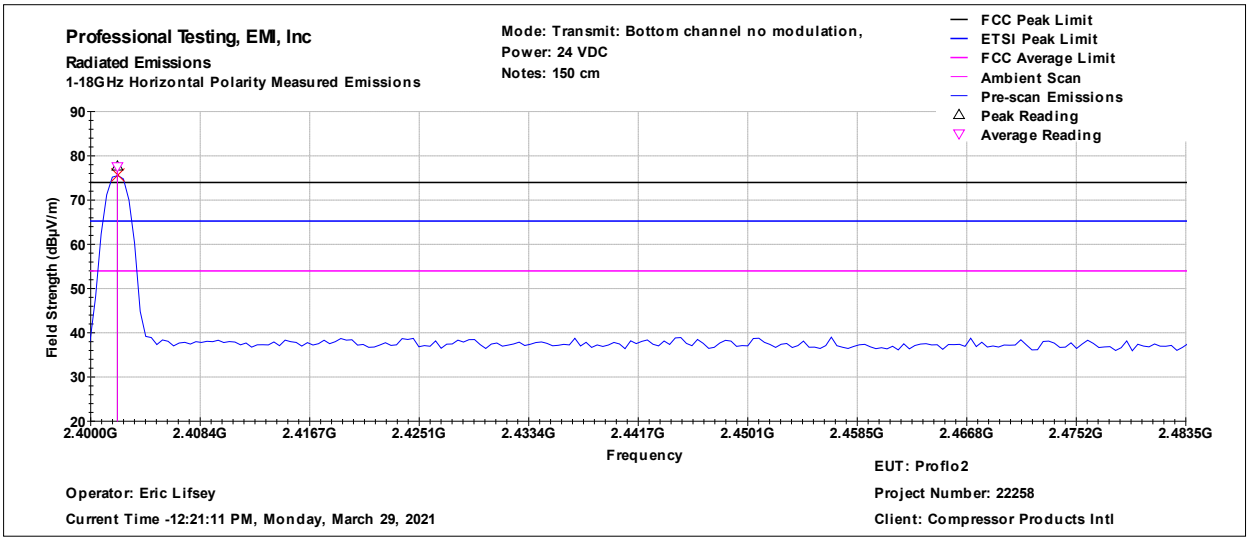
Frequency (MHz)	Azimuth ((deg))	Height ((cm))	Peak ((dBuV))
2440.0	154	189	82.3



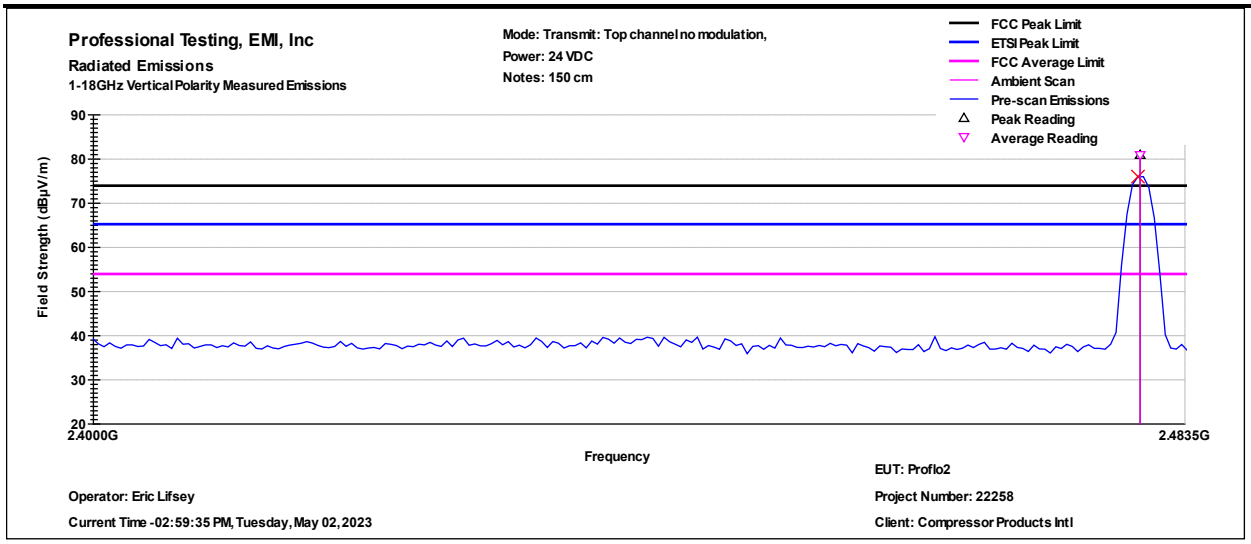
Frequency (MHz)	Azimuth ((deg))	Height ((cm))	Peak ((dBuV))
2440.0	247	349	77.6



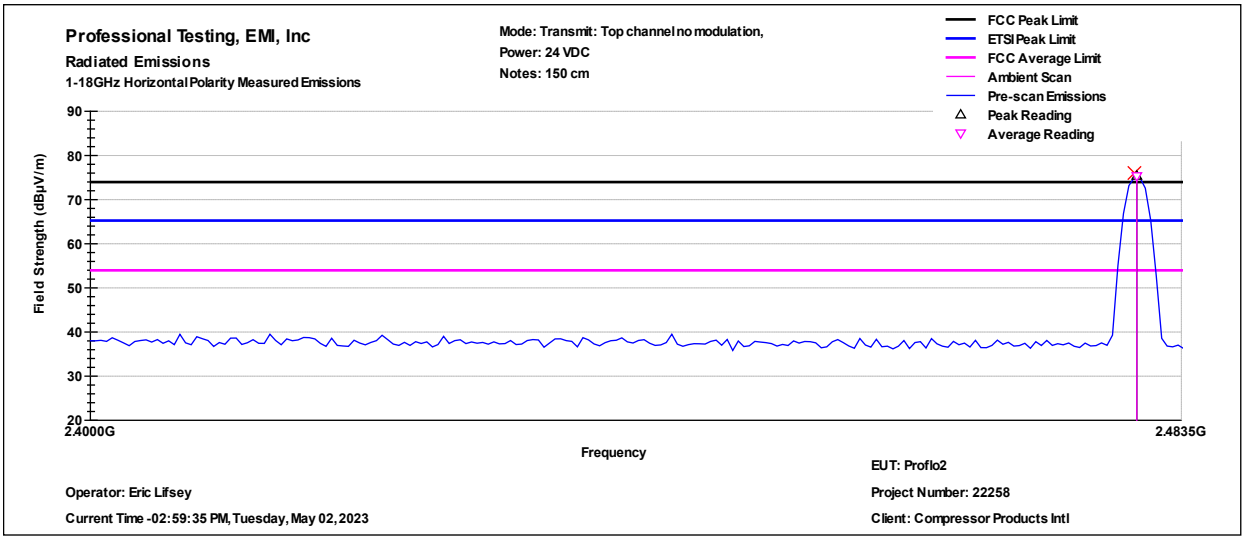
Frequency (MHz)	Azimuth ((deg))	Height ((cm))	Peak ((dBuV))
2402.0	163	363	82.3



Frequency (MHz)	Azimuth ((deg))	Height ((cm))	Peak ((dBuV))
2402.0	239	375	77.6



Frequency (MHz)	Azimuth ((deg))	Height ((cm))	Peak ((dBuV))
2480.0	136	218	80.9



Frequency (MHz)	Azimuth ((deg))	Height ((cm))	Peak ((dBuV))
2480.0	247	102	75.4

2.5 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.

This test was not needed due to the very low transmit power employed and the corresponding low spurious emissions.

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) // ISED (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	N/A

3.3 Test Results

The measured peak power measured lower than the PSD limit. Measurement of PSD was not required.

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) // ISED (Canada)		
Section Reference	Parameter	Date(s)
15.247(a)(2), 2.1049, KDB 558074 D01 // RSS-Gen 6.6, RSS-247 5.2(a)	Bandwidth, 6 dB, 99%	

4.3 Test Results

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

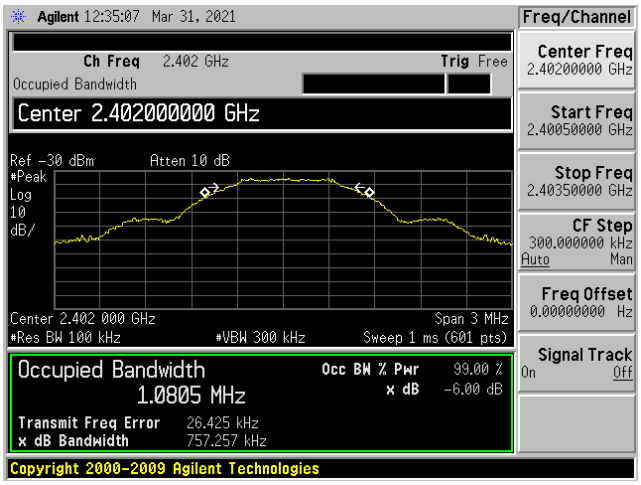
The EUT satisfied the requirements.

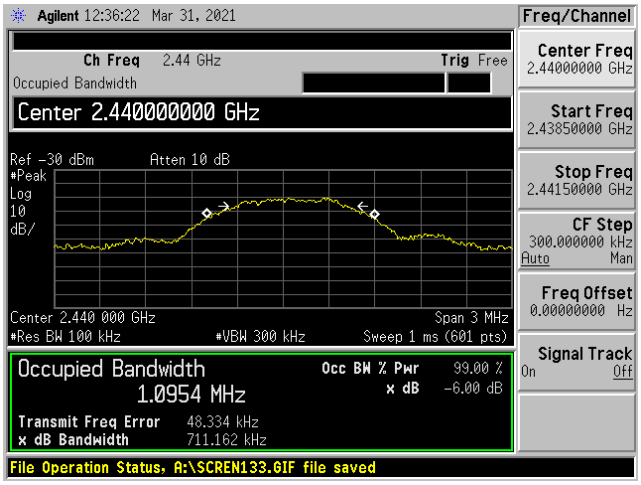
Table 4.3.1 Bandwidth 6 dB, Minimum 500 kHz in 100 kHz RBW			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Reported Minimum BW (kHz)**
757	711	732	**711**

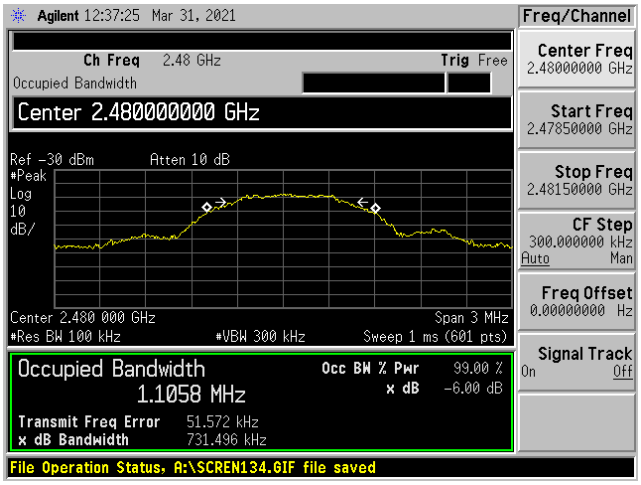
Table 4.3.2 Bandwidth 99%, Measure and Report			
Low Channel Measured BW (kHz)	Mid Channel Measured BW (kHz)	High Channel Measured BW (kHz)	**Reported Maximum BW (kHz)**
1057	1071	1074	**1074**

Plotted measurements appear on the following pages.

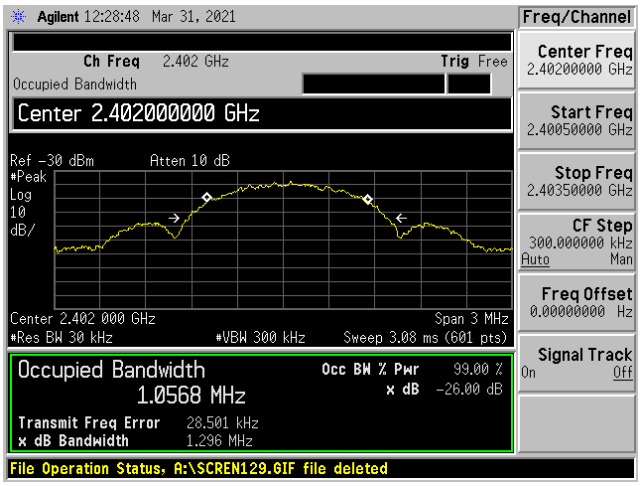
4.3.1 Bandwidth Plots, 6 dB

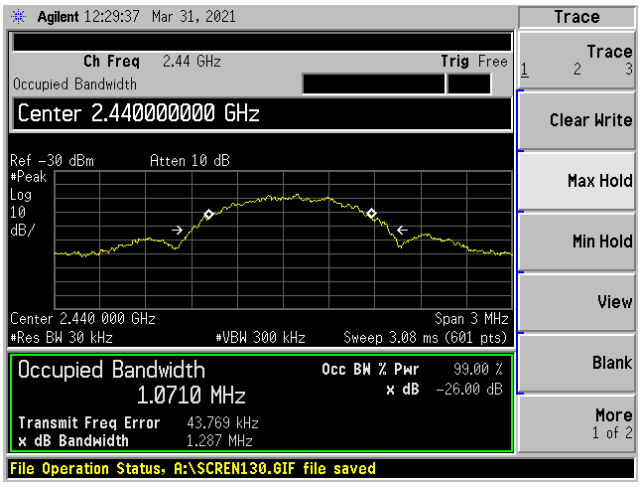


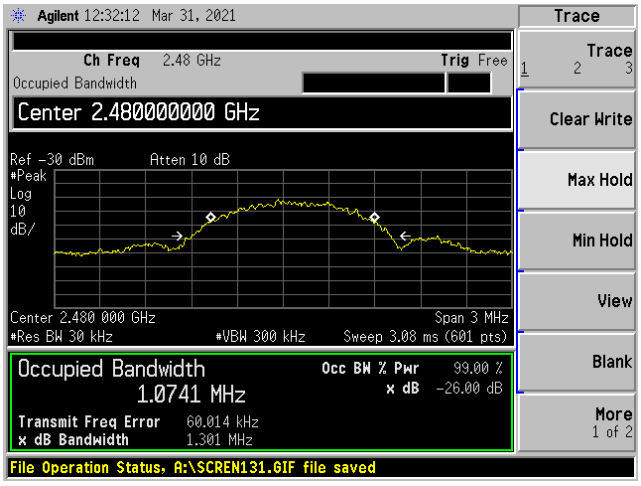




4.3.2 Bandwidth Plots, 99%





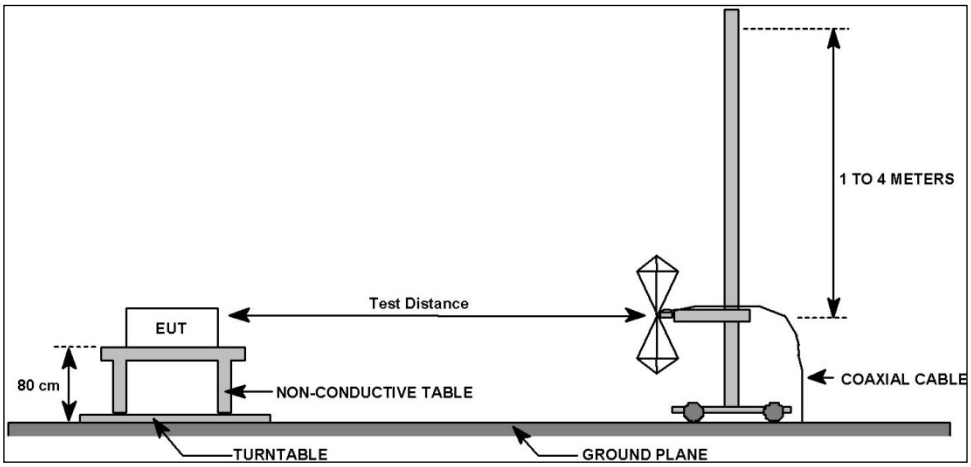


5.0 Radiated Spurious Emissions, Receive Mode

5.1 Test Procedure

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

Spurious emissions below 1 GHz were measured with quasi-peak detection with a resolution bandwidth of 120 kHz. Above 1 GHz peak measurements were taken and average measured where appropriate and 1 MHz resolution bandwidth. A diagram showing the test setup appears below.



5.2 Test Criteria

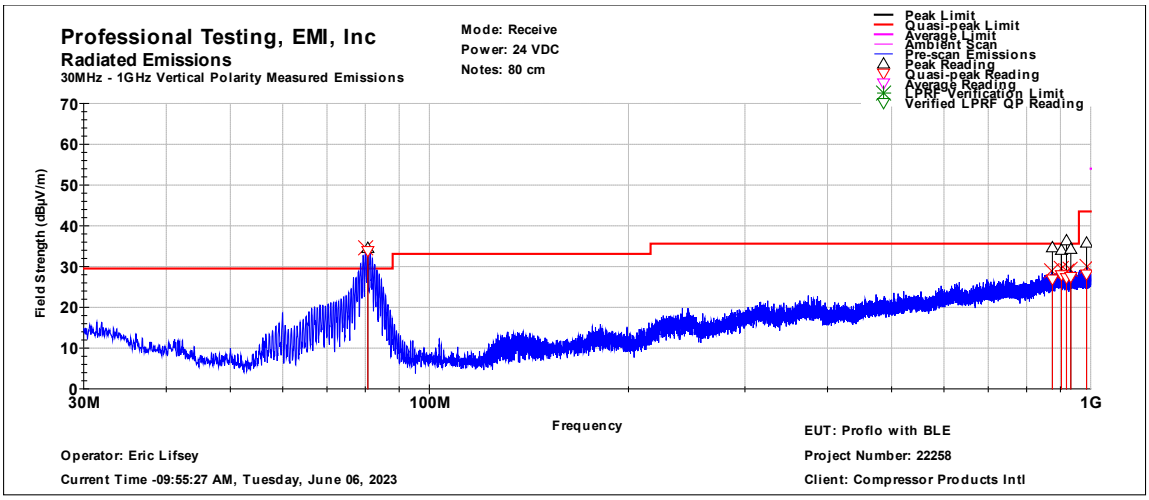
47 CFR (USA) // ISED (Canada)		
Section Reference	Parameter	Date(s)
47 CFR 15.109(a) // RSS-Gen 7.3 & 8.10	Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode	23 Mar 2021

5.3 Test Results

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

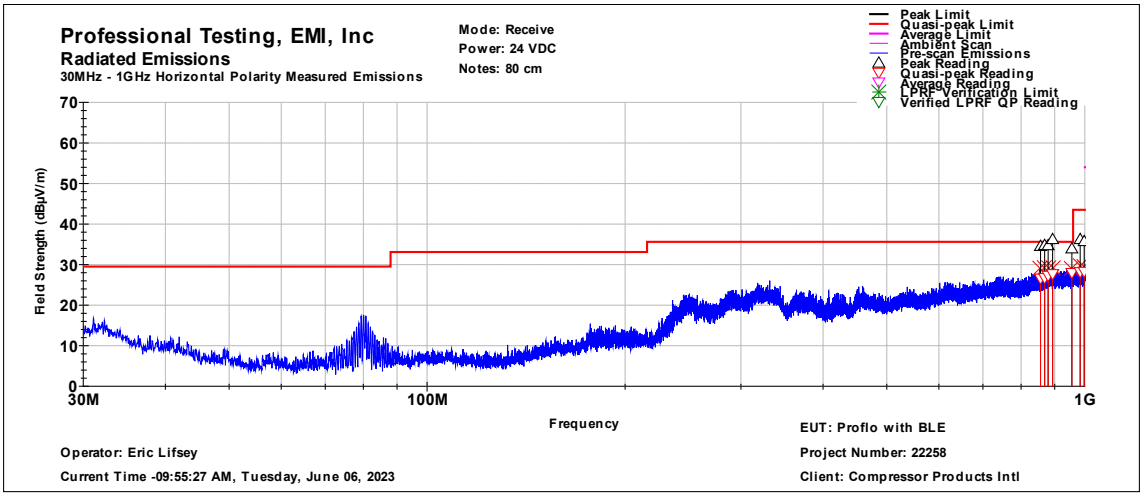
The EUT satisfied the criteria.

5.3.1 Up to 1 GHz



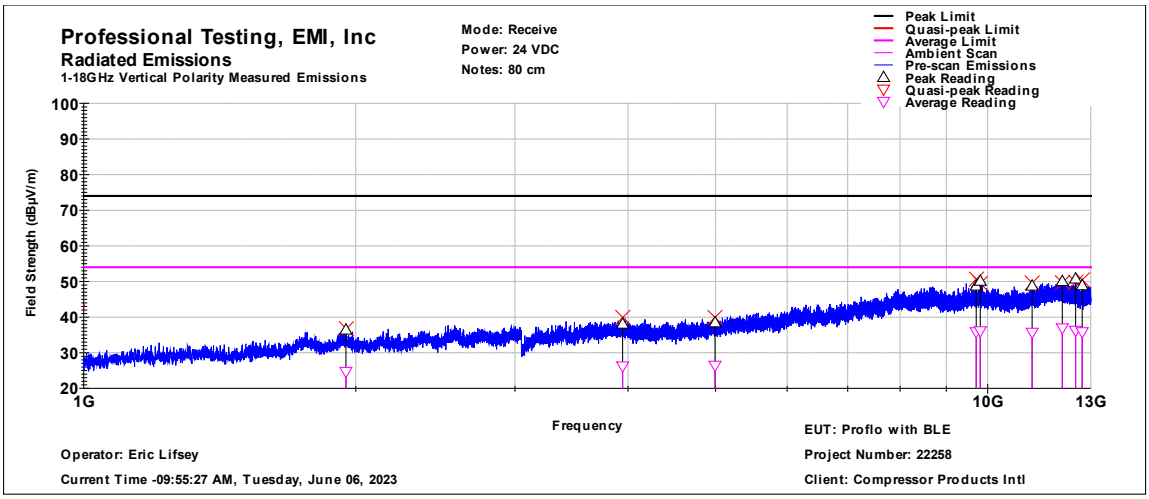
Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
MHz	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
80.716*	50.000	244.000	33.824	39.1*	-5.256	PASS	34.519
875.391	84.000	156.000	26.859	35.6	-8.741	PASS	34.682
903.346	143.000	374.000	27.912	35.6	-7.688	PASS	34.055
919.310	238.000	118.000	27.194	35.6	-8.406	PASS	36.385
933.230	138.000	330.000	27.470	35.6	-8.13	PASS	34.297
985.730	226.000	308.000	28.065	43.5	-15.435	PASS	35.813

*Non-spurious emission from DC-DC circuitry subject to Class A limit

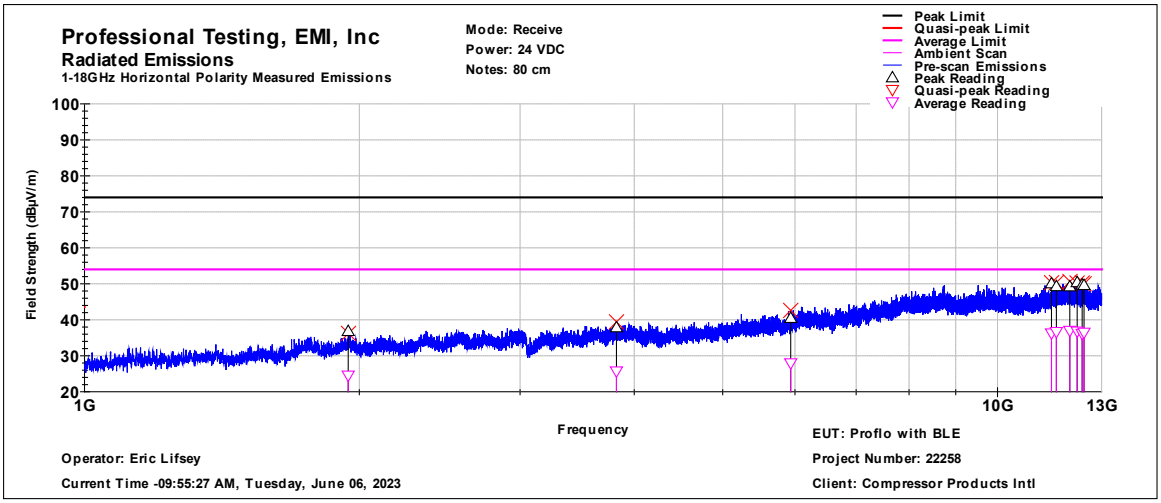


Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results	Peak
(MHz)	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)	(dBµV)
856.505	16.000	193.000	26.573	35.6	-9.027	PASS	34.553
868.869	298.000	368.000	26.715	35.6	-8.885	PASS	34.779
879.657	100.000	371.000	27.266	35.6	-8.334	PASS	34.721
893.524	100.000	281.000	27.677	35.6	-7.923	PASS	36.225
955.919	261.000	382.000	27.974	35.6	-7.626	PASS	33.930
983.990	94.000	377.000	28.181	43.5	-15.319	PASS	36.233
997.917	293.000	357.000	28.267	43.5	-15.233	PASS	35.732

5.3.2 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)
1950.40	291	240	36.425	74	-37.575	PASS	24.650	54	-29.35	PASS
3946.09	327	373	38.085	74	-35.915	PASS	26.194	54	-27.806	PASS
4993.61	155	141	38.468	74	-35.532	PASS	26.384	54	-27.616	PASS
9713.10	1	101	48.769	74	-25.231	PASS	35.797	54	-18.203	PASS
9813.48	49	367	50.142	74	-23.858	PASS	36.074	54	-17.926	PASS
11198.58	310	397	48.770	74	-25.23	PASS	35.642	54	-18.358	PASS
12094.22	40	140	50.052	74	-23.948	PASS	36.867	54	-17.133	PASS
12510.61	293	201	50.746	74	-23.254	PASS	36.191	54	-17.809	PASS
12722.01	155	102	48.871	74	-25.129	PASS	35.791	54	-18.209	PASS

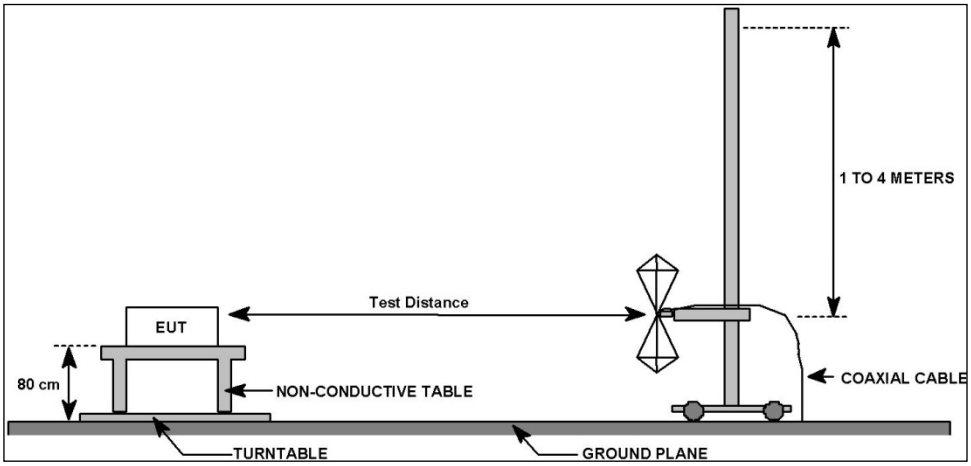


Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
1944.77	10	315	36.823	74	-37.177	PASS	24.525	54	-29.475	PASS
3825.09	8	397	37.865	74	-36.135	PASS	25.671	54	-28.329	PASS
5935.67	103	222	40.475	74	-33.525	PASS	27.935	54	-26.065	PASS
11458.25	66	209	50.076	74	-23.924	PASS	36.245	54	-17.755	PASS
11598.85	67	305	49.281	74	-24.719	PASS	36.642	54	-17.358	PASS
11999.67	335	183	49.242	74	-24.758	PASS	36.952	54	-17.048	PASS
12223.64	233	177	50.395	74	-23.605	PASS	36.757	54	-17.243	PASS
12378.69	337	213	49.743	74	-24.257	PASS	36.121	54	-17.879	PASS
12435.66	316	196	49.612	74	-24.388	PASS	36.429	54	-17.571	PASS

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, Detection Method, EUT Height		
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
80 cm	150 cm	150 cm

6.2 Test Criteria

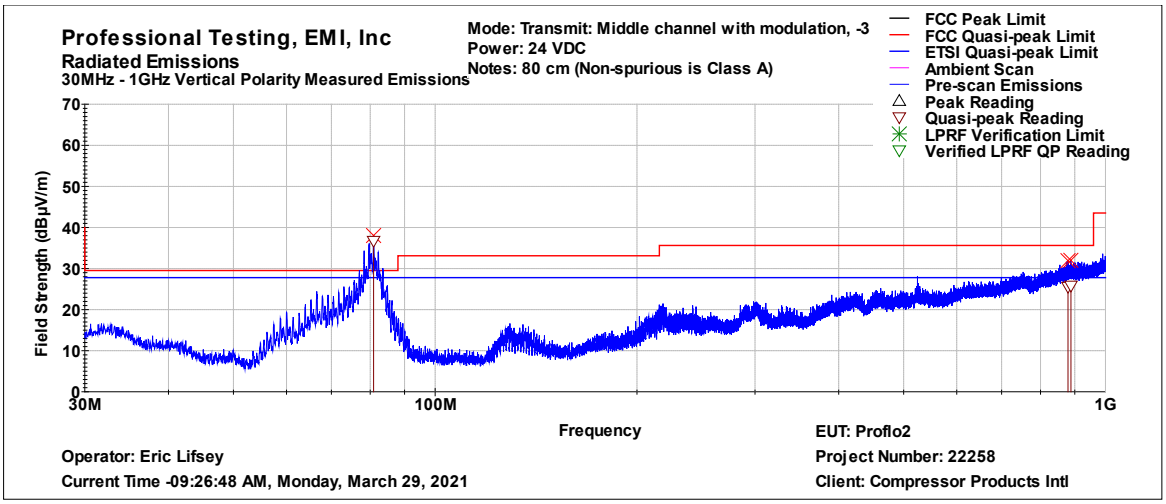
47 CFR (USA) // ISED (Canada)		
Section Reference	Parameter	Date(s)
15.247(d), 15.205 // RSS-247 5.5, RSS-Gen 6.13 & 8.10	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode	29 Mar 2021 30 Mar 2021

6.3 Test Results

Modulation was enabled for measurements below 1 GHz but disabled above 1 GHz. The transmitter was placed into continuous transmit mode.

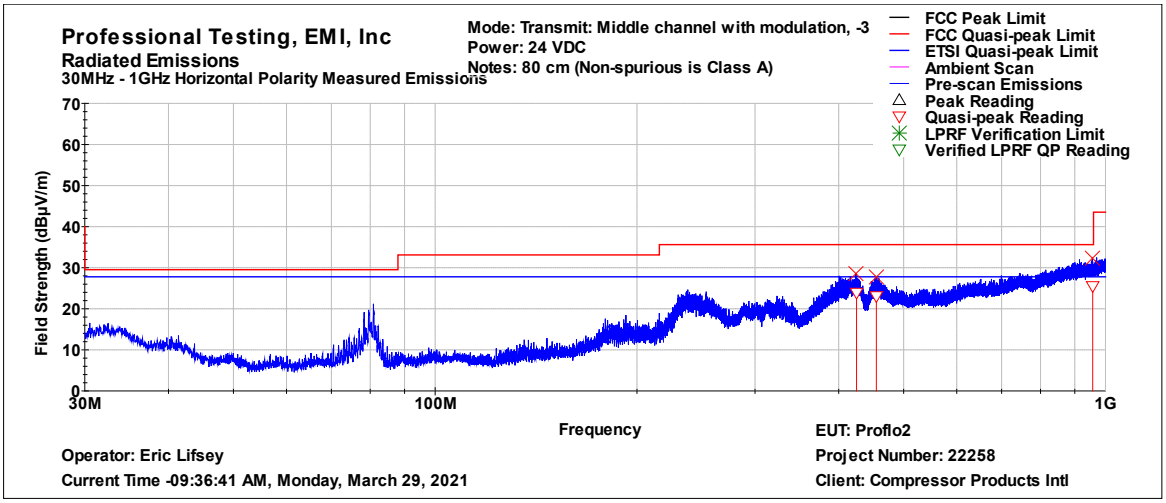
The duty cycle averaging factor was not determined as all peak readings were below the general average limits.

6.3.1 Up to 1 GHz, Middle Channel



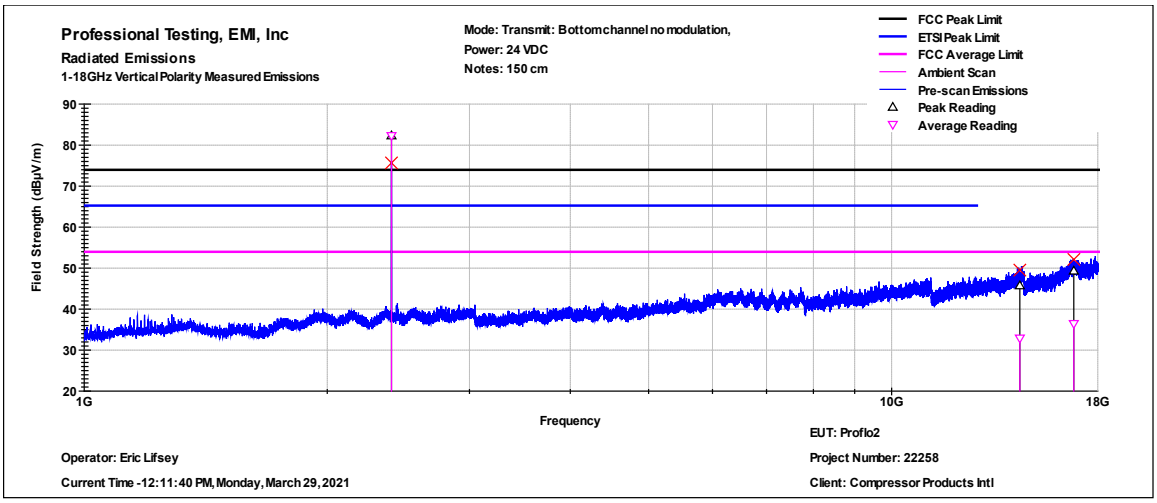
Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results
MHz	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)
80.922*	98.000	189.000	36.699	39.100*	-2.401	PASS
879.307	127.000	257.000	25.518	35.600	-10.082	PASS
888.285	24.000	384.000	25.814	35.600	-9.786	PASS

*This is a non-spurious emission from DC/DC inverter circuitry. It is subject to the Class A limit.



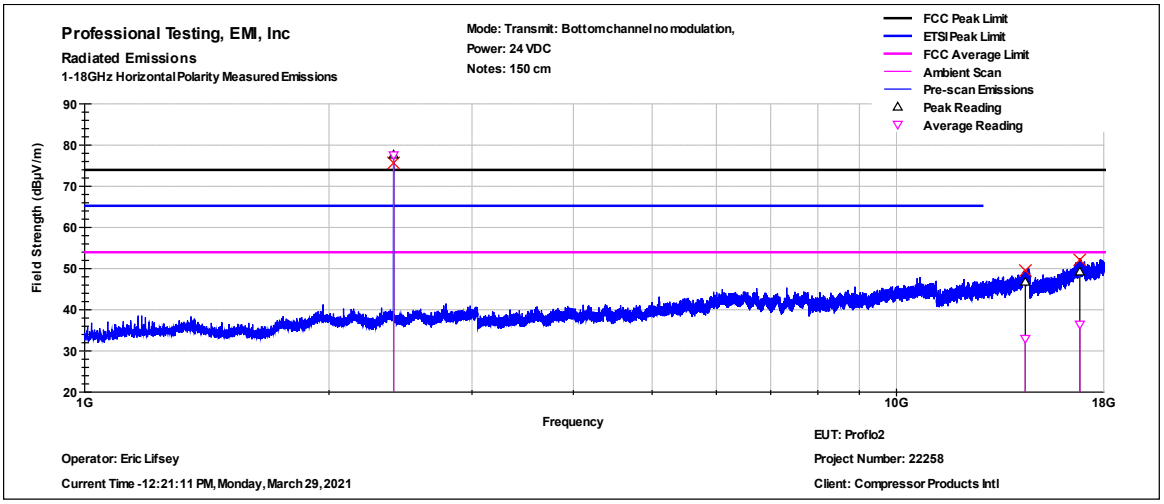
Frequency	Azimuth	Height	QP	QP Limit	QP Margin	QP Results
(MHz)	(deg)	(cm)	(dBµV)	(dBµV)	(dB)	(P/F)
425.210	135.000	222.000	23.884	35.600	-11.716	PASS
455.264	247.000	248.000	23.038	35.600	-12.562	PASS
957.153	357.000	126.000	25.487	35.600	-10.113	PASS

6.3.2 Up to 18 GHz, Bottom Channel



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)
2402.03*	163	363	82.303	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14412.71	181	102	45.743	73.958	-28.215	PASS	32.861	53.958	-21.097	PASS
16811.98	293	102	49.333	73.958	-24.625	PASS	36.415	53.958	-17.543	PASS

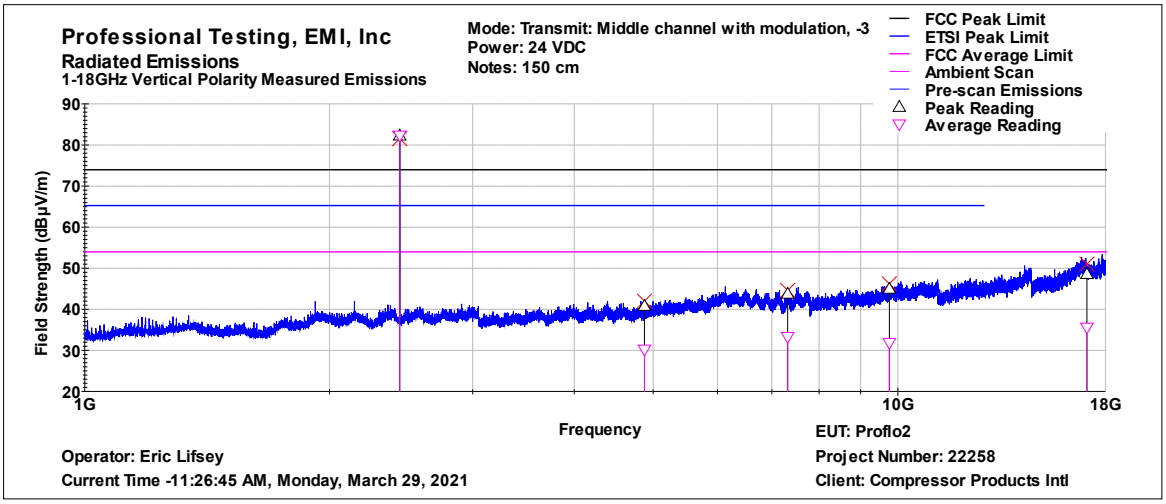
*This is the fundamental.



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)
2402.04*	239	375	77.624	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14410.55	218	154	46.761	73.958	-27.197	PASS	32.974	53.958	-20.984	PASS
16817.57	360	102	49.213	73.958	-24.745	PASS	36.443	53.958	-17.515	PASS

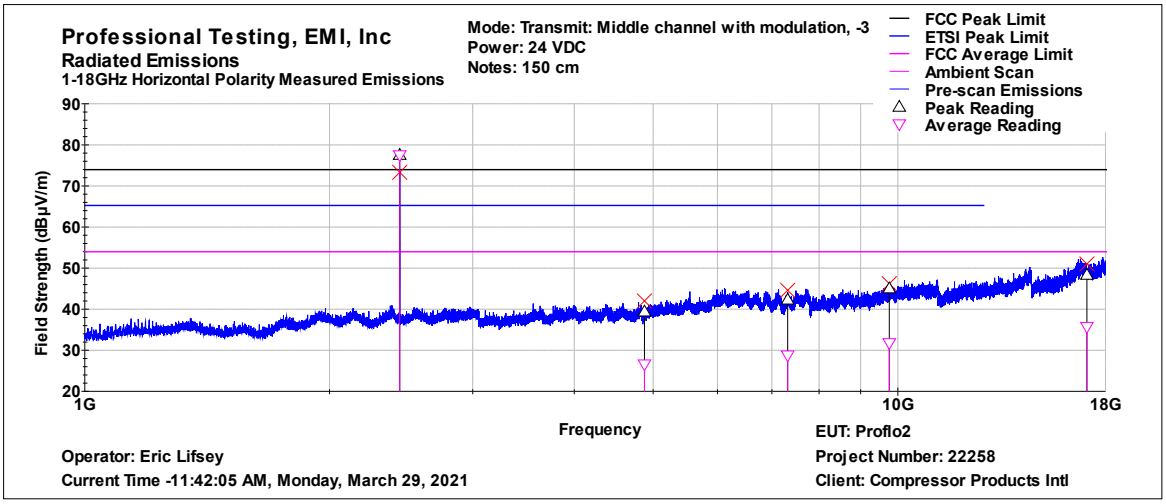
*This is the fundamental.

6.3.3 Up to 18 GHz, Middle Channel



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)
2440.02*	154	189	82.301	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4880.02	2	332	40.826	73.958	-33.132	PASS	30.162	53.958	-23.796	PASS
7319.87	282	332	43.798	73.958	-30.160	PASS	33.228	53.958	-20.730	PASS
9763.11	126	318	45.004	73.958	-28.954	PASS	31.775	53.958	-22.183	PASS
17080.64	86	375	48.599	73.958	-25.359	PASS	35.507	53.958	-18.451	PASS

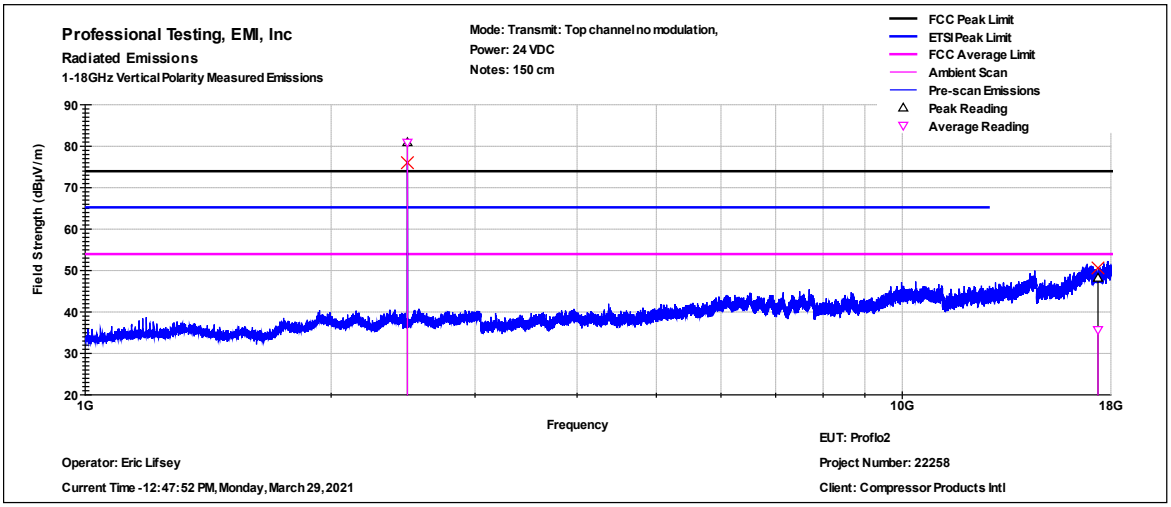
*This is the fundamental.



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)
2440.02*	247	349	77.577	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4880.00	189	102	39.443	73.958	-34.515	PASS	26.531	53.958	-27.427	PASS
7319.80	120	238	42.349	73.958	-31.609	PASS	28.705	53.958	-25.253	PASS
9760.02	55	329	45.077	73.958	-28.881	PASS	31.698	53.958	-22.260	PASS
17079.61	2	102	48.374	73.958	-25.584	PASS	35.648	53.958	-18.310	PASS

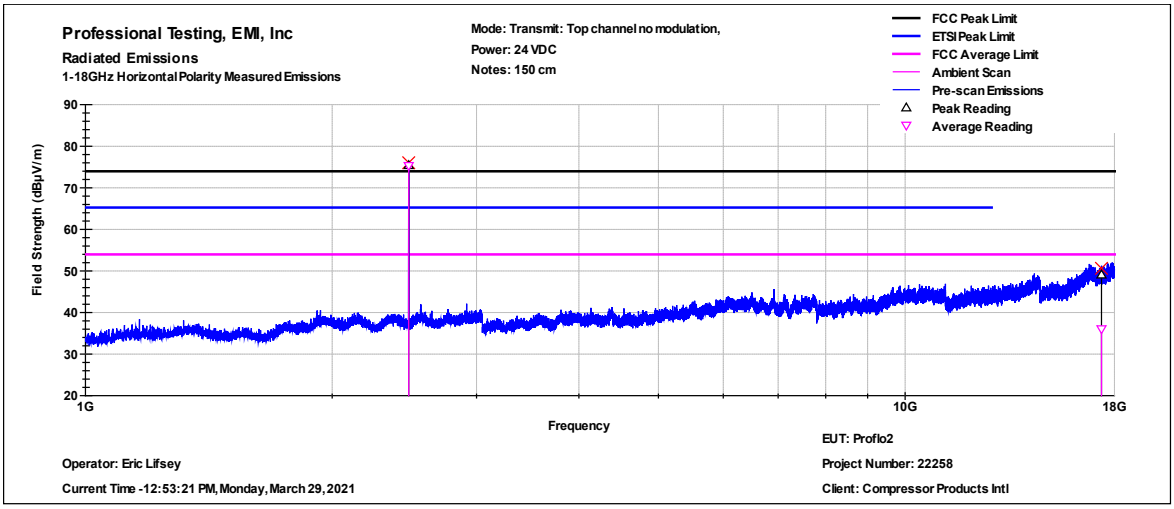
*This is the fundamental.

6.3.4 Up to 18 GHz, Top Channel



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)
2480.02*	136	218	80.925	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17361.10	2	265	48.214	73.958	-25.744	PASS	35.686	53.958	-18.272	PASS

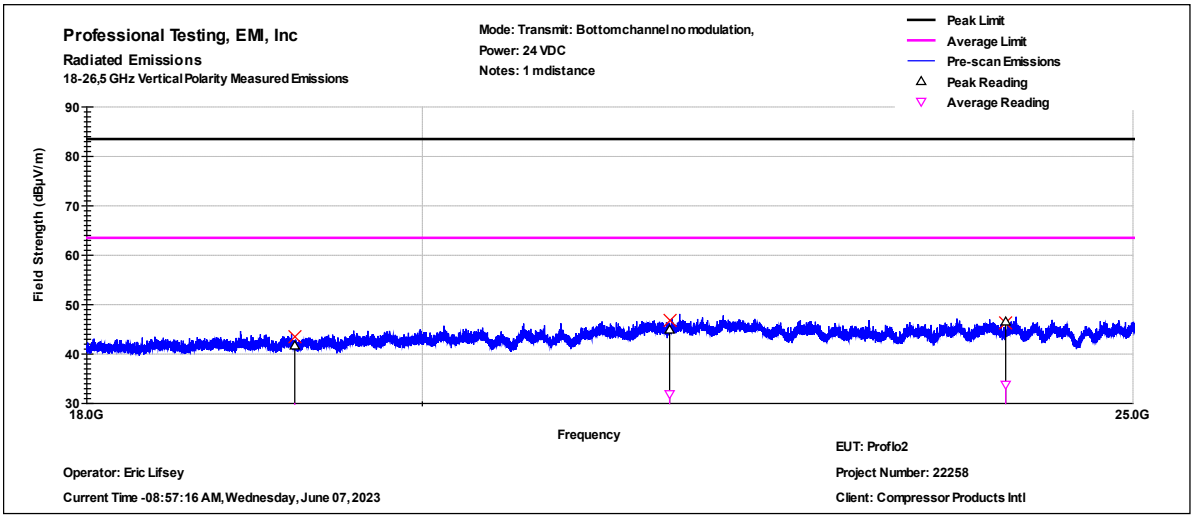
*This is the fundamental.



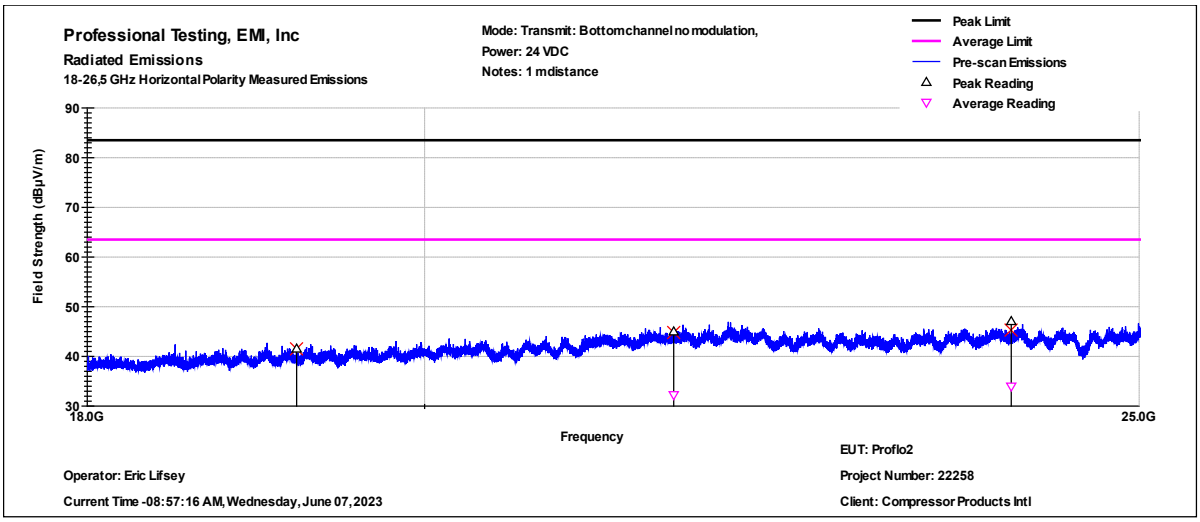
Frequency	Azimuth	Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
2480.04*	247	102	75.397	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17357.06	41	102	49.097	73.958	-24.861	PASS	35.999	53.958	-17.959	PASS

*This is the fundamental.

6.3.5 Up to 25 GHz, Bottom Channel

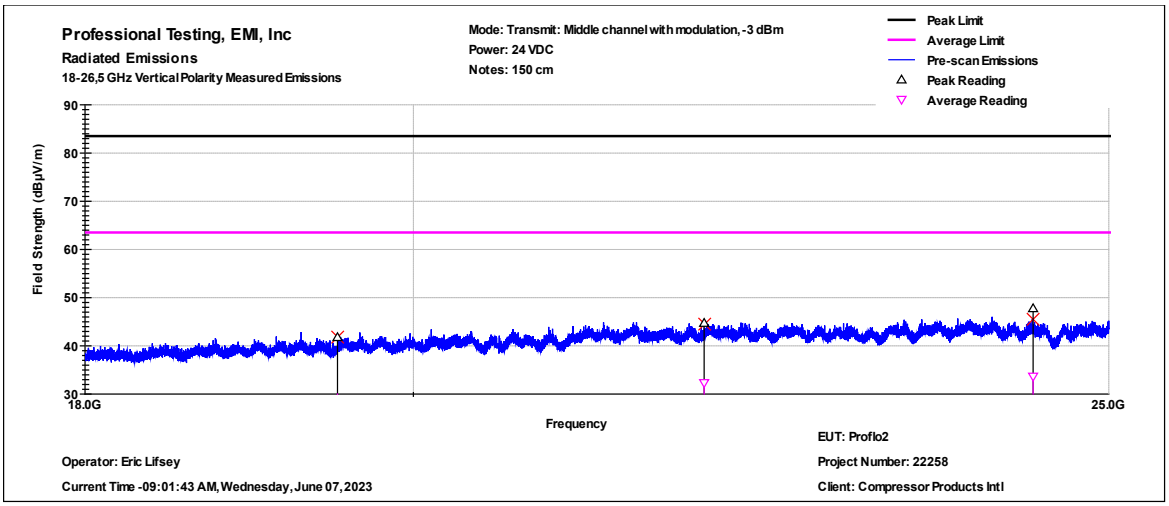


Frequency	Azimuth	Antenna Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
19214.93	304	100.000	41.693	83.5	-41.807	PASS	28.667	63.5	-34.833	PASS
21614.92	112	100.000	44.93	83.5	-38.57	PASS	31.908	63.5	-31.592	PASS
24020.49	265	100.000	46.554	83.5	-36.946	PASS	33.809	63.5	-29.691	PASS

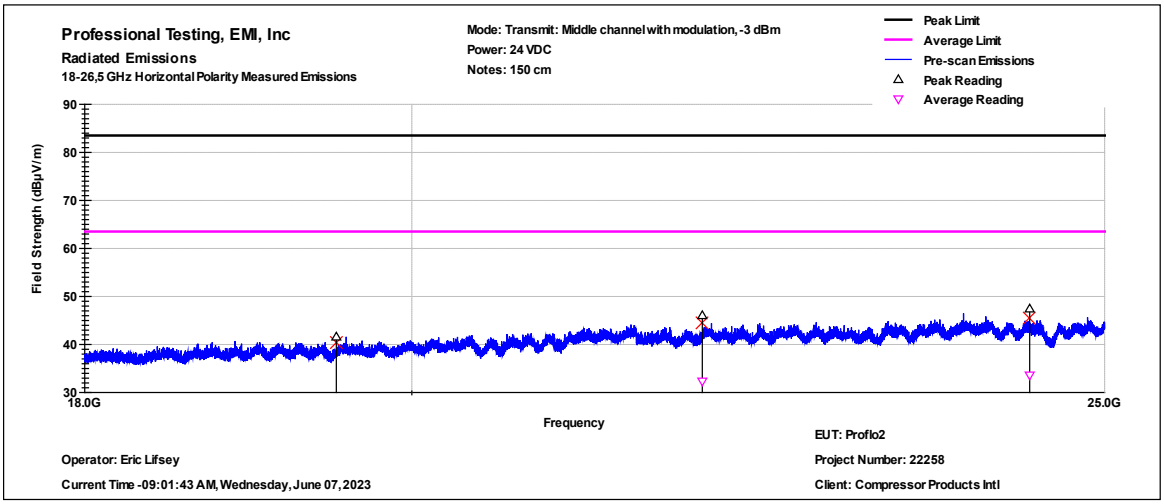


Frequency	Azimuth	Antenna Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
19216.75	16	100.000	41.548	83.5	-41.952	PASS	28.857	63.5	-34.643	PASS
21618.22	108	100.000	45.002	83.5	-38.498	PASS	32.218	63.5	-31.282	PASS
24021.66	28	100.000	47.066	83.5	-36.434	PASS	33.936	63.5	-29.564	PASS

6.3.6 Up to 25 GHz, Middle Channel

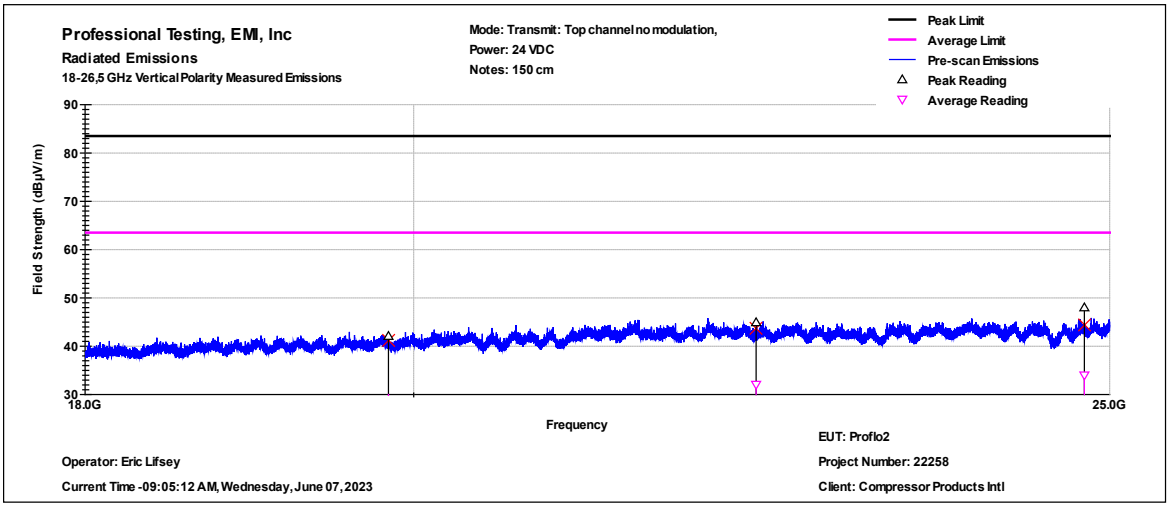


Frequency	Azimuth	Antenna Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
19518.87	344	100.000	41.777	83.5	-41.723	PASS	28.765	63.5	-34.735	PASS
21955.96	15	100.000	44.722	83.5	-38.778	PASS	32.316	63.5	-31.184	PASS
24400.11	108	100.000	47.759	83.5	-35.741	PASS	33.639	63.5	-29.861	PASS

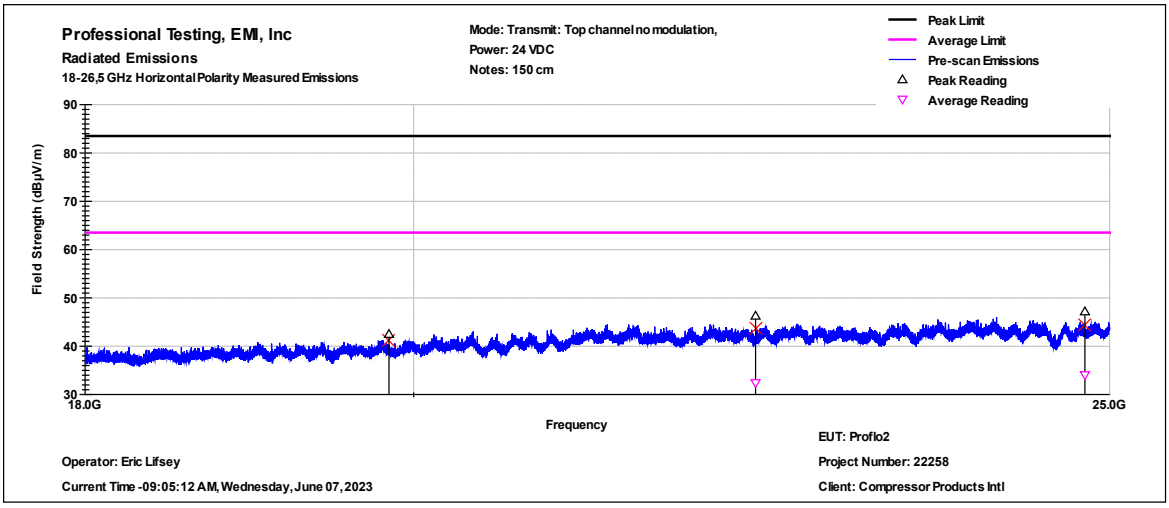


Frequency	Azimuth	Antenna Height	Peak	Peak Limit	Peak Margin	Peak Results	Avg	Avg Limit	Avg Margin	Avg Results
(MHz)	(deg)	(cm)	(dBuV)	(dBuV)	(dB)	(P/F)	(dBuV)	(dBuV)	(dB)	(P/F)
19519.81	299	100.000	41.593	83.5	-41.907	PASS	28.62	63.5	-34.88	PASS
21961.38	138	100.000	46.061	83.5	-37.439	PASS	32.303	63.5	-31.197	PASS
24403.72	37	100.000	47.451	83.5	-36.049	PASS	33.565	63.5	-29.935	PASS

6.3.7 Up to 25 GHz, Top Channel



Frequency	Azimuth	Antenna 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)
19838.67	95	100.000	42.088	83.5	-41.412	PASS	28.914	63.5	-34.586	PASS
22320.81	14	100.000	44.93	83.5	-38.57	PASS	32.056	63.5	-31.444	PASS
24798.28	294	100.000	47.996	83.5	-35.504	PASS	33.986	63.5	-29.514	PASS



Frequency	Azimuth	Antenna 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)
19842.36	4	100.000	42.497	83.5	-41.003	PASS	29.222	63.5	-34.278	PASS
22317.07	289	100.000	46.267	83.5	-37.233	PASS	32.382	63.5	-31.118	PASS
24802.42	125	100.000	47.162	83.5	-36.338	PASS	34.037	63.5	-29.463	PASS

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

7.1 Test Procedure

EUT is placed into normal modulated 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. Band edge measurements were made on 4/26/2021.

7.2 Test Criteria

Unwanted Emissions
Emissions Adjacent to Authorized Band

7.3 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.

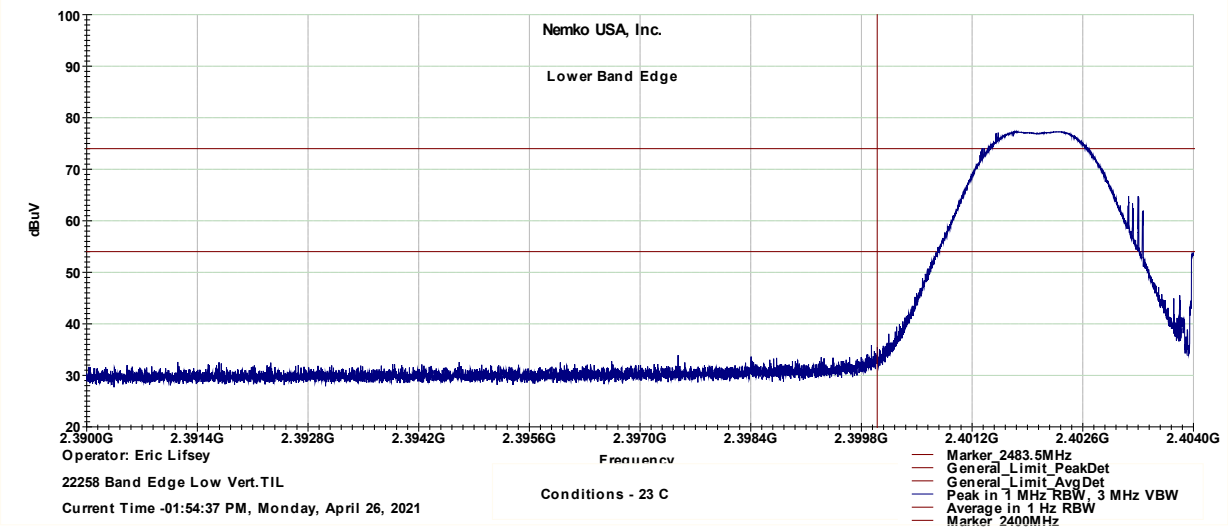
This is a radiated measurement with limits derived from the general emission field strength limits.

Emissions below band were measured with peak detection in 1 MHz RBW.

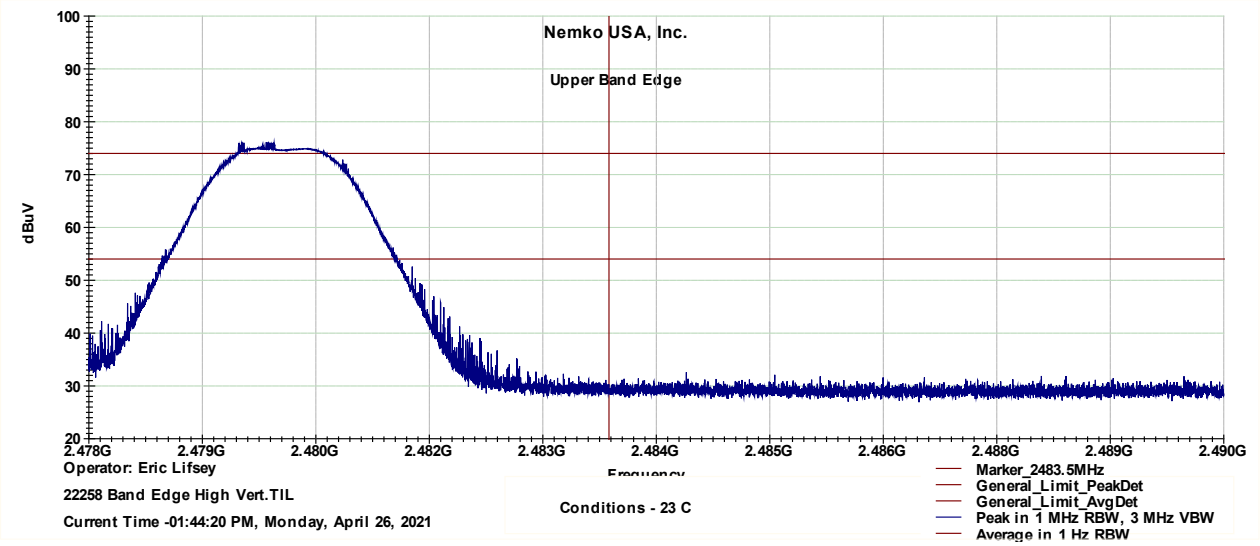
Emissions above band measured with peak detection and 1 Hz video average in 1 MHz RBW if the peak emission exceeds the average limit.

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

7.3.1 Lower Band Edge Measurement



7.3.2 Upper Band Edge Measurement



8.0 Antenna Construction Requirements

8.1 Procedure

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

8.2 Criteria

47 CFR (USA) // ISED (Canada)		
Section Reference	Parameter	Date(s)
15.203 // RSS-Gen 6.8	Antenna Construction	4/26/2023

8.3 Results

Table 7.3.1 Antenna Construction Details
Manufacturer: Johanson Technology
P/N: 2450AT18A100 2.4 GHz SMT Mounted Ceramic Chip Antenna Peak Gain : 0.5 dBi

- Antenna is chip style soldered to board.
- No connector is used.
- The end user cannot change or modify the antenna.
- Effect of gain is included in field strength measurements.

The antenna design above satisfies the requirements of the rules.

9.0 Equipment

9.1 Radiated Emissions, Transmit & Receive Mode

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
2172	ETS-Lindgren	3142C	Antenna, Biconilog, 26 MHz-3GHz	49383	3/11/2023
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
819	EMCO	3115	Antenna, Horn, DRG, 1-18GHz	113	9/11/2022
1542	A.H. Systems	SAS-572	Antenna, Horn 18-26.5GHz, 20dB gain	225	N/A
1974	Agilent	83017A	Amplifier, Microwave 0.5-26.5 GHz	MY39500684	11/20/2022

9.2 Measurements of PSD, Bandwidth, and Timings

Asset #	Manufacturer	Model #	Description	Calibration Due
1937	Agilent	E4440A	Spectrum Analyzer	11 Nov 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 ANAB policy. Since Nemko USA, Inc. operates in accordance with ANAB Document Number AR 2250: 2021/06/16, 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 ANAB Document Number AR 2250.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at Nemko USA 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 Nemko USA's 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	2.82
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	3.48
Radiated Emissions	30 to 1,000 MHz	10 m	3.88
	1 to 18 GHz	3 m	4.31

End of Report