H.B. Compliance Solutions

# Intentional Radiator Test Report

For the

**Microchip Technology Inc.**

**915 MHz Ultra Low-Power Sub-GHz Transceiver Module**

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 15.249

**Prepared for:**

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**Prepared By:**

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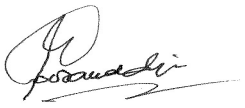


Hoosamuddin Bandukwala

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 15 of the FCC Rules under normal use and maintenance.**

## Report Status Sheet

| Revision # | Report Date | Reason for Revision |
|---|---|---|
| Ø | March 22, 2011 | 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 15.249. All tests were conducted using measurement procedure from ANSI C63.4-2003.

| Test Name | Test Method/Standard | Result | Comments |
|---|---|---|---|
| Unintentional Radiated Emissions | 15.109 | Pass | |
| A/C Power Line Conducted Emissions | 15.207 | Pass | |
| Radiated Spurious Emissions | 15.249, 15.209(a), 15.205 | Pass | |
| Emissions At Band Edges & Restricted Band | 15.249, 15.209(a), 15.205 | Pass | |

# EQUIPMENT CONFIGURATION

## 1. Overview

H.B Compliance Solutions was contracted by Microchip Technology Inc. to perform testing on the 915 MHz Ultra Low-Power Sub-GHz Transceiver Module under the purchase order number 159432.

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

The tests were based on FCC Part 15 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. Microchip 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:** | 915 MHz Ultra Low-Power Sub-GHz Transceiver Module |
| **Model(s) Tested:** | MRF89XAM9A |
| **FCC ID:** | OA3MRF89XAM9A |
| **Supply Voltage Input:** | Primary Power : 3.3 Vdc |
| **Frequency Range:** | 903-927 MHz |
| **No. of Channels:** | Single Chanel |
| **Type(s) of Modulation:** | OOK |
| **Range of Operation Power:** | 9.9nW (Radiated) |
| **Emission Designator:** | N/A |
| **Channel Spacing(s)** | None |
| **Test Item:** | Pre-Production |
| **Type of Equipment :** | Fixed |
| **Antenna Requirement (§15.203) :** | Type of Antenna: PCB Meander<br>Gain of Antenna: -1dBi |
| **Environmental 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):** | 03/07/11 till 03/22/11 |
| | |
| | |

## 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 Microchip, The MRF89XAM9A is an Ultra Low-Power Sub-GHz surface mount transceiver module with integrated crystal, internal voltage regulator, matching circuitry and PCB antenna. The MRF89XAM9A module operates in the 902–928 MHz ISM frequency band. The module interfaces to many Microchip PIC microcontrollers through a 4-wire SPO interface. The operating voltage is 3.3VDC typical.

## 4. Equipment Configuration

| Ref. ID | Name / Description | Model Number | Serial Number |
|---|---|---|---|
| # 1 | 915 MHz Ultra Low –Power Sub-GHz Transceiver Module | MRF89XAM9A | 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 | Laptop Computer | IBM | Thinkpad T 41 | 99-K3967 |
| #4 | Microcontroller Board | Microchip | PICDEM Z | BUR062000003 |

**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 |
|---|---|---|---|---|---|---|
| #5 | Power | 2 wire | 1 | 1 | N | DC Power Supply |
| #6 | Serial | DB-9 | 1 | 2 | N | Laptop |

**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 test software which was operated through a laptop computer. This software allowed the transmitter to switch between each channel and its mode from modulated to 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 Microchip Technology Inc. upon completion of testing & certification

# Criteria for Un-Intentional Radiators

## 1. Radiated Emissions

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §15.109 | **Test Engineer(s):** | Frank Farrone |
| **Test Results:** | Pass | **Test Date(s):** | 03/15/11 |

***Test Procedures:***

The final radiated emissions test was performed using the parameters described above as worst case. That final test was conducted at a facility that meets the ANSI C63.4 NSA requirements. The frequency range noted in the data sheets was scanned/tested at that facility. Emissions were maximized as specified, by varying table azimuth, antenna height, and manipulating cables.

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This requires the use of a turntable and an antenna positioner. The preferred method of a continuous azimuth search is utilized for frequency scans of the EUT field strength with both polarities of the measuring antenna. A calibrated, linearly polarized antenna was positioned at the specified distance from the periphery of the EUT.

> *Note: The specified distance is the horizontal separation between the closest periphery of the EUT and the center of the axis of the elements of the receiving antenna. However, if the receiving antenna is a log-periodic array, the specified distance shall be the distance between the closest periphery of the EUT and the front-to-back center of the array of elements.*

Tests were made with the antenna positioned in both the horizontal and vertical polarization planes. The measurement was varied in height above the conducting ground plane to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters. At any measurement distance, the antenna height was varied from 1 meter to 4 meters. These height scans apply for both horizontal and vertical polarization, except that for vertical polarization the minimum height of the center of the antenna shall be increased so that the lowest point of the bottom of the antenna clears the ground surface by at least 25 cm.

| Frequency Range (MHz) | Peak Data (kHz) | Quasi-Peak Data (kHz) | Average Data (kHz) |
|---|---|---|---|
| 30 MHz to 1 GHz | 120 kHz | 120 kHz | N/A |
| 1 GHz to 11 GHz | 1MHz | N/A | 1MHz |
| | | | |
| | | | |
| Measurements were made using the bandwidths and detectors specified. The video filter was at least as wide as the IF bandwidth of the measuring receiver. | | | |

**Table 4. Radiated Emissions – Measurement Bandwidth**

## Emissions Tests Calculations

In the case of indoor measurements, radiated emissions measurements are made by the manipulation of correction factors using Rohde and Schwarz ES-K1 software. This is done automatically by the software during the final measurement process.

In both cases, the level of the Field Strength of the interfering signal is calculated by adding the Antenna Factor, Cable Factor and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

FS = RA + AF + (CF –AG)

Where: FS = Field Strength

RA = Receiver (indicated) Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

This laboratory uses an approach of combining the CF and AG using an end-to-end measurement of the entire cabling system, including the test cable, any in-line amplifiers, attenuators, or transient protection networks, all measured in-situ.

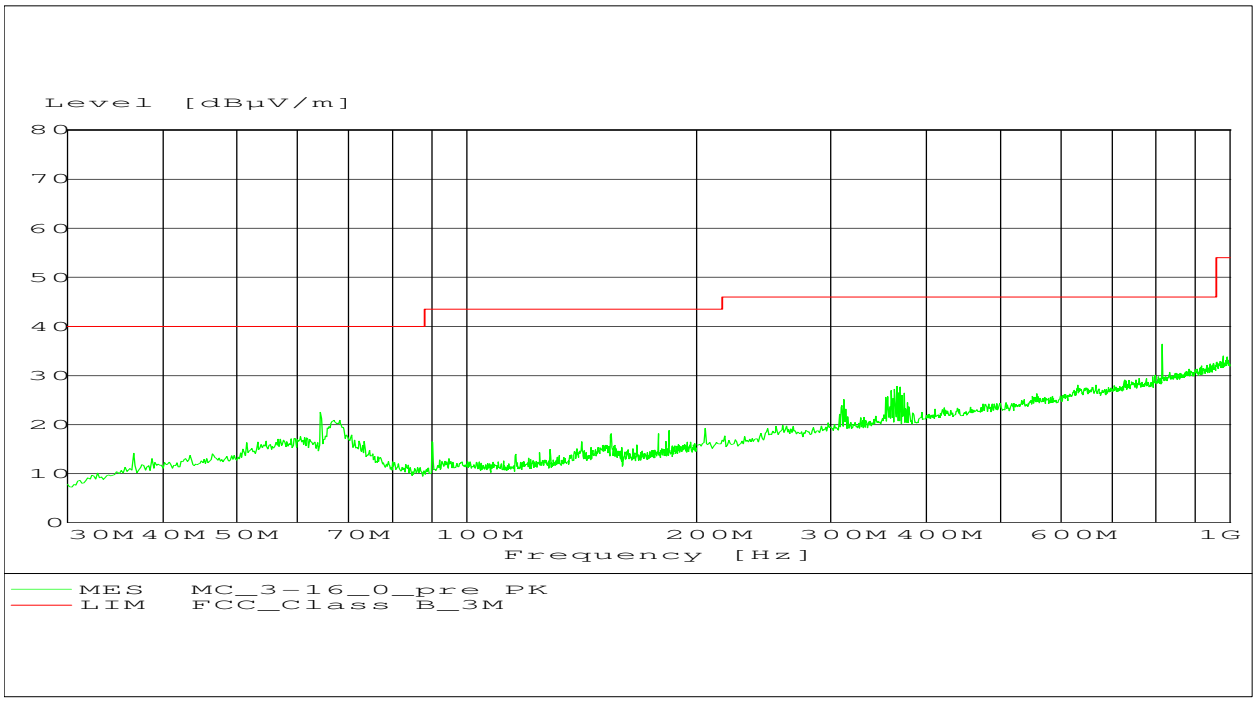
For a sample calculation, assume a receiver reading of 52.5 dBuV is obtained. With an antenna factor of 7.4 and a combined cable factor (CF + AG) of -27.9:

FS = 52.5 + 7.4 + (-27.9) = 32 dBuV/m

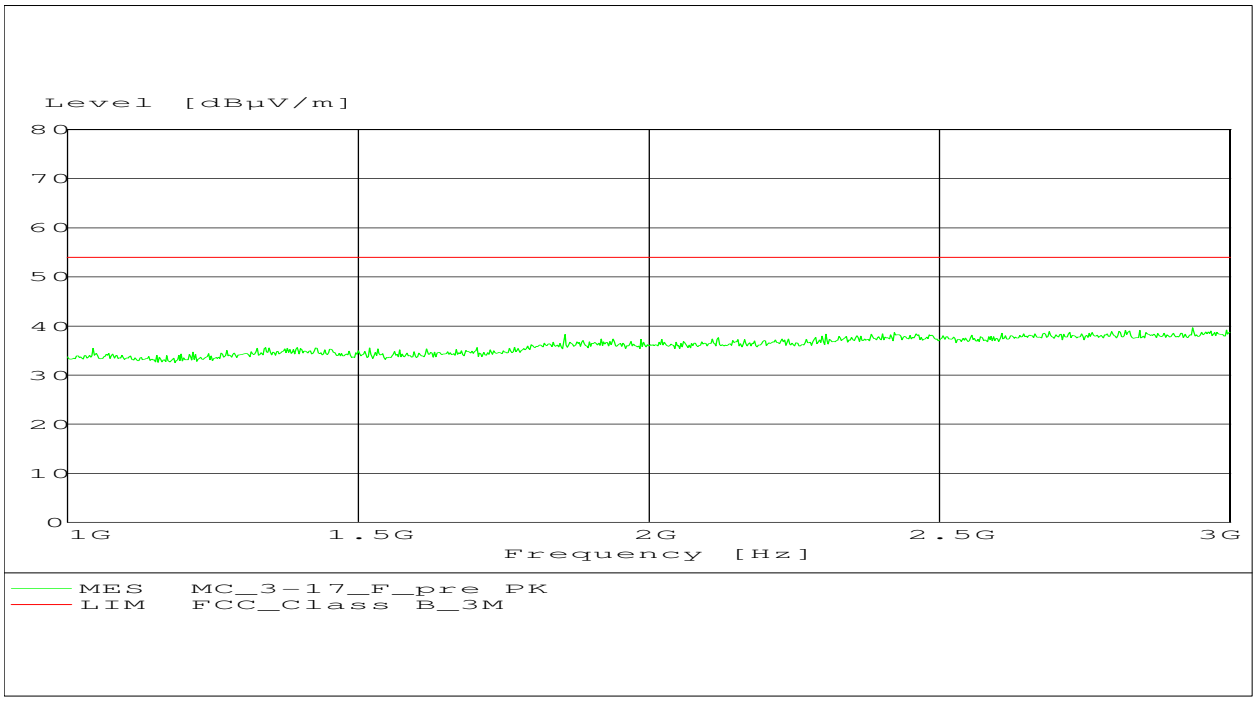
FS = 32 dBuV/m

If desired, this can be converted into its corresponding level in uV/m:

FS = 10^((32 dBuV/m)/20) = 39.8 uV/m




**Plot 1 – Radiated Emissions – 30MHz to 1GHz**




**Plot 2 – Radiated Emissions – 1GHz to 3GHz**

| Frequency (MHz) | Measured Level | Height(cm) | Azimuth (deg) | Polarization |
|---|---|---|---|---|
| 814.22 | 36.83 | 100 | 0 | Vertical |

**Table 5. Final Measurement Results for Radiated Emissions**

## 2. Conducted Emissions

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §15.207 | **Test Engineer(s):** | N/A |
| **Test Results:** | DC powered device | **Test Date(s):** | N/A |

**Test Procedures:** The EUT was placed on a non-metallic table, 80cm above the ground plane inside a shielded enclosure. The EUT was powered through a 50Ω/50µH LISN. The conducted emissions tests were performed using the mode of operation and configuration noted within this report. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with power cords that are the same as those cords normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network). All 50 Ohm measuring ports of the LISN are terminated by 50 Ohms, either by the 50 Ohm EMI receiver or a 50 Ohm resistive load.

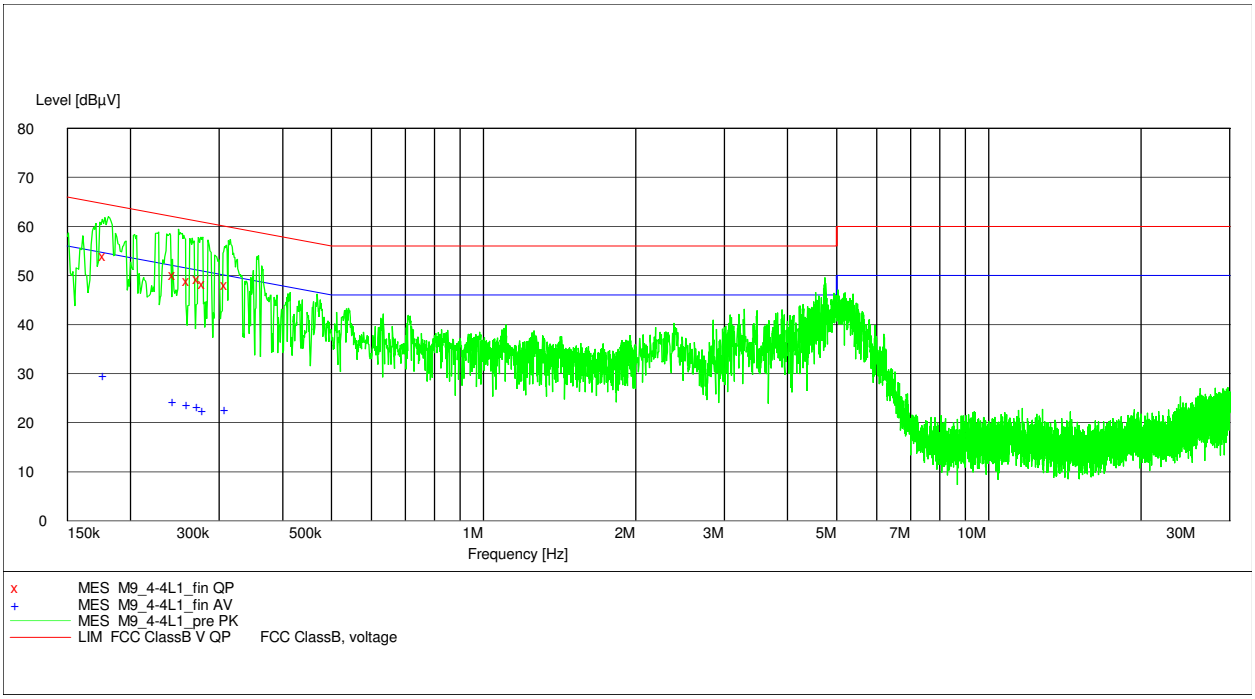
Refer to the Emissions Tests Calculations section in the Radiated Emissions section for sample calculations. For the purposes of the conducted emissions test, the Antenna Factor (AF) is replaced by the LISN correction factor.

| Frequency Range (MHz) | Peak Data (kHz) | Quasi-Peak Data (kHz) | Average Data (kHz) |
|---|---|---|---|
| 0.150 - 30 | 9.0 | 9.0 | 9.0 |
| | | | |
| **Measurements were made using the bandwidths and detectors specified. No video filter was used.** | | | |

**Table 6.Conducted Emissions – Measurement Bandwidth**

| Frequency Range ( MHz) | 15.107(b), Class A Limits (dBuV) | | 15.107(a), Class B Limits (dBuV) | |
|---|---|---|---|---|
| | Quasi-Peak | Average | Quasi Peak | Average |
| 0.15 – 0.5 | 79 | 66 | 66 - 56 | 56 - 46 |
| 0.5 – 5.0 | 73 | 60 | 56 | 46 |
| 5.0 – 30 | 73 | 60 | 60 | 50 |
| **Note 1 – The lower limit shall apply at the transition frequencies.** | | | | |

**Table 7. Conducted Emissions Limits – FCC Limits from Section 15.107(a)(b)**



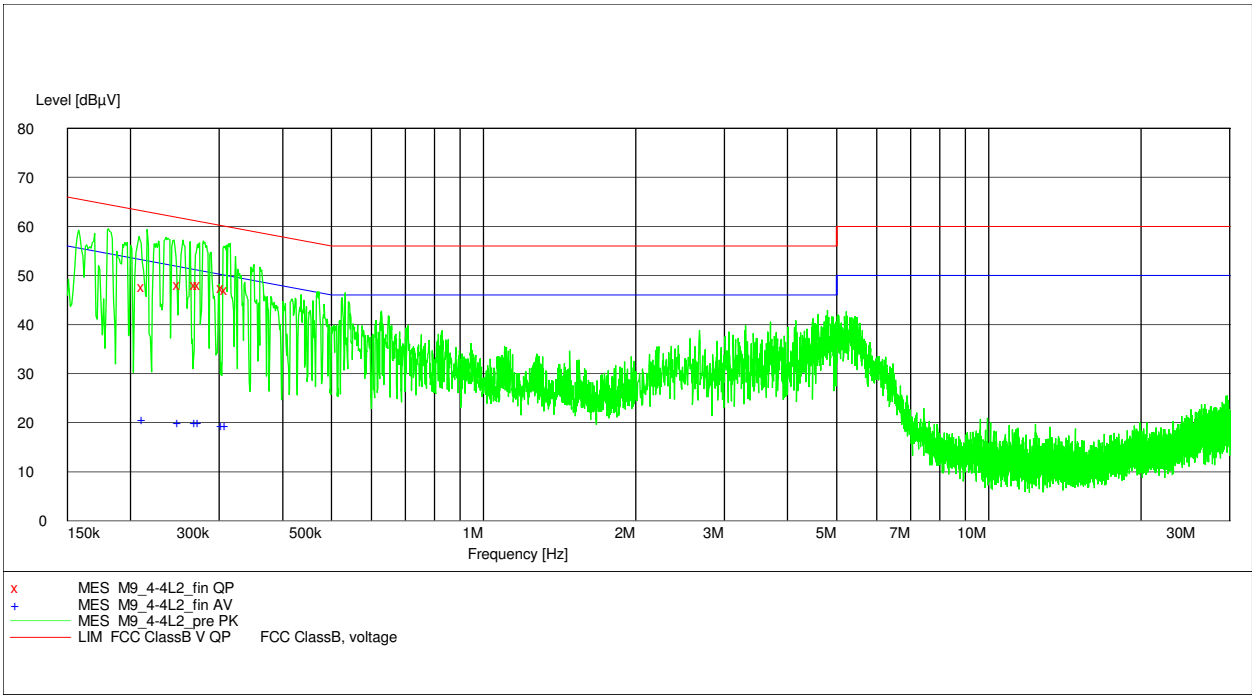

**Plot 3 – Conducted Emission Plot – Positive Side**

| Frequency (MHz) | Measured Level (dBuV) | Transducer (dB) | Limit(dBuV) | Margin(dB) |
|---|---|---|---|---|
| 0.181 | 54.0 | 10.1 | 64 | 10.4 |
| 0.249 | 50.20 | 10.1 | 62 | 11.5 |
| 0.265 | 49.00 | 10.0 | 61 | 11.4 |
| 0.285 | 48.30 | 10.0 | 61 | 12.3 |
| 0.315 | 48.20 | 10.0 | 60 | 11.7 |

**Table 8. Measurement Results for QP**

| Frequency (MHz) | Measured Level (dBuV) | Transducer (dB) | Limit(dBuV) | Margin(dB) |
|---|---|---|---|---|
| 0.181 | 29.70 | 10.1 | 54 | 24.7 |
| 0.249 | 24.40 | 10.1 | 52 | 27.4 |
| 0.265 | 23.90 | 10.1 | 51 | 27.3 |
| 0.278 | 23.40 | 10.0 | 51 | 27.4 |
| 0.285 | 22.60 | 10.0 | 51 | 28.0 |
| 0.315 | 22.90 | 10.0 | 50 | 27.0 |

**Table 9. Measurement Results for Average**




**Plot 4 – Conducted Emissions – Ground Side**

| Frequency (MHz) | Measured Level (dBuV) | Transducer (dB) | Limit(dBuV) | Margin(dB) |
|---|---|---|---|---|
| 0.216 | 47.70 | 10.1 | 63 | 15.3 |
| 0.254 | 48.0 | 10.1 | 62 | 13.6 |
| 0.274 | 48.10 | 10.0 | 61 | 12.9 |
| 0.279 | 48.10 | 10.0 | 61 | 12.8 |
| 0.310 | 47.50 | 10.0 | 60 | 12.5 |
| 0.315 | 47.20 | 10.0 | 60 | 12.7 |

**Table 10. Measurement Results for Quasi Peak**

| Frequency (MHz) | Measured Level (dBuV) | Transducer (dB) | Limit | Margin |
|---|---|---|---|---|
| 0.216 | 20.80 | 10.1 | 53 | 32.2 |
| 0.254 | 20.20 | 10.1 | 52 | 31.4 |
| 0.274 | 20.10 | 10.0 | 51 | 30.9 |
| 0.279 | 20.10 | 10.0 | 51 | 30.7 |
| 0.310 | 19.60 | 10.0 | 50 | 30.4 |
| 0.315 | 19.50 | 10.0 | 50 | 30.3 |

**Table 11. Measurement Results for Average**

## 3. Radiated Spurious Emissions and Restricted Band

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §15.249, 15.209(a), 15.205 | **Test Engineer(s):** | Tom Karas |
| **Test Results:** | Pass | **Test Date(s):** | 03/17/11 |

**Test Procedures:** As required by 47 CFR 15.249, Radiated spurious measurements were made in accordance with the procedures of the ANSI C63.4-2003.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

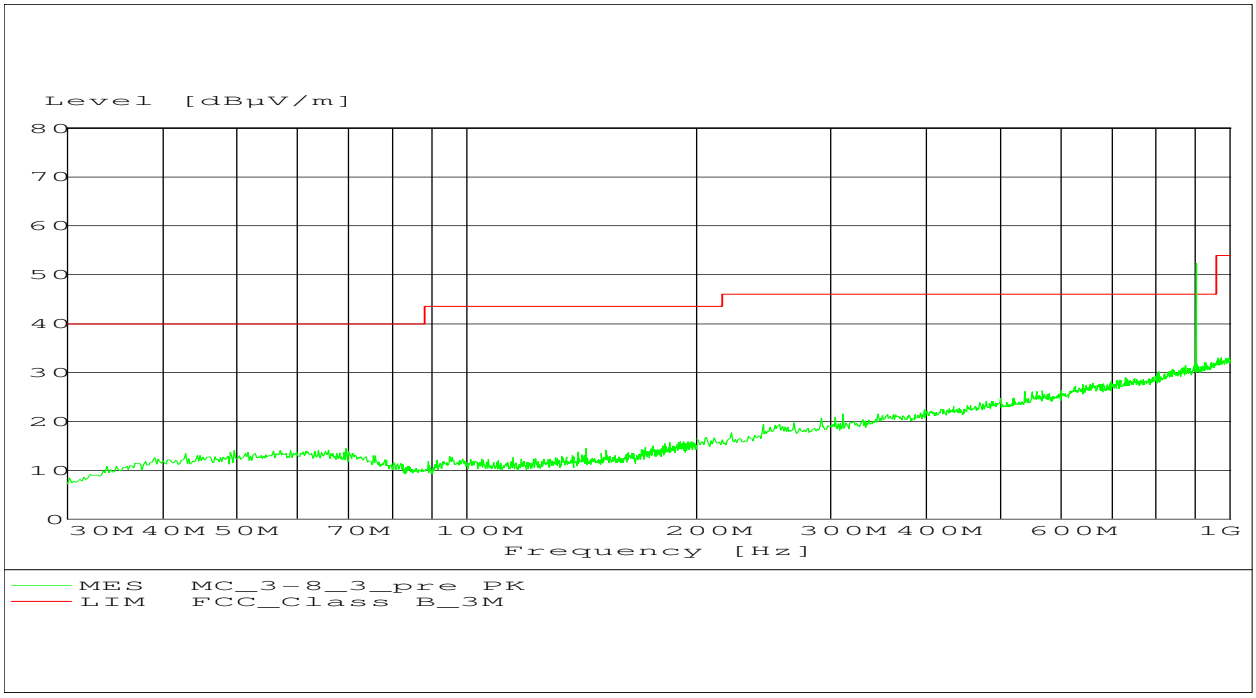
The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The frequency range up to the 10$^{th}$ harmonic was investigated.

| Detector Setting Below 1 GHz | Resolution Bandwidth | Video Bandwidth | Span |
|---|---|---|---|
| Peak | 120KHz | 100Khz | As necessary |
| Quasi Peak | 120Khz | As necessary | 0 Hz |

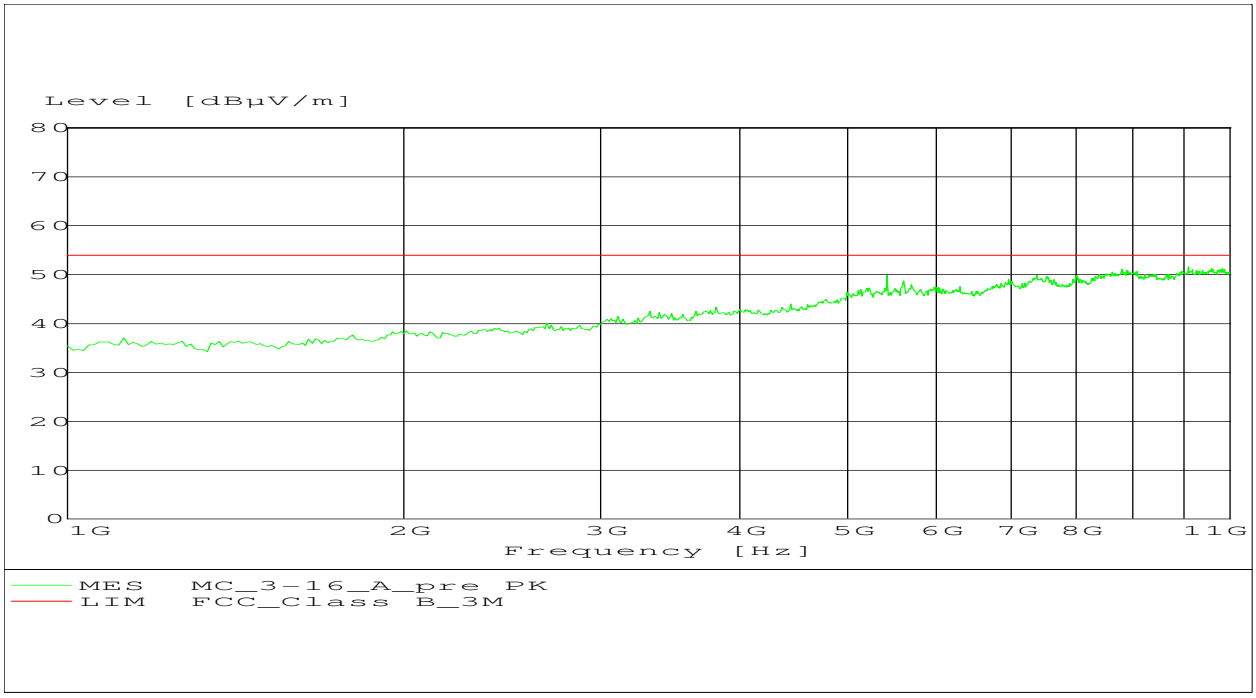
**Table 8 - Analyzer Settings below 1 GHz**

| Detector Setting Above 1 GHz | Resolution Bandwidth | Video Bandwidth | Span |
|---|---|---|---|
| Peak | 1MHz | 1MHz | As necessary |
| Average | 1MHz | 10Hz | 0 Hz |

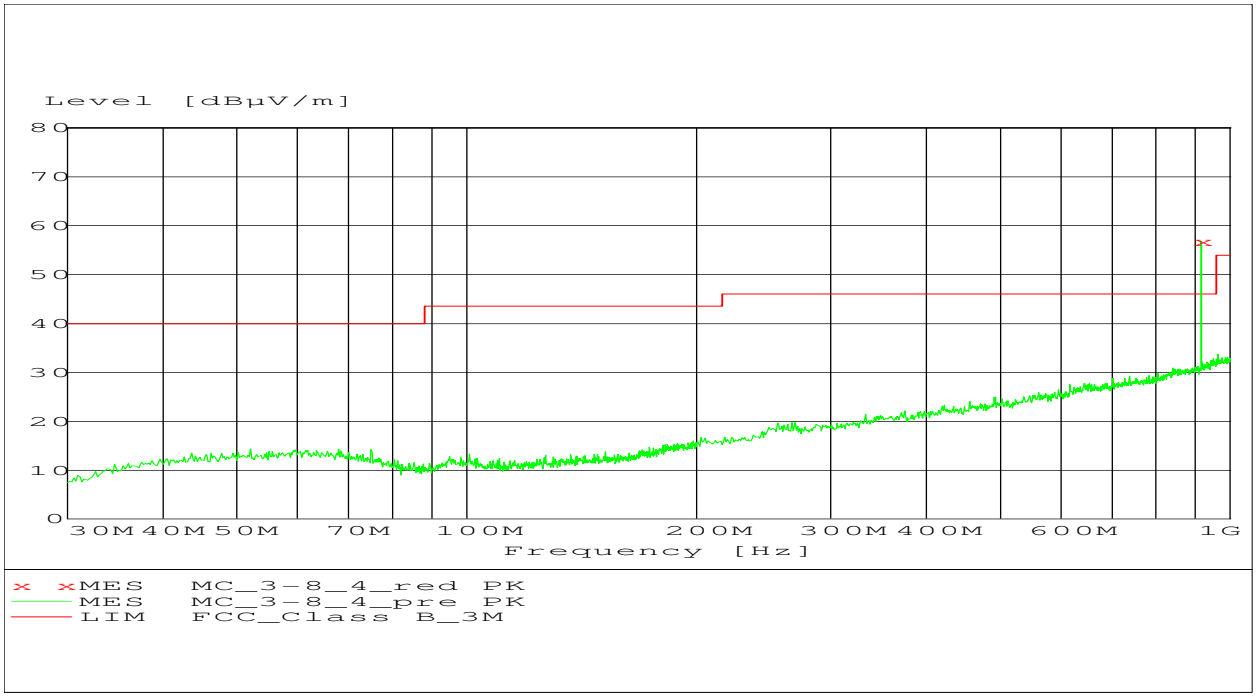
**Table 9 - Analyzer Settings Above 1 GHz**



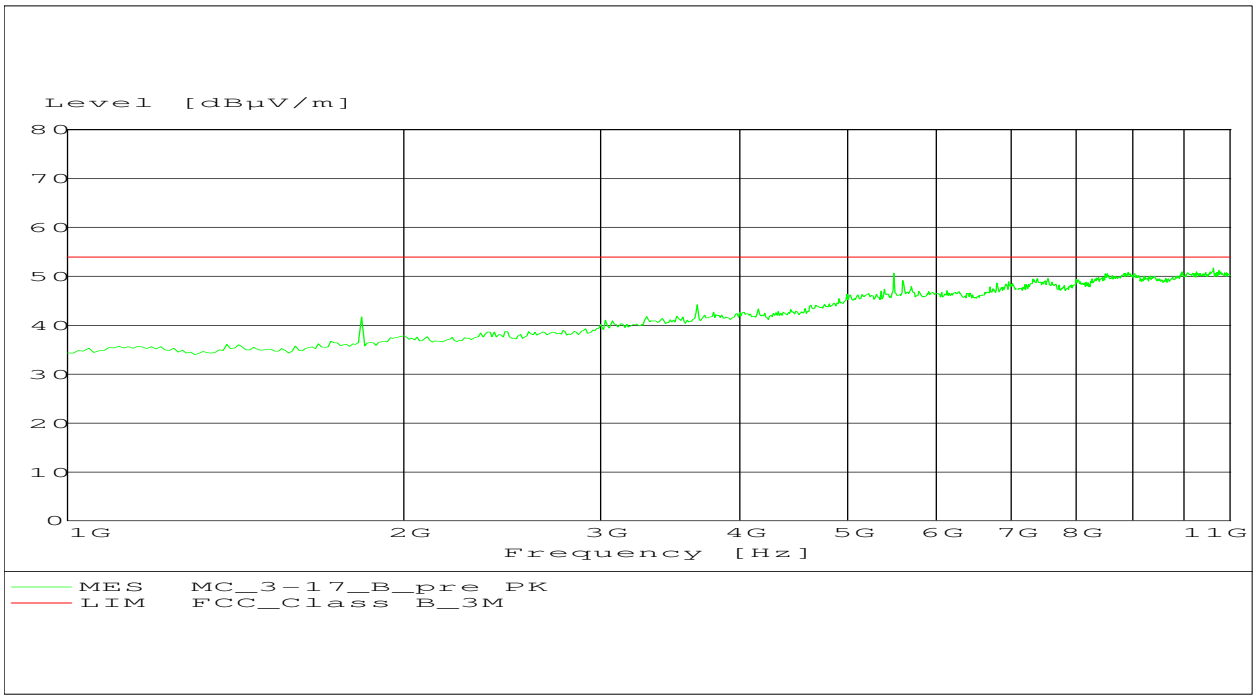

**Plot 3 – Lowest Channel (30MHz to 1GHz)**



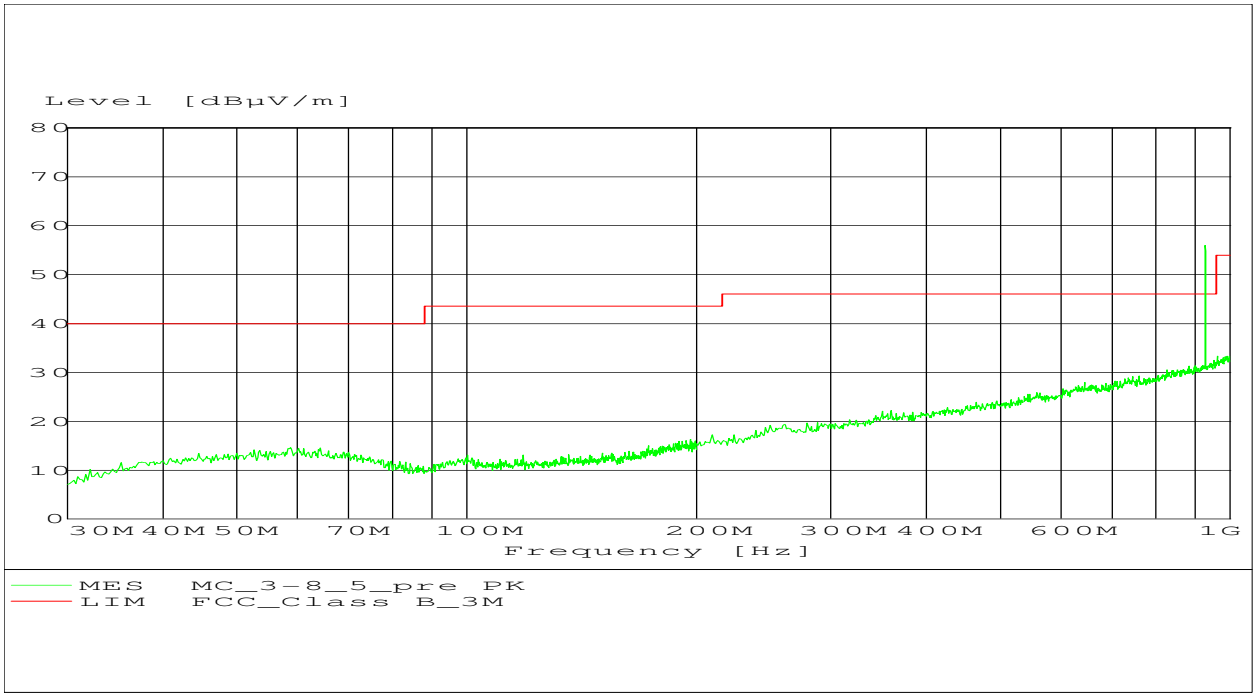

**Plot 4 – Lowest Channel 1GHz to 11GHz)**



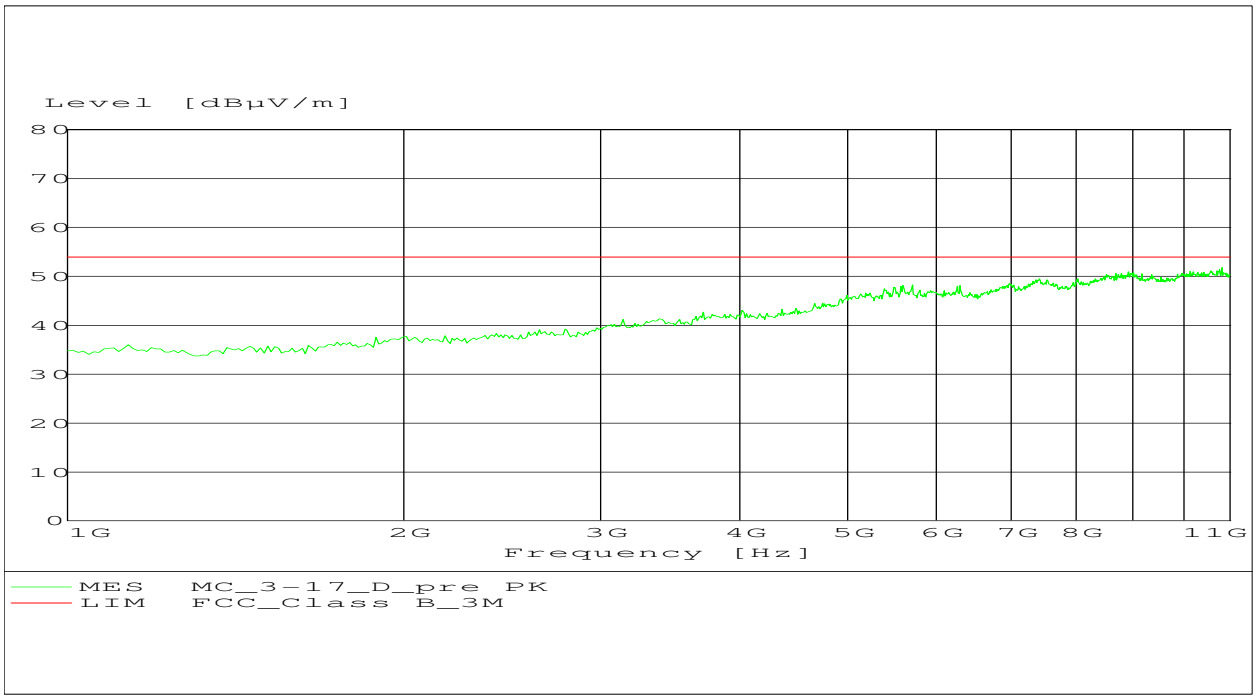

**Plot 5 – Middle Channel (30MHz to 1GHz)**




**Plot 6 – Middle Channel (1GHz to 11GHz)**




**Plot 7 – Highest Channel (30MHz to 1GHz)**




**Plot 8 – Highest Channel (1GHz to 11GHz)**

| Frequency (MHz) | Radiated Power (dBuV/m) | Radiated Power (mV/m) | Specification Limit |
|---|---|---|---|
| 903.11 | 52.33 | 0.413 | 50mV/m |
| 915.55 | 56.82 | 0.692 | 50mV/m |
| 926.80 | 57.1 | 0.715 | 50mV/m |

**Table 10. Fundamental RF Power Output, Test Results**

| Frequency (MHz) | Peak Amplitude (dbuV/m) | Peak Limit (dBuV/m) | Average Amplitude (dBuV/m)) | Average Limit (dBuV/m) |
|---|---|---|---|---|
| 1811.11 | 51.53 | 74.0 | N/A | 54.0 |
| 3611.11* | 47.95 | 74.0 | N/A | 54.0 |
| 5422.22* | 49.85 | 74.0 | N/A | 54.0 |
| 8933.33 | 51.81 | 74.0 | N/A | 54.0 |

**Table 11 - Spurious Radiated Emission Data – Low Band**

| Frequency (MHz) | Peak Amplitude (dbuV/m) | Peak Limit (dBuV/m) | Average Amplitude (dBuV/m) | Average Limit (dBuV/m) |
|---|---|---|---|---|
| 4911.11 | 45.45 | 74.0 | N/A | 54.0 |
| 5500.00 | 50.67 | 74.0 | N/A | 54.0 |

**Table 12– Spurious Radiated Emission Data – Mid Band**

| Frequency (MHz) | Peak Amplitude (dbuV/m) | Peak Limit (dBuV/m) | Average Amplitude (dBuV/m) | Average Limit (dBuV/m) |
|---|---|---|---|---|
| 4922.22 | 45.42 | 74.0 | N/A | 54.0 |
| 7366.66 | 49.30 | 74.0 | N/A | 54.0 |

**Table 13– Spurious Radiated Emission Data – High Band**

Note: Frequency marked with "*" falls under the restricted band

## 4. Emissions at Band Edges

| | | | |
|---|---|---|---|
| **Test Requirement(s):** | §15.249, 15.209(a), 15.205 | **Test Engineer(s):** | Hoosam B. |
| **Test Results:** | Pass | **Test Date(s):** | 03/08/11 |

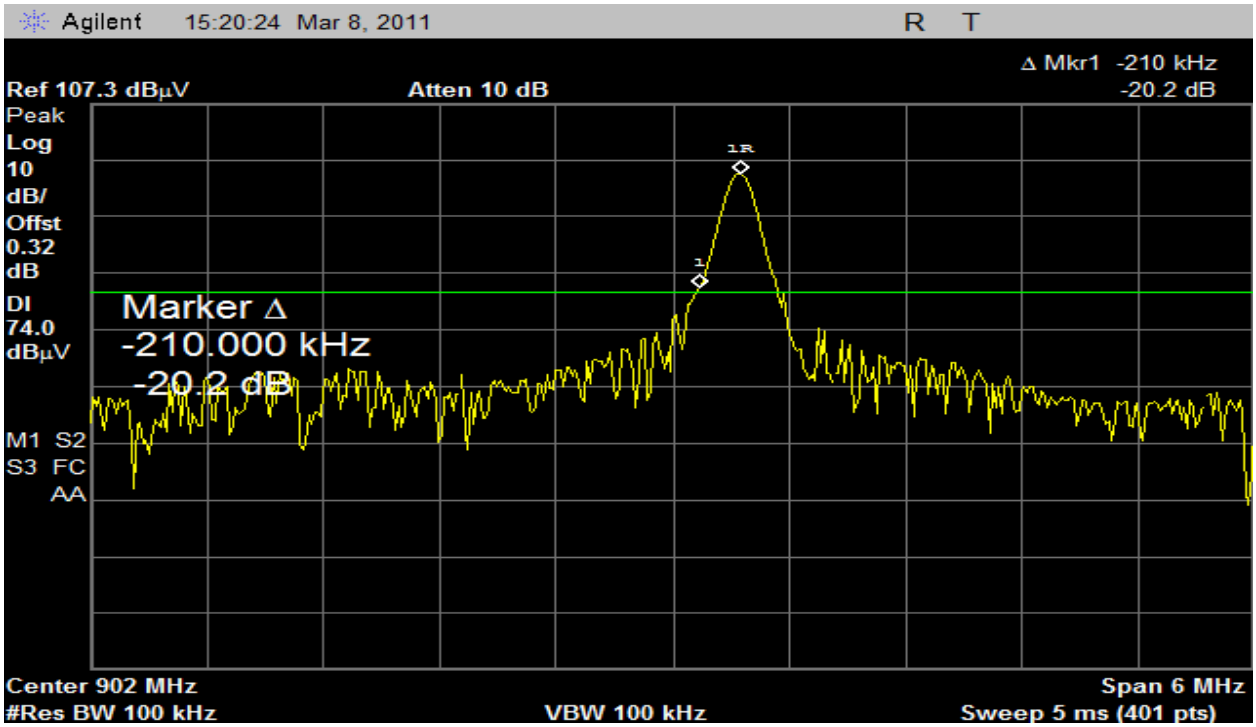
**Test Procedures:** As required by 47 CFR 15.247, Band edge radiated emissions measurements were made at the RF antenna output terminals of the EUT.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

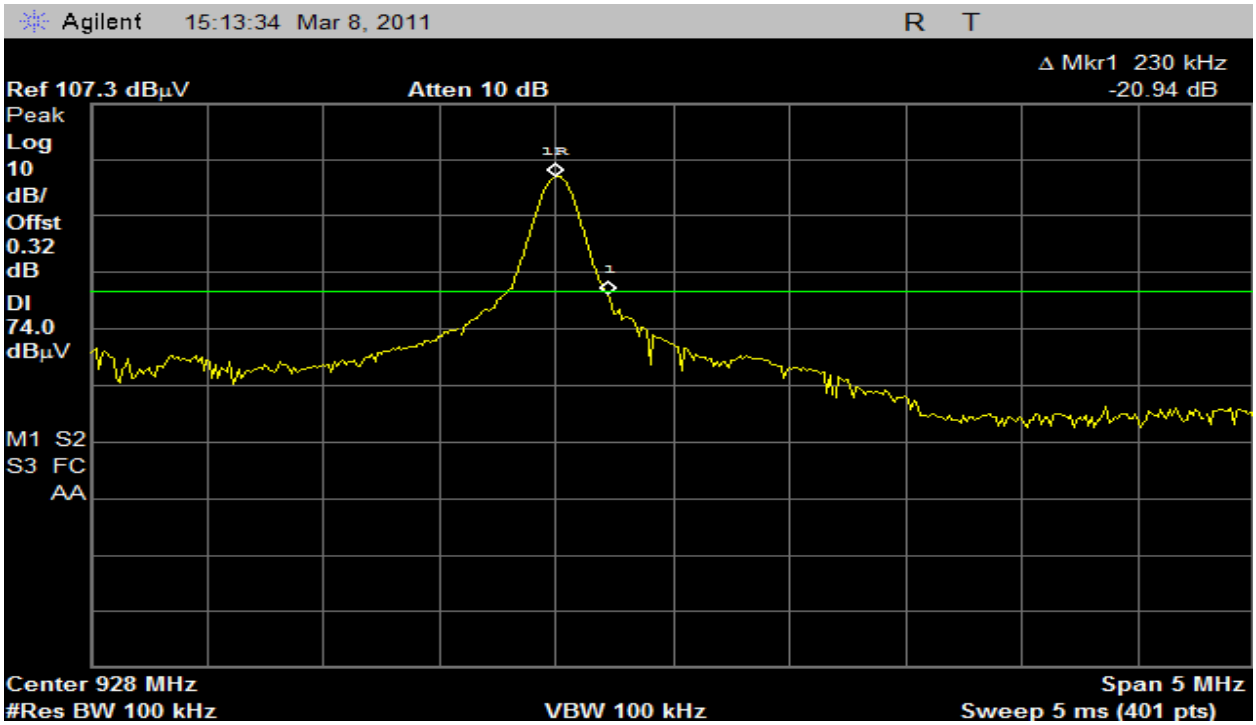
The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The EUT was set up at maximum power, first on the lowest operating channel, then on the highest operating channel of the transmit band.

| Frequency (MHz) | Measured Level (dB) | Detector | Limit |
|---|---|---|---|
| 902.0 | -34.00 | Peak | -20dBc |
| 928.0 | -33.00 | Peak | -20dBc |

**Table 14 – Band Edge Emissions Summary**




**Plot 3 – Lowest Channel (Band Edge)**




**Plot 4 – Highest Channel (Band Edge)**

# I. Test Equipment

| Equipment | Manufacturer | Model | Serial # | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| Power Supply | H.P | E3610A | KR83021468 | NCR | None |
| Spectrum Analyzer | Agilent | E4402B | USA1192757 | Sep/24/10 | Sep/24/11 |
| DMM | H.P | 34401A | US36054008 | Nov/11/10 | Nov/11/11 |
| Spectrum Analyzer | H.P. | 8595E | 3543A01606 | Apr/08/10 | Apr/08/11 |
| Combiner/Splitter | Mini-Circuits | ZFSC-2-2 | None | NCR | None |
| High Pass Filter | Mini-Circuits | VHF-3100+ | 15542 | NCR | None |
| Temperature Meter | Fluke | 52 | 6767008 | 10/30/10 | 10/30/11 |
| Attenuator 30dB | Bird | 10-A-MFN-30 | 0031039 | 11/03/10 | 11/03/11 |
| Directional Coupler | Werlatone | C1795-13 | 18722 | Oct/01/10 | Oct/01/11 |
| Variable Attenuator | H.P. | None | None | NCR | None |
| EMI Receiver | R&S | ESCS-30 | 828985/007 | Sep/03/10 | Sep/03/11 |
| Signal Generator | R&S | SMY02 | 1062.5502.12 | NCR | None |
| Attenuator 20dB | Mini Circuits | CAT-20 | 10012 | NCR | None |
| Horn Antenna | EMCO | 3115 | 9505-4428 | Nov/04/09 | Nov/04/11 |
| Bilog Antena | Chase | CBL6140 | 1040 | Nov/09/09 | Nov/09/11 |

**Table 15 – Test Equipment List**

**END OF TEST REPORT**