



**Compliance Testing, LLC**  
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## Test Report

Prepared for: Ubiquiti Networks, Inc

Model: PBE-M5

Description: PowerBeam M5

Serial Number: N/A

FCC ID: SWX-PBE5M

To

FCC Part 15.407

Date of Issue: June 2, 2015

On the behalf of the applicant:

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Project No: p14a0028

**Alex Macon**  
Project Test Engineer

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All results contained herein relate only to the sample tested.



### Test Report Revision History

| Revision | Date         | Revised By | Reason for Revision                                                                          |
|----------|--------------|------------|----------------------------------------------------------------------------------------------|
| 1.0      | May 5, 2015  | Alex Macon | Original Document                                                                            |
| 2.0      | May 18, 2015 | Alex Macon | Updated EUT specification table on pg. 7<br>Updated Annex A to reflect antenna list provided |
| 3.0      | June 2, 2015 | Alex Macon | Corrected Annex A Output power tables                                                        |
|          |              |            |                                                                                              |



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The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.

Testing Certificate Number: **2152.01**



**FCC Site Reg. #349717**

**IC Site Reg. #2044A-2**

**Non-accredited tests contained in this report:**

**N/A**



**The applicant has been cautioned as to the following**

**15.21 - Information to User**

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**15.27(a) - Special Accessories**

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.



## Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

| Environmental Conditions |                 |                    |
|--------------------------|-----------------|--------------------|
| Temperature<br>(°C)      | Humidity<br>(%) | Pressure<br>(mbar) |
| 24.6 – 25.7              | 28.9 – 34.5     | 965.1 – 966.3      |

## EUT Operation during Tests

The EUT was configured to run in a continuous data stream using ART software through a POE adaptor and Ethernet connection.

### EUT Description

**Model:** PBE-M5

**Description:** PowerBeam M5

**Firmware:** N/A

**Software:** N/A

**Serial Number:** N/A

**Additional Information:** The EUT is a 2x2 MIMO 802.11n radio



## EUT Specifications

|                                 |                                                                                          |
|---------------------------------|------------------------------------------------------------------------------------------|
| <b>EUT Specifications</b>       | 15.407                                                                                   |
| <b>Equipment Code</b>           | NII                                                                                      |
| <b>FCC ID</b>                   | SWX-PBE5M                                                                                |
| <b>Model(s) Tested</b>          | PBE-M5                                                                                   |
| <b>Model(s) Covered</b>         | PBE-M5-Omni, PBE-M5-300, PBE-M5-400, PBE-M5-620                                          |
| <b>Maximum Output Power</b>     | 18.7                                                                                     |
| <b>Frequency Ranges Covered</b> | 5725-5850MHz                                                                             |
| <b>EUT Temperature Range</b>    | -30°C to 75°C                                                                            |
| <b>Bandwidths</b>               | 10/20/30/40 MHz                                                                          |
| <b>Data Rates</b>               | 6, 9, 12, 18, 24, 36, 48, 54, MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7, MCS8, MCS9 |
| <b>Modulations</b>              | BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM                                                      |

## Antenna List

| <b>Model No.</b> | <b>Manufacturer</b> | <b>Antenna Type</b> | <b>Peak Gain</b> |
|------------------|---------------------|---------------------|------------------|
| PBE-AC Omni      | Ubiquiti            | OMNI                | 6                |
| PBE-AC-300       | Ubiquiti            | Dish                | 22               |
| PBE-AC-400       | Ubiquiti            | Dish                | 25               |
| PBE-AC-620       | Ubiquiti            | Dish                | 29               |



**15.203: Antenna Requirement:**

- ☐ The antenna is permanently attached to the EUT
- ☐ The antenna uses a unique coupling
- ☒ The EUT must be professionally installed
- ☐ The antenna requirement does not apply

**Accessories:** None

**Cables:** None

**Modifications:** None



## Test Results Summary

| Specification                    | Test Name                                                                        | Pass, Fail, N/A | Comments |
|----------------------------------|----------------------------------------------------------------------------------|-----------------|----------|
| §15.203                          | Antenna Requirements                                                             | Pass            |          |
| §15.207<br>§15.407(b)(6)         | Line Conducted Emissions                                                         | Pass            |          |
| §15.407(a)(3)                    | Conducted Output Power                                                           | Pass            |          |
| §15.407(a)(3),(5)                | Power Spectral Density                                                           | Pass            |          |
| §15.403(i)<br>§15.407(e)         | 6dB Occupied Bandwidth                                                           | Pass            |          |
|                                  | 99% Occupied Bandwidth                                                           |                 |          |
| §15.407(b)(4)                    | Undesirable Emissions                                                            | Pass            |          |
| §15.205<br>§15.407(b)(4),(5),(6) | General Field Strength Limits<br>(Restricted Bands and Radiated Emission limits) | Pass            |          |
| §15.407(g)                       | Frequency Stability                                                              | Pass            |          |
| §15.407(f)                       | RF Exposure                                                                      | Pass            |          |

| References                | Description                                                                                                                       |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| CFR47, Part 15, Subpart B | Unintentional Radiators                                                                                                           |
| CFR47, Part 15, Subpart C | Intentional Radiators                                                                                                             |
| CFR47, Part 15, Subpart E | Unlicensed Nation Information Infrastructure Devices (U-NII)                                                                      |
| ANSI C63.10-2013          | American National standard for testing Unlicensed Wireless Devices                                                                |
| ANSI C63.4-2014           | Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz. |
| ISO/IEC 17025:2005        | General requirements for the Competence of Testing and Calibrations Laboratories                                                  |
| KDB 644545 D03            | Guidance for IEEE 802 11ac New Rules                                                                                              |
| KDB 789033 D02            | General U-NII Test Procedures New Rules V01                                                                                       |
| KDB 926956 D01            | U-NII Transition Plan                                                                                                             |



## Peak Output Power

**Engineer:** Alex Macon

**Test Date:** 4/24/15

### Test Requirements

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

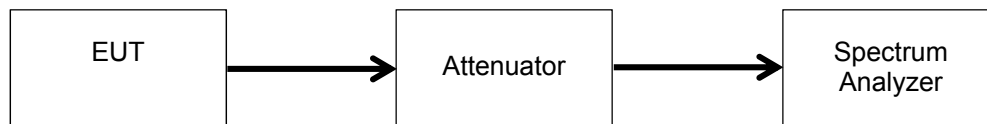
### Test Procedure

The RF power was calculated using the spectrum analyzers' band power function per Method SA-1 from KDB 789033 D02 General U-NII Test Procedures New Rules v01. Measurements were made at the low, mid and high channels of the band.

#### The Spectrum analyzer was set to the following:

- a. RBW = 1 MHz
- b. VBW  $\geq$  3 MHz
- c. Sweep time = auto
- d. Detector = RMS
- e. 100 traces in power averaging mode

### Test Setup





**Test Results for a 6 dBi antenna**

| Bandwidth | Test Frequency | Data Rate | TP | J1 Level | J3 Level | J1 Level | J3 Level | Combined Output Power | Limit | Margin |
|-----------|----------------|-----------|----|----------|----------|----------|----------|-----------------------|-------|--------|
| MHz       | MHz            |           |    | dBm      | dBm      | W        | W        | dBm                   | dBm   | dB     |
| 10        | 5735           | 6         | 20 | 11.8     | 14.6     | 15.1     | 28.8     | 16.4                  | 30    | -13.6  |
| 10        | 5800           | 6         | 20 | 15.8     | 15.5     | 38.0     | 35.5     | 18.7                  | 30    | -11.3  |
| 10        | 5840           | 6         | 20 | 14.4     | 13.5     | 27.5     | 22.4     | 17.0                  | 30    | -13.0  |
| 20        | 5740           | 6         | 20 | 13.6     | 14.6     | 22.9     | 28.8     | 17.1                  | 30    | -12.9  |
| 20        | 5800           | 6         | 20 | 14.6     | 15.3     | 28.8     | 33.9     | 18.0                  | 30    | -12.0  |
| 20        | 5835           | 6         | 20 | 15.3     | 15.1     | 33.9     | 32.4     | 18.2                  | 30    | -11.8  |
| 30        | 5745           | 6         | 20 | 13       | 14.8     | 20.0     | 30.2     | 17.0                  | 30    | -13.0  |
| 30        | 5800           | 6         | 20 | 15       | 15.3     | 31.6     | 33.9     | 18.2                  | 30    | -11.8  |
| 30        | 5830           | 6         | 20 | 15.5     | 14.4     | 35.5     | 27.5     | 18.0                  | 30    | -12.0  |
| 40        | 5750           | f0        | 19 | 11.9     | 13.7     | 15.5     | 23.4     | 15.9                  | 30    | -14.1  |
| 40        | 5800           | f0        | 20 | 15.1     | 15.2     | 32.4     | 33.1     | 18.2                  | 30    | -11.8  |
| 40        | 5825           | f0        | 20 | 15.8     | 15.6     | 38.0     | 36.3     | 18.7                  | 30    | -11.3  |



## Transmitter Power Spectral Density

**Engineer:** Alex Macon

**Test Date:** 4/24/15

### Test Requirements

For the band 5.725-5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in power spectral density.

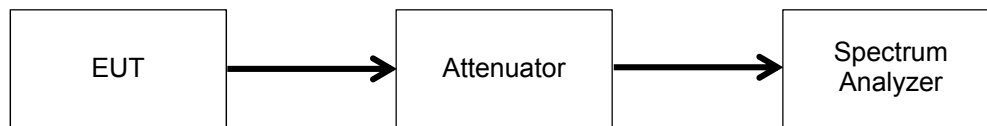
### Test Procedure

The Power Spectral Density was measured using the method per SA-1 from KDB 789033 D02 General U-NII Test Procedures New Rules v01. Measurements were made at the low, mid and high channels of the band. The maximum PSD was determine by finding the peak value across the carrier bandwidth.

The Spectrum Analyzer was set to the following:

- a. RBW = 500 KHz.
- b. VBW  $\geq$  1500 MHz
- c. Span  $1.5 * BW$
- d. Sweep time = auto
- e. Detector = RMS
- f. 100 traces in power averaging mode

### Test Setup





**Test Results for a 6dBi antenna**

| Bandwidth | Test Frequency | Data Rate | TP | J1 Level | J3 Level | J1 Level | J3 Level | Total Summed SD | Limit/500KHz | Margin |
|-----------|----------------|-----------|----|----------|----------|----------|----------|-----------------|--------------|--------|
| MHz       | MHz            |           |    | dBm      | dBm      | mW       | mW       | dBm             | dBm          | dB     |
| 10        | 5735           | 6         | 20 | 1.7      | 3.6      | 1.479    | 2.291    | 5.8             | 30           | -24.2  |
| 10        | 5800           | 6         | 20 | 5.3      | 4.6      | 3.388    | 2.884    | 8.0             | 30           | -22.0  |
| 10        | 5840           | 6         | 20 | 4.6      | 2.9      | 2.884    | 1.950    | 6.8             | 30           | -23.2  |
| 20        | 5740           | 6         | 20 | 0.7      | 1.1      | 1.175    | 1.288    | 3.9             | 30           | -26.1  |
| 20        | 5800           | 6         | 20 | 1.8      | 1.6      | 1.514    | 1.445    | 4.7             | 30           | -25.3  |
| 20        | 5835           | 6         | 20 | 1.7      | 1.8      | 1.479    | 1.514    | 4.8             | 30           | -25.2  |
| 30        | 5745           | 6         | 20 | -1.2     | -1.2     | 0.759    | 0.759    | 1.8             | 30           | -28.2  |
| 30        | 5800           | 6         | 20 | 0.7      | -0.1     | 1.175    | 0.977    | 3.3             | 30           | -26.7  |
| 30        | 5830           | 6         | 20 | -0.6     | -1.1     | 0.871    | 0.776    | 2.2             | 30           | -27.8  |
| 40        | 5750           | f0        | 19 | -1.8     | -3.2     | 0.661    | 0.479    | 0.6             | 30           | -29.4  |
| 40        | 5800           | f0        | 20 | -0.2     | -1.6     | 0.955    | 0.692    | 2.2             | 30           | -27.8  |
| 40        | 5825           | f0        | 20 | -1.6     | -0.5     | 0.692    | 0.891    | 2.0             | 30           | -28.0  |



## Undesirable Emissions Conducted

**Engineer:** Alex Macon

**Test Date:** 4/24/15

### Test Requirements

#### Unwanted Emissions that fall Outside Restricted Bands

For transmitters operating in the 5.725-5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of -17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. of -27 dBm/MHz. The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

The provisions of §15.205 apply to intentional radiators operating under this section.

Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209.

#### For Conducted Unwanted Emissions in the Restricted Bands

For conducted measurements above 1000 MHz, EIRP was determined and then the field strength computed by the following:

$E[\text{dB}\mu\text{V}/\text{m}] = \text{EIRP}[\text{dBm}] - 20 \log(d[\text{meters}]) + 104.77$ , where  $E$  = field strength and  $d = 3\text{m}$

$E[\text{dB}\mu\text{V}/\text{m}] = \text{EIRP}[\text{dBm}] + 95.2$ , for  $d = 3\text{ meters}$ .

### Test Procedure

Per KDB 789033 D02 General U-NII Test Procedures New Rules v01 conducted RF port measurements were made in lieu of radiated. In addition, Cabinet Emissions measurements were performed in a semi-anechoic chamber with the antenna port terminated by a matching load. See additional section for Radiated Emissions.

The following criteria were addressed:

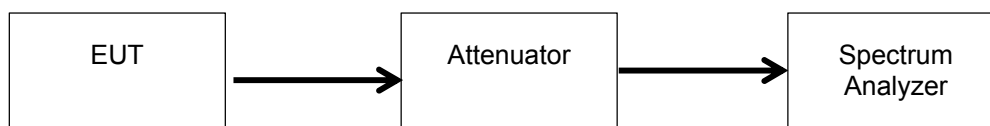
#### The Spectrum Analyzer was set to the following for emissions > 1000MHz:

- a. RBW = 1 MHz
- b. VBW  $\geq$  3 MHz
- c. Detector = Peak.
- d. Sweep time = auto.
- e. Trace mode = max hold.
  1. Note: For emissions where the peak exceeded that of the average 15.209 emission limit the following was performed.
- f. RBW = 1 MHz
- g. VBW  $\leq$  RBW/100 (i.e., 10 kHz) but not less than 10 Hz.

#### For emissions below 1000MHz the Spectrum Analyzer settings were as follows:

- a. RBW = 100 kHz
- b. VBW  $\geq$  300 kHz
- c. Detector = Peak.
- d. Sweep time = auto.
- e. Trace mode = max hold.

### Test Setup



**Test Results:** See Annex B: Undesirable Emissions Conducted



## Undesirable Emissions Radiated

Engineer: Alex Macon

Test Date: 5/4/15

### Test Requirements

The provision of §15.209 were applied. In addition the requirements of §15.205 were also applied.

### FCC Part 15 Subpart C Paragraph 15.209(a) Limits

| Frequency (MHz) | Frequency (microvolts/meter) | Frequency (meter) |
|-----------------|------------------------------|-------------------|
| 0.009-0.490     | 2400/F(kHz)                  | 300               |
| 0.490-1.705     | 24000/F(kHz)                 | 30                |
| 1.705-30        | 30                           | 30                |
| 30-88           | 100                          | 3                 |
| 88-216          | 150                          | 3                 |
| 216-960         | 200                          | 3                 |
| Above 960       | 500                          | 3                 |

Remarks: E field strength (dBµV/m) = 20 log E field strength (uV/m)

### Test Procedure

The EUT was setup in accordance with ANSI C63.10. 2013 and tested per KDB 789033. The antenna was replaced with non-radiating matched load. The EUT is placed on non-conductive platform at a height of 0.8 meters above the ground plane of the semi-anechoic chambers. The EUT was rotated 360 degrees and the receive antenna raised and lowered to find the maximum emissions from 30MHz to the 10<sup>th</sup> harmonic of the fundamental. The EUT was set to the maximum power level allowed and the low, mid, and high channels were investigated for emissions.

### The Spectrum Analyzer was set to the following for emissions > 1000MHz:

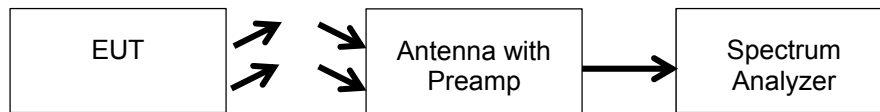
- (RBW = 1 MHz
- VBW ≥ 3 MHz
- Detector = Peak.
- Sweep time = auto.
- Trace mode = max hold.
  - Note: For emissions where the peak exceeded that of the average 15.209 emission limit the following was performed.
- RBW = 1 MHz
- VBW ≤ RBW/100 (i.e., 10 kHz) but not less than 10Hz

### For emissions below 1000MHz the Spectrum Analyzer settings were as follows:

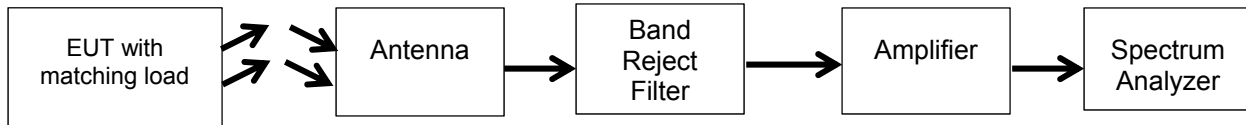
- RBW = 100 kHz
- VBW ≥ 300 kHz
- Detector = Peak.
- Sweep time = auto.
- Trace mode = max hold.
  - Note: A quasi peak detector was used for emissions where the peak exceeded that of the average 15.209 emission limits



**Test Setup below 1000MHz**



**Test Setup above 1000MHz**



**Test Results:**      **See Annex C: Undesirable Emission Radiated**



## Occupied Bandwidth

**Engineer:** Alex Macon

**Test Date:** 1/22/15

### Test Requirement

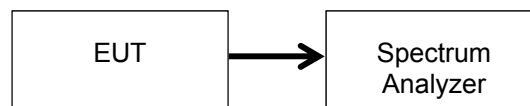
Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz. For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 6 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement

### Test Procedure

The Spectrum analyzer was set to the following parameters

- a. RBW = 100 kHz.
- b. VBW  $\geq$  300 kHz
- c. Detector = Peak.
- d. Trace mode = max hold.

### Test Setup



**Test Results:**      **See Annex D: Occupied Bandwidth**



## Frequency Stability

**Engineer:** Alex Macon

**Test Date:** 4/28/15

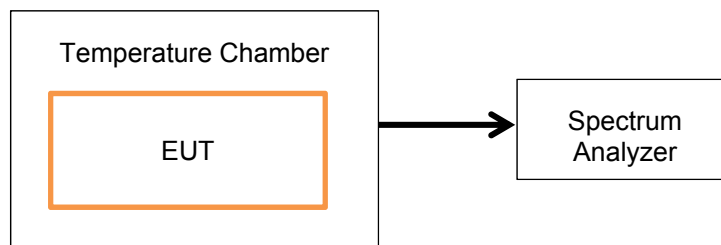
### Test Requirement

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

### Test Procedure

- The EUT was placed into a temperature chamber and the temperature ranges were set to the manufacturers' specifications.
- The RF output of the EUT was connected to a spectrum analyzer
- The lowest and highest channels of the band were set to transmit
- The carrier plots were measured to insure that the 6dB band width remained within the band over the prescribed temperature extremes.

### Test Setup



**Test Results:**      **See Annex E: Frequency Stability**



## RF Exposure

**Engineer:** Alex Macon

**Test Date:** 5/5/15

### Requirements

U-NII devices are subject to the radio frequency radiation exposure requirements specified in §1.1307(b), §2.1091 and §2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a “general population/uncontrolled” environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. In addition, systems operating under the provisions of this section shall be operated in a manner that insures that the public is not exposed to radio frequency energy levels in excess of the Commission’s guidelines.

### Exposure Limits

At operating frequencies less than or equal to 6 GHz, the limits for maximum permissible exposure (MPE) shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Section 1.1307(b), except for portable devices as defined in §2.1093 as these evaluations shall be performed according to the SAR provisions in §2.1093 of this chapter.

### MPE Limit Calculations

Exposure Limit  $1\text{mW}/\text{cm}^2$

### Source Based Time Averaged Power Calculation

#### Average Power Calculations

Average Power = Peak Power \* duty-cycle%

| Tuned Frequency<br>(MHz) | Conducted Peak Output Power<br>(mW) | Duty Cycle<br>(%) | Average Power<br>(mW) |
|--------------------------|-------------------------------------|-------------------|-----------------------|
| 5200                     | 74.1                                | 100               | 74.1                  |



## MPE Evaluation

This is a **fixed/mobile** device used in uncontrolled /general population exposure environment.

|                                                                                    |                  |                                                     |
|------------------------------------------------------------------------------------|------------------|-----------------------------------------------------|
| <b>Limits Uncontrolled Exposure</b><br><b>47 CFR 1.1310</b><br><b>Table 1, (B)</b> | 0.3-1.234 MHz    | Limit [mW/cm <sup>2</sup> ] = 100                   |
|                                                                                    | 1.34-30 MHz      | Limit [mW/cm <sup>2</sup> ] = (180/f <sup>2</sup> ) |
|                                                                                    | 30-300 MHz       | Limit [mW/cm <sup>2</sup> ] = 0.2                   |
|                                                                                    | 300-1500 MHz     | Limit [mW/cm <sup>2</sup> ] = f/1500                |
|                                                                                    | 1500-100,000 MHz | Limit [mW/cm <sup>2</sup> ] = 1.0                   |

## Test Data

|                          |      |
|--------------------------|------|
| Test Frequency, MHz      | 5200 |
| Power, Conducted, mW (P) | 74.1 |
| Antenna Gain Isotropic   | 6    |
| Antenna Gain Numeric (G) | 3.98 |
| Antenna Type             | Omni |
| Distance (R)             | 20   |

|                                      |              |                  |                               |
|--------------------------------------|--------------|------------------|-------------------------------|
| $S = \frac{P * G}{4\pi r^2}$         |              |                  |                               |
| Power Density (S) mw/cm <sup>2</sup> | Power mW (P) | Numeric Gain (G) | Distance (r <sup>2</sup> ) cm |
|                                      | 74.1         | 3.98             | 20                            |

|                             |       |
|-----------------------------|-------|
| Power Density (S) =         | 0.058 |
| Limit =(from above table) = | 1.0   |



## A/C Powerline Conducted Emission

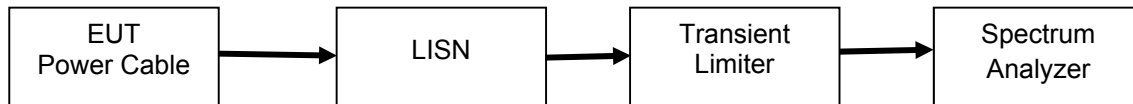
**Engineer:** Alex Macon

**Test Date:** 11/3/15

### Test Procedure

The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

### Test Setup



**Test Results:** See Annex F: A/C Powerline Conducted Emission



### Test Equipment Utilized

| Description                   | Manufacturer                | Model #                                                                  | CT Asset #     | Last Cal Date | Cal Due Date |
|-------------------------------|-----------------------------|--------------------------------------------------------------------------|----------------|---------------|--------------|
| Temperature Chamber           | Tenney                      | Tenney Jr                                                                | i00027         | NCR           | NCR          |
| EMI Receiver                  | HP                          | 8546A                                                                    | i00033         | 2/26/15       | 2/26/16      |
| Preamplifier                  | HP                          | 8447D                                                                    | i00055         | NCR           | NCR          |
| Horn Antenna                  | EMCO                        | 3116                                                                     | i00085         | NCR           | NCR          |
| Horn Antenna, Amplified       | ARA                         | DRG-118/A                                                                | i00271         | 5/8/14        | 5/8/16       |
| *Horn Antenna, Amplified      | ARA                         | MWH-1826/B                                                               | i00273         | 4/9/12        | 4/9/2015     |
| Humidity / Temp Meter         | Newport                     | IBTHX-W-5                                                                | i00282         | 4/1/15        | 4/1/16       |
| Spectrum Analyzer             | Agilent                     | E4407B                                                                   | i00331         | 6/13/14       | 6/13/15      |
| Data Logger                   | Fluke                       | Hydra Data Bucket                                                        | i00343         | 3/24/15       | 3/24/16      |
| Bi-Log Antenna                | Schaffner                   | CBL 6111D                                                                | i00349         | 10/8/13       | 10/8/15      |
| EMI Analyzer                  | Agilent                     | E7405A                                                                   | i00379         | 2/5/15        | 2/5/16       |
| Standard Gain Horn Kit        | Pacific Millimeter Products | Mixer Mdl: MD1A<br>60 – 90 GHz Horn Mdl: EM<br>90 – 140 GHz Horn Mdl: FM | i00394         | NCR           | NCR          |
| 3 Meter Semi-Anechoic Chamber | Panashield                  | 3 Meter Semi-Anechoic Chamber                                            | i00428         | 11/26/13      | 11/26/15     |
| Spectrum Analyzer             | Agilent                     | E4446A                                                                   | S/N:MY46180386 | 10/26/14      | 10/26/16     |
| Spectrum Analyzer             | Agilent                     | E4448A                                                                   | S/N:US42510268 | 10/23/13      | 10/23/15     |
| Spectrum Analyzer             | Agilent                     | E4407B                                                                   | S/N:SG44210864 | 1/8/15        | 1/8/16       |
| Spectrum Analyzer             | Agilent                     | E4448A                                                                   | S/N:MY46180566 | 3/20/15       | 12/1/16      |

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT