Project 21817-15

**Pharos Marine Automatic Power**

**Phalcon-NT**

**RACON Radar Transponder**

**Band X Section**

# Wireless Certification Report

Prepared for:

Pharos Marine Automatic Power Systems
10810 W Little York St. Suite 130
Houston TX 77041

By

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

28 Sep 2020

Reviewed by

Larry Finn
Chief Technical Officer

Written by

Eric Lifsey
EMC Engineer

**Revision History**

| Revision Number | Description | Date |
|---|---|---|
| Draft 01 | For review. | 28 Sep 2020 |
| Final1 | | 19 Oct 2020 |
| Final2 | Add radiated emission data 18-26.5 GHz. Correct certificate page reference from S to X Band. Correct typos & cal date. | 22 Oct 2020 |

**Errata:**

**Table of Contents**

# Certificate of Compliance

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

| Applicant | Device & Test Identification |
|---|---|
| Pharos Marine Automatic Power Systems<br>10810 W Little York St. Suite 130<br>Houston TX 77041<br>Certificate Date: 28 Sep 2020 | Model(s): Phalcon-NT<br>FCC ID: 2ARGZPHALCON-NT<br>Laboratory Project ID: 21817-15 |

The EUT model(s) listed above were tested utilizing the following documents and found to be in compliance with the required criteria.

| 47 CFR, FCC, Part 87 and Part 2<br>Band X Section, FCC Paragraph 80.215(n)(3) | |
|---|---|
| **Section/Clause** | **Description** |
| 80.215(n)(3); 2.1046 | Power and emissions; conducted output power, limited to 20 W peak. |
| 2.1047 | Modulation: P0N |
| 2.1049 | Occupied BW Mask |
| 2.1051 | Emission limitations; Spurious/harmonic emissions at antenna terminals |
| 2.1053 | Emission limitations; radiated emissions 30 MHz - 40 GHz |
| 2.1055(a)(2); 80.209(c) | Frequency stability (Maritime Services Part 80; ±1.5 MHz) |

I, Eric Lifsey, for Professional Testing (EMI), Inc., being familiar with the above rules 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.

## 1.2 EUT Description

| Table 1.2.1 Equipment Under Test | | |
|---|---|---|
| **Manufacturer & Description** | **Model(s)** | **Serial #(s)** |
| Pharos Marine Automatic Power Systems<br><br>RACON Radar Transponder | Phalcon-NT<br><br>X-Band Section | Item A: 19384-12<br><br>Item E: 19384-11 |

| Table 1.2.2: EUT Essential Specifications | |
|---|---|
| Power Output to Antenna | ~+30 dBm |
| Frequency Range | X-Band<br>Test Frequencies: 9201, 9350, 9499 MHz |
| Channel Bandwidths Supported (kHz) | N/A |
| Modulation Methods Supported | P0N |
| Antenna | Fixed omni-directional slot array |
| Operating Voltage and Power Required | 10 to 36 VDC, 10 Watts |
| Environment | Outdoor |

## 1.3 EUT Operation

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

The EUT utilizes a 2-band RACON radio unit in the same enclosure driving an independent antenna for each band. Bands S and X are supported. The antennas are fixed and omni-directional transmit and receive.

A RACON transmits a very fast simple Morse code character when it detects a signal from a ship radar. The responding transmission appears at a graphical Morse code character on the ship radar display. The decoded Morse character is then matched to navigational maps. This provides a way to mark hazards or similar important items for safe ship navigation.

## 1.4 Modifications to EUT

None.

## 1.5 Measurement Correction Methods

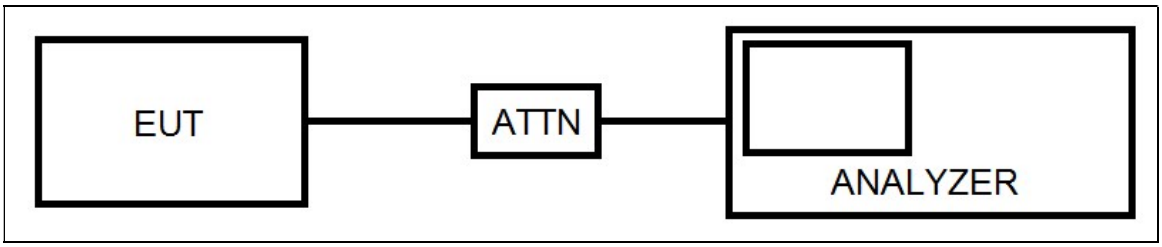
| Table 1.6 1 Measurement Corrections | |
|---|---|
| **Parameter** | **From Sums Of** |
| **Radiated Field Strength** | Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain |
| **Conducted Antenna Port** | Raw Measured Level + Attenuator Factor + Cable Losses |
| **Conducted Mains Port** | 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. | |

## 1.6 Test Site

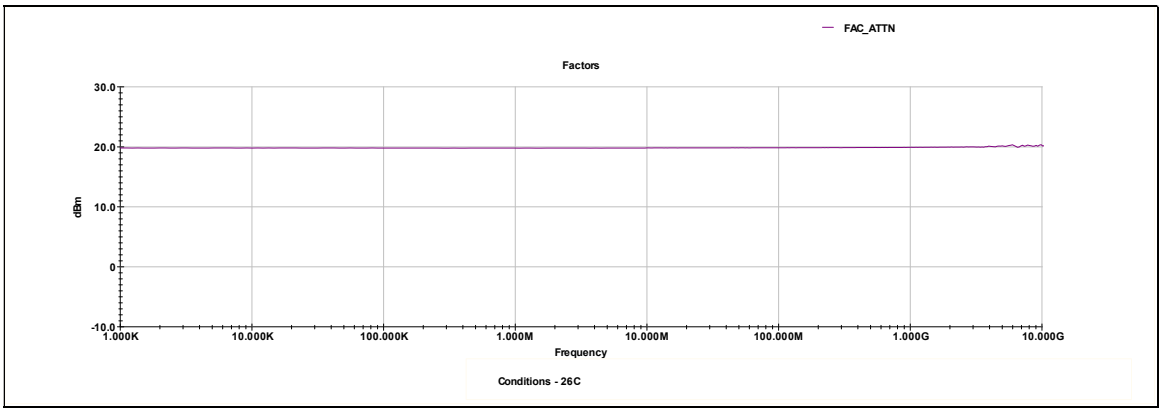
Radiated measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 459644, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RS-GEN and is subsequently confirmed by laboratory accreditation (NVLAP 200026-0). The test site 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.

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.

## 1.7 Test Setup Diagram




**Setup for Conducted Port Measurements: Power, Mask, Spurious, Bandwidth**




**Attenuator Factor vs Frequency, Asset Number A105, 20 dB 20 W Narda Attenuator**

# 2.0 Applicable Documents

| Table 2.0.1: Applicable Documents | |
|---|---|
| **Document #** | **Title/Description** |
| ANSI C63.26-2015 | American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services |
| 47 CFR | FCC Part 80 – Subpart E – Technical requirements<br>FCC Part 2 – Subpart J – Equipment authorization procedures |

# 3.0 Conducted Output Power at Antenna Terminal, Clause 80.215(n)(3), 2.1046

## 3.1 Test Procedure

The output of the EUT was connected by cable and attenuator to a spectrum analyzer. A peak detector was used for the measurement. The transmitter was switched on, and the measurement receiver was tuned to the frequency of the transmitter under test. The loss of the attenuator was compensated by adding an offset to the analyzer amplitude. Power was measured directly with the spectrum analyzer using a resolution bandwidth greater than the occupied bandwidth of the transmitter.

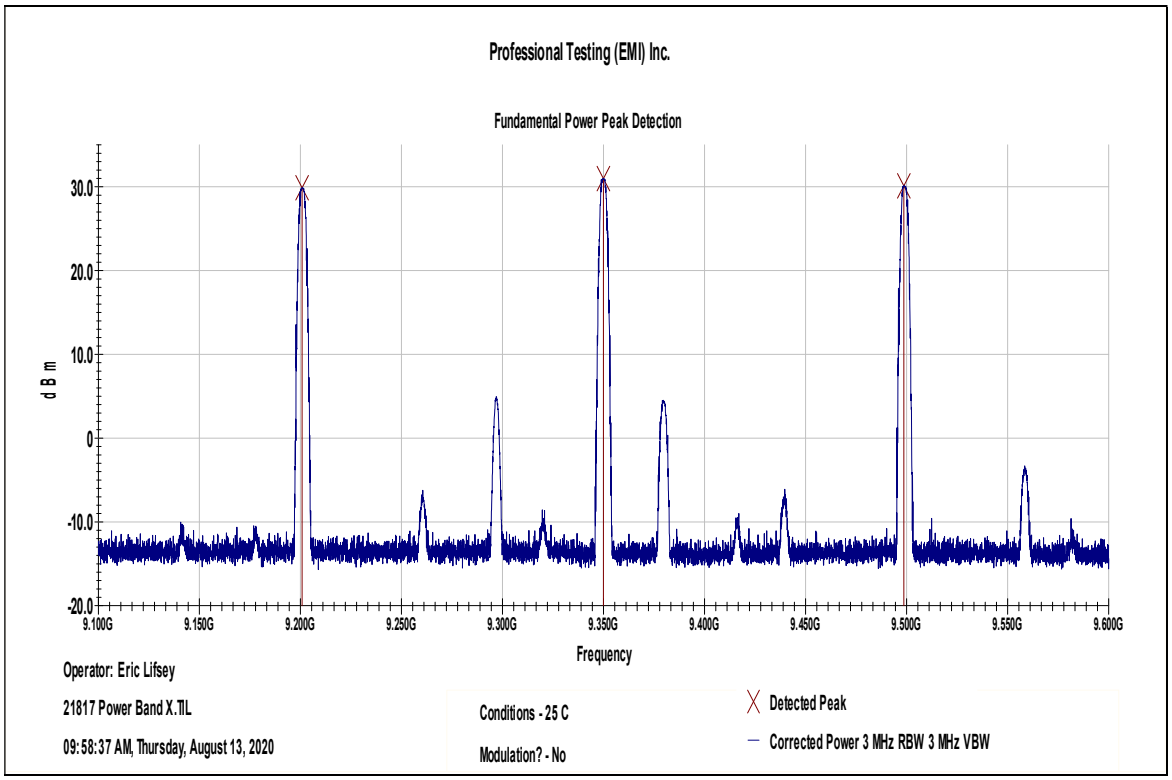
## 3.2 Test Criteria

| Authorized Power |
|---|
| Maximum peak power 20 Watts |

## 3.3 Test Results

| Table 3.3.1 Power Measured In 3 MHz RBW/VBW | | | |
|---|---|---|---|
| **Frequency** | **Measured Peak Power** | **Antenna Gain** | **EIRP** |
| 9201 MHz | 29.9 dBm or 0.977 Watts | 6 dBi | 35.9 dBm or 3.891 Watts |
| 9350 MHz | 31.0 dBm or 1.260 Watts | 6 dBi | 37.0 dBm or 5.011 Watts |
| 9499 MHz | 30.1 dBm or 1.023 Watts | 6 dBi | 36.1 dBm or 4.074 Watts |

The EUT satisfied the requirements.




**All Channels**

# 4.0 Occupied Bandwidth, Clause 2.1049

## 4.1 Test Procedure

The output of the EUT was connected to an attenuator and then to the spectrum analyzer. The spectrum analyzer was tuned to the frequency of the transceiver under test and the EUT activated in continuous transmit mode. Bandwidth is measured relative to the peak power measurement measured separately in full bandwidth.

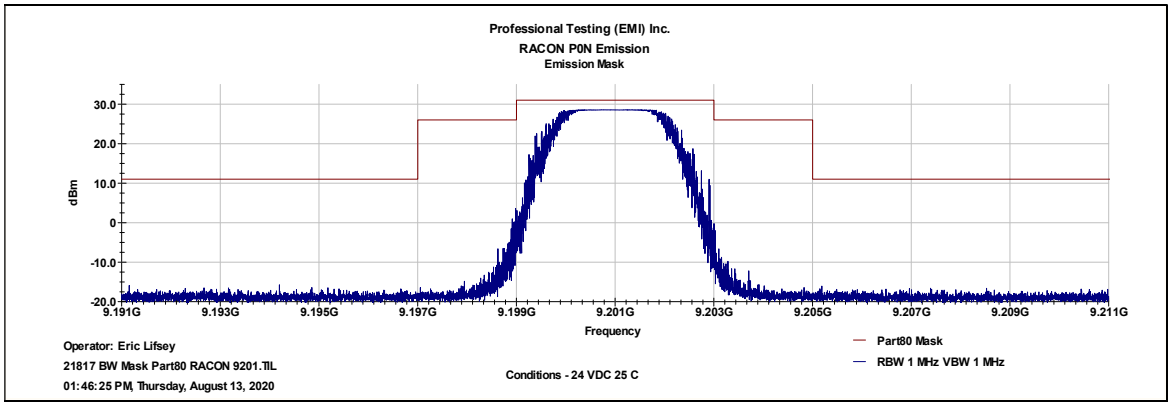
This device is keyed without modulation.

## 4.2 Test Criteria

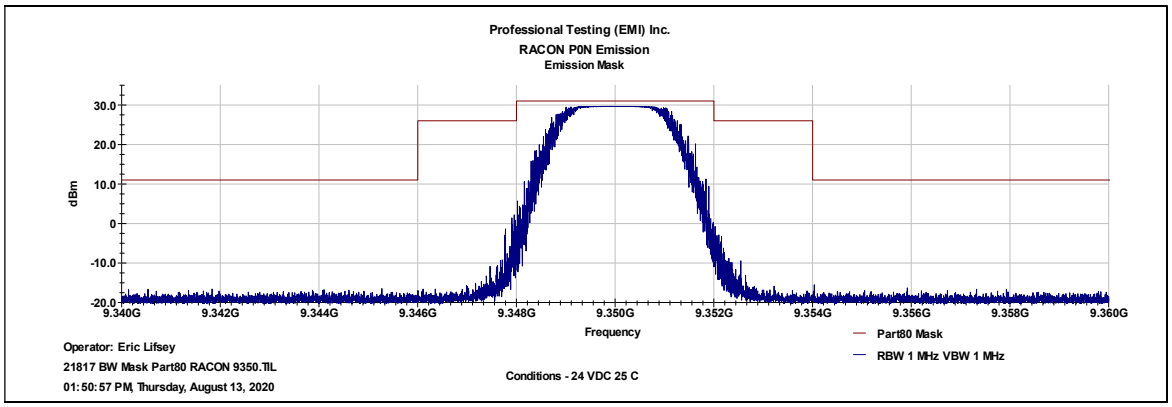
| Authorized Bandwidth, 2.1049 |
|---|
| < 2 MHz at -5 dBc,<br>< 4 MHz at -20 dBc; |

## 4.3 Test Results

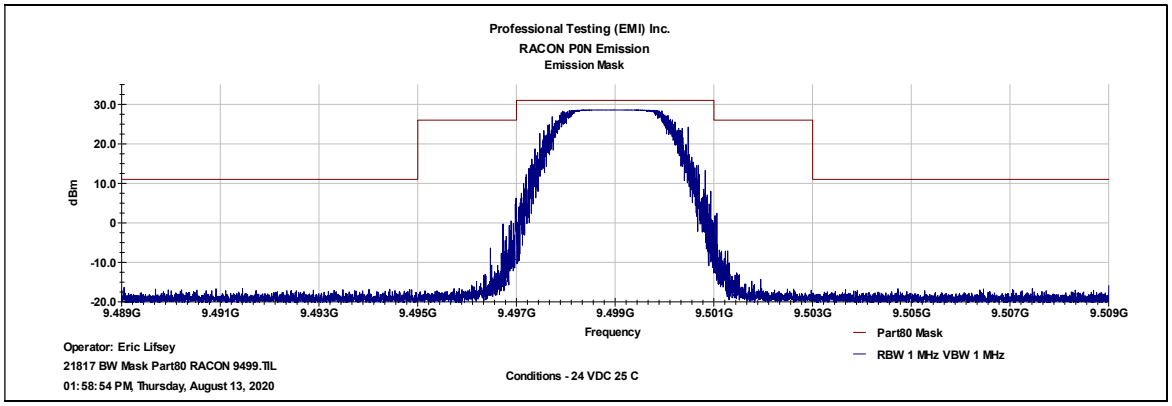
The EUT satisfied the requirements.




**Bottom Channel**




**Middle Channel**


Professional Testing (EMI) Inc.
RACON P0N Emission
Emission Mask
30.0
20.0
10.0
0
-10.0
-20.0
dBm
9.489G
9.491G
9.493G
9.495G
9.497G
9.499G
9.501G
9.503G
9.505G
9.507G
9.509G
Frequency
Part80 Mask
RBW 1 MHz VBW 1 MHz
Operator: Eric Lifsey
21817 BW Mask Part80 RACON 9499.TIL
01:58:54 PM, Thursday, August 13, 2020
Conditions - 24 VDC 25 C

**Top Channel**

# 5.0 Spurious Emissions at Antenna Terminals, Clause 80.211(f)(1)

## 5.1 Test Procedure

The output of the EUT was connected directly to an attenuator and then to the spectrum analyzer. A peak detector was used for the measurement. The transmitter was switched on, and the measurement receiver was tuned to the frequency of the transmitter under test. The loss of the attenuator was compensated by adding an offset to the analyzer amplitude. Spurious power was then measured directly with the spectrum analyzer.

## 5.2 Test Criteria

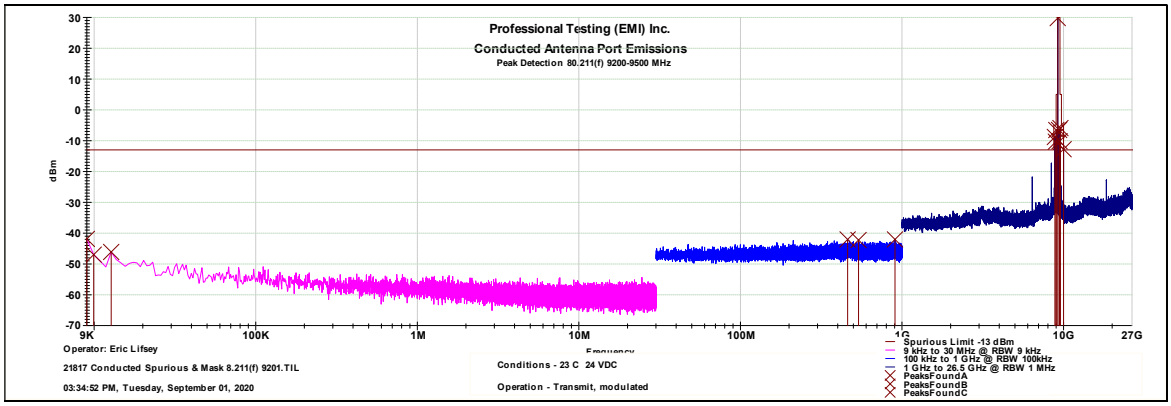
| Spurious Limit |
|---|
| Authorized BW 9.2 – 9.5 GHz or 300 MHz.<br><br>(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;<br>*100 MHz to 200 MHz outside band: 30 dBm - 25 dB = 5 dBm*<br><br>(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and<br>*200 MHz to 500 MHz outside band: 30 dBm - 35 dB = -5 dBm*<br><br>(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10log10 (mean power in watts) dB.<br>*Use -13 dBm as conservative limit (is closer to -12.6 dBm)*<br>*Beyond 300 * 2.5 = 750 MHz; 43+10log(1W) = 30 dBm - 43 dB = -13 dBm* |

## 5.3 Test Results

Conducted port emissions were performed to 26.5 GHz. Above this frequency the emissions were measured as radiated with the antenna attached.

The EUT satisfied the requirements.

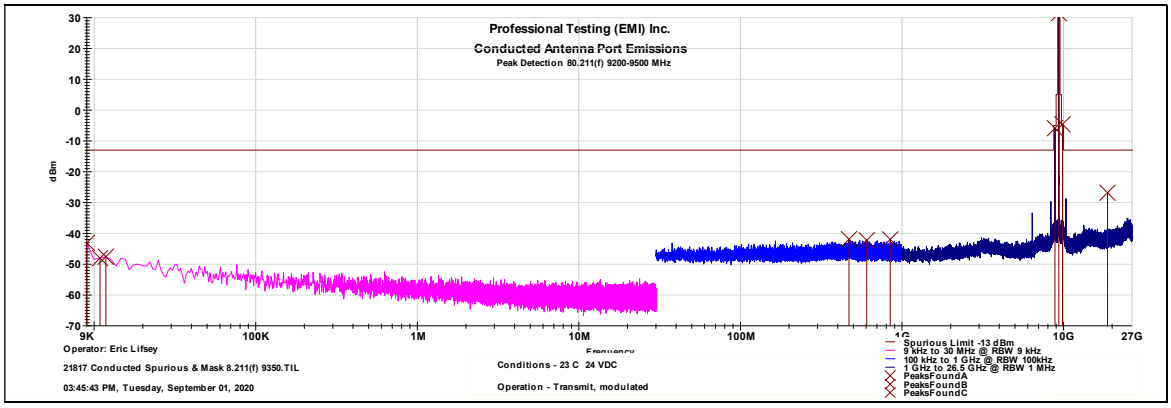
### 5.3.1 Bottom Channel




Signals under mask reported elsewhere.

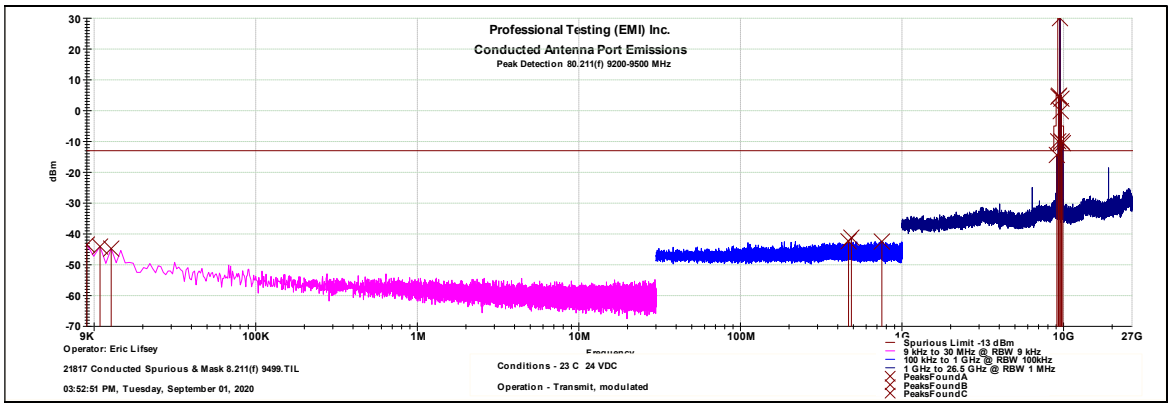
| Frequency | Level |
|---|---|
| MHz | dBm |
| 9.0 KHz | -41.9 |
| 9.9372 KHz | -47.0 |
| 12.749 KHz | -46.1 |
| 461.04 MHz | -42.1 |
| 538.12 MHz | -42.3 |
| 904.46 MHz | -42.1 |

### 5.3.2 Middle Channel




| Frequency | Levels |
|---|---|
| MHz | dBm |
| 9.0 KHz | -43.1 |
| 10.874 KHz | -48.1 |
| 11.812 KHz | -47.6 |
| 469.65 MHz | -41.9 |
| 605.61 MHz | -42.3 |
| 846.42 MHz | -42.0 |

### 5.3.3 Top Channel




| Frequency | Level |
|---|---|
| MHz | dBm |
| 9.0 KHz | -43.5 |
| 10.874 KHz | -44.1 |
| 12.749 KHz | -44.8 |
| 466.62 MHz | -42.4 |
| 486.14 MHz | -41.2 |
| 750.91 MHz | -42.5 |

# 6.0 Field Strength of Spurious Emissions, Clause 80.211(f)(1)

## 6.1 Test Procedure

The EUT was placed on a non-conductive table above the ground plane. The table was centered on a rotating turntable at a distance of 10 meters from the measurement antenna. The EUT was placed into transmit mode with the antenna removed and a resistive terminator substituted. EUT height was 80 cm below 1 GHz and 150 cm above 1 GHz.

## 6.2 Test Criteria

| Spurious Limit |
|---|
| Authorized BW 9.2 – 9.5 GHz or 300 MHz.<br><br>(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;<br>*100 MHz to 200 MHz outside band: 30 dBm - 25 dB = 5 dBm*<br><br>(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and<br>*200 MHz to 500 MHz outside band: 30 dBm - 35 dB = -5 dBm*<br><br>(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10log10 (mean power in watts) dB.<br>*Use -13 dBm as conservative limit (is closer to -12.6 dBm)*<br>*Beyond 300 * 2.5 = 750 MHz; 43+10log(1W) = 30 dBm - 43 dB = -13 dBm*<br>***Radiated limit (avg det.) > 1 GHz is 82.2 dBuV/m @ 3 meters.*** |

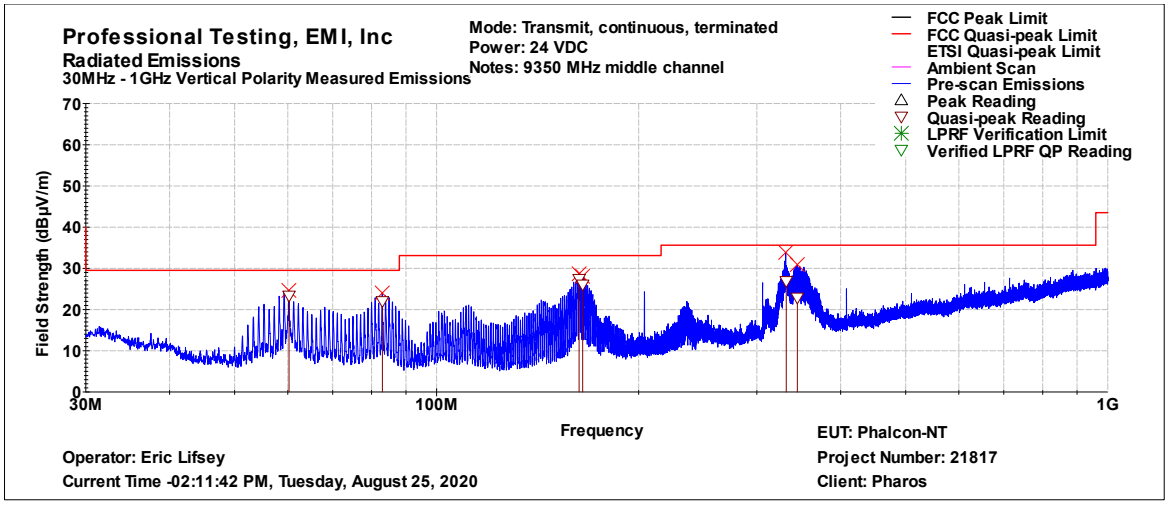
## 6.3 Test Results

The EUT satisfied the requirements.

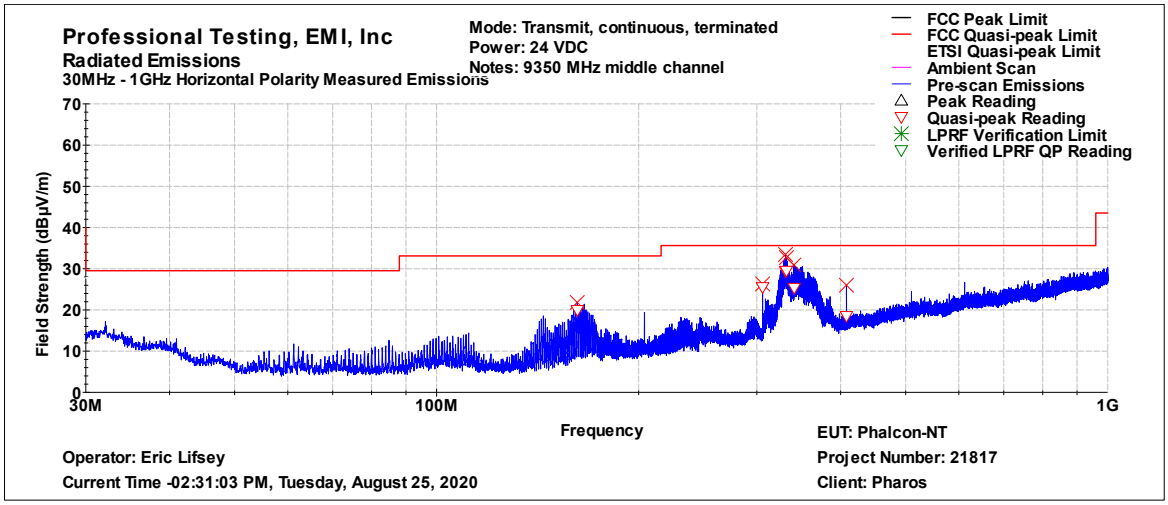
Above 26.5 GHz the radiated emissions were measured with the antenna attached.

While the general emission limits of 15.209 are shown below and largely satisfied, the spurious limit (average detection) is ~18 dB higher.

### 6.3.1 Middle Channel to 1 GHz

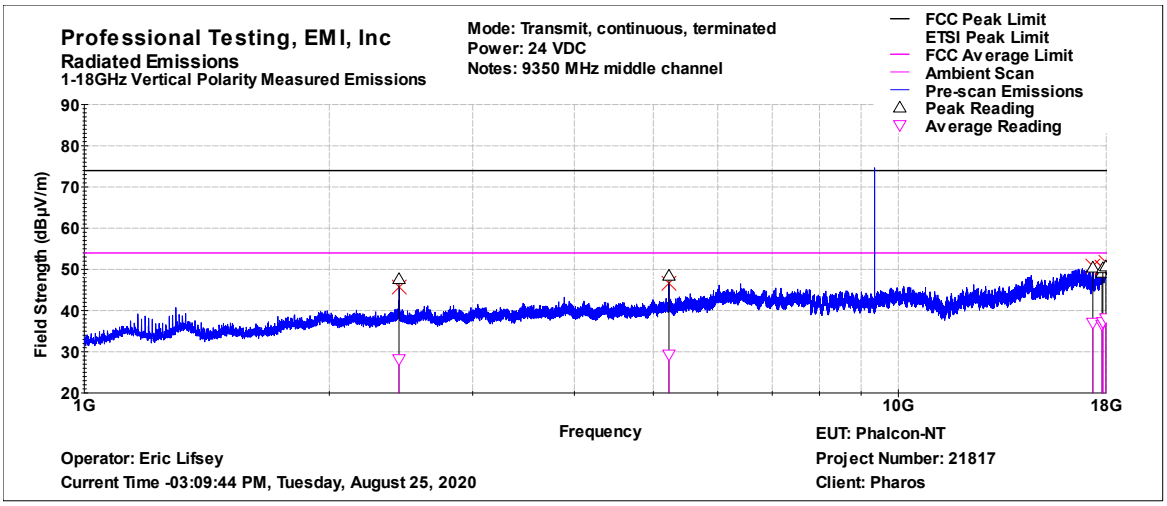



| Frequency | Azimuth | Height | QP | QP Limit | QP Margin | QP Results |
|---|---|---|---|---|---|---|
| MHz | (deg) | (cm) | (dBµV) | (dBµV) | (dB) | (P/F) |
| 60.261 | 23.000 | 245.000 | 23.369 | 29.500 | -6.131 | PASS |
| 83.004 | 5.000 | 151.000 | 22.023 | 29.500 | -7.477 | PASS |
| 163.033 | 339.000 | 127.000 | 27.406 | 33.100 | -5.694 | PASS |
| 165.029 | 354.000 | 127.000 | 26.034 | 33.100 | -7.066 | PASS |
| 331.845 | 67.000 | 127.000 | 26.877 | 35.600 | -8.723 | PASS |
| 344.764 | 21.000 | 127.000 | 22.892 | 35.600 | -12.708 | PASS |

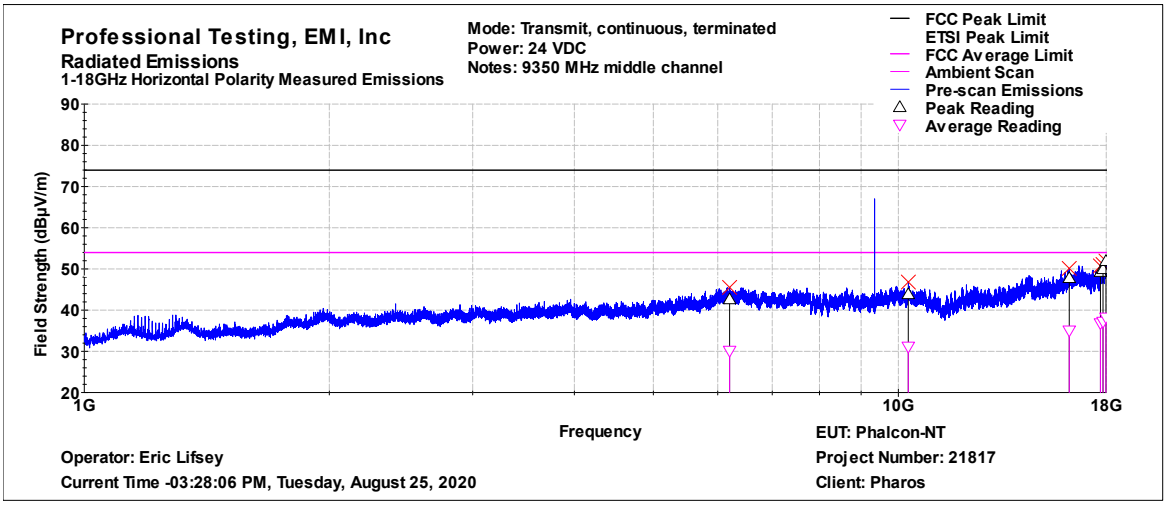



| Frequency | Azimuth | Height | QP | QP Limit | QP Margin | QP Results |
|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBµV) | (dBµV) | (dB) | (P/F) |
| 162.069 | 115.000 | 379.000 | 19.931 | 33.100 | -13.169 | PASS |
| 306.007 | 180.000 | 244.000 | 25.498 | 35.600 | -10.102 | PASS |
| 331.137 | 224.000 | 227.000 | 29.407 | 35.600 | -6.193 | PASS |
| 332.114 | 215.000 | 224.000 | 29.488 | 35.600 | -6.112 | PASS |
| 341.022 | 209.000 | 216.000 | 25.333 | 35.600 | -10.267 | PASS |
| 408.010 | 357.000 | 187.000 | 18.498 | 35.600 | -17.102 | PASS |

### 6.3.2 Middle Channel 1 to 18 GHz

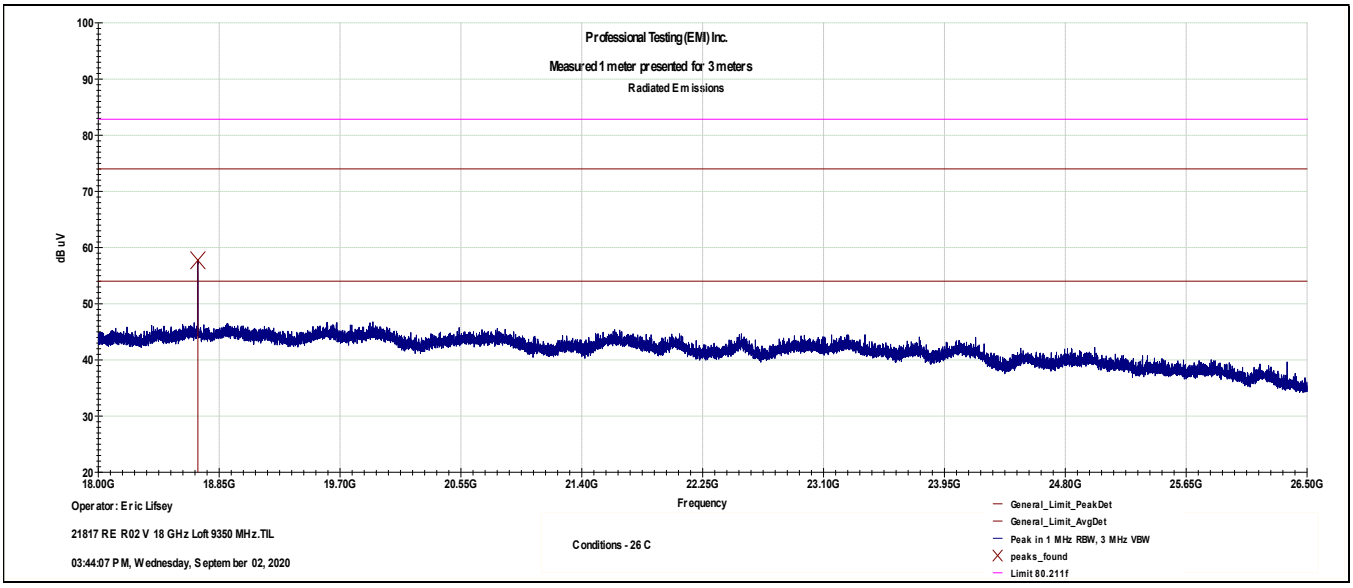



| Frequency | Azimuth | Height | Peak | Peak Limit | Peak Margin | Peak Results | Avg | Avg Limit | Avg Margin | Avg Results |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBuV) | (dBuV) | (dB) | (P/F) | (dBuV) | (dBuV) | (dB) | (P/F) |
| 2435.49 | 344 | 206 | 47.649 | 73.958 | -26.309 | PASS | 28.168 | 53.958 | -25.790 | PASS |
| 5227.01 | 201 | 377 | 48.459 | 73.958 | -25.499 | PASS | 29.300 | 53.958 | -24.658 | PASS |
| 17331.32 | 174 | 102 | 50.437 | 73.958 | -23.521 | PASS | 37.018 | 53.958 | -16.940 | PASS |
| 17791.90 | 3 | 157 | 49.183 | 73.958 | -24.775 | PASS | 36.540 | 53.958 | -17.418 | PASS |
| 17831.56 | 57 | 126 | 50.277 | 73.958 | -23.681 | PASS | 37.169 | 53.958 | -16.789 | PASS |
| 17984.03 | 37 | 307 | 50.714 | 73.958 | -23.244 | PASS | 38.099 | 53.958 | -15.859 | PASS |

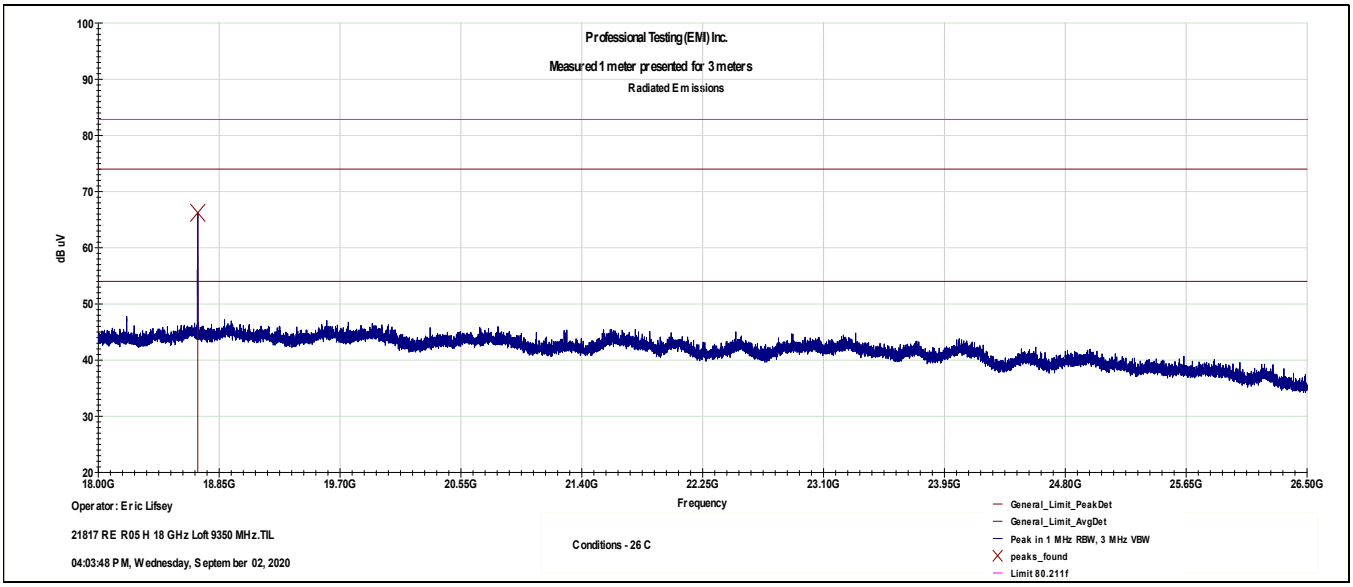



| Frequency | Azimuth | Height | Peak | Peak Limit | Peak Margin | Peak Results | Avg | Avg Limit | Avg Margin | Avg Results |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBuV) | (dBuV) | (dB) | (P/F) | (dBuV) | (dBuV) | (dB) | (P/F) |
| 6203.91 | 177 | 140 | 42.635 | 73.958 | -31.323 | PASS | 30.118 | 53.958 | -23.840 | PASS |
| 10285.20 | 158 | 320 | 43.881 | 73.958 | -30.077 | PASS | 31.115 | 53.958 | -22.843 | PASS |
| 16213.21 | 51 | 377 | 47.805 | 73.958 | -26.153 | PASS | 35.028 | 53.958 | -18.930 | PASS |
| 17711.19 | 161 | 103 | 49.285 | 73.958 | -24.673 | PASS | 36.787 | 53.958 | -17.171 | PASS |
| 17838.67 | 69 | 378 | 49.948 | 73.958 | -24.010 | PASS | 37.139 | 53.958 | -16.819 | PASS |
| 17987.46 | 326 | 293 | 51.930 | 73.958 | -22.028 | PASS | 38.156 | 53.958 | -15.802 | PASS |

### 6.3.3 Middle Channel 18 to 26.5 GHz

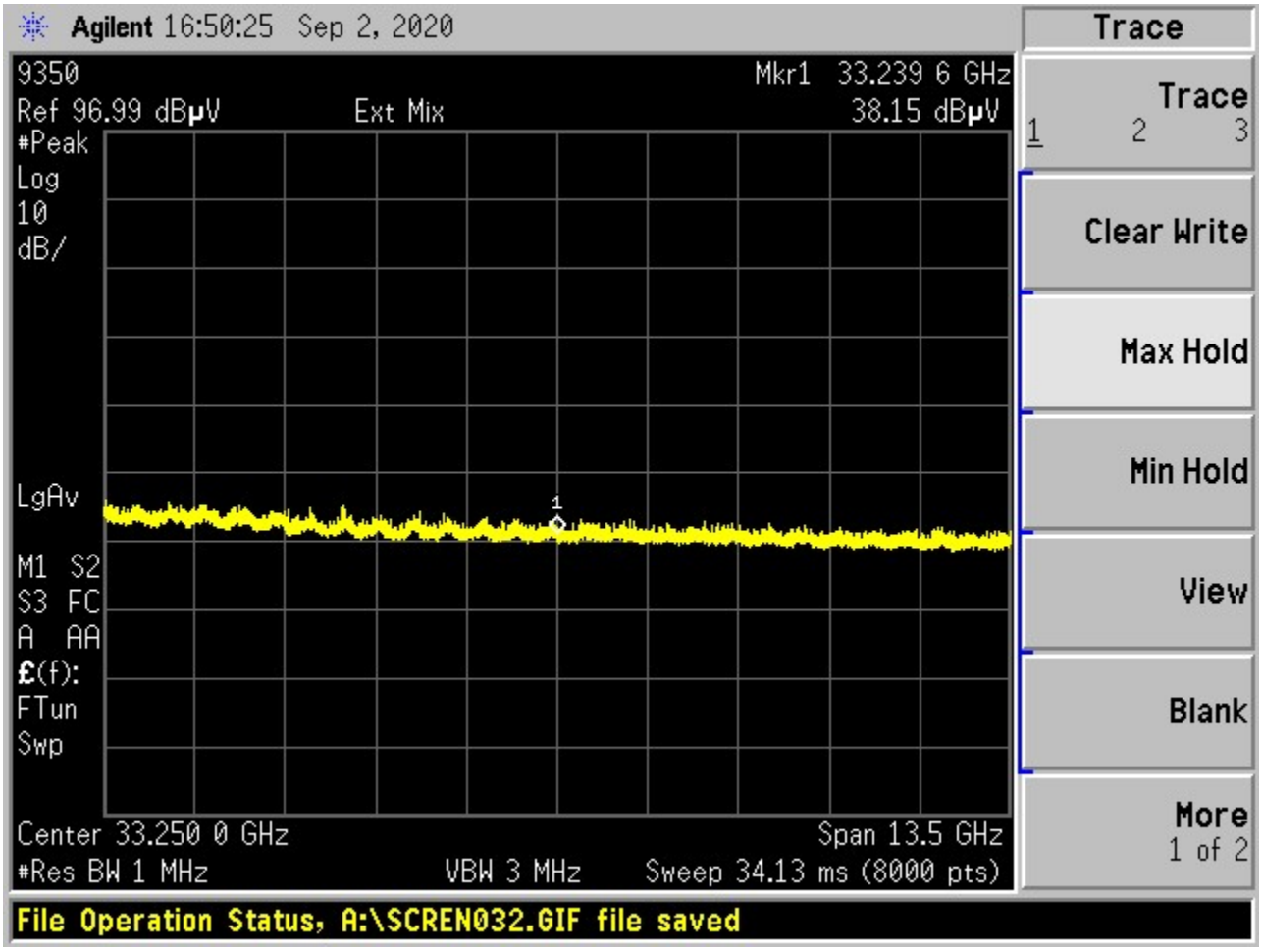



**Vertical Polarity; highest recorded: 57.7 dBµV/m, 18.701 GHz**



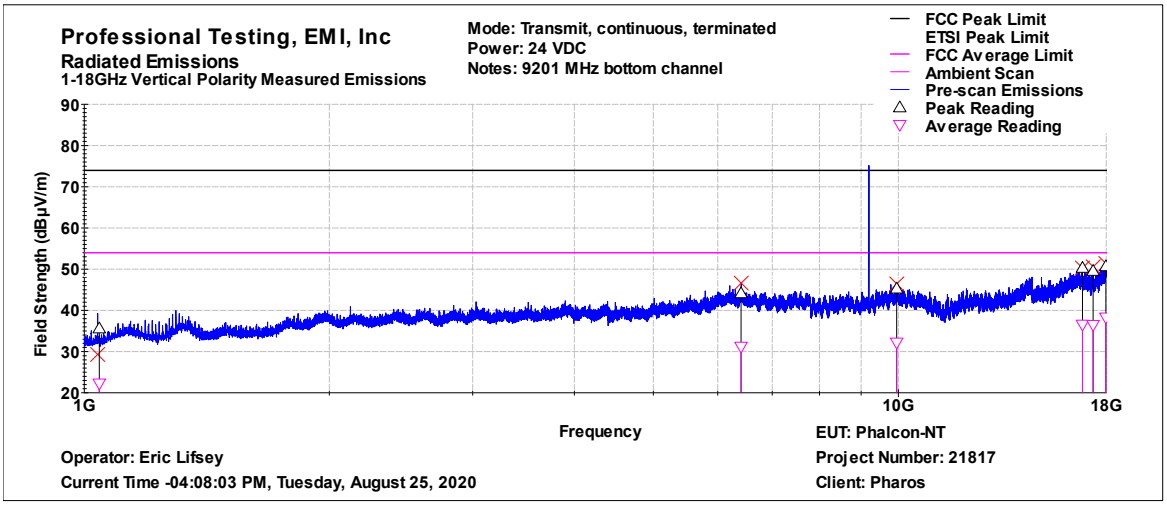

**Horizontal Polarity; highest recorded: 66.2 dBµV/m, 18.700 GHz**

### 6.3.4 Middle Channel 26.5 to 40 GHz

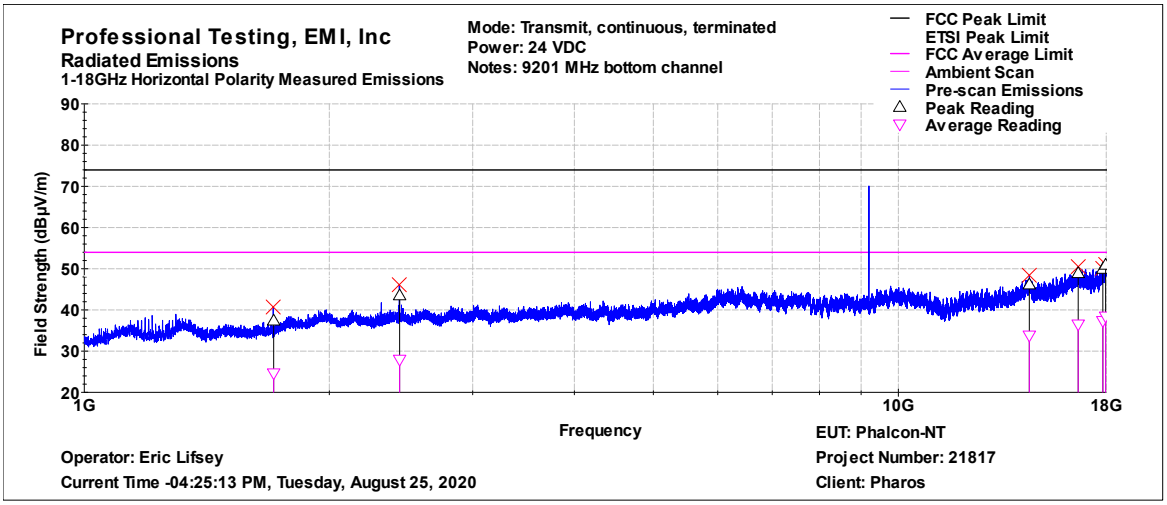



**26.5 to 40 GHz**
**Max-hold of vertical and horizontal emissions.**

### 6.3.5 Bottom Channel 1 to 18 GHz

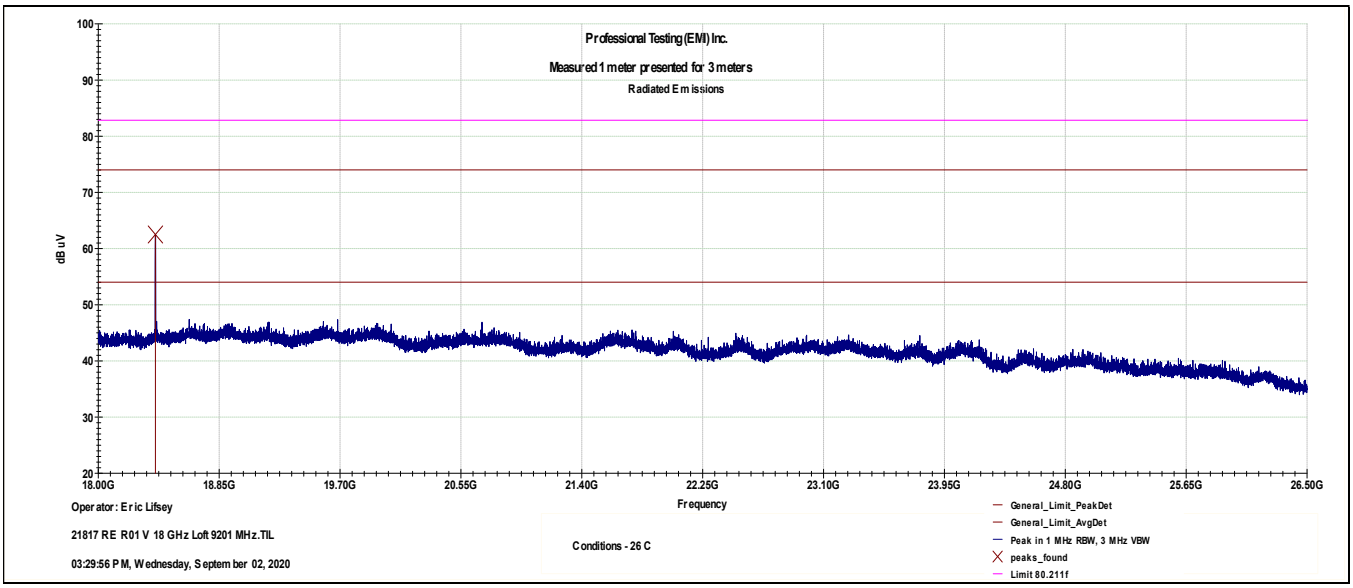



| Frequency | Azimuth | Height | Peak | Peak Limit | Peak Margin | Peak Results | Avg | Avg Limit | Avg Margin | Avg Results |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBuV) | (dBuV) | (dB) | (P/F) | (dBuV) | (dBuV) | (dB) | (P/F) |
| 1043.45 | 169 | 326 | 35.624 | 73.958 | -38.334 | PASS | 22.227 | 53.958 | -31.731 | PASS |
| 6408.27 | 127 | 185 | 44.163 | 73.958 | -29.795 | PASS | 31.157 | 53.958 | -22.801 | PASS |
| 9950.87 | 329 | 240 | 45.298 | 73.958 | -28.660 | PASS | 32.154 | 53.958 | -21.804 | PASS |
| 16831.38 | 122 | 296 | 50.325 | 73.958 | -23.633 | PASS | 36.498 | 53.958 | -17.460 | PASS |
| 17347.93 | 134 | 102 | 49.597 | 73.958 | -24.361 | PASS | 36.439 | 53.958 | -17.519 | PASS |
| 17983.41 | 2 | 376 | 50.712 | 73.958 | -23.246 | PASS | 38.240 | 53.958 | -15.718 | PASS |

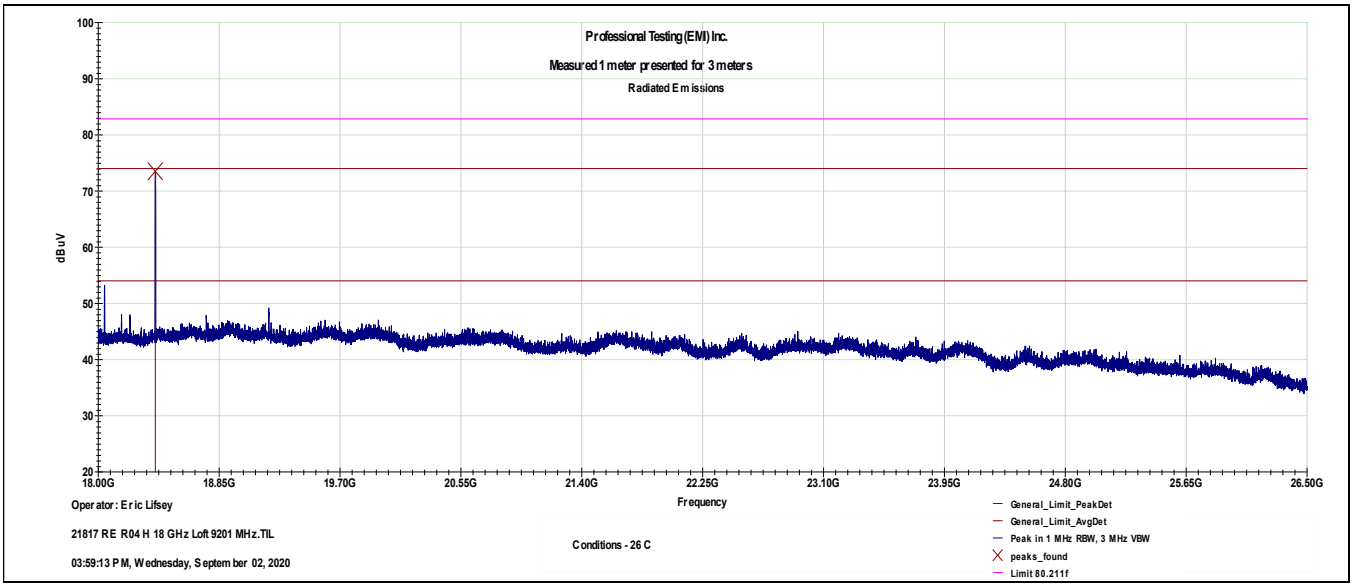



| Frequency | Azimuth | Height | Peak | Peak Limit | Peak Margin | Peak Results | Avg | Avg Limit | Avg Margin | Avg Results |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBuV) | (dBuV) | (dB) | (P/F) | (dBuV) | (dBuV) | (dB) | (P/F) |
| 1708.54 | 19 | 321 | 37.426 | 73.958 | -36.532 | PASS | 24.569 | 53.958 | -29.389 | PASS |
| 2440.04 | 42 | 102 | 43.552 | 73.958 | -30.406 | PASS | 27.880 | 53.958 | -26.078 | PASS |
| 14483.06 | 288 | 102 | 46.200 | 73.958 | -27.758 | PASS | 33.747 | 53.958 | -20.211 | PASS |
| 16629.76 | 30 | 102 | 48.936 | 73.958 | -25.022 | PASS | 36.435 | 53.958 | -17.523 | PASS |
| 17830.51 | 260 | 102 | 49.974 | 73.958 | -23.984 | PASS | 37.273 | 53.958 | -16.685 | PASS |
| 17972.29 | 251 | 102 | 50.977 | 73.958 | -22.981 | PASS | 38.365 | 53.958 | -15.593 | PASS |

### 6.3.6 Bottom Channel 18 to 26.5 GHz

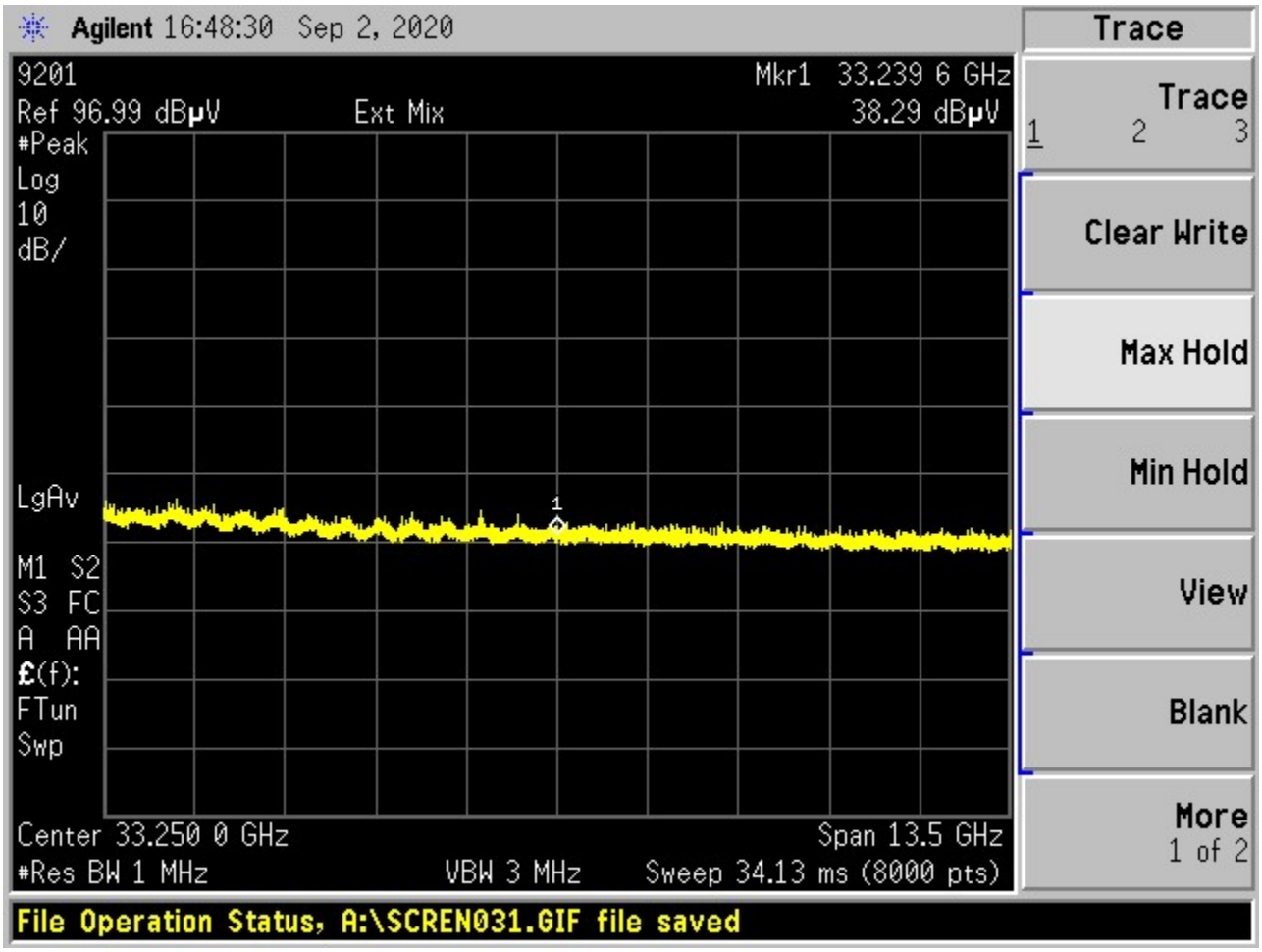



**Vertical Polarity; highest recorded: 62.5 dBµV/m, 18.402 GHz**



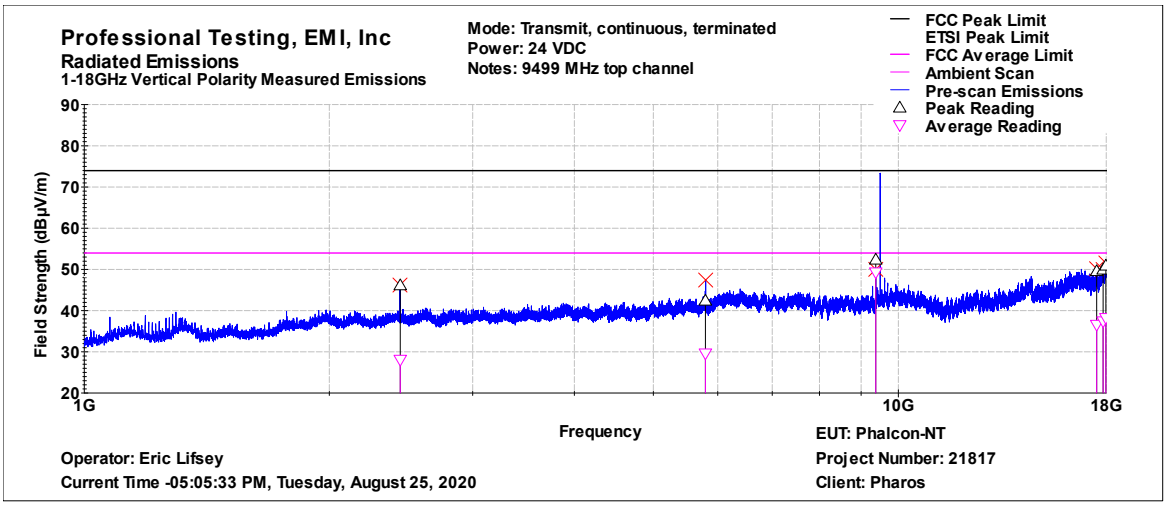

**Horizontal Polarity; highest recorded: 73.5 dBµV/m, 18.401 GHz**

### 6.3.7 Bottom Channel 26.5 to 40 GHz

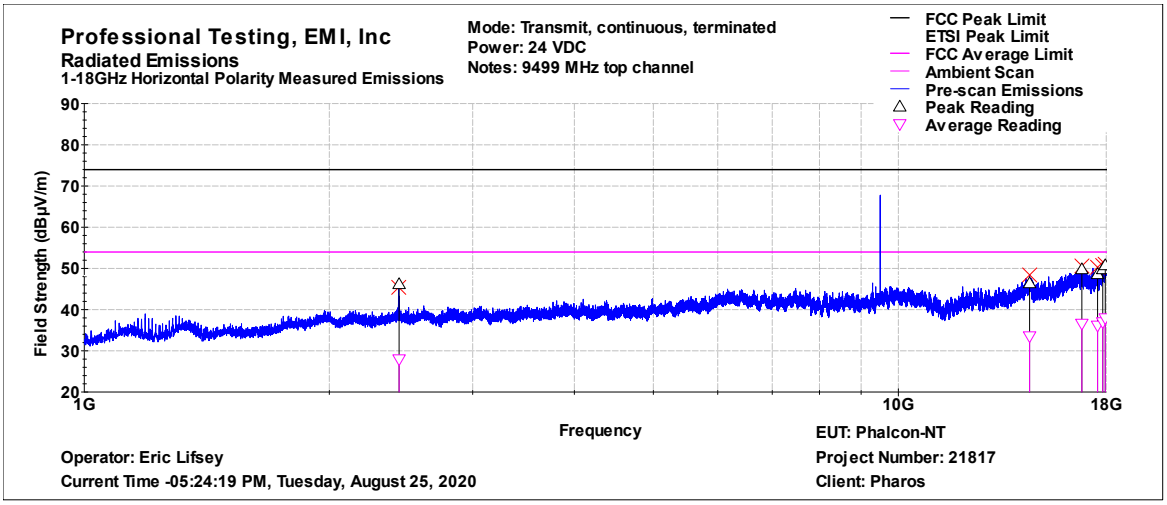



**26.5 to 40 GHz**
**Max-hold of vertical and horizontal emissions.**

### 6.3.8 Top Channel 1 to 18 GHz

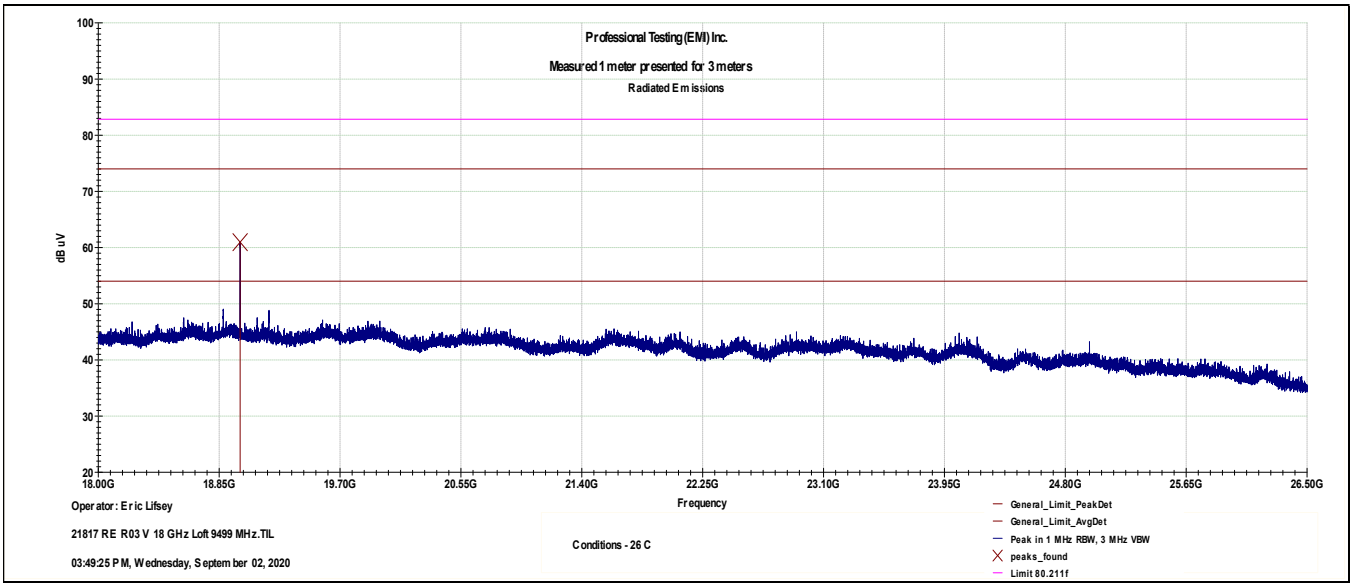



| Frequency | Azimuth | Height | Peak | Peak Limit | Peak Margin | Peak Results | Avg | Avg Limit | Avg Margin | Avg Results |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBuV) | (dBuV) | (dB) | (P/F) | (dBuV) | (dBuV) | (dB) | (P/F) |
| 2444.40 | 138 | 271 | 46.155 | 73.958 | -27.803 | PASS | 28.035 | 53.958 | -25.923 | PASS |
| 5794.06 | 60 | 351 | 42.418 | 73.958 | -31.540 | PASS | 29.573 | 53.958 | -24.385 | PASS |
| 9380.04 | 126 | 377 | 52.388 | 73.958 | -21.570 | PASS | 49.235 | 53.958 | -4.723 | PASS |
| 17520.94 | 2 | 373 | 49.591 | 73.958 | -24.367 | PASS | 36.524 | 53.958 | -17.434 | PASS |
| 17844.87 | 33 | 329 | 49.968 | 73.958 | -23.990 | PASS | 37.361 | 53.958 | -16.597 | PASS |
| 17984.57 | 261 | 102 | 50.939 | 73.958 | -23.019 | PASS | 38.174 | 53.958 | -15.784 | PASS |

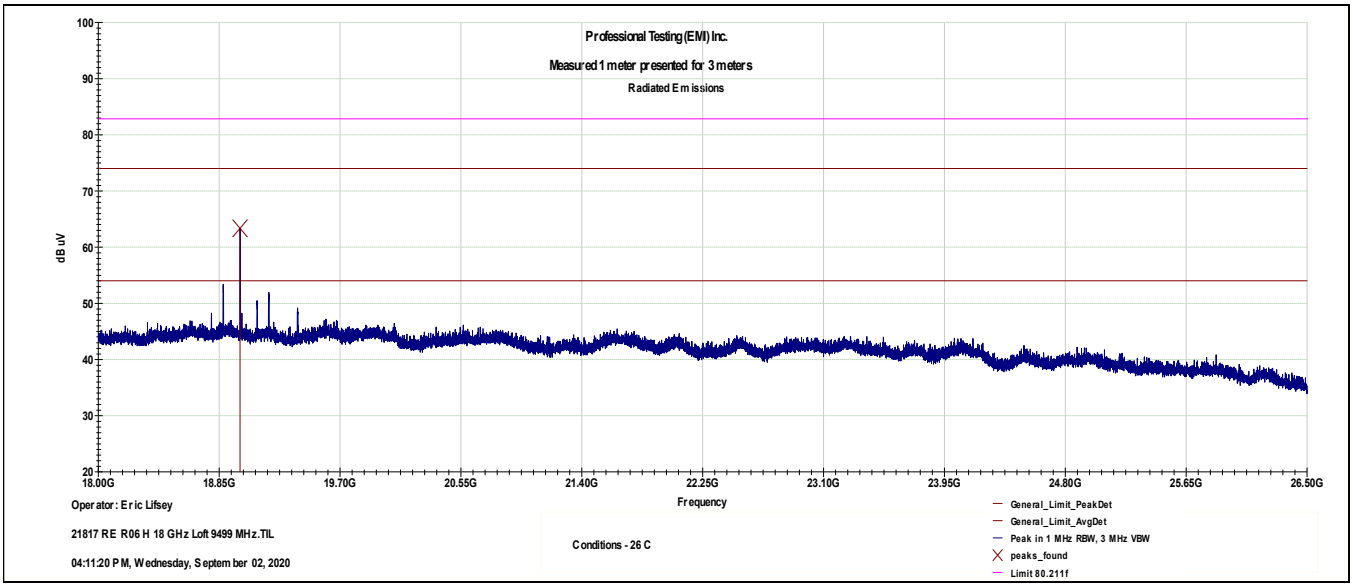



| Frequency | Azimuth | Height | Peak | Peak Limit | Peak Margin | Peak Results | Avg | Avg Limit | Avg Margin | Avg Results |
|---|---|---|---|---|---|---|---|---|---|---|
| (MHz) | (deg) | (cm) | (dBuV) | (dBuV) | (dB) | (P/F) | (dBuV) | (dBuV) | (dB) | (P/F) |
| 2436.29 | 333 | 135 | 46.190 | 73.958 | -27.768 | PASS | 27.912 | 53.958 | -26.046 | PASS |
| 14494.94 | 357 | 312 | 46.416 | 73.958 | -27.542 | PASS | 33.489 | 53.958 | -20.469 | PASS |
| 16803.16 | 222 | 377 | 49.808 | 73.958 | -24.150 | PASS | 36.544 | 53.958 | -17.414 | PASS |
| 17567.83 | 357 | 126 | 48.625 | 73.958 | -25.333 | PASS | 36.084 | 53.958 | -17.874 | PASS |
| 17825.93 | 161 | 229 | 49.803 | 73.958 | -24.155 | PASS | 36.909 | 53.958 | -17.049 | PASS |
| 17951.85 | 2 | 140 | 50.783 | 73.958 | -23.175 | PASS | 37.869 | 53.958 | -16.089 | PASS |

### 6.3.9 Top Channel 18 to 26.5 GHz

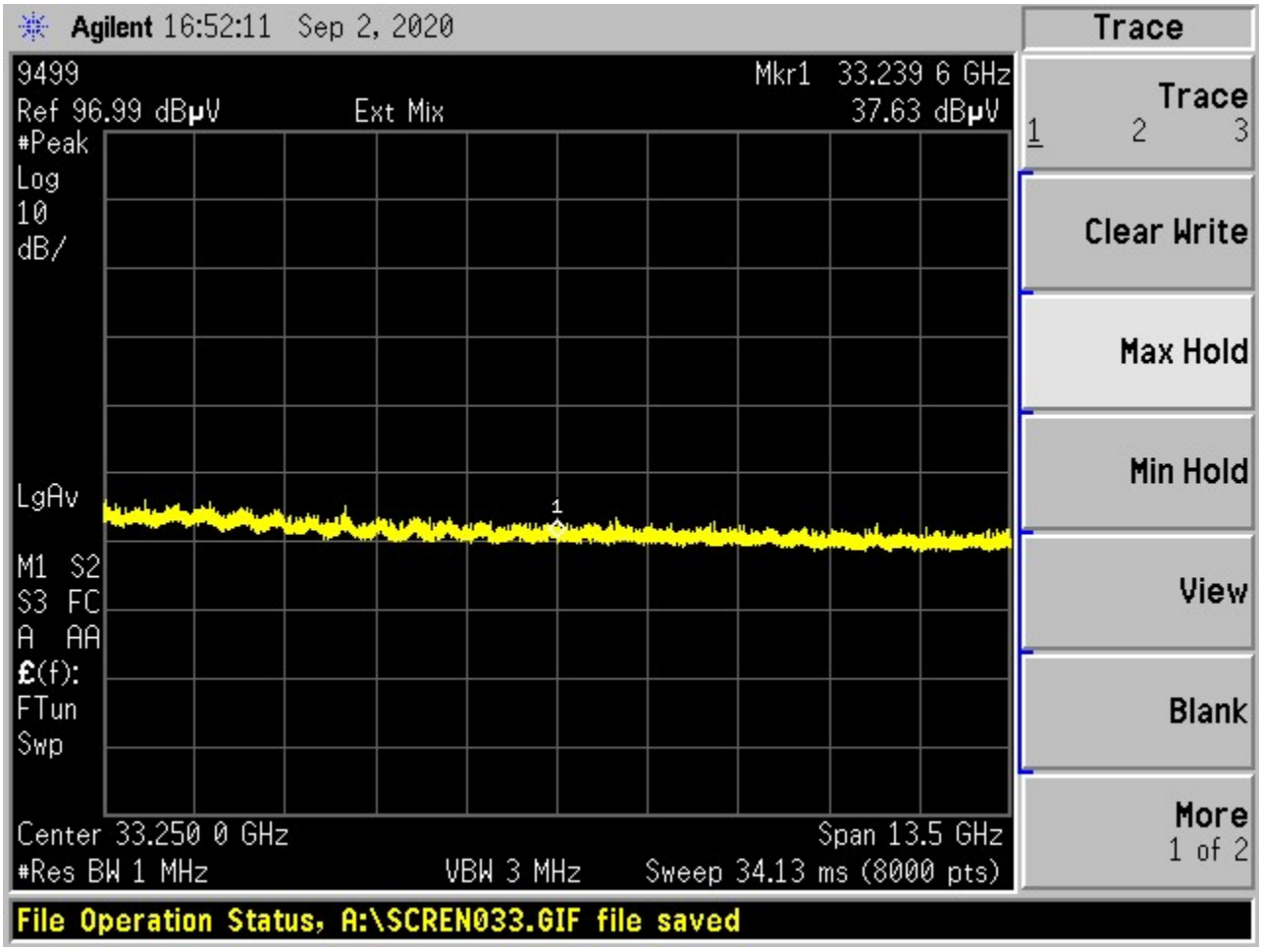



**Vertical Polarity; highest recorded: 60.9 dBµV/m, 18.998 GHz**




**Horizontal Polarity; highest recorded: 63.3 dBµV/m, 18.997 GHz**

### 6.3.10 Top Channel 26.5 to 40 GHz




**26.5 to 40 GHz**
**Max-hold of vertical and horizontal emissions.**

# 7.0 Frequency Stability

## 7.1 Test Procedure

The EUT is placed into a temperature chamber and connected by cable to a spectrum analyzer; attenuation added if needed. On reaching each set point temperature, the EUT is allowed to soak at least 15 minutes without power applied. After soak time was satisfied, the EUT is powered on in transmit mode and the frequency is observed until it becomes stable; then the measurement of frequency is taken.

Operating voltage stability was also measured for selected extremes based on operating design. This device operates over a wide voltage range greater than the FCC basic requirement.

The EUT is operated in unmodulated mode and continuous transmit.

## 7.2 Test Criteria

**Parameter: Frequency Tolerance**

*80.209 (c) For stations in the maritime radiodetermination service, other than ship radar stations, the authorized frequency tolerance will be specified on the license when it is not specified in this part.*

**From Technical Manual:**

| **Frequency performance** | |
|---|---|
| Frequency accuracy (50ns to 200ns pulse widths) | ±3.5MHz |
| Frequency accuracy(>200ns pulse widths) | ±1.5MHz |

**Using ±1.5MHz as criteria.**

| **Test Conditions, Temperatures** |
|---|
| -20 C to 50 C and by 10 C steps |

| **Test Conditions, Voltage** | |
|---|---|
| Low Voltage | 10 V |
| Nominal Voltage | 28 VDC |
| High Voltage | 40 VDC |

## 7.3 Test Results

The EUT satisfies the requirement.

### 7.3.1 Temperature

| | | | 12-Aug-2020 |
|---|---|---|---|
| **Condition** | **Frequency** | | **Deviation** |
| Temperature (C) | Reference Center Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) |
| -20 | 9201.000000 | 9201.030000 | 30000 |
| -10 | 9201.000000 | 9201.050000 | 50000 |
| 0 | 9201.000000 | 9201.015000 | 15000 |
| 10 | 9201.000000 | 9201.035000 | 35000 |
| 20 | 9201.000000 | 9201.025000 | 25000 |
| 30 | 9201.000000 | 9201.015000 | 15000 |
| 40 | 9201.000000 | 9201.030000 | 30000 |
| 50 | 9201.000000 | 9201.020000 | 20000 |
| Max Deviation (Hz) | | | 50000 |
| Min Deviation (Hz) | | | 15000 |

| | | | 12-Aug-2020 |
|---|---|---|---|
| **Condition** | **Frequency** | | **Deviation** |
| Temperature (C) | Reference Center Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) |
| -20 | 9499.000000 | 9499.040000 | 40000 |
| -10 | 9499.000000 | 9499.015000 | 15000 |
| 0 | 9499.000000 | 9499.100000 | 100000 |
| 10 | 9499.000000 | 9499.020000 | 20000 |
| 20 | 9499.000000 | 9499.000000 | 0 |
| 30 | 9499.000000 | 9499.035000 | 35000 |
| 40 | 9499.000000 | 9499.095000 | 95000 |
| 50 | 9499.000000 | 9499.110000 | 110000 |
| Max Deviation (Hz) | | | 110000 |
| Min Deviation (Hz) | | | 0 |

### 7.3.2 Voltage

| | | | | 12-Aug-2020 |
|---|---|---|---|---|
| **Condition** | **Voltage** | **Frequency** | | |
| Voltage Extreme | Voltage (V DC) | Reference Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) |
| Low | 10.6 | 9201.000000 | 9201.030000 | 30000 |
| Nominal | 24.0 | 9201.000000 | 9201.025000 | 25000 |
| High | 36.0 | 9201.000000 | 9201.055000 | 55000 |

| | | | | 12-Aug-2020 |
|---|---|---|---|---|
| **Condition** | **Voltage** | **Frequency** | | |
| Voltage Extreme | Voltage (V DC) | Reference Frequency (MHz) | Measured Frequency (MHz) | Calculated Deviation (Hz) |
| Low | 10.6 | 9499.000000 | 9499.015000 | 15000 |
| Nominal | 24.0 | 9499.000000 | 9499.000000 | 0 |
| High | 36.0 | 9499.000000 | 9499.045000 | 45000 |

# 8.0 Equipment Lists

| Table 9.1 Equipment List; Power, Bandwidth, and Mask | | | | |
|---|---|---|---|---|
| **Asset #** | **Manufacturer** | **Model #** | **Description** | **Calibration Due** |
| 1937 | Agilent | E4440A | Spectrum Analyzer | 8 Nov 2020 |
| A105 | Narda | 768A-20 | Attenuator, 20 W, 20 dB | 23 Sep 2020 |
| 0463 | Fluke | 77A | DMM | 13 Jul 2021 |
| 1268 | HP | 6291A | DC Power Supply | CIU |

| Table 9.2 Equipment List; Frequency Stability | | | | |
|---|---|---|---|---|
| **Asset #** | **Manufacturer** | **Model #** | **Description** | **Calibration Due** |
| 1937 | Agilent | E4440A | Spectrum Analyzer | 8 Nov 2020 |
| A105 | Narda | 768A-20 | Attenuator, 20 W, 20 dB | 23 Sep 2020 |
| 2134 | Tenny | TPC T2C | Temperature Chamber | 8 Oct 2020 |
| C247 | Pasternack | RG type | Coaxial Cable, double shielded | CNR |
| 0463 | Fluke | 77A | DMM | 13 Jul 2021 |
| 1268 | HP | 6291A | DC Power Supply | CIU |

## Table 9.3 Equipment List; Radiated Emissions

| 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:** | | | **2019_May_Unintentional RE_TILE7_v2.5.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 | 11/6/2020 |
| 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 |
| | | | | | |
| 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 |
| | | | | | |

# 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**

***