# FCC Certification Test Report

## FCCID: ZQ3-SPS-UTPAD

## STRATA PROXIMITY SYSTEMS
## UNDERGROUND HAZARDAVERT TRAMGUARD PAD
## MODEL HA-PAD-2100

WLL REPORT# **12035-01 Rev 1**
**September 9, 2011**
**Re-issued October 3, 2011**

Prepared for:

**Strata Proximity Systems**
**1769 Jeff Road**
**Huntsville, AL 35806**

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ACLASS ACCREDITED TESTING

**Testing Certificate AT-1448**

# FCC Certification Test Report

## For the

## STRATA PROXIMITY SYSTEMS

## UNDERGROUND HAZARDAVERT TRAMGUARD PAD

## MODEL HA-PAD-2100

## FCCID: ZQ3-SPS-UTPAD

WLL REPORT# **12035-01 Rev 2**
**September 9, 2011**
**Re-issued October 3, 2011**

Prepared by:

Steven Dovell
Compliance Engineer

Reviewed by:

Steven D. Koster
VP, EMC & Wireless

# Abstract

This report has been prepared on behalf of Strata Proximity Systems to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.249 (10/2009) of the FCC Rules. This Certification Test Report documents the test configuration and test results for a Strata Proximity Systems Underground HazardAvert Tramguard 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. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Strata Proximity Systems Underground HazardAvert Tramguard PAD complies with the limits for an Intentional Radiator device under FCC Part 15.249.

| Revision History | Reason | Date |
|---|---|---|
| Rev 0 | Initial Release | September 9, 2011 |
| Rev 1 | Corrected Duty Cycle Correction value | September 26, 2011 |
| Rev 2 | Restored original cable correction factors, Detector settings listed in 4.3.1 | October 3, 2011 |

 

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# 1 Introduction

## 1.1 Compliance Statement

The Strata Proximity Systems Underground HazardAvert Tramguard PAD complies with the limits for an Intentional Radiator device under FCC Part 15.249 (7/2008).

## 1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed in accordance with FCC Public Notice DA 00-705 and the 2003 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

## 1.3 Contract Information

| | |
|---|---|
| Customer: | Strata Proximity Systems<br>1769 Jeff Road<br>Huntsville, AL 35806 |
| Purchase Order Number: | SP5195 |
| Quotation Number: | 66219 |

## 1.4 Test Dates

| | |
|---|---|
| Testing was performed on the following date(s): | 6/27/11 |

## 1.5 Test and Support Personnel

| | |
|---|---|
| Washington Laboratories, LTD | Steven Dovell |
| Client Representative | Stephen Gilbert |

## 1.6 Abbreviations

| | |
|---|---|
| **A** | **A**mpere |
| **ac** | **a**lternating **c**urrent |
| **AM** | Amplitude Modulation |
| **Amps** | **Amp**ere**s** |
| **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 Underground PAD is part of a complete HazardAvert proximity warning system from Strata Proximity Systems which provides warnings to both individuals and to machinery to alert them that the individual has entered too close to an operating piece of equipment and is in a dangerous situation or that vehicles or machinery are getting close enough that a collision possibility exists. The Underground PAD is worn by an individual and can be connected to a cap lamp if desired. The Underground PAD is housed with an integral rechargeable Lithium Ion battery pack which contains an audible alert buzzer and a visual alerting lamp.

The functions of the Underground PAD are:

To detect the presence of a 73 kHz electromagnetic field generated by vehicles or machinery equipped with the HazardAvert system and to determine if the field strength level detected indicates that the individual and vehicle or machinery is approaching or is in a dangerous situation.

To provide an audible and visual indication to the wearer of the Underground PAD that they are approaching or are in a dangerous location as a result of the 73 kHz filed strength level.

To transmit a 916.48MHz RF signal to vehicles or machinery equipped with the HazardAvert system signaling that the individual is entering or has entered into a dangerous area relative to the vehicle or machinery.

The Underground PAD has a 73kHz receiver that is constantly on and monitoring the strength of fields emitted by vehicles and machinery equipped with the HazardAvert proximity and collision avoidance system . The Underground PAD monitors the strength of the 73kHz fields in three axis and determines if the field strength has risen to a level that would indicate that the individual is approaching a “Warning Zone” or is in a “Danger Zone” due to being too close to the vehicle or machinery. If the Underground PAD determines that the individual is too close to the vehicle or machinery, it gives the individual both a visual and audible indication. At the same time, the Underground PAD transmits a 916.48MHz RF signal to inform the vehicle or machinery that the individual is approaching too close. If The Underground PAD determines that the field strength indicates that the individual is not in a Warning or Danger Zone area, it will transmit a data packet every 10 seconds via the 916.48MHz with its status condition.

 

**Table 1. Device Summary**

| ITEM | DESCRIPTION |
|---|---|
| Manufacturer: | Strata Proximity Systems |
| FCC ID: | ZQ3-SPS-UTPAD |
| Model: | HA-PAD-2100 |
| FCC Rule Parts: | §15.249 |
| Frequency Range: | 916.48MHz |
| Maximum Output Power: | 40891.1 µV/m @ 3 meters |
| Modulation: | FM |
| Occupied Bandwidth: | 78.4kHz |
| Keying: | automatic |
| Type of Information: | Data |
| Number of Channels: | 1 |
| Power Output Level | Fixed |
| Antenna Connector | None |
| Antenna Type | Internal |
| Interface Cables: | None |
| Power Source & Voltage: | Battery |
| TX Spurious | 80.7 µV/m @ 3 meters |

## 2.2 Test Configuration

The Underground HazardAvert Tramguard PAD was configured with the 916.48MHz transmitter constantly on. A sample operating normally was use to determine the EUT duty cycle.

## 2.3 Testing Algorithm

The Underground HazardAvert Tramguard PAD was programmed for continuous operation by the vendor. Under normal conditions there are no user accessible settings. The unit is simply plugged in to the battery pack to operate.

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 ACLASS under Certificate AT-1448 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

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

## 2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

 

# 3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

**Table 2: Test Equipment List**

| Test Name: | **Radiated Emissions** | Test Date: | **06/27/2011** |
|---|---|---|---|
| **Asset #** | **Manufacturer/Model** | **Description** | **Cal. Due** |
| 528 | AGILENT - E4446A | ANALYZER SPECTRUM | 9/27/2011 |
| 382 | SUNOL SCIENCES CORPORATION - JB1 | ANTENNA BICONLOG | 1/12/2012 |
| 4 | ARA - DRG-118/A | ANTENNA DRG 1-18GHZ | 2/15/2013 |
| 522 | HP - 8449B | PRE-AMPLIFIER 1-26.5GHZ | 7/27/2011 |
| 542 | MEGAPHASE - TM40-K1K1-660 | CABLE COAXIAL 660IN. | 12/30/2011 |

 

# 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 pulsed licensed and unlicensed devices.

- For Unlicensed Intentional Radiators under 47CFR Part 15, all duty cycle measurements compared to a 100 millisecond period
- i.e. duty cycle = on time/100, milliseconds
- The EUT under normal operating conditions has 6.609ms on time. This results in a -23.6dB Duty Cycle Correction.
- DCC = 20*log(6.609e-3/100e-3) = -23.6dB

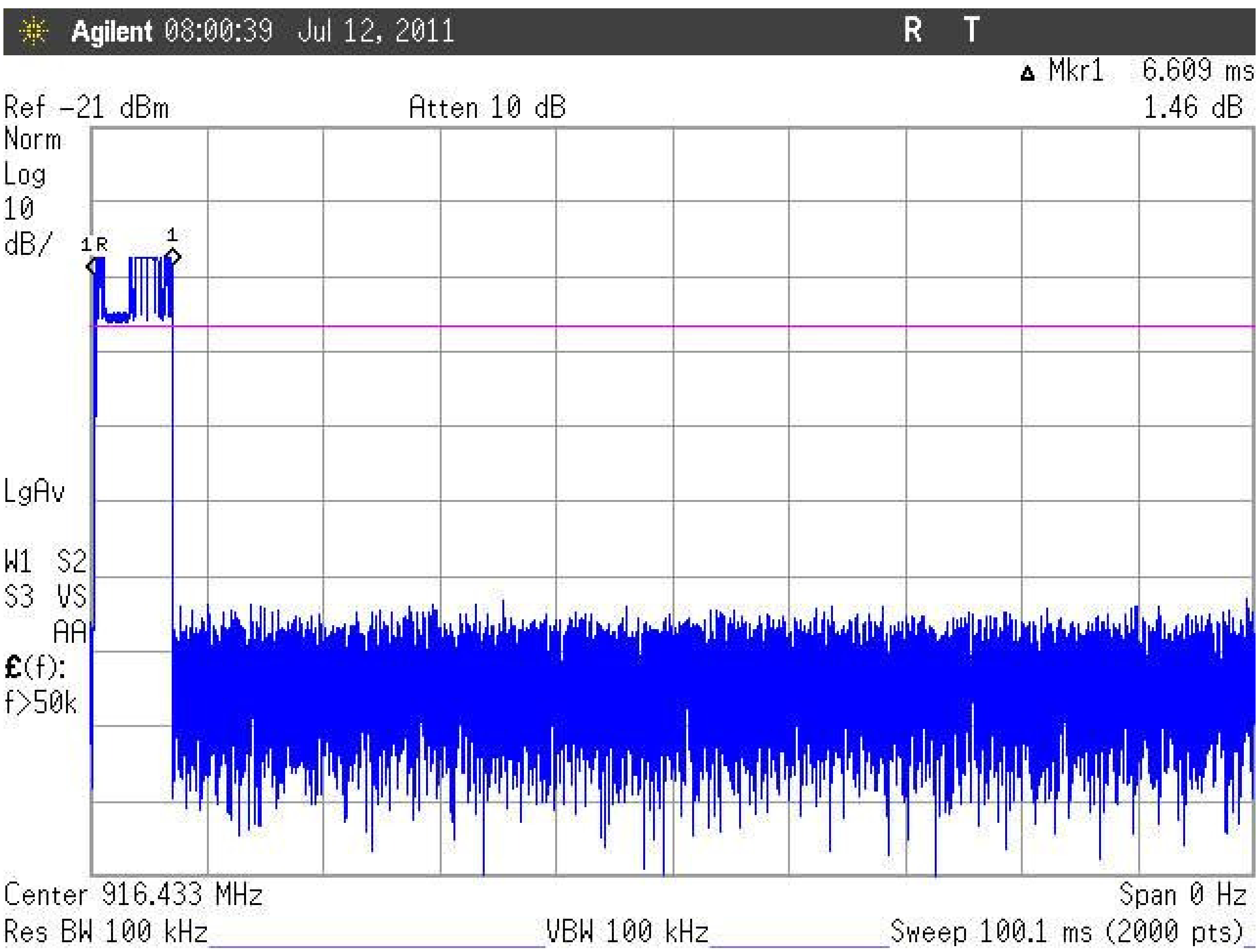


**Figure 4-1. Duty Cycle**

 

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

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

At full modulation, the occupied bandwidth was measured as shown:

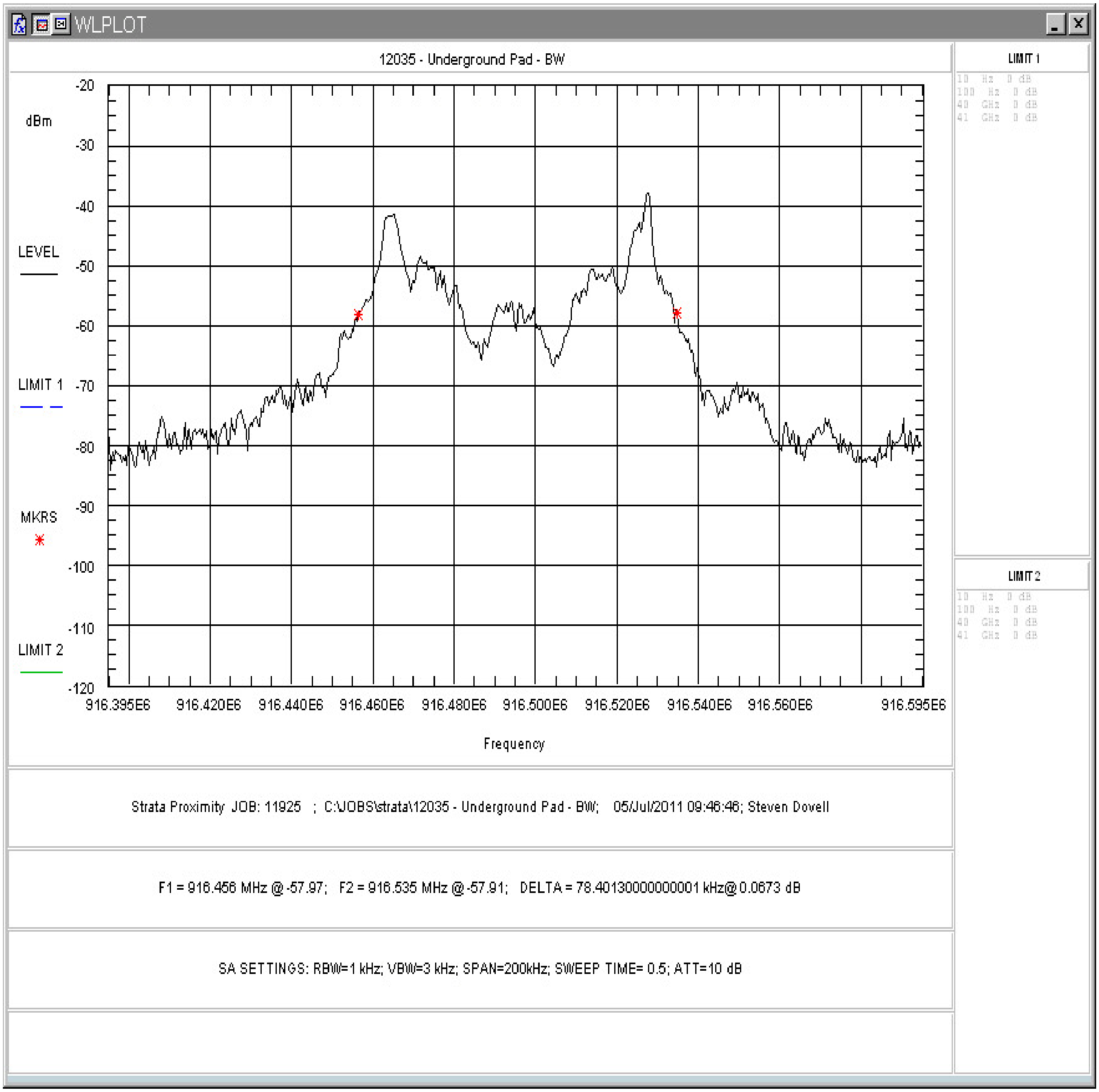


**Figure 4-2. Occupied Bandwidth**

 

Table 3 provides a summary of the Occupied Bandwidth Results.

**Table 3. Occupied Bandwidth Results**

| Frequency | Bandwidth | Limit | Pass/Fail |
|---|---|---|---|
| 916.48MHz | 78.4kHz | N/A | Pass |

### 4.3 Radiated Emissions: (FCC Part §2.1053, RSS210 A2.9)

The EUT must comply with the radiated emission limits of 15.249(a). The limits are as shown in the following table.

**Table 4. Radiated Emissions Limits**

| Fundamental Frequency | Field Strength of Fundamental (µV/m) | Field Strength of Harmonics (µV/m) |
|---|---|---|
| 902 – 928 MHz | 50,000 | 500 |
| 2400 – 2483.5 MHz | 50,000 | 500 |
| 5725 – 5875 MHz | 50,000 | 500 |
| 24.00 – 24.25 GHz | 250,000 | 2500 |

#### 4.3.1 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. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured. Readings under 1000MHz were performed using a Quasi-Peak Detector function. Since the fundamental signal is FM modulation no pulse correction is required.

The unit was examined in three orthogonals with the worst case being reported.

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 | <30 Hz (Avg.)<br>1MHz (Peak) |

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

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.

<u>Sample Calculation:</u>

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 Fundamental and > 1GHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 916.53 | V | 90.00 | 1.16 | 62.28 | 30.0 | 40891.1 | 50000.0 | -1.7 | Fundamental |
| **Peak** | | | | | | | | | |
| 1833.05 | V | 180.00 | 2.49 | 61.00 | -5.6 | 591.8 | 5000.0 | -18.5 | |
| 2749.58 | V | 10.00 | 2.61 | 50.00 | -0.7 | 291.4 | 5000.0 | -24.7 | |
| 3666.05 | V | 180.00 | 1.85 | 48.90 | 4.6 | 473.3 | 5000.0 | -20.5 | |
| 4582.61 | V | 190.00 | 1.84 | 49.40 | 6.2 | 603.7 | 5000.0 | -18.4 | |
| 5499.13 | V | 120.00 | 1.51 | 48.80 | 9.5 | 826.1 | 5000.0 | -15.6 | |
| | | | | | | | | | |
| 1833.05 | H | 120.00 | 2.30 | 57.31 | -5.6 | 387.0 | 5000.0 | -22.2 | |
| 2749.58 | H | 0.00 | 2.30 | 50.10 | -0.7 | 294.8 | 5000.0 | -24.6 | |
| 3666.05 | H | 0.00 | 1.90 | 51.55 | 4.6 | 642.2 | 5000.0 | -17.8 | |
| 4582.61 | H | 180.00 | 1.83 | 55.37 | 6.2 | 1200.3 | 5000.0 | -12.4 | |
| 5499.13 | H | 270.00 | 1.47 | 52.50 | 9.5 | 1264.9 | 5000.0 | -11.9 | |
| **Average** | | | | | | | | | |
| 1833.05 | V | 180 | 2.49 | 61 | -29.2 | 38.9 | 500 | -22.2 | |
| 2749.58 | V | 10 | 2.61 | 50 | -24.3 | 19.3 | 500 | -28.3 | |
| 3666.05 | V | 180 | 1.85 | 48.9 | -19 | 31.3 | 500 | -24.1 | |
| 4582.61 | V | 190 | 1.84 | 49.4 | -17.4 | 39.8 | 500 | -22.0 | |
| 5499.13 | V | 120 | 1.51 | 48.8 | -14.1 | 54.3 | 500 | -19.3 | |
| | | | | | 0.3 | 1.0 | 500 | -53.7 | |
| 1833.05 | H | 120 | 2.3 | 57.31 | -29.2 | 25.4 | 500 | -25.9 | |
| 2749.58 | H | 0 | 2.3 | 50.1 | -24.3 | 19.5 | 500 | -28.2 | |
| 3666.05 | H | 0 | 1.9 | 51.55 | -19 | 42.4 | 500 | -21.4 | |
| 4582.61 | H | 180 | 1.83 | 55.37 | -17.4 | 79.2 | 500 | -16.0 | |
| 5499.13 | H | 270 | 1.47 | 52.5 | -14.1 | 83.2 | 500 | -15.6 | |

 

## Table 6: Radiated Emission Test Data < 1GHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| 52.01 | V | 0.00 | 1.00 | 7.40 | 8.5 | 6.2 | 100.0 | -24.1 |
| 123.95 | V | 0.00 | 1.00 | 3.10 | 15.6 | 8.6 | 150.0 | -24.8 |
| 181.14 | V | 0.00 | 1.00 | 9.50 | 14.1 | 15.2 | 150.0 | -19.9 |
| 266.94 | V | 0.00 | 1.00 | 5.70 | 16.8 | 13.4 | 200.0 | -23.5 |
| 352.78 | V | 0.00 | 1.00 | 6.00 | 19.1 | 18.0 | 200.0 | -20.9 |
| 541.73 | V | 0.00 | 1.00 | 6.30 | 24.3 | 34.0 | 200.0 | -15.4 |
| | | | | | | | | |
| 52.01 | H | 0.00 | 4.00 | 5.70 | 8.5 | 5.1 | 100.0 | -25.8 |
| 123.95 | H | 0.00 | 4.00 | 7.90 | 15.6 | 15.0 | 150.0 | -20.0 |
| 181.14 | H | 0.00 | 4.00 | 10.80 | 14.1 | 17.6 | 150.0 | -18.6 |
| 266.94 | H | 0.00 | 4.00 | 4.30 | 16.8 | 11.4 | 200.0 | -24.9 |
| 352.78 | H | 0.00 | 4.00 | 3.70 | 19.1 | 13.8 | 200.0 | -23.2 |
| 541.73 | H | 0.00 | 4.00 | 8.40 | 24.3 | 43.2 | 200.0 | -13.3 |