

## Electromagnetic Compatibility INTENTIONAL RADIATOR TEST REPORT

### IC RSS-210; FCC 47 CFR Part 15/C 15.247

**Report Reference No.** .....: E10612-1403A Rev 2.0

Date of issue .....: September 16, 2014

Total number of pages.....: 35

**Testing Laboratory** .....: Quality Auditing Institute  
 Address .....: 16 – 211 Schoolhouse Street, Coquitlam, BC, V3K 4X9, Canada

#### **Accreditations (ISO 17025):**



**Standard Council of Canada: Accredited Laboratory No. 743**

**International Accreditation Service Inc. : Accredited Laboratory: No. TL-239**

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**Applicant's name** .....: LED Roadway Lighting Ltd.  
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 Phone .....: (250)544-0143

**Test Standard** .....: RSS-210 Issue 8, FCC 47 CFR Part15 Subpart C 15.247

**Test item description** .....: IEEE 802.15.4 Wireless module

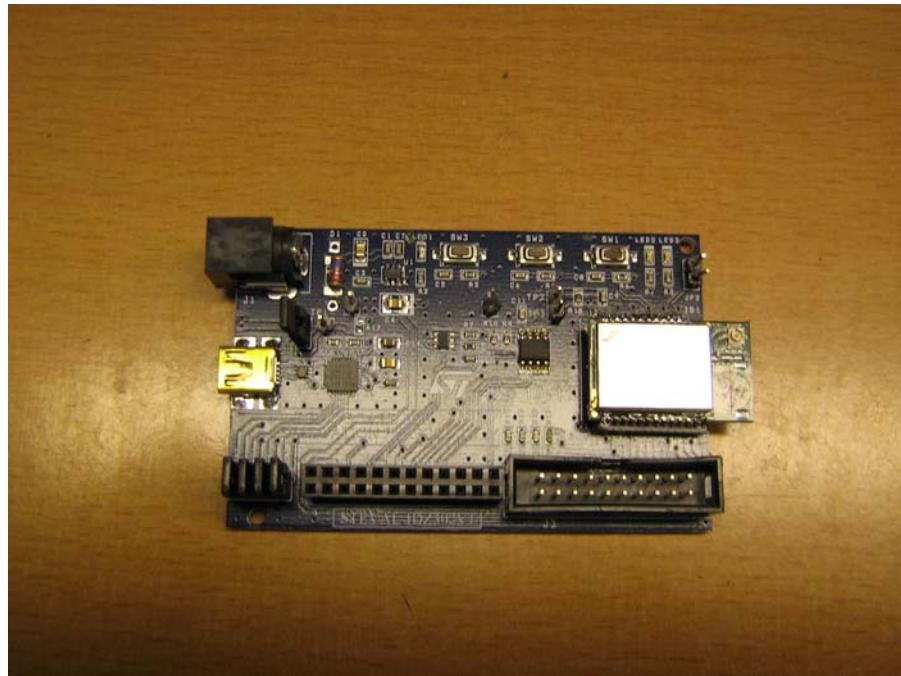
**Model** .....: ASM0115

**Trade Mark** .....:



Manufacturer .....: LED Roadway Lighting Ltd.

Registrations: : FCC ID: 2ACR30115  
 IC: 12047A-0115



**ASM0115 Module installed onto Demo PCB**



**ASM0115 Module installed onto LED Roadway PCB**



## Revision History

| Date   | Report Number | Rev # | Details   | Authors Initials |
|--|---------------|-------|---|------------------|
| Sep 05, 2014   | E10612-1403A  | 0.0   | Draft Test Report   | DJ               |
| Sep 09, 2014   | E10612-1403A  | 1.0   | Client changes added and final Release  | DJ               |
| Sep 16, 2014   | E10612-1403A  | 2.0   | Page 5 updated Statement of Compliance table<br>Page 19 – updated version number of KDB 558074<br>Page 11-14 – added 99% OBW plots<br>Page 29-30 – added RF Exposure evaluation | DJ               |
| <i>Note: All previous versions of this report have been superseded by the latest dated revision as listed in the above table. Please dispose of all previous electronic and paper printed revisions accordingly.</i> |               |       |   |                  |

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## Statement of Compliance

The following tests demonstrate testimony for the FCC & IC Marks for Transceivers / electromagnetic compatibility testing for this EUT as required by FCC Part 15 Section 15.247 and IC RSS-210 Appendix8.

| Test / Requirement Description   | Applicable FCC Rule Parts  | Applicable Industry Canada Rule Parts            | Results                          |                                | Pass / Fail |
|--|----------------------------|--|----------------------------------|--------------------------------|-------------|
|  |                            |  | Limit                            | Measured                       |             |
| Antenna Requirement  | 15.203                     | RSS-Gen (7.1.2)                                  | Approved Antenna                 | PCB Antenna                    | Pass        |
| Maximum Peak Conducted Output Power Level  | 15.247 (b)(3)              | RSS-210 A8.4(4)                                  | Max Peak: 1W<br>Max Peak EIRP 4W | 19.6dBm 91mW                   | Pass        |
| Emission Bandwidth (EBW)   | 15.247(a)(2);              | RSS-210 A8.2(a)                                  | Min. 500kHz                      | 1.62MHz (6dB)<br>2.42MHz (99%) | Pass        |
| Spurious Emissions at antenna terminals  | 15.247 (d)                 | RSS-210 A8.5                                     | Min 20dBc                        | 22.2dBc                        | Pass        |
| Spurious Emissions Radiated Field Strength   | 15.247 (d)<br>15.205 (c)   | RSS-210 A8.5<br>RSS-Gen                          | Min 20dBc and 54dBuv             | 1.8dB Margin                   | Pass        |
| Maximum Power Spectral Density Level in Fundamental Emission                           | 15.247 (e)                 | RSS-210 A8.2(b)                                  | 8dBm                             | 3.94dBm                        |             |
| Frequency Stability  | 15.215 (c)                 | RSS-Gen  | +/- 5.0ppm                       | +/-4.2ppm                      | Pass        |
| Duty Cycle Correction  | 15.247(a)(1) (iii)         | RSS-Gen.   |                                  | 17.6dB                         | Pass        |
| RF Exposure Evaluation<br>Safe Distance for General Population for 1mW/cm <sup>2</sup> | 1.1307(b)<br>15.247 (b)(5) | Safety Code 6<br>RSS-Gen (5.6) and RSS-102 (2.5) | >20cm                            | 4cm                            | Pass        |

Tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with CFR 47 FCC Part 15 and Industry Canada RSS-210. The manufacturer is responsible for the tested product configuration, continued product compliance with these standards listed, and for the appropriate auditing of subsequent products as required.

X

Tested By & Report Written By David Johanson,  
 RF/EMC Test Engineer

X

Reviewed By Amandeep Jathaul  
 RF/EMC Test Engineer



## Testing Location and Procedures

|  |  |
|--|--|
| <b>Testing Laboratory:</b>                                 | Quality Auditing Institute                                 |
| Testing location/ address .....                            | 16 – 211 Schoolhouse Street, Coquitlam, BC, 3K 4X9, Canada |
| Associated Laboratory.....:                                | Quality Auditing Institute (Remote location)               |
| Testing location/ address .....                            | 19473 Fraser Way, Pitt Meadows, BC, V3Y 2V4, Canada        |
| FCC Test Site Registration Number (OATS 10m and SAC-3m):   | 226383   |
| FCC Accredited CAB Designation Number:                     | CA9543   |
| FCC Accredited Test Firm Registration #:                   | 388697   |
| Industry Canada Site Registration Number (SAC-3m).....:    | 9543B-1  |
| Industry Canada Test Site Registration Number (OATS-10m).. | 9543C-1  |
| Tested by .....  | David Johanson   |
| Reviewed by.....:  | Aman Jathaul   |
| <b>Sample Information:</b>                                 |  |
| Product Name.....:   | IEEE 802.15.4 Wireless Communications Module               |
| Part Number.....:  | ASM0115  |
| Company:.....:   | LED Roadway  |
| Received Date:.....:                                       | 03July2014   |
| Received By.....:  | Aman Jathaul   |
| Sample Log.....:   | QAI Product Control Log (QM 1301 - Sample Inventory)       |
| <b>Environmental Conditions:</b>                           |  |
| Indoor:  | Temperature: 22°C R.H.: 40.0%                              |

### Measurement Uncertainty

Radio Frequency .....:  $\pm 1.5 \times 10^{-5}$  MHz  
 Total RF power, conducted.....:  $\pm 1$  dB  
 RF power density, conducted.....:  $\pm 2.75$  dB  
 Spurious emissions, conducted.....:  $\pm 3$  dB  
 All emissions, radiated.....:  $\pm 3.5$  dB  
 Temperature.....:  $\pm 1^\circ\text{C}$   
 Humidity.....:  $\pm 5$  %  
 DC and low frequency voltages.....:  $\pm 3$  %

### Test Bench Equipment List

| Manufacturer    | Model     | Description                  | Serial No. | Last Cal     | Cal Due Date |
|-----------------|-----------|------------------------------|------------|--------------|--------------|
| Tektronix       | TDS754C   | Oscilloscope                 | B012403    | 10-Oct-2013  | 10-Oct-2016  |
| HP              | 8648C     | Signal Generator             | 3623A03622 | 30-Oct-2012  | 30-Oct-2015  |
| Boonton         | 4200-S/17 | RF MicroWattmeter            | 430519 BG  | 13-Mar-2013  | 13-Mar-2016  |
| Boonton         | 51033-6E  | Power Sensor<br>100kHz-18GHz | 15779      | 18-Mar-2013  | 18-Mar-2016  |
| Rohde & Schwarz | ESU40     | EMI Receiver                 | 100011     | 26-June-2012 | 26-Jun-2015  |
| Rohde & Schwarz | ESCI      | EMI Receiver                 | 1000123    | 29-Mar-2012  | 29-Mar-2015  |

### Semi-Anechoic Chamber Equipment List

| Manufacturer    | Model            | Description                                  | Serial No. | Last Cal     | Cal Due Date |
|-----------------|------------------|--|------------|--------------|--------------|
| ETS Lindgren    | 2165             | Turntable                                    | 00043677   | N/A          | N/A          |
| ETS Lindgren    | 2125             | Mast   | 00077487   | N/A          | N/A          |
| Rohde & Schwarz | ESU40            | EMI Receiver                                 | 100011     | 26-June-2012 | 26-Jun-2015  |
| FCC             | FCC-LISN-50-25-2 | LISN   | 9927       | 30-Nov-2012  | 30-Nov-2015  |
| EMCO            | 6502             | 60cm Active Loop<br>Antenna<br>9kHz to 30MHz | 2178       | 14-Jun-2013  | 10-Jun-2015  |
| Sunol Sciences  | JB3              | Biconilog Antenna<br>30MHz – 3GHz            | A042004    | 31-Oct-2012  | 31-Oct-2015  |
| AILTECH/Eaton   | 94455-1          | Biconical Antenna<br>20-200MHz               | 0931       | 14-Jun-2013  | 14-Jun-2016  |
| EMCO            | 93146            | Log Periodical Antenna<br>200-1000MHz        | 9811-5136  | 14-Jun-2013  | 10-Jun-2016  |
| COM-POWER       | AHA-118          | Dual Ridge Horn<br>Antenna<br>1-18GHz        | 711040     | 14-Jun-2013  | 14-Jun-2016  |
| EMCO            | 3160-09          | Pyramidal Horn<br>Antenna<br>18-26GHz        | 9701-1071  | 30-Aug-2013  | 30-Aug-2016  |
| EMCO            | 3160-10          | Pyramidal Horn<br>Antenna<br>26-40GHz        | 9708-1055  | 30-Aug-2013  | 30-Aug-2016  |
| ETS Lindgren    | S201             | 3 meter Semi-Anechoic<br>Chamber             | 1030       | N/A          | N/A          |

## Product Description

### **Introduction:**

The ASM0115 is a IEEE 802.15.4 wireless communications module employed only in a number of LED Roadway Lighting Luminaire Control Systems. It plugs onto the application PCB, which varies with each application. It is the same module as produced by ST Microelectronics as part number SPZB32W1C1.1 (FCC ID: S9NZB32C1) and is licensed to be manufactured by LED Roadway. It comes with an integrated UFL connector for use with various antennas

ASM0115 requires +3.3VDC nominal to operate, which it receives from a regulated power supply on the application board.

### **EUT Test Configuration:**

The ASM0115 (EUT) was provided preprogrammed with custom firmware for EMC compliance testing. It was provided with 2 modules.

One module was mounted to an LED Roadway PCB that is used to control an LED Street Light with a Molex 2.4GHz/5GHz Combo PCB antenna that comes with a 10cm (nom.) flexible cable. This PCB was used to verify the AC mains conducted emissions when connected to an AC power source in a typical normal configuration. It was powered using 120Vac 60Hz or 230Vac 50Hz.

The other module was mounted to an ST Microelectronics Demo Evaluation PCB. This PCB was used to verify the Radiated and RF Conducted emissions from the transmitter using a flexible cable connected to the UFL RF connector. It was powered using 3.3Vdc from an Auxiliary AC/DC power adapter.

The EUT was programmed using a USB interface and Hyperterminal command strings provided by LED Roadway. The EUT was verified in various orientations for the radiated emissions to find the worst case orientation. All radiated emissions were done with the EUT in the Horizontal orientation with the antenna in a vertical orientation which was designated the worst case orientation.

### **Equipment Under Test Information**

|                     |  |
|---------------------|--|
| <b>Manufacturer</b> | LED Roadway Lighting Ltd.                      |
| <b>Product Name</b> | IEEE 802.15.4 Wireless Communications Module   |
| <b>Model Name</b>   | ASM0115  |
| <b>Serial No.</b>   | PROTO-001 (Radiated) and PROTO-002 (conducted) |

### AC-DC Power Adapter

|                     |                               |
|---------------------|-------------------------------|
| <b>Manufacturer</b> | MicroWC                       |
| <b>Product Name</b> | Switching power supply 5.0Vdc |
| <b>Model</b>        | 188594                        |
| <b>Input</b>        | AC100-240V, 50/60Hz,          |
| <b>Output</b>       | DC 5.0V 1A                    |

### PC Laptop

|                         |   |
|-------------------------|---|
| <b>Manufacturer</b>     | Dell                                      |
| <b>Product Name</b>     | Latitude D630                             |
| <b>Model</b>            | Pp18L                                     |
| <b>Operating System</b> | Windows                                   |
| <b>Software</b>         | Hyperterminal and LumenAppTest3.2.0.0-DEV |

### Controller Cabling Configuration

| <b>Description</b>           | <b>Number of Lines</b> | <b>Connection Type</b> | <b>Load or Termination</b> | <b>Shielded</b> | <b>Ferrites</b> |
|------------------------------|------------------------|------------------------|----------------------------|-----------------|-----------------|
| DC Power Cord from -AC Power | 2                      | 2.5mm barrel DC plug   | No                         | No              | No              |

## **Test Results**

### **Antenna Requirements**

DATE: July 10, 2014

TEST STANDARD: FCC 15.203; IC RSS-Gen (7.1.2)

APPLICABLE REGULATIONS : - “An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that the user can replace a broken antenna, but the use of a standard antenna jack or electrical connector is prohibited.” ... “the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.”

RESULT : This unit meets this requirement. The antenna uses a UFL connector antenna connected to a PCB trace based antenna.

It is installed by the manufacturer into the final product.

The End User will have no access to change the antenna.

The only tested antenna for this product is:

- Molex #47950-0001  
Omnidirectional 2.4GHz / 5GHz Wifi Stand Alone Antenna, 9.00mm, Cable Length 100.00mm
- Peak Gain (dBi) 3.5



(Reference image only)

**Maximum Peak Conducted Output Power Level**

DATE(s): July 22, 2014

TEST STANDARD: FCC Part 15.247 (b)(3); IC RSS-210 (A8.2(a))

TEST PROCEDURE: ANSI c63.10

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: 1 Watt ( 30dBm )

TEST SETUP: The EUT was programmed for maximum output. The antenna port of EUT was directly connected to an RF Power Meter through a 10dB Attenuator.

MEASUREMENT METHOD: As called by the standards above.

DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

EMISSIONS DATA:

20°Cel

| Frequency (GHz) | Pwr meter (dB) | Correction Factor (dB) | Corrected Power (dBm) |
|-----------------|----------------|------------------------|-----------------------|
| 2405            | 7.93           | 11.18                  | 19.11                 |
| 2440            | 8.45           | 10.74                  | 19.19                 |
| 2480            | 8.50           | 11.10                  | 19.60                 |

OBSERVATIONS: The EUT performed as expected.

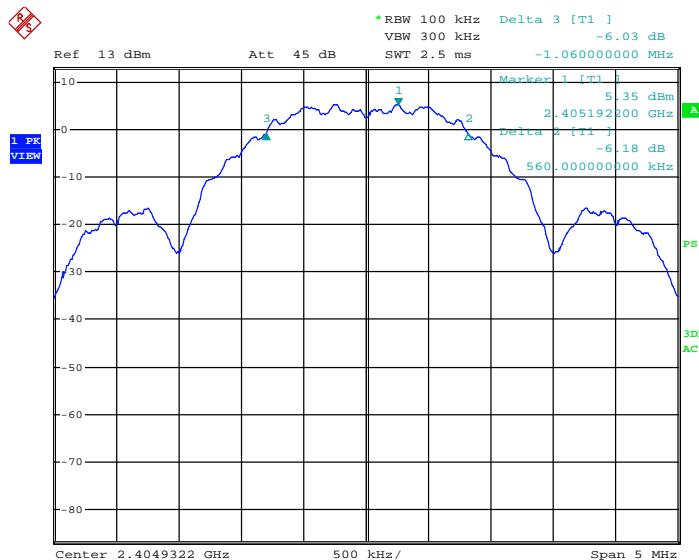
PERFORMANCE: Complies.

## Occupied Bandwidth

DATE(s): July 18, 2014  
 TEST STANDARD: FCC Part 15.247(a)(2) RSS-210 ( A8.2(a))  
 TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter  
 MINIMUM STANDARD: the 6dB bandwidth must be greater than 500kHz  
 TEST SETUP: The antenna port of EUT was directly connected to a Spectrum Analyzer through a 30dB Attenuator.  
 MEASUREMENT METHOD: As called by the standards above.  
 DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.

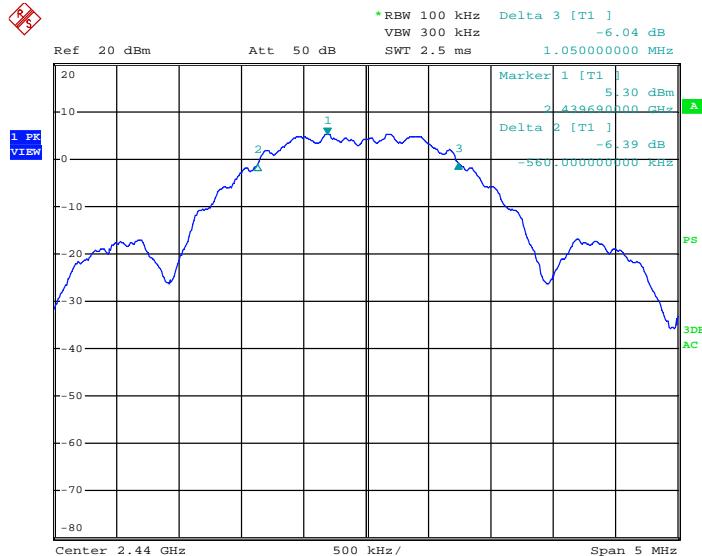
EMISSIONS DATA:

| Frequency (GHz) | Measured 6dB (MHz) | Measured 99% (MHz) |
|-----------------|--------------------|--------------------|
| 2.405           | 1.62               | 2.43               |
| 2.440           | 1.61               | 2.41               |
| 2.480           | 1.62               | 2.43               |



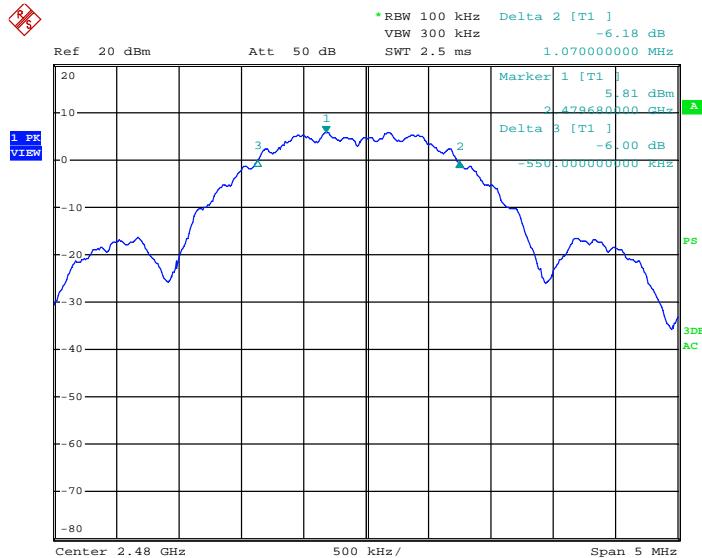
Date: 18.JUL.2014 15:20:22

6dB Occupied Band Width – Low Channel



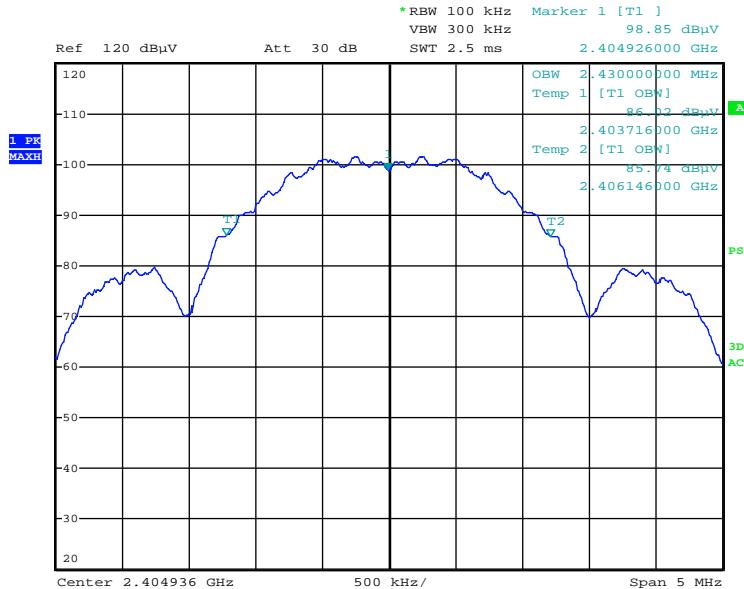
Date: 18.JUL.2014 16:13:50

## 6dB Occupied Band Width – Middle Channel



Date: 18.JUL.2014 15:37:51

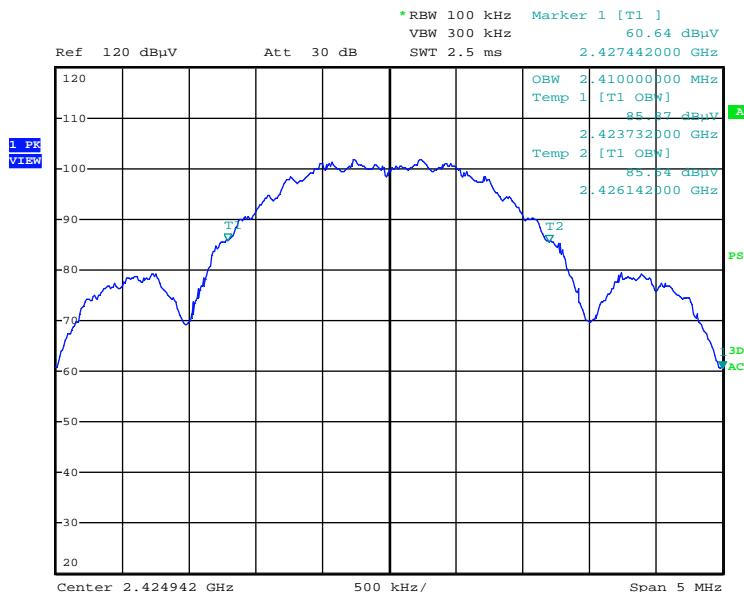
## 6dB Occupied Band Width – High Channel



120V

Date: 17.SEP.2014 17:49:23

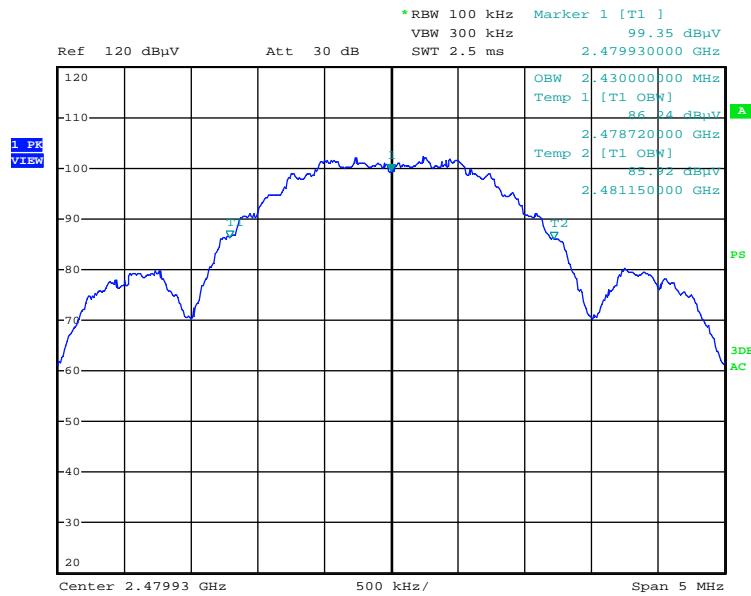
### 99% Occupied Band Width – Low Channel



120V

Date: 17.SEP.2014 17:46:57

### 99% Occupied Band Width – Middle Channel



120V

Date: 17.SEP.2014 17:45:20

99% Occupied Band Width – High Channel

## Out Of Band Spurious Emissions Conducted

**DATE:** July 21, 2014  
**TEST STANDARD:** FCC Part 15.247(d) RSS-210(A8.5)  
**TEST VOLTAGE:** 120Vac 60Hz AC to 3.3Vdc Power Adapter  
**MINIMUM STANDARD:** Emissions must be at least 20dB down from the highest emission level within the authorized band as measured with a 100kHz RBW  
**TEST SETUP:** The antenna port of EUT was directly connected to a Spectrum Analyzer through a 20dB Attenuator and appropriated RF Filters.  
 Conversion Formulas used: For the frequency measurement:  

$$E(\text{dBm}) = \text{Meas}(\text{dBm}) + \text{Cable Loss}(\text{dB}) + \text{Attenuator/Filter Loss}(\text{dB})$$
**MEASUREMENT METHOD:** Measurements were made using spectrum analyser and receiver using the appropriate attenuators and filters to optimize the reading. The settings used were:  
 200Hz RBW average detector for the frequency range 9kHz-150kHz  
 9kHz RBW average detector for the Frequency range 150kHz to 30MHz  
 120kHz RBW quasi-peak detector for the frequency range 30MHz to 1GHz  
 1MHz RBW Average detector for the frequency range 1GHz to 20GHz  
**DEVICE DESCRIPTIONS:** As described in the above EUT description and setup section.  
**EMISSIONS DATA:** No transmitter Conducted Spurious Emissions were detected 9kHz to 2.4GHz. Highest power level within the band: 19.6dBm

### Low Channel

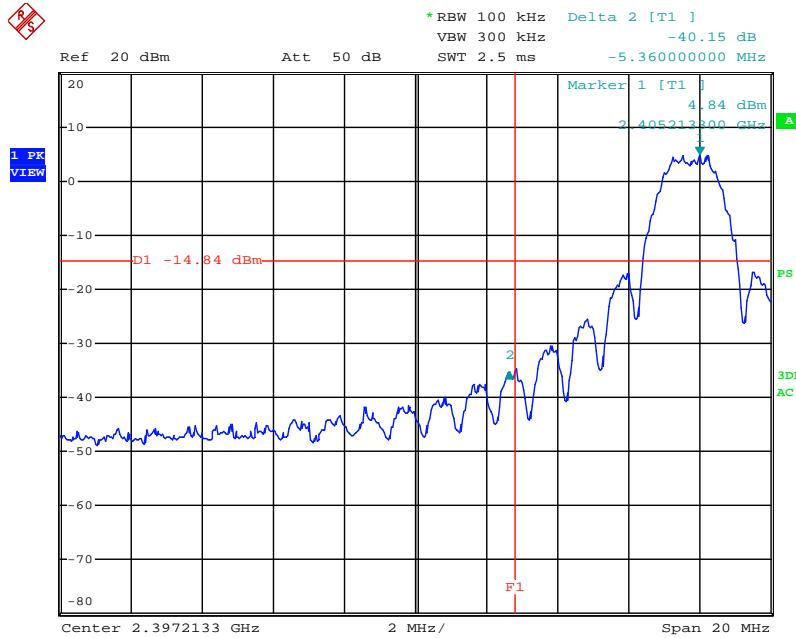
| Frequency | Uncorr-Peak | Bandwidth | Correction Factors | Corr. Peak | Limit (19.6dBm - 20dB) | Margin |
|-----------|-------------|-----------|--------------------|------------|------------------------|--------|
| GHz       | dBm         | kHz       |                    | dBm        | dBm                    | dB     |
| 4.810800  | -64.14      | 1000.00   | 10.83              | -53.31     | -0.4                   | 52.9   |
| 7.216000  | -68.57      | 1000.00   | 12.55              | -56.02     | -0.4                   | 55.6   |
| 9.617720  | -71.35      | 1000.00   | 14.06              | -57.29     | -0.4                   | 56.9   |
| 12.022000 | -75.66      | 1000.00   | 12.46              | -63.20     | -0.4                   | 62.8   |
| 14.426000 | -75.90      | 1000.00   | 16.03              | -59.87     | -0.4                   | 59.5   |
| 16.833000 | -80.09      | 1000.00   | 14.59              | -65.50     | -0.4                   | 65.1   |

Middle Channel

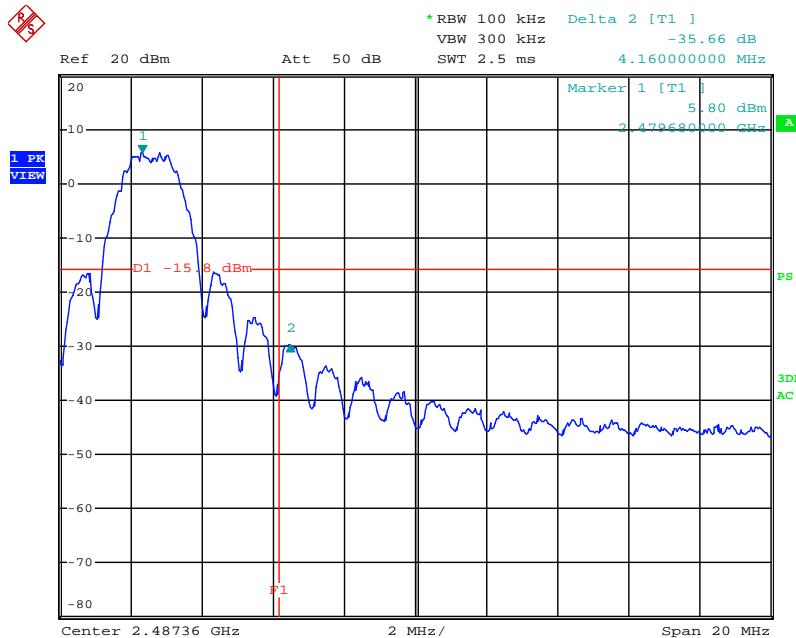
| Frequency | Uncorr-Peak | Bandwidth | Correction Factors | Corr. Peak | Limit (19.6dBm - 20dB) | Margin |
|-----------|-------------|-----------|--------------------|------------|------------------------|--------|
| GHz       | dBm         | kHz       |                    | dBm        | dBm                    | dB     |
| 4.880850  | -65.97      | 1000.00   | 22.00              | -53.83     | -0.4                   | 53.4   |
| 7.321100  | -55.15      | 1000.00   | 22.20              | -41.80     | -0.4                   | 41.4   |
| 9.761760  | -71.00      | 1000.00   | 22.10              | -57.38     | -0.4                   | 57.0   |
| 12.199900 | -77.97      | 1000.00   | 21.00              | -65.44     | -0.4                   | 65.0   |
| 14.607900 | -79.80      | 1000.00   | 24.20              | -61.60     | -0.4                   | 61.2   |

High Channel

| Frequency | Uncorr-Peak | Bandwidth | Correction Factors | Corr. Peak | Limit (19.6dBm - 20dB) | Margin |
|-----------|-------------|-----------|--------------------|------------|------------------------|--------|
| GHz       | dBm         | kHz       |                    | dBm        | dBm                    | dB     |
| 4.958800  | -69.60      | 1000.00   | 12.33              | -57.27     | -0.4                   | 56.9   |
| 7.441290  | -56.50      | 1000.00   | 13.06              | -43.44     | -0.4                   | 43.0   |
| 9.921730  | -67.48      | 1000.00   | 13.30              | -54.18     | -0.4                   | 53.8   |
| 12.401100 | -78.59      | 1000.00   | 13.47              | -65.12     | -0.4                   | 64.7   |
| 14.642800 | -80.00      | 1000.00   | 18.30              | -61.70     | -0.4                   | 61.3   |



Band Edge Low Channel



Band Edge High Channel

## Out Of Band Spurious Emissions Radiated

DATE: July 11, 2014

TEST STANDARD: FCC Part 15.247(d) RSS-210(A8.5)

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

MINIMUM STANDARD: All emissions that fall in the restricted bands (15.205 or RSS-Gen (7.2.2)) must comply with the limits as listed in 15.209 and RSS-Gen (7.2.5). All other emissions must be at least 20dB down from the highest emission level within the authorized band as measured with a 100kHz RBW

TEST SETUP: The EUT was tested in our 3 m SAC and was positioned on the center of the turntable and powered up. The Transmitter Output was connected to its standard antenna. The transmitter was set for continuous transmission. The lowest, middle and highest channels were measured for all radiated emissions 10kHz to 25 GHz. The EUT was verified in 3 orthogonal orientations and the worst orientation was used for the final measurements. The EUT was tested and placed in the Vertical orientation on the table top as indicated in the test photos.

MEASUREMENT METHOD: Measurements were made using spectrum analyser and receiver using the appropriate antennas, amplifiers, attenuators and filters as per ANSI c63.10 and FCC KDB 558074 D01 DTS Meas Guidance v03r02

Because the EUT is using a pulsed train transmission a Duty Cycle correction of 17.6dB was used for the spurious emissions. Refer to Duty Cycle Section contained in this document for details.

DEVICE DESCRIPTIONS: As described in the above EUT description and setup section.

EMISSIONS DATA: No transmitter Radiated Spurious Emissions were detected 9kHz to 2.4GHz and above 12.5GHz.

### Low Channel – Streaming Mode

| Frequency | Corrected Peak | Antenna height | Pol | Turntable position | Duty Cycle Corrected Average based on Peak | Margin Corrected Avg | Average Limit  |
|-----------|----------------|----------------|-----|--------------------|--|----------------------|----------------|
| (GHz)     | (dB $\mu$ V/m) | (cm)           |     | (deg)              | (dB)                                       | (dB)                 | (dB $\mu$ V/m) |
| 2.4050    | 115.6          | 100.0          | V   | 339.0              |  |                      |                |
| 4.8088    | 63.5           | 100.0          | V   | 73.0               | 45.9                                       | 8.1                  | 54.0           |
| 7.2133    | 68.6           | 100.0          | V   | 87.0               | 51.0                                       | 3.0                  | 54.0           |
| 9.6177    | 64.1           | 148.0          | V   | 66.0               | 46.5                                       | 7.5                  | 54.0           |
| 12.0222   | 65.9           | 100.0          | V   | 112.0              | 48.3                                       | 5.7                  | 54.0           |

Middle Channel – Streaming Mode

| Frequency | Corrected Peak | Antenna height | Pol | Turntable position | Duty Cycle Corrected Average based on Peak | Margin Corrected Avg | Limit          |
|-----------|----------------|----------------|-----|--------------------|--|----------------------|----------------|
| (GHz)     | (dB $\mu$ V/m) | (cm)           |     | (deg)              | (dB)                                       | (dB)                 | (dB $\mu$ V/m) |
| 2.4400    | 113.7          | 100.0          | V   | 340.0              |  |                      |                |
| 4.8789    | 66.3           | 100.0          | V   | 8.0                | 48.7                                       | 5.3                  | 54.0           |
| 7.3183    | 65.8           | 150.0          | V   | 84.0               | 48.2                                       | 5.8                  | 54.0           |
| 9.7577    | 69.5           | 156.0          | V   | 345.0              | 52.0                                       | 2.0                  | 54.0           |
| 12.1972   | 69.1           | 155.0          | V   | 304.0              | 51.5                                       | 2.5                  | 54.0           |

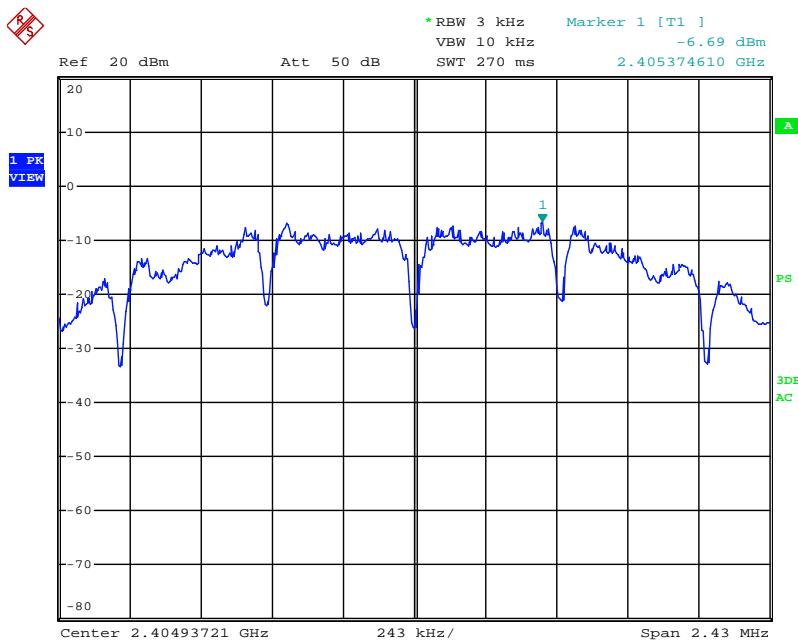
High Channel – Streaming Mode

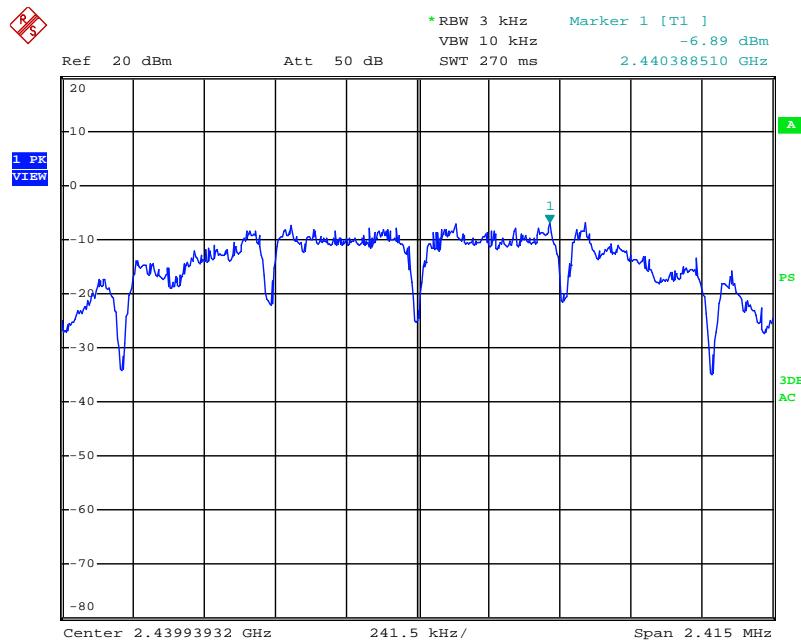
| Frequency | Corrected Peak | Antenna height | Pol | Turntable position | Duty Cycle Corrected Average based on Peak | Margin Corrected Avg | Limit          |
|-----------|----------------|----------------|-----|--------------------|--|----------------------|----------------|
| (GHz)     | (dB $\mu$ V/m) | (cm)           |     | (deg)              | (dB)                                       | (dB)                 | (dB $\mu$ V/m) |
| 2.4800    | 121.6          | 100.0          | V   | 340.0              |  |                      |                |
| 4.9609    | 69.0           | 122.0          | V   | 13.0               | 51.4                                       | 2.6                  | 54.0           |
| 7.4413    | 69.8           | 100.0          | V   | 342.0              | 52.2                                       | 1.8                  | 54.0           |
| 9.9217    | 67.5           | 152.0          | V   | 198.0              | 49.9                                       | 4.1                  | 54.0           |
| 12.4021   | 63.8           | 136.0          | V   | 318.0              | 46.2                                       | 7.8                  | 54.0           |

## Power Spectral Density

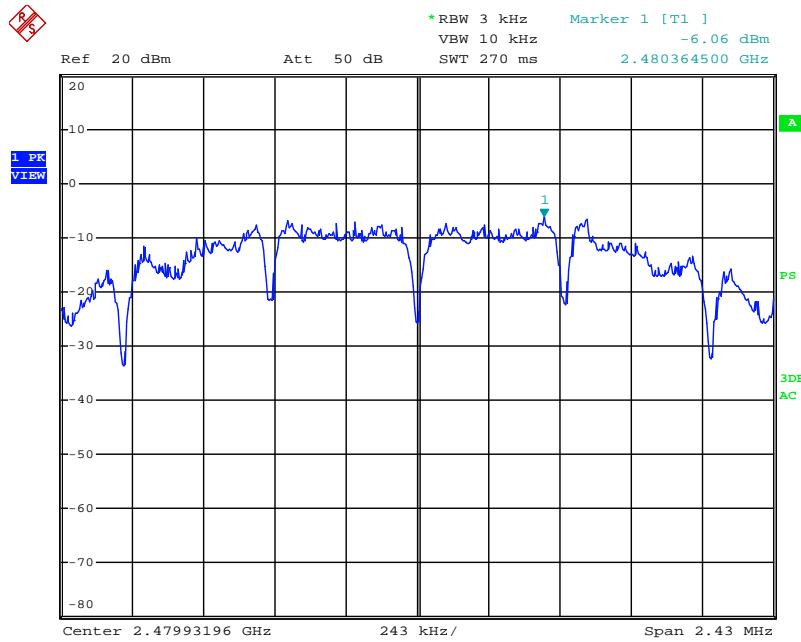
DATE(s): July 18, 2014  
 TEST STANDARD: FCC Part 15.247(e) RSS-210 ( A8.2(b))  
 TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter  
 MINIMUM STANDARD: Maximum of 8dBm in any 3kHz band  
 TEST SETUP: The antenna port of EUT was directly connected to a Spectrum Analyzer through a 10dB Attenuator.  
 MEASUREMENT METHOD: As called by the standards above.  
 DEVICE DESCRIPTIONS: As described in the above EUT description and set up section.  
 EMISSIONS DATA:

| Frequency (GHz) | Measured (dBm) |
|-----------------|----------------|
| 2.40537         | 3.31           |
| 2.44039         | 3.11           |
| 2.48036         | 3.94           |





Date: 18.JUL.2014 16:28:42



Date: 18.JUL.2014 16:38:12

## **Frequency Stability**

|                      |   |
|----------------------|---|
| DATE:                | July 23, 2014   |
| TEST STANDARD:       | FCC Part 15.215(c) and RSS-Gen Section (4.7) and (7.2.6)  |
| TEST VOLTAGE:        | 2.6-5Vdc  |
| MINIMUM STANDARD:    | <p>Not specified.</p> <p>RSS-Gen (4.7)With the transmitter installed in an environment test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below:</p> <ul style="list-style-type: none"><li>(a) at temperatures of -30°C, +20°C and +55°C, at the manufacturer's rated supply voltage of the battery.</li><li>(b) at a temperature of +20°C and at ±15 percent of the manufacturer's rated supply voltage.</li></ul> <p>RSS-Gen (7.2.6) Transmitter frequency stability for licence-exempt radio apparatus shall be measured in accordance with Section 4.7. Also, for licence-exempt radio apparatus, the frequency stability shall be measured at temperatures of -20°C, +20°C and +55°C instead of at the temperatures specified in Section 4.7(a). If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standards, measurement of the frequency stability is not required provided that the occupied bandwidth of the licence-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-806 MHz.</p> <p>FCC (15.215(c) )</p> <p>The 20dB bandwidth must remain within the designated frequency band over the expected variations in temperature and voltage range</p> |
| TEST SETUP:          | The EUT was bench tested and in our temperature chamber. Due to the outdoor location and mounting method of the EUT, the EUT voltage and temperature range was specified by the manufacturer and verified at 2.6, 3 and 5Vdc; +85, +20, and -40° Celsius. The transmitter was set for Carrier Wave (CW) mode and the lowest and highest channel Frequency was measured at each Temperature setting, after the Transmitter stabilized at the temperature.  |
| MEASUREMENT METHOD:  | Measurements were made using a Spectrum Analyzer with 120kHz RBW Average detector while directly connected to the EUT through the antenna port.   |
| DEVICE DESCRIPTIONS: | As described in the above EUT description and setup section.  |

DATA:  
 Low Channel

| Temp (C) | Power Level (dBm) | Voltage | Frequency (GHz) | Drift (kHz) |
|----------|-------------------|---------|-----------------|-------------|
| 20       | 19.11             | 3       | 2.4049          | Ref         |
| -40      | 15.08             | 2.6     | 2.4049          | <100        |
| -40      | 18.28             | 3       | 2.4049          | <100        |
| -40      | 20.28             | 5       | 2.4049          | <100        |
| 85       | 14.43             | 2.6     | 2.4049          | <100        |
| 85       | 16.18             | 3       | 2.4049          | <100        |
| 85       | 17.19             | 5       | 2.4049          | <100        |

Mid Channel

| Temp (C) | Power Level (dBm) | Voltage | Frequency (GHz) | Drift (kHz) |
|----------|-------------------|---------|-----------------|-------------|
| 20       | 19.19             | 3       | 2.4395          | Ref         |
| -40      | 14.04             | 2.6     | 2.4395          | <100        |
| -40      | 17.94             | 3       | 2.4395          | <100        |
| -40      | 20.14             | 5       | 2.4395          | <100        |
| 85       | 14.32             | 2.6     | 2.4395          | <100        |
| 85       | 16.04             | 3       | 2.4395          | <100        |
| 85       | 17.00             | 5       | 2.4395          | <100        |

High Channel

| Temp (C) | Power Level (dBm) | Voltage | Frequency (GHz) | Drift (kHz) |
|----------|-------------------|---------|-----------------|-------------|
| 20       | 19.60             | 3       | 2.4799          | Ref         |
| -40      | 15.00             | 2.6     | 2.4799          | <100        |
| -40      | 18.60             | 3       | 2.4799          | <100        |
| -40      | 21.00             | 5       | 2.4799          | <100        |
| 85       | 15.06             | 2.6     | 2.4799          | <100        |
| 85       | 16.84             | 3       | 2.4799          | <100        |
| 85       | 17.88             | 5       | 2.4799          | <100        |

### **Duty Cycle Correction - Pulsed Train Average Time of Occupancy**

DATE: Aug 10, 2014

TEST STANDARD: FCC Part 15.35(c) and RSS-Gen Section 4.5

TEST VOLTAGE: 120Vac 60Hz AC to 3.3Vdc Power Adapter

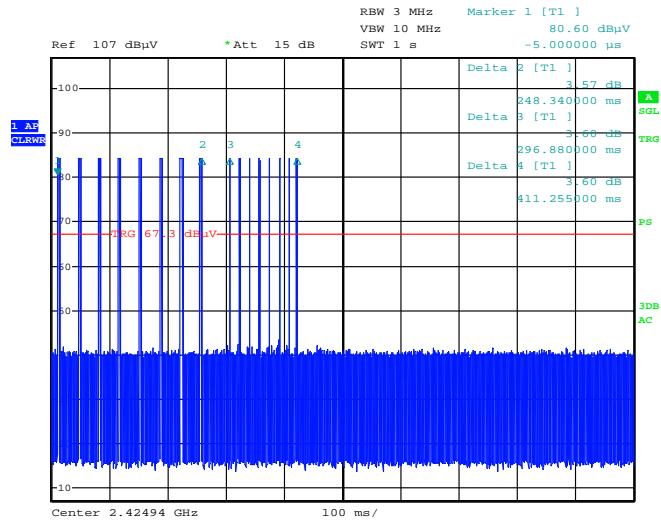
MINIMUM STANDARD: Not specified.  
(4.5) Pulsed Operation  
When the field strength (or envelope power) is not constant or it is in pulses, and an average detector is specified to be used, the value of field strength or power shall be determined by averaging over one complete pulse train, including blanking intervals within the pulse train, as long as the pulse train does not exceed 0.1 seconds. In cases where the pulse train exceeds 0.1 second, the average value of field strength or output power shall be determined during a 0.1 second interval during which the field strength or power is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST SETUP: The antenna port of EUT was directly connected to a Spectrum Analyzer through a 20dB Attenuator

MEASUREMENT METHOD: Measurements were made using a Spectrum Analyzer with 3MHz RBW Peak detector using Zero Span mode.

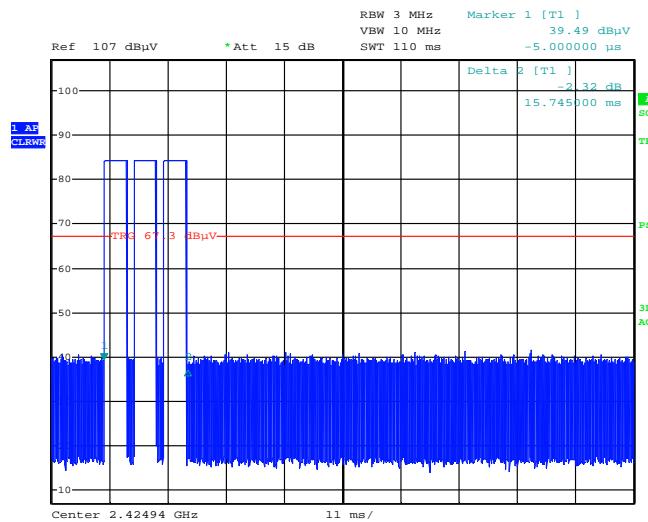
DEVICE DESCRIPTIONS: As described in the above EUT description and setup section.  
As per the manufacturer, the transmitter sends data packets of various lengths when requested. The requests for data is greater than once per second.  
During testing it was identified that there were 3 distinct patterns, depending on operation.

EMISSIONS DATA:  
Pulse On Time: 4.4ms or 0.45ms per pulse; 3 wide pulses or 7narrow pulses per 100ms; Maximum 13.2ms On time per 100ms  
Radiated emission Relaxation Correction for dBuV:  $(20\log (13.2/100)) = 17.6\text{dB}$



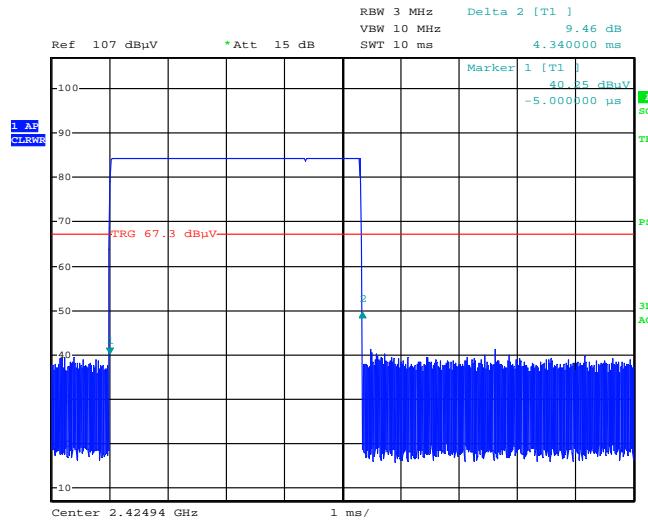
120V  
Date: 28.AUG.2014 12:53:36

#### Normal Transmission sequence



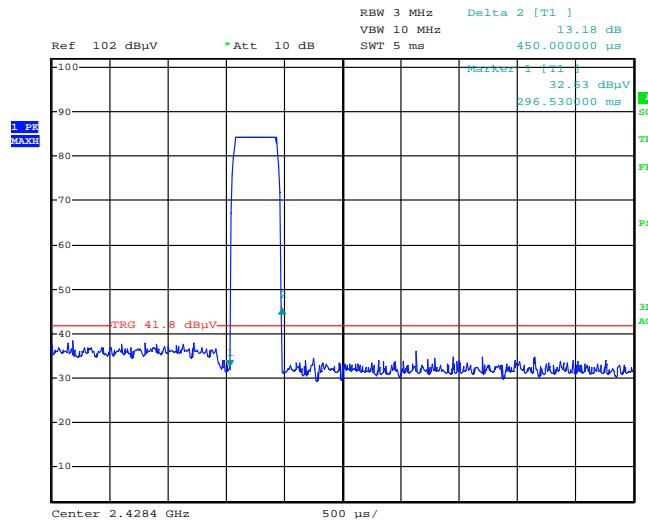
120V  
Date: 28.AUG.2014 12:57:07

No receiver was present to receive transmission



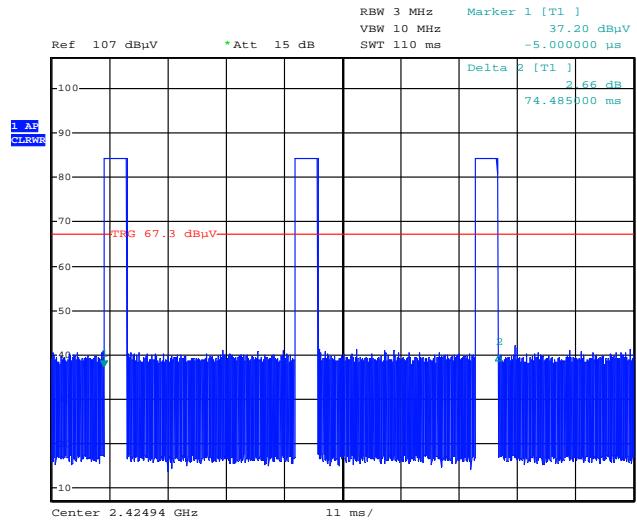
120V  
Date: 28.AUG.2014 12:36:52

### Wide pulse duration



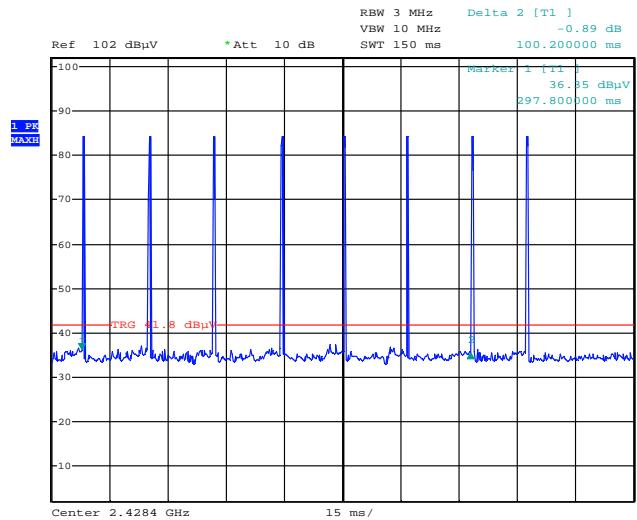
120V  
Date: 29.AUG.2014 23:30:11

### Narrow pulse duration



120V  
Date: 28.AUG.2014 12:55:08

### 3 Wide pulses per 100ms



120V  
Date: 29.AUG.2014 23:13:11

### 7 Narrow pulses per 100ms

## RF Exposure Evaluation

FCC 1.1310 states the criteria listed in the table below shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Section 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Section 2.1093. Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation".

| Frequency Range (MHz)                                    | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm <sup>2</sup> ) | Average Time (s) |
|--|-------------------------------|-------------------------------|-------------------------------------|------------------|
| (A) Limits for Occupational/Control Exposures            |                               |                               |                                     |                  |
| 300-1500   | -                             | -                             | F/300                               | 6                |
| 1500-100,000   | -                             | -                             | 5                                   | 6                |
| (B) Limits for General Population/Uncontrolled Exposures |                               |                               |                                     |                  |
| 300-1500   | -                             | -                             | F/1500                              | 6                |
| 1500-100,000   | -                             | -                             | 1                                   | 30               |

TABLE 1 - POWER DENSITY LIMITS

### 1.1 EUT OPERATING CONDITION

- The antenna used for this product is a Flexilbe PCB trace antenna connected to a UFL Connector and is designed for a Peak antenna gain of 3.5 dBi (peak)
- Highest measured conducted output level = 19.6dBm
- From Table 1, the Maximum Power Density safe exposure level for General Population Uncontrolled Exposure of 30 Seconds for the frequency range of 2.4 to 2.4835GHz is 1mW/cm<sup>2</sup>.
- 

| Conducted Output Power (dBm) | Max Antenna Gain | Max EIRP (mW) | Power Density Limit Allowed (mW/cm <sup>2</sup> ) | Safe distance (cm) |
|------------------------------|------------------|---------------|---|--------------------|
| 19.6                         | 3.5              | 204           | 1   | 4.1                |

### 1.2 RF EXPOSURE EVALUATION DISTANCE CALCULATION

$$d = \sqrt{\frac{EIRP}{4\pi S}}$$

where: d = Distance to the center of radiation of the antenna (cm) for the allowable Power Density

S = Allowable Power density Limit (mW/cm<sup>2</sup>)

EIRP = Equivalent isotropically radiated power (mW) = 10<sup>[TX Power (dBm) + Ant Gain (dBi)/10]</sup>

As shown above, the minimum distance where the MPE limit is reached is 4.1 cm from the EUT with the 3.5dBi antenna.

It is recommended that the unit is positioned so that the typical distance from the antenna to the end user is 20cm or greater.

**EUT photos during the testing**





