H.B. Compliance Solutions

# Intentional Radiator Test Report

For the

**ECO Wireless**

**Sentinel Transceiver**

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 90 for

Private Land Mobile Radio Services

August 31, 2009

**Prepared for:**

ECO Wireless

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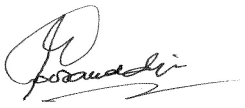


Hoosamuddin Bandukwala

Cert # ATL-0062-E


**Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 90 of the FCC Rules under normal use and maintenance.**

## Report Status Sheet

| Revision # | Report Date | Reason for Revision |
|---|---|---|
| Ø | September 02, 2009 | Initial Issue |

# Table of Contents

# EXECUTIVE SUMMARY

## 1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 90. All tests were conducted using measurement procedure from ANSI TIA/EIA-603-A-2004 as appropriate.

| Test Name | Test Method/Standard | Result | Comments |
|---|---|---|---|
| RF Output Power | 2.1046; 90.205 | Pass | |
| Modulation Characteristics | 2.1047(a) | Pass | The EUT does not transmit voice. The device transmit data signal only |
| Occupied Bandwidth | 2.1049; 90.210 | Pass | EUT Meets Mask D |
| Spurious Emissions at Antenna Terminals | 2.1051; 90.210 | Pass | |
| Radiated Spurious Emissions | 2.1053; 90.210 | Pass | |
| Frequency Stability over Temperature Variations | 2.1055(a)(1); 90.213 | Pass | |
| Frequency Stability over Voltage Variations | 2.1055(d) | Pass | |
| Transient Frequency Behavior | 90.214 | Pass | |

# EQUIPMENT CONFIGURATION

## 1. Overview

H.B Compliance Solutions was contracted by ECO Wireless to perform testing on the Sentinel Transceiver under the purchase order number 20091003.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the ECO Wireless, Sentinel Transceiver.

The tests were based on FCC Part 90 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications. ECO Wireless should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

| | |
|---|---|
| **Product Name:** | Relume Sentinel Wireless Light controller Sentinel Transceiver |
| **Model(s) Tested:** | ST-001 |
| **FCC ID:** | XO7ST001 |
| **Supply Voltage Input:** | Primary Power : 7.2 Vdc |
| **Frequency Range:** | 451.0MHz to 465.0MHz |
| **No. of Channels:** | Single Chanel |
| **Necessary Bandwidth** | 12.5kHz |
| **Type(s) of Modulation:** | GFSK |
| **Range of Operation Power:** | 3.41W |
| **Voltage into final Transistor** | 7.2 volts |
| **Current into final Transistor** | 1.3 amps |
| **Emission Designator:** | 8K00F1D (For Frequency Modulation Bn=2M+2DK)<br>Where M= B/2 = 1500 D = 2.5KHz and K = 1 |
| **Channel Spacing(s)** | None |
| **Test Item:** | Pre-Production |
| **Type of Equipment :** | Fixed |
| **Antenna:** | 50 ohm SMA Connector |
| **Enviromental Test Conditions:** | Temperature: 15-35°C<br>Humidity: 30-60%<br>Barometric Pressure: 860-1060 mbar |
| **Modification to the EUT:** | None |
| **Evaluated By:** | Staff at Emerson Network |
| **Test Date(s):** | 08/04/09 till 08/22/09 |

## 2. Test Facility

All testing was performed at Emerson Network Power. This facility is located at 2900 S. Diablo Way, Suite 190, Tempe, AZ 85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Test facility at Emerson Network power is an A2LA accredited test site. The A2LA certificate number is 2716.01. The scope of accreditation covers the FCC Method - 47 CFR Part 15, ICES-003, CISPR 22, AS/NZS 3548 and VCCI

Radiated Emissions measurements were performed in a semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Emerson Network Power.

## 3. Description of Test Sample

The ECO Wireless, Sentinel Transceiver, is a street light monitoring & control unit. The components are contained in a plastic enclosure. It is mounted on top of the street lights. It runs off 7.2 Vdc via a 2 wire cord. This model transmit data in a in the 450 to 465MHz range.

## 4. Equipment Configuration

| Ref. ID | Name / Description | Model Number | Serial Number |
|---|---|---|---|
| # 1 | Sentinel Street light Monitoring & Control | ST-001 | N/A |

**Table 1. Equipment Configuration**

## 5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

| Ref ID | Name / Description | Manufacturer | Model # | Serial # |
|---|---|---|---|---|
| #2 | DC Power Supply | Hewlett Packard | E3610A | KR83021468 |
| #3 | Attenuator/50ohm Load | Bird | 10-A-MFN-30 | 0031039 |

**Table 2. Support Equipment**

## 6. Ports and Cabling Information

| Ref ID | Port name on the EUT | Cable Description | Qty. | Length (m) | Shielded? (Y/N) | Termination Box ID & Port ID |
|---|---|---|---|---|---|---|
| #4 | Power | 2 wire | 1 | 2 | N | DC Power Supply |
| #5 | Aux | 2 wire | 1 | 2 | N | Push Switch |

**Table 3. Ports and Cabling Information**

## 7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

## 8. Mode of Operation

The EUT will be configured to transmit at maximum power level. Test mode was provided to select the lower, middle and upper band of the transmitter by a push switch. This switch cycled the transmitter from three frequencies modulated and the other three in CW mode. These settings were created for testing purpose only.

## 9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

## 10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to ECO Wireless upon completion of testing & certification

## 1. RF Power Output

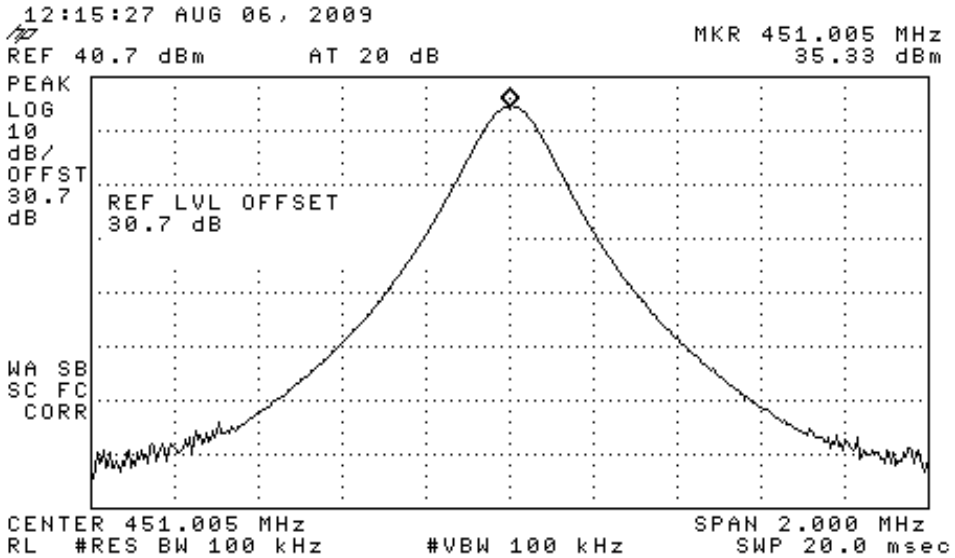
| Test Requirement(s): | §2.1046 and §90.215 | Test Engineer(s): | Tom Karas |
|---|---|---|---|
| Test Results: | Pass | Test Date(s): | 08/04/09 |

**Test Procedures:** As required by 47 CFR 2.1046, RF Power output measurements were made at the RF output terminals of the EUT.

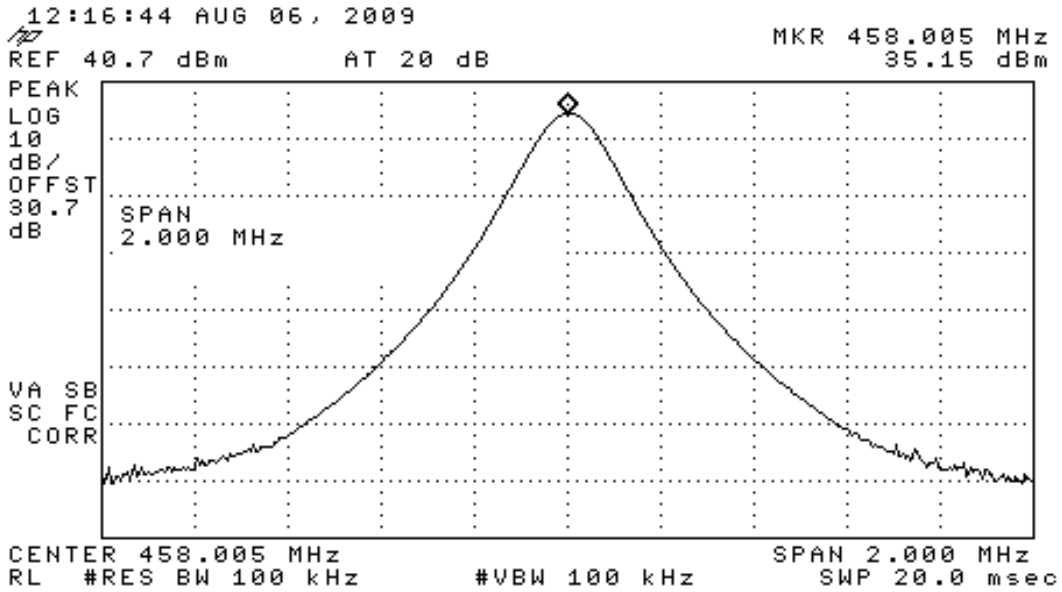
Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer capable of making power measurements. Measurements were made at the low, mid, and high channels of the entire frequency band.

| Frequency (MHz) | Conducted Power (dBm) | Conducted Power (W) |
|---|---|---|
| 451.0 | 35.33 | 3.41 |
| 458.0 | 35.15 | 3.27 |
| 465.0 | 34.72 | 2.96 |

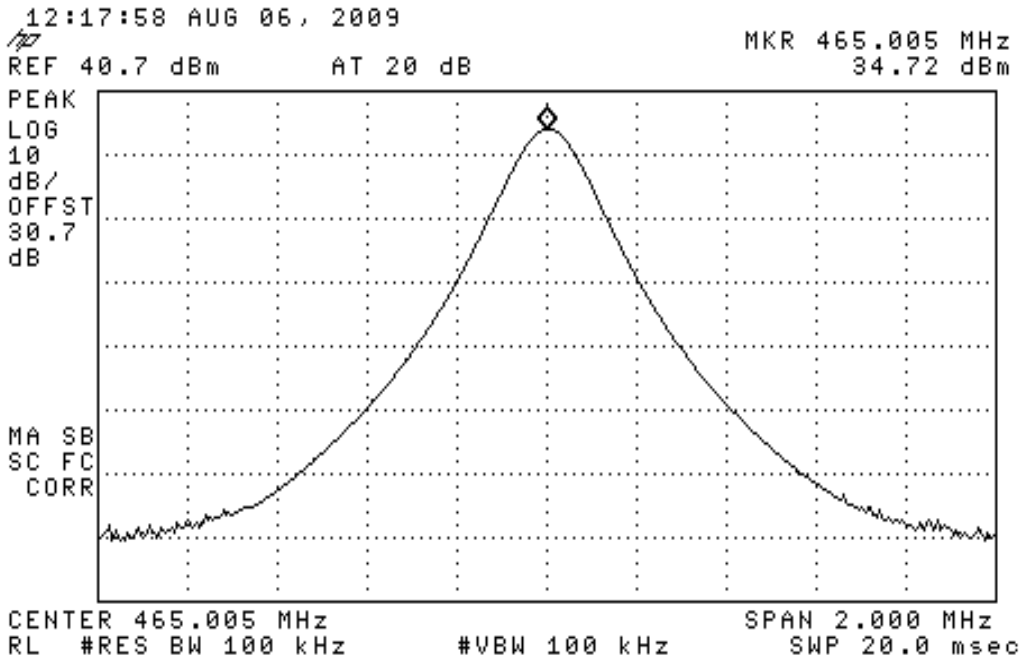
**Table 4. RF Power Output, Test Results**




**Plot 1 – Output Power – Low**




**Plot 2 – Output Power – Mid**




**Plot 3 – Output Power – High**

## 2. Modulation Characteristics

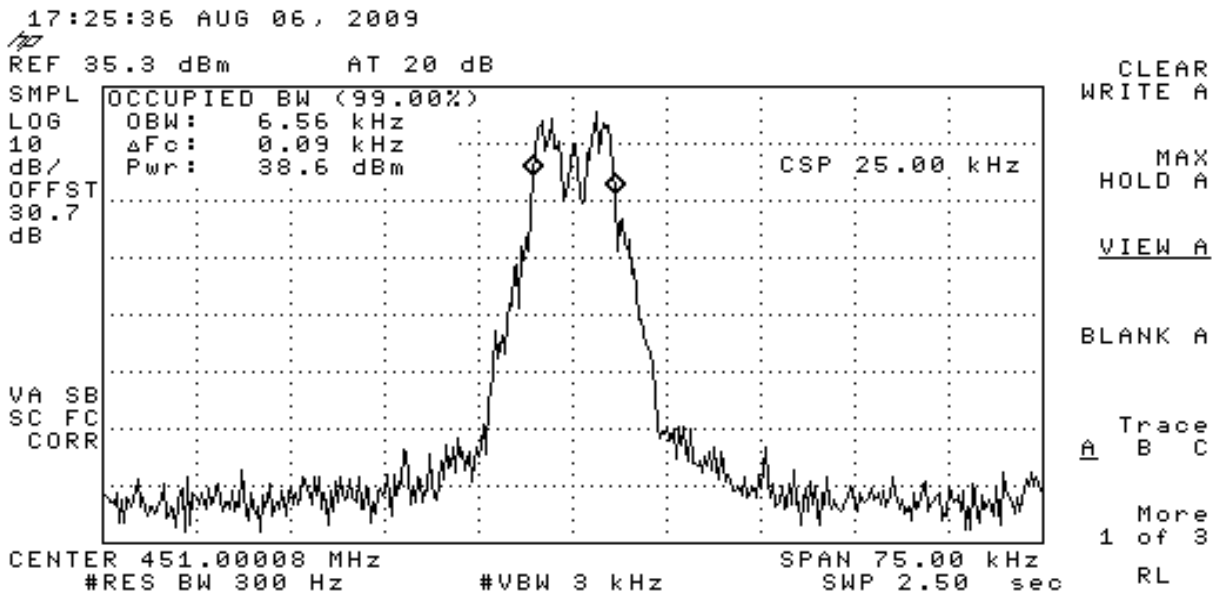
| | | | |
|---|---|---|---|
| **Test Requirement(s):** | 2.1047 and §90.207 | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/11/09 |

**Test Procedure:** As required by 47 CFR 2.1047, Modulation characteristics measurements were made at the RF output terminals of the EUT.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer.

As per standard a curve or equivalent data of the EUT is shown

The plot(s) of the modulation characteristic is presented hereinafter as reference.




**Plot 4 – For 12.5kHz Channel Spacing**

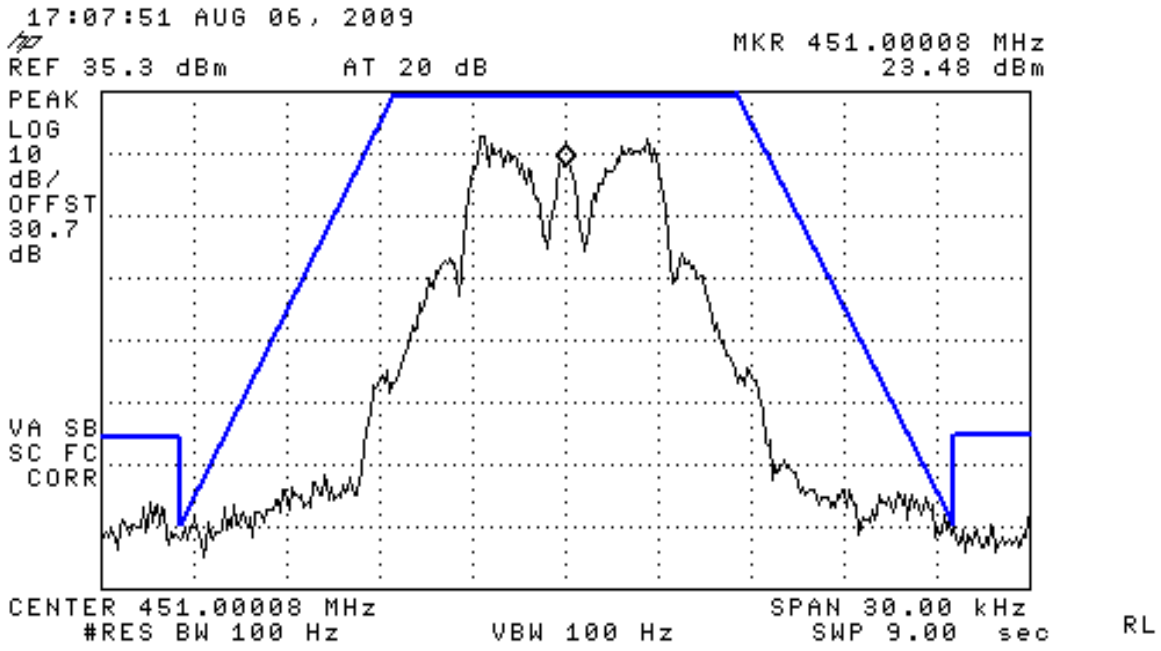
## 3. Occupied Bandwidth (Emission Mask)

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | 2.1049 and §90.210 with FCC (Emission Mask D) | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/11/09 |

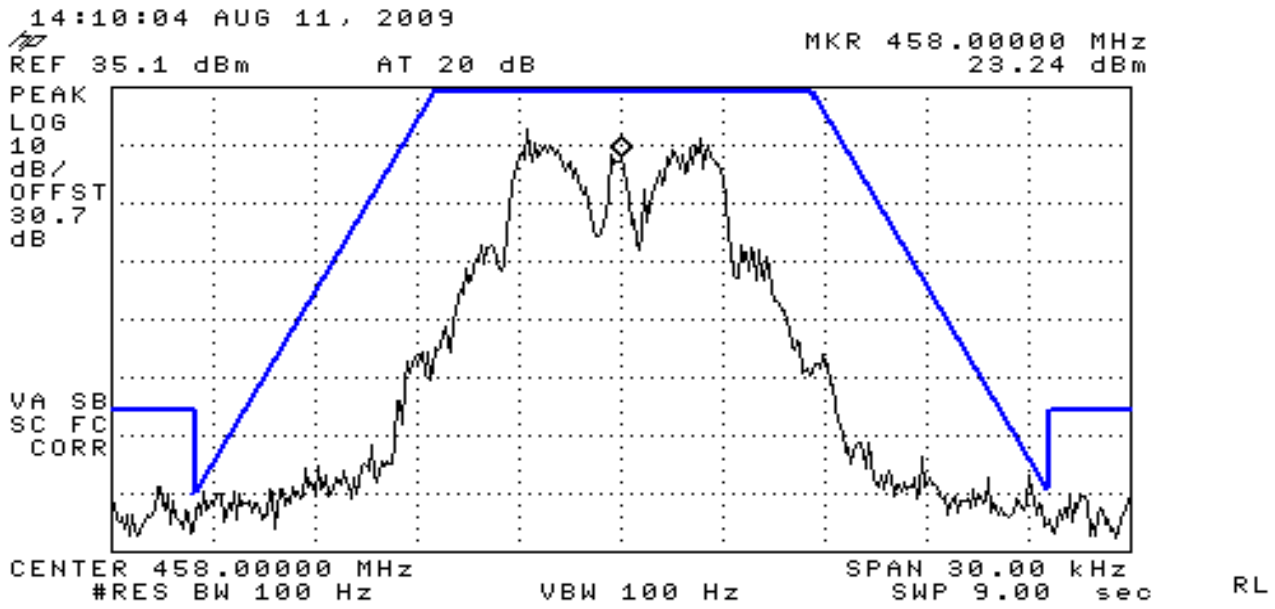
**Test Procedure:** As required by 47 CFR 2.1049, occupied bandwidth measurements were made at the output terminals of the EUT.

Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer. The measured highest peak power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to at least 1% of the channel bandwidth. Measurements were carried out at the low, mid and high channels of the TX band.

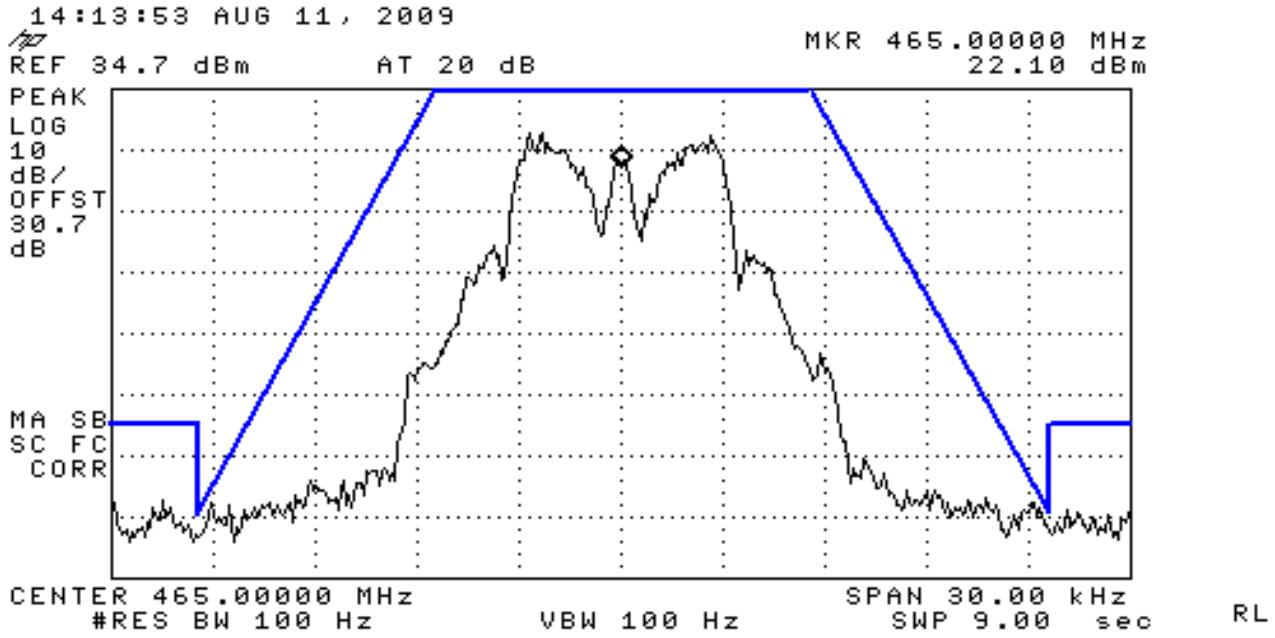
The following pages show measurements of Emission Mask plots:




**Plot 5 – 451MHz (Low) – Mask D**




**Plot 6 – 458MHz (Mid) – Mask D**




**Plot 7 – 465MHz (High) – Mask D**

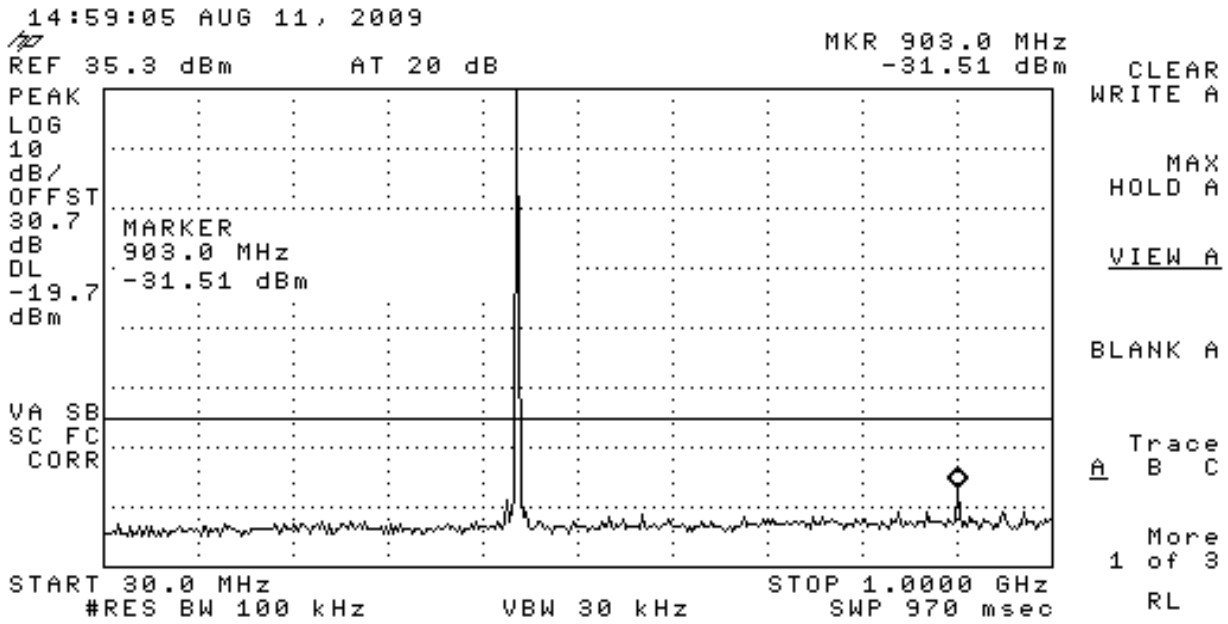
## 4. Spurious Emissions at Antenna Terminals

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §2.1051 and 90.210(m) | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/11/09 |

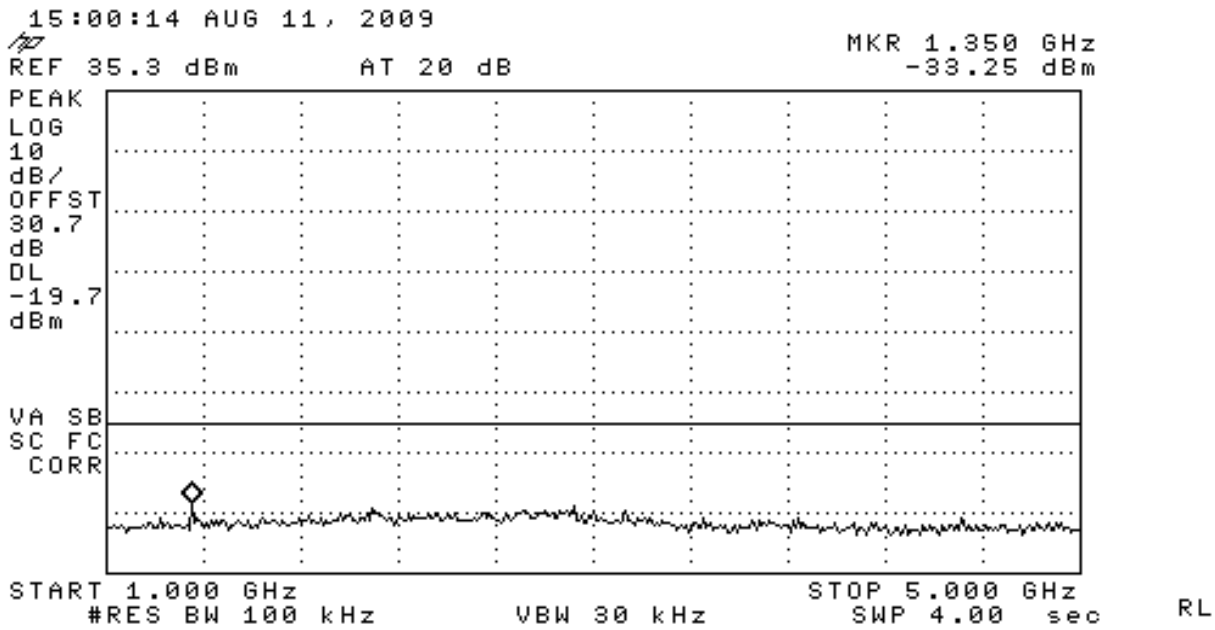
**Test Procedures:**

As required by 47 CFR 2.1051, spurious emissions at antenna terminal measurements were made at the RF output antenna terminal of the EUT.

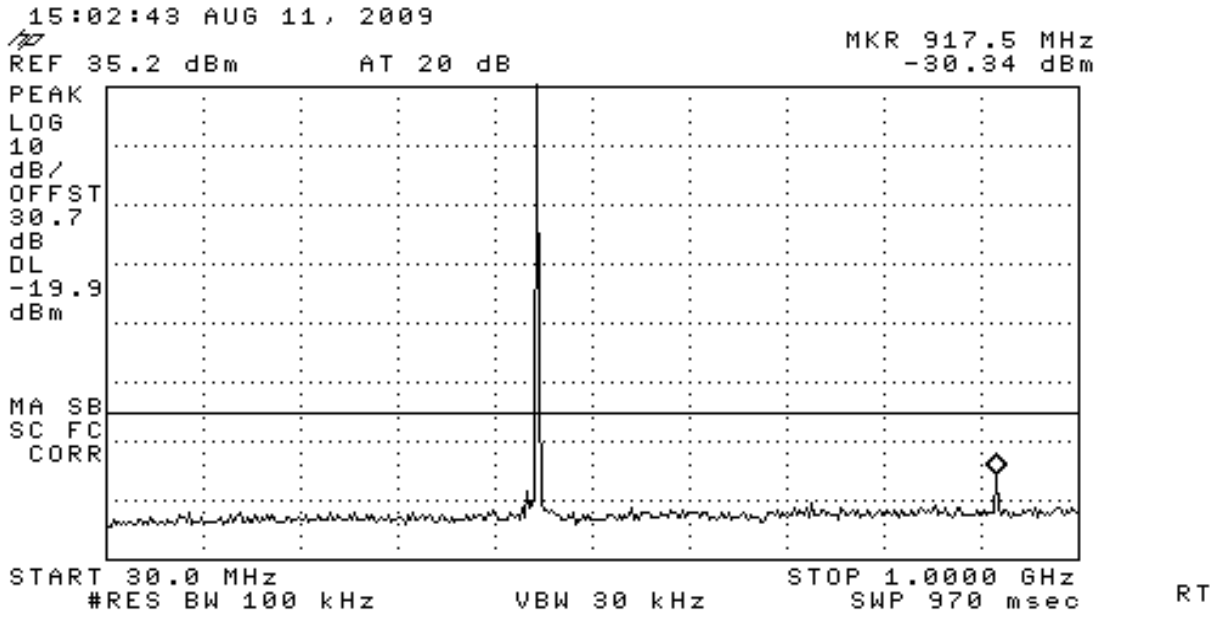
Customer provided a test mode internal to the EUT to control the RF modulation, and frequency channel. The EUT was connected through an attenuator to a Spectrum Analyzer. The Spectrum Analyzer was set to sweep from 30MHz up to 10th harmonic of the fundamental or 40GHz whichever is the lesser. Measurements were made at the low, mid and high frequency of the transmit band.



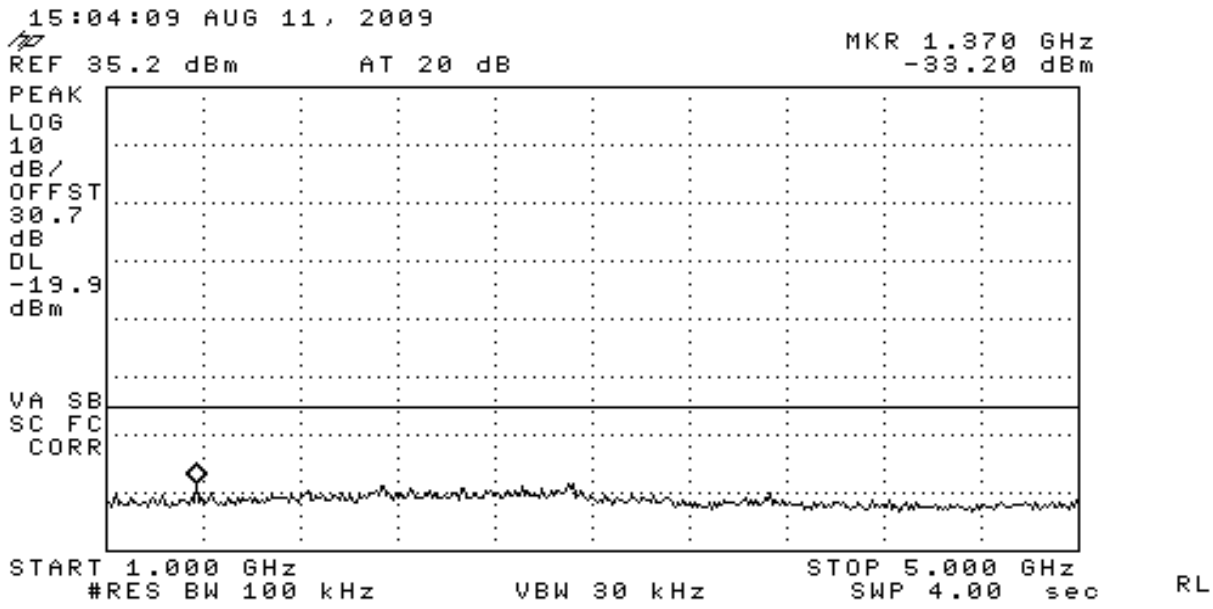

**Plot 8 – Low Band**



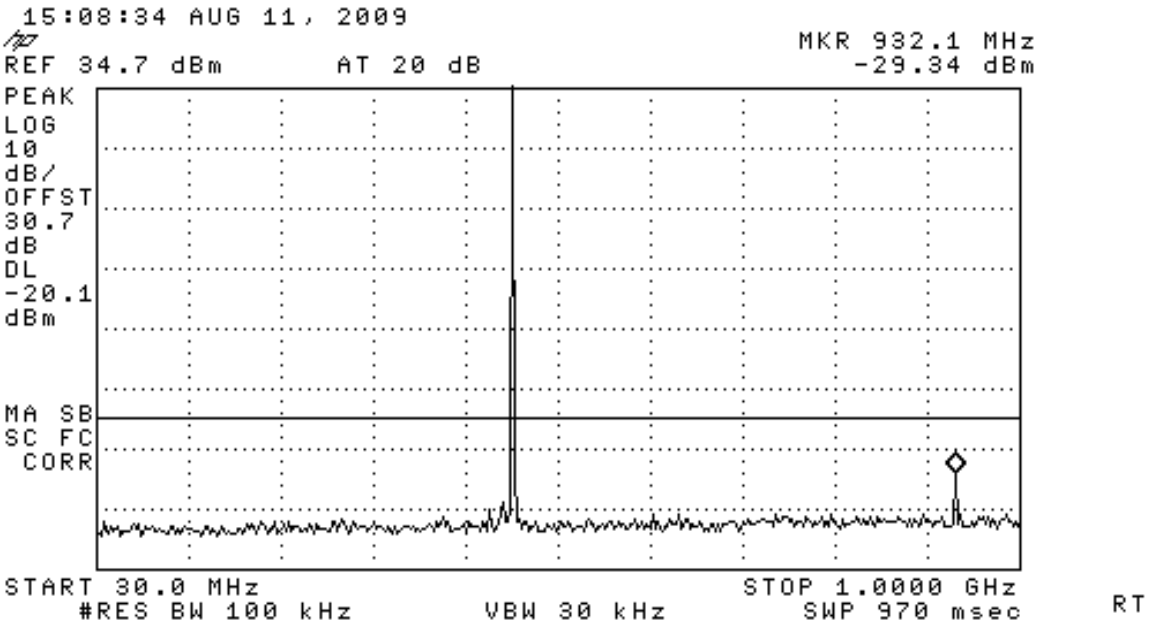

**Plot 9 – Low Band**



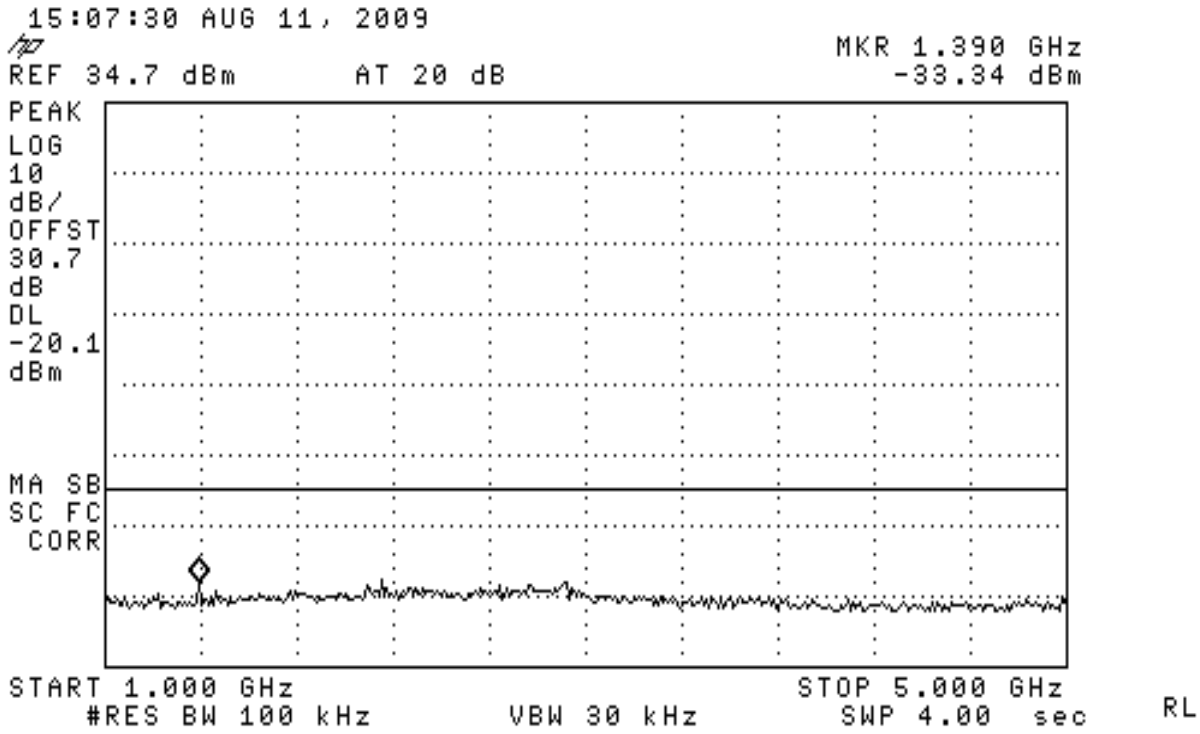

**Plot 10 – Mid Band**




**Plot 11 – Mid Band**




**Plot 12 – High Band**




**Plot 13 – High Band**

## 5. Radiated Spurious Emissions

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §2.1053 and 90.210(m) | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/12/09 |

**Test Procedures:**

As required by 47 CFR 2.1053, field strength of radiated spurious measurements were made in accordance with the procedures of the TIA/EIA-603-A-2004.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was transmitting into a non-radiating load which was directly connected to the EUT antenna port.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3 orthogonal axis. The frequency range up to the $10^{th}$ harmonic was investigated.

The EUT is removed and replaced with a substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = 10 log (Txpwr in Watts/0.001)-the absolute level

Spurious attenuation limit in dB = 50 + 10 $\log_{10}$ (power out in Watts) for EUT with a 12.5KHz channel

| Frequency | Amplitude (dbuV) | Antenna Polarity | Cable Loss | Substitution Generator Level (dbm) | Transmit Antenna Gain | Corrected Amplitude (dBm) | Limit (dBm) |
|---|---|---|---|---|---|---|---|
| 902 MHz | 25.8 | Horz | 2.6 | -28.45 | -7.7 | -33.55 | -20 |
| 1.353 GHz | 20 | Horz | 3.55 | -50.2 | 7.5 | -39.15 | -20 |

**Table - Spurious Radiated Emission Data – Low Band**

| Frequency | Amplitude (dbuV) | Antenna Polarity | Cable Loss | Substitution Generator Level (dbm) | Transmit Antenna Gain | Corrected Amplitude (dBm) | Limit (dBm) |
|---|---|---|---|---|---|---|---|
| 916 MHz | 22 | Horz | 2.67 | -33 | -7.7 | -38.03 | -20 |
| 1.374 GHz | 17 (N.F) | Horz | 3 | -56.45 | 7.5 | -45.95 | -20 |
| 4.580 GHz | 21.1 (N.F) | Horz | 6.53 | -42.5 | 10.81 | -25.16 | -20 |

**Table – Spurious Radiated Emission Data – Mid Band**

| Frequency | Amplitude (dbuV) | Antenna Polarity | Cable Loss | Substitution Generator Level (dbm) | Transmit Antenna Gain | Corrected Amplitude (dBm) | Limit (dBm) |
|---|---|---|---|---|---|---|---|
| 930 MHz | 24.9 | Horz | 2.69 | -28.45 | -7.7 | -33.46 | -20 |
| 1.395 GHz | 19 | Horz | 3.05 | -51.1 | 7.5 | -40.55 | -20 |
| 2.325 GHz | 20.7 (N.F) | Horz | 4.24 | -46.2 | 8.932 | -33.028 | -20 |

**Table – Spurious Radiated Emission Data – High Band**

**NOTE: There were no detectable emissions above the 2nd harmonic. Measurement was made at the 10th harmonic to show the Receiver Noise Floor (N.F)**

## 6. Frequency Stability vs Temperature

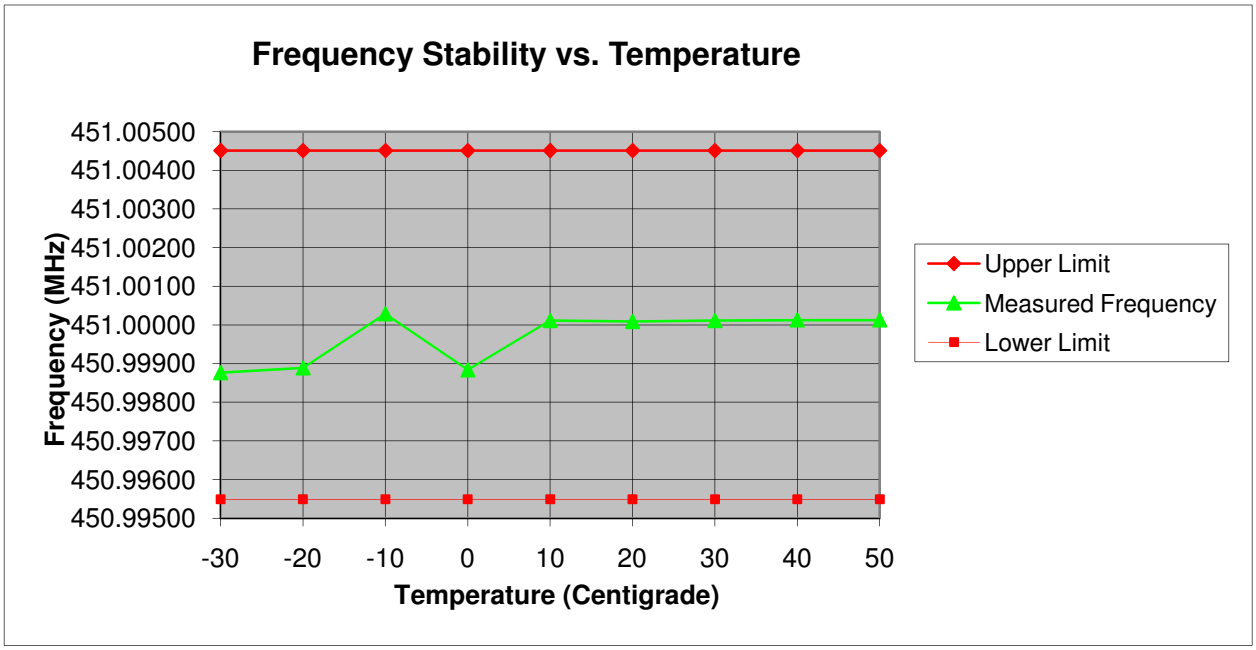
| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §2.1055 and 90.213 | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/11/09 |

**Test Procedures:** As required by 47 CFR 2.0155, Frequency Stability measurements were made at the RF antenna output terminals of the EUT.

The EUT was placed in an Environmental Chamber with all the support equipment outside the chamber. The EUT was set to transmit a modulated carrier. The reference frequency at 20°C was observed and noted down. The frequency drift was investigated for every 10°C increment until the unit was stabilized then recorded the reading in tabular format with the temperature range of -30°C to 50°C.

| Temperature centigrade | Measured Frequency (MHz) | Upper Margin (MHz) | Lower Margin (MHz) |
|---|---|---|---|
| -30 | 450.99876 | -0.00575 | 0.00327 |
| -20 | 450.99889 | -0.00562 | 0.00340 |
| -10 | 451.00029 | -0.00422 | 0.00480 |
| 0 | 450.99884 | -0.00567 | 0.00335 |
| 10 | 451.00011 | -0.00440 | 0.00462 |
| 20 | 451.00009 | -0.00442 | 0.00460 |
| 30 | 451.00011 | -0.00440 | 0.00462 |
| 40 | 451.00013 | -0.00438 | 0.00464 |
| 50 | 451.00013 | -0.00438 | 0.00464 |

**Table 5 – Temperature vs Frequency Test Result**




**Plot 14 – Temperature vs Frequency**

## 7. Frequency Stability vs Voltage

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §2.1055 | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/11/09 |

**Test Procedures:** As required by 47 CFR 2.0155, Frequency Stability measurements were made at the RF antenna output terminals of the EUT.

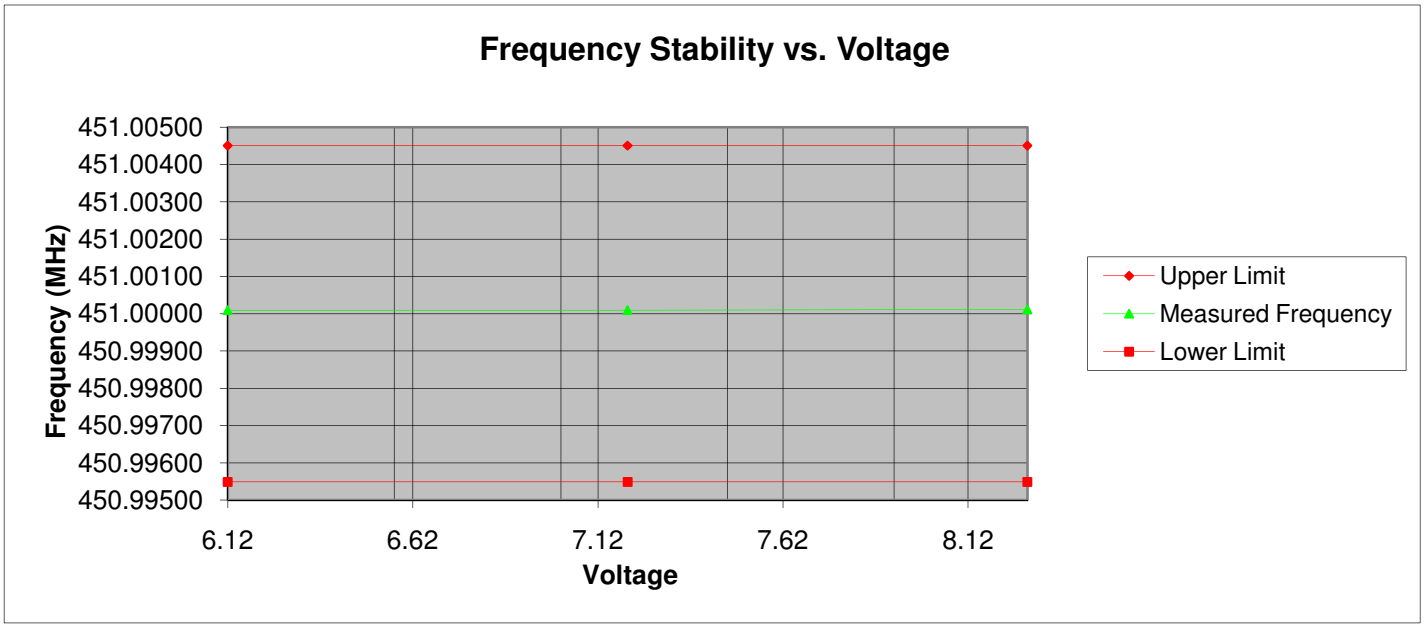
The EUT was connected to a variable DC source. The frequency was measured at both the nominal 7.2 Vdc of the EUT and at the extreme ±15% of nominal which is 85% level or 6.12Vdc and at the 115% level or 8.28Vdc

With the voltage set to a measurement point, the transmitted signal was captured by the spectrum analyzer and the frequency value determined. The frequencies are compared to the tuned frequency. All data for these measurements are found in the table 6.

**Reference Frequency: 451MHz at 7.2VdC at 25°C**

| Input Voltage (Vdc) | Measured Frequency (MHz) | Upper Margin (MHz) | Lower Margin (MHz) |
|---|---|---|---|
| 6.12 | 451.00010 | -0.00441 | 0.00460 |
| 7.20 | 451.00010 | -0.00441 | 0.00460 |
| 8.28 | 451.00012 | -0.00439 | 0.00462 |

**Table 6. Temperature vs. Voltage Test Result**




**Plot 15 – Temperature vs Voltage**

## 8. Transient Frequency Behavior

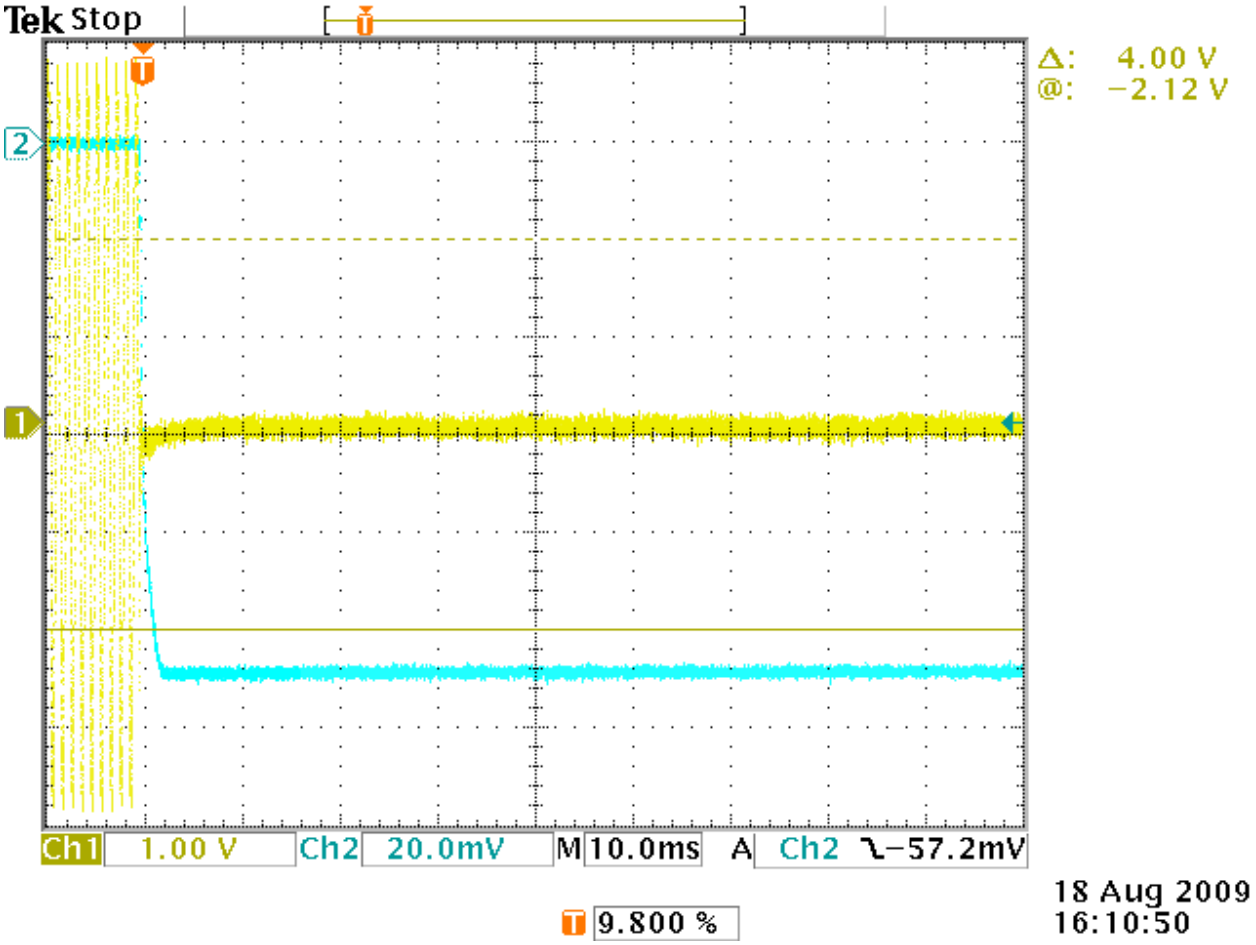
| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §90.214 | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 08/22/09 |

**Test Procedures:** The EUT was tested for transient frequency behavior using the test method of TIA/EIA 603.

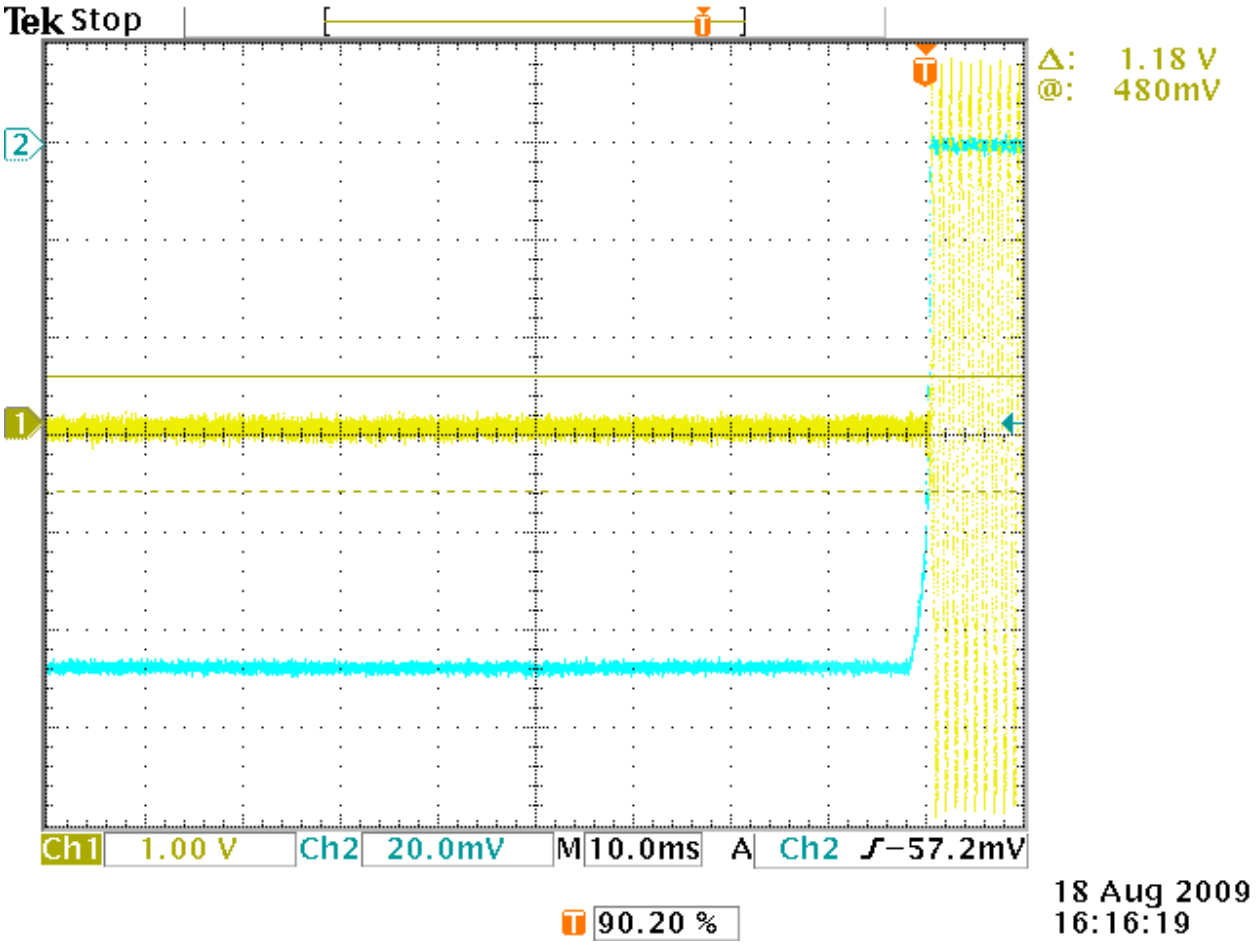
| RF Frequency | Channel Bandwidth | Transient Period | Transient Behavior | Result |
|---|---|---|---|---|
| 450MHz | 12.5KHz | t1= 10ms | <±12.5kHz | Pass |
| | | t2= 25ms | <±6.25kHz | Pass |
| | | t3= 10ms | <±12.5kHz | Pass |

**Table 7. Transient Frequency – Test Requirement**

The following pages show measurements of Transient Frequency Behavior plots:




**Plot 16 – On Time**




**Plot 17 – Off Time**

# I. Test Equipment

| Equipment | Manufacturer | Model | Serial # | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| Power Supply | H.P | E3610A | KR83021468 | NCR | None |
| DMM | H.P | 34401A | US36054008 | Oct/23/08 | Oct/23/09 |
| Spectrum Analyzer | H.P. | 8595E | 3543A01606 | Nov/06/08 | Nov/06/09 |
| Diode/Crystal Detector | H.P | 8470B | None | NCR | None |
| Combiner/Splitter | MiniCircuits | ZFSC-2-2 | None | NCR | None |
| Temp Chamber | Thermotron | ATSS-80-6-6 | 36758 | 11/14/07 | 11/14/09 |
| Temperature Meter | Fluke | 52 | 6767008 | 10/30/07 | 10/30/09 |
| Attenuator 30dB | Bird | 10-A-MFN-30 | 0031039 | 11/03/08 | 11/03/09 |
| Directional Coupler | Werlatone | C1795-13 | 18722 | 09/03/08 | 09/03/09 |
| Variable Attenuator | H.P. | None | None | NCR | None |
| EMI Receiver | R&S | ESCS-30 | 828985/007 | 08/20/08 | 08/20/09 |
| Signal Generator | R&S | SMY02 | 1062.5502.12 | NCR | None |
| Oscilloscope | Tektronix | TDS3052 | B010822 | 12/17/08 | 12/17/09 |
| Attenuator 20dB | Mini Circuits | CAT-20 | 10012 | NCR | None |
| Horn Antenna | EMCO | 3115 | 9505-4428 | 10/22/08 | 10/22/09 |
| Dipole Antenna | Schwarzbeck | UHAP-10dB | 173 | 12/19/08 | 12/19/09 |
| Bilog Antena | Chase | CBL6140 | 1040 | 10/28/08 | 10/28/09 |

**Table 8 – Test Equipment List**

**END OF TEST REPORT**