Washington Laboratories, Ltd.
www.wll.com
7560 Lindbergh Drive . Gaithersburg, MD 20879
301.216.1500 . info@wll.com

# FCC Test Report
# For the
# Frederick Energy Products LLC
# DDAC-PAD and DDAC-PAD-XL (PAD)

## FCC ID: QUI-DDAC-PAD
## IC: 11625A-DDACPAD

WLL JOB# **16002**
**April 23, 2019**

Prepared for:
**Frederick Energy Products LLC**
**1769 Jeff Road**
**Huntsville, AL 35806**

Prepared By:
Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ilac-MRA

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY AT-1448

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Prepared by:

Michael Violette
Compliance Engineer

Reviewed by:

Steven D. Koster
President

 

# Abstract

This report has been prepared on behalf of Frederick Energy Products LLC to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.231 (10/2014) of the FCC Rules and Regulations and Industry Canada RSS210 issue 9 Annex A. This Certification Test Report documents the test configuration and test results for a Frederick Energy Products LLC DDAC-PAD and DDAC-PAD-XL (PAD).

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Frederick Energy Products LLC DDAC-PAD and DDAC-PAD-XL (PAD) complies with the limits for an Intentional Radiator device under FCC Part 15.231 and RSS210 Annex A.

 

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# 1 Introduction

## 1.1 Compliance Statement

The Frederick Energy Products LLC DDAC-PAD and DDAC-PAD-XL (PAD) complies with the limits for an Intentional Radiator device under FCC Part 15.231 (10/2014) and IC RSS210 issue 9.

## 1.2 Test Scope

Tests for radiated were performed. All measurements were performed in accordance with FCC part 15.231 and the 2013 version of ANSI C63.10. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

## 1.3 Contract Information

| | |
|---|---|
| Customer: | Frederick Energy Products LLC<br>1769 Jeff Road<br>Huntsville, AL 35806 |
| Quotation Number: | 71334 |

## 1.4 Test Dates

| | |
|---|---|
| Testing was performed on the following date(s): | 03/20/19 & 03/21/19 |

## 1.5 Test and Support Personnel

| | |
|---|---|
| Washington Laboratories, LTD | Michael Violette |
| Client Representative | Ishmael Chigumira |

## 1.6 Abbreviations

| | |
|---|---|
| **A** | **A**mpere |
| **ac** | **a**lternating **c**urrent |
| **AM** | Amplitude Modulation |
| **Amps** | **Amp**eres |
| **b/s** | **b**its per **s**econd |
| **BW** | **B**and**W**idth |
| **CE** | **C**onducted **E**mission |
| **cm** | **c**enti**m**eter |
| **CW** | **C**ontinuous **W**ave |
| **dB** | **d**eci**B**el |
| **dc** | **d**irect **c**urrent |
| **EMI** | **E**lectro**m**agnetic **I**nterference |
| **EUT** | **E**quipment **U**nder **T**est |
| **FM** | **F**requency **M**odulation |
| **G** | **g**iga - prefix for $10^9$ multiplier |
| **Hz** | **H**ertz |
| **IF** | **I**ntermediate **F**requency |
| **k** | **k**ilo - prefix for $10^3$ multiplier |
| **LISN** | **L**ine **I**mpedance **S**tabilization **N**etwork |
| **M** | **M**ega - prefix for $10^6$ multiplier |
| **m** | **m**eter |
| **µ** | **m**icro - prefix for $10^{-6}$ multiplier |
| **NB** | **N**arrow**b**and |
| **QP** | **Q**uasi-**P**eak |
| **RE** | **R**adiated **E**missions |
| **RF** | **R**adio **F**requency |
| **rms** | **r**oot-**m**ean-**s**quare |
| **SN** | **S**erial **N**umber |
| **S/A** | **S**pectrum **A**nalyzer |
| **V** | **V**olt |

 

# 2 Equipment Under Test

## 2.1 EUT Identification & Description

The Frederick Energy Products LLC DDAC-PAD and DDAC-PAD-XL (PAD) is a personnel worn proximity alarm that operates in conjunction with the Frederick Energy products, LLC Magnetic Field Generator which produces a 73kHz proximity field. When a DDAC-PAD and DDAC-PAD-XL (PAD) enters this field it causes the PAD unit to visually and audibly alarm. In addition the PAD unit sends its serial number back to the Magnetic Field Generator that causes the generator to visibly and audibly alarm.

The generator device is typically mounted on a vehicle, the PAD units are worn by personnel to warn both the equipment operators and people in the proximity of this equipment of possibly dangerous conditions

**Table 1. Device Summary**

| ITEM | DESCRIPTION |
|---|---|
| Manufacturer: | Frederick Energy Products LLC |
| FCC ID: | QUI-DDAC-PAD |
| IC: | 11625A-DDACPAD |
| Model: | DDAC-PAD and DDAC-PAD-XL (PAD) |
| FCC Rule Parts: | §15.231 |
| IC Rule Parts: | RSS210 Annex A |
| Emission Designator: | 448KF1D |
| Maximum Field Strength | 1972 uV/m @ 3m |
| Modulation: | FM/FSK |
| Occupied Bandwidth: | 448.7kHz |
| Keying: | Automatic |
| Type of Information: | Data |
| Number of Channels: | 1 (916.48MHz) |
| Power Output Level | Fixed |
| Antenna Connector | integral |
| Antenna Type | Grounded Line Planar Antenna |
| Interface Cables: | None |
| Power Source & Voltage: | 3.7Vdc Li-ion battery |
| Receiver | 73kHz |

## 2.2 Test Configuration

The EUT is a standalone unit. The EUT has a rechargeable battery, however the transceiver does not operate while charging.

## 2.3 Testing Algorithm

The DDAC-PAD and DDAC-PAD-XL (PAD) was configured to transmit constantly at 916.48MHz for radiated measurements.

Worst case emission levels are provided in the test results data.

 

## 2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by the American Association for Laboratory Accreditation (A2LA) under Certificate 2675.01 as an independent FCC test laboratory.

## 2.5 Measurements

### 2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 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

## 2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

**Equation 1: Standard Uncertainty**

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + .....}$$

Where $u_c$ = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a,\ b,\ c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

 

**Equation 2: Expanded Uncertainty**

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)

$u_c$ = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

**Table 2: Expanded Uncertainty List**

| Scope | Standard(s) | Expanded Uncertainty |
|---|---|---|
| Conducted Emissions | CISPR11, CISPR22, CISPR14, FCC Part 15 | 2.63 dB |
| Radiated Emissions | CISPR11, CISPR22, CISPR14, FCC Part 15 | 4.55 dB |

.

 

# 3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

**Table 3: Test Equipment List**

| Test Name: | **Radiated Emissions** | Test Date: | **03/20/2019** |
|---|---|---|---|
| **Asset #** | **Manufacturer/Model** | **Description** | **Cal. Due** |
| 528 | AGILENT - E4446A | 3HZ - 44GHZ ANALYZER SPECTRUM | 2/7/2020 |
| 276 | ELECTRO-METRICS - BPA-1000 | RF PRE-AMPLIFIER | 4/3/2020 |
| 522 | HP - 8449B | PRE-AMPLIFIER 1-26.5GHZ | 4/3/2020 |
| 644 | SUNOL SCIENCES CORPORATION - JB1 925-833-9936 | BICONALOG ANTENNA | 1/16/2020 |
| 4 | ARA - DRG-118/A | ANTENNA DRG 1-18GHZ | 6/14/2019 |

# 4 Test Results

## 4.1 Duty Cycle Correction

Measurements may be adjusted where pulsed RF is utilized to find the average level associated with a quantity. This calculation is applied to limits for unlicensed devices.

- For Unlicensed Intentional Radiators under 47CFR Part 15, all duty cycle measurements are compared to a 100 millisecond period

The duty cycle correction factor is calculated by:

20 x LOG (on time/100 ms)

The following Figures show the plots of the modulated carrier. The spectrum analyzer was set to Zero Span and the video triggered to collect the pulse train of the modulation. Calculations of the duty cycle correction factor were obtained from time data provided by the plots.

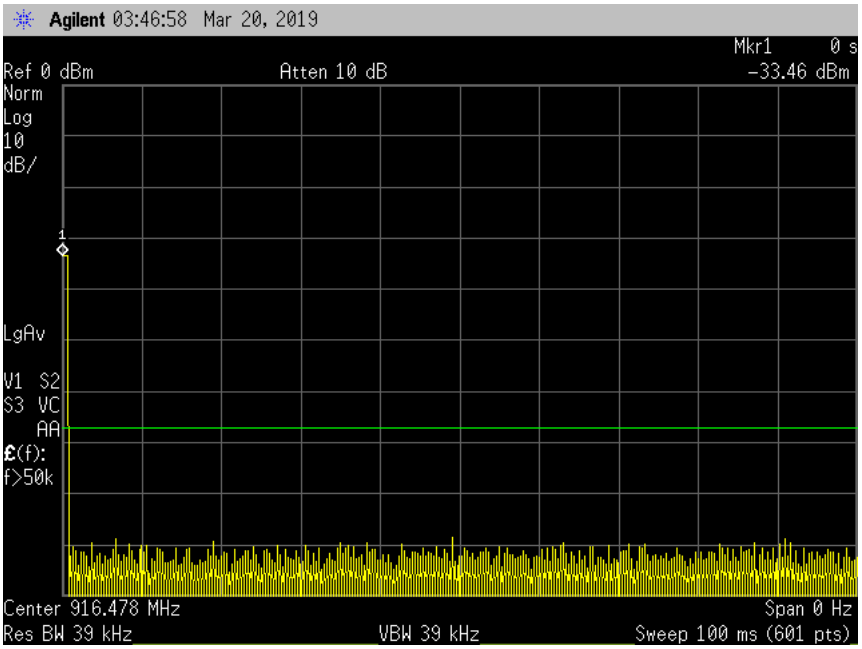


**Figure 1: Duty Cycle Plot – Worst Case 100ms and Pulse Train**

 

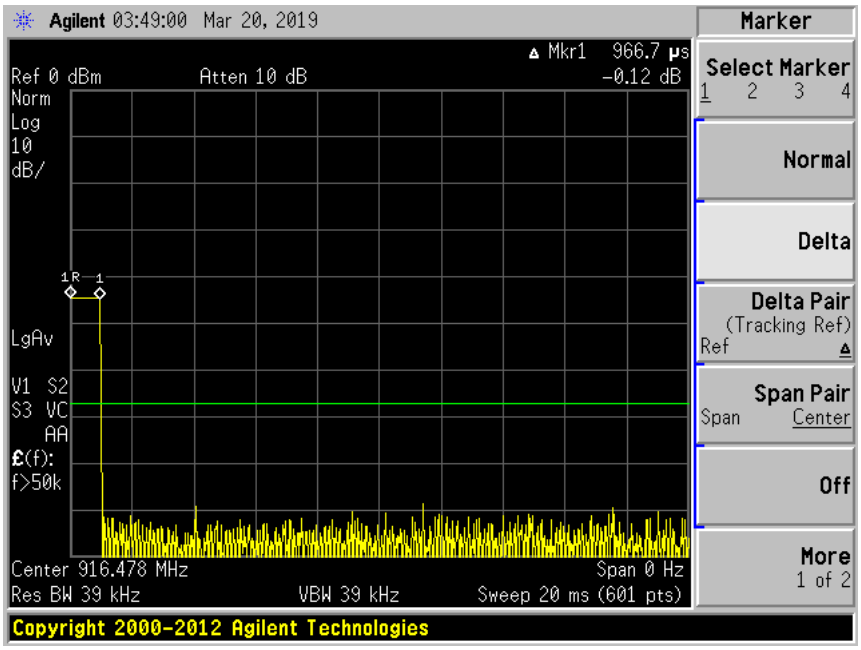


**Figure 2: Duty Cycle Plot – Pulse Width**

From the data in figures 2 and 3 the following calculations are made.

On Time Per 100ms (worst case) 966.7 us~1ms.

1 x 1ms = 1ms

Duty cycle calculation:

1/100ms = 20Log(1ms/100ms)= 20LOG(0.01) = -40dB duty cycle correction

However, the maximum duty cycle allowed under the Rules is 20dB. This correction was applied to the fundamental.

 

Transmit Turnoff Time (FCC Part §15.231(a) (2))
Per FCC part 15.231 Paragraph (a)(2) and RSS210 Annex A '*A transmitter activated automatically shall cease transmission within 5 seconds after activation.*'

The below figure shows that the turnoff time after activation is less than 5 seconds (see marker delta on plot) complying with the requirements of part 15.231(a)(2).

The EUT was measured by a spectrum analyzer through a near field antenna. The sweep was activated at the start of the EUT transmit signal.

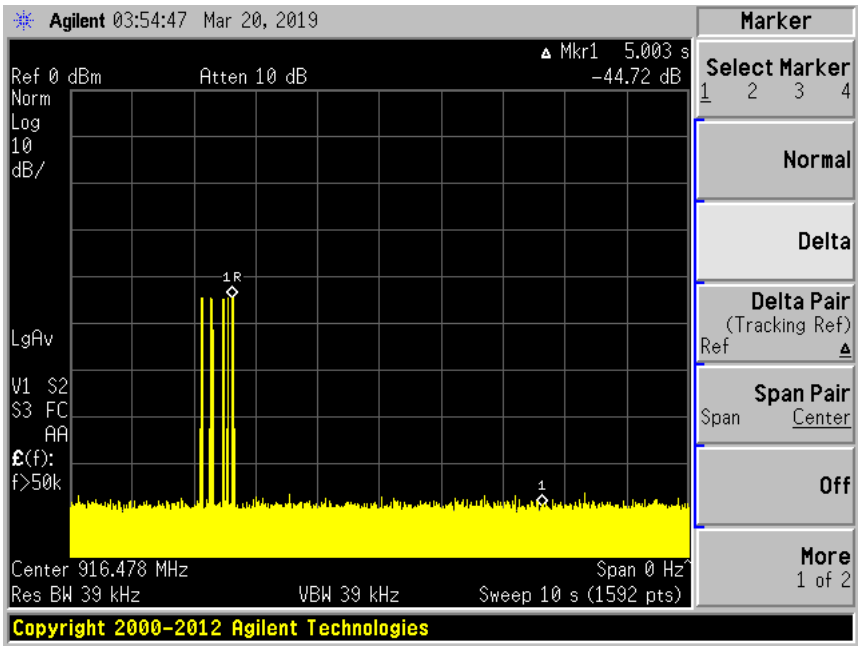


**Figure 3: EUT Turnoff Time**

 

## 4.2 FCC Part §15.231(a) (3) Compliance

Per FCC part 15.231 Paragraph (a)(3) and RSS210 Annex A *'Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour'*

The EUT transmits periodic data consisting of its serial number and battery. The below figures show that the periodic signal on time equals 8.5ms per 40.2 seconds or 0.761 seconds per hour. As this is used in a personnel safety application this complies with this section.

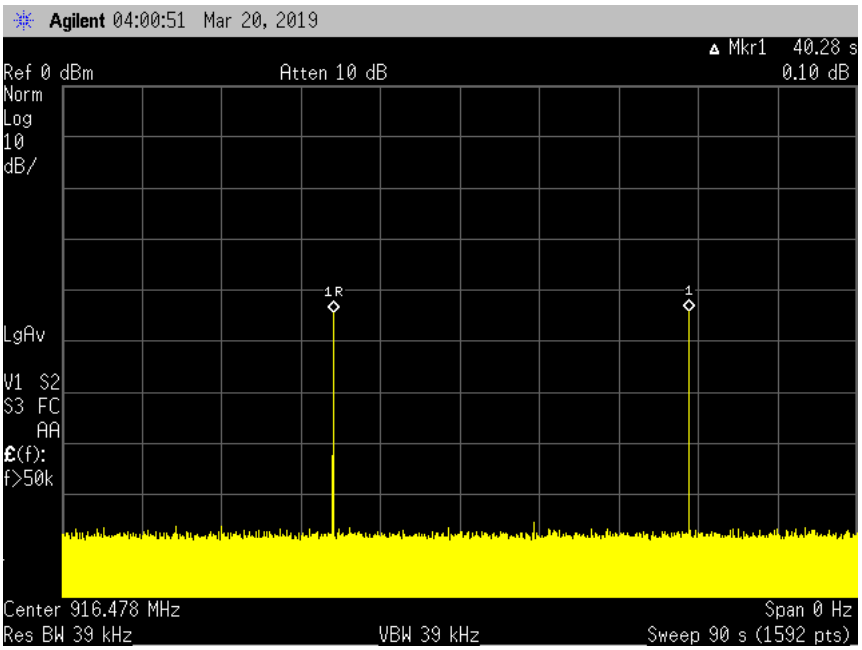


**Figure 4: Periodic Transmission Timing**

 

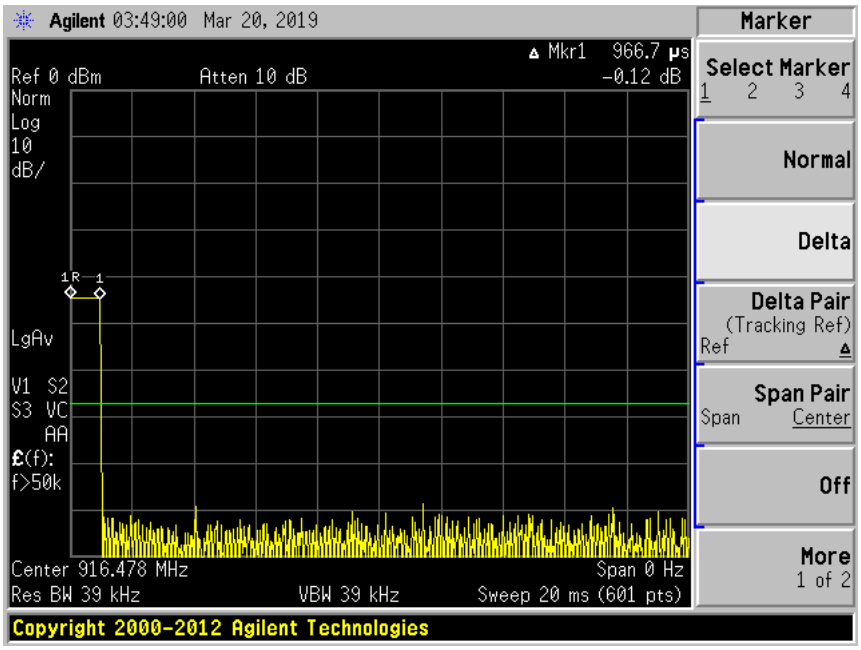


**Figure 5: Single Pulse Time**

 

## 4.3 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

According to FCC Part 15.231 & RSS210 Annex A the Occupied bandwidth (20dB) shall be:

> *(c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.*

Note: Industry Canada accepts the FCC 20dB Measurements technique in lieu of a 99% bandwidth plot.

For a system operating at 916.48MHz the maximum 20dB bandwidth is 4.58MHz.

At full modulation, the occupied bandwidth was measured at 448.7kHz (as shown below):

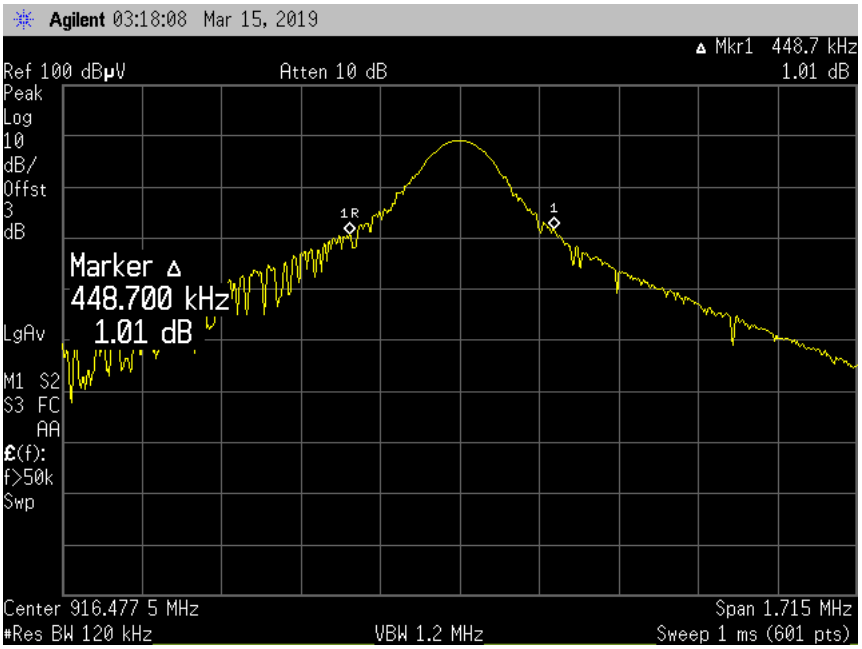


**Figure 6: Occupied Bandwidth**

 

## 4.4 Radiated Emissions: (FCC Part §2.1053)

The EUT must comply with the radiated emission limits of 15.231(a). The limits are as shown in the following table.

**Table 4. Radiated Emissions Limits**

| Fundamental Frequency (MHz) | Field Strength of Fundamental (µV/m) | Field Strength of Field strength of spurious emission (µV/m) |
|---|---|---|
| 40.66-40.70 | 2250 | 225 |
| 70-130 | 1250 | 125 |
| 130-174 | 1250 to 3750 | 125 to 375 |
| 174-260 | 3750 | 375 |
| 260-470 | 3750 to 12500 | 375 to 1250 |
| Above 470 | 12500 | 1250 |

Frequencies that fall in FCC part 15.205 restricted bands must be below part 15.209 limits within these bands.

In accordance with FCC part 15.35, when averaging is used the peak limit shall be no greater than 20 dB above the average limits.

### 4.4.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters.

In accordance with FCC part 15.35 averaging was performed by using a duty cycle correction subtracted from from the peak reading. For this EUT a duty cycle correction of -20dB was used.

The EUT was tested in 3 orthogonals with the worst case reported (fundamental frequency is reported in all orthogonals).

Non harmonic spurious emissions peaks were tested against the average limits for compliance (no duty cycle correction was used).

The emissions were measured using the following resolution bandwidths:

| Frequency Range | Resolution Bandwidth | Video Bandwidth |
|---|---|---|
| 30MHz-1000 MHz | 120kHz | >100 kHz |
| >1000 MHz | 1 MHz | 1MHz (Peak) |

Emissions were measured to the 10th harmonic of the transmit frequency. Worst case emission levels are reported.

Readings of the fundamental are with duty cycle correction.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level): V dBµV

Antenna Factor (Ant Corr): AFdB/m

Cable Loss Correction (Cable Corr): CCdB

Duty Cycle Correction (Average) DCCdB

Amplifier Gain: GdB

Electric Field (Corr Level): EdBµV/m = VdBµV + AFdB/m + CCdB + DCCdB - GdB

 

## Table 5: Radiated Emission Test Data, 916.48MHz (Fundamental & spurious)

| Freq (MHz) | Pol H/V | Az (Deg) | Ant Ht (m) | SA Level (dBuV) | Corr Factors (dB) | Level (uV/m) | Limit (uV/m) | Margin (dB) | Note |
|---|---|---|---|---|---|---|---|---|---|
| 916.48 | V | 0.0 | 2.0 | 85.0 | -24.6 | 1047.1 | 12500 | -21.5 | X |
| 916.48 | V | 0.0 | 2.5 | 87.0 | -24.6 | 1318.3 | 12500 | -19.5 | Y |
| 916.48 | V | 0.0 | 2.0 | 81.0 | -24.6 | 660.7 | 12500 | -25.5 | Z |
| 1832.98 | V | 0.0 | 1.0 | 60.0 | -14.6 | 187.1 | 1250 | -16.5 | Amb |
| 2749.47 | V | 0.0 | 1.0 | 52.20 | -8.0 | 161.4 | 1250 | -17.8 | Amb |
| 3665.96 | V | 0.0 | 1.0 | 48.0 | -4.0 | 157.9 | 1250 | -18.0 | Amb |
| 4582.45 | V | 0.0 | 1.0 | 44.0 | -0.4 | 151.2 | 1250 | -18.3 | Amb |
| 5498.94 | V | 0.0 | 1.0 | 45.20 | 3.6 | 275.6 | 1250 | -13.1 | Amb |
| 6415.43 | V | 0.0 | 1.0 | 41.70 | 6.4 | 253.6 | 1250 | -13.9 | Amb |
| 7331.92 | V | 0.0 | 1.0 | 40.07 | 10.1 | 322.9 | 1250 | -11.8 | Amb |
| 8248.41 | V | 0.0 | 1.0 | 41.20 | 11.9 | 453.8 | 1250 | -8.8 | Amb |
| | | | | | | | | | |
| 916.48 | H | 0.0 | 2.0 | 90.50 | -24.6 | 1972.4 | 12500 | -16.0 | X |
| 916.48 | H | 0.0 | 2.5 | 82.0 | -24.6 | 741.3 | 12500 | -24.5 | Y |
| 916.48 | H | 0.0 | 2.0 | 84.0 | -24.6 | 933.3 | 12500 | -22.5 | Z |
| 1832.98 | H | 0.0 | 1.0 | 60.0 | -14.6 | 187.1 | 1250 | -8.5 | Amb |
| 2749.47 | H | 0.0 | 1.0 | 52.20 | -8.0 | 161.4 | 1250 | -9.8 | Amb |
| 3665.96 | H | 0.0 | 1.0 | 48.0 | -4.0 | 157.9 | 1250 | -10.0 | Amb |
| 4582.45 | H | 0.0 | 1.0 | 44.0 | -0.4 | 151.2 | 1250 | -10.4 | Amb |
| 5498.94 | H | 0.0 | 1.0 | 45.20 | 3.6 | 275.6 | 1250 | -5.2 | Amb |
| 6415.43 | H | 0.0 | 1.0 | 41.70 | 6.4 | 253.6 | 1250 | -5.9 | Amb |
| 7331.92 | H | 0.0 | 1.0 | 40.07 | 10.1 | 322.9 | 1250 | -3.8 | Amb |
| 8248.41 | H | 0.0 | 1.0 | 41.20 | 11.9 | 453.8 | 1250 | -0.8 | Amb |

**Table 6: Radiated Emission Test Data, Spurious Emissions**

## 4.5 Conducted Emissions (AC Power Line)

As this unit is only powered from in internal battery, no power mains testing is required.

## 4.6 Receiver Emissions

As the receiver associated with this transmitter operates below 30MHz it is exempt from SDoC or certification.