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# Summary Report On

On Ramp Wireless
Sectorized RPMA Access Point Model TRN AP-1000

FCC Part 15 Subpart C §15.247
IC RSS-210 Issue 8 December 2010

**Note. -** Radiated power and radiated Spurious Emissions Only.

Report No. SC1411653 March 2015

| | |
|---|---|
| **REPORT ON** | On Ramp Wireless<br>Sectorized RPMA Access Point |
| **TEST REPORT NUMBER** | SC1411653 |
| **PREPARED FOR** | On Ramp Wireless<br>10920 Via Frontera #200<br>San Diego, CA 92127-1729 USA |
| **CONTACT PERSON** | Alain Charles<br>Hardware Engineer<br>(858) 592-6008<br>alain.charles@onrampwireless.com |
| **PREPARED BY** | Juan Manuel Gonzalez<br>**Name**<br>Authorized Signatory<br>Title: Commercial/Wireless EMC Lab manager |
| **APPROVED BY** | Chip R. Fleury<br>**Name**<br>Authorized Signatory<br>Title: EMC West Cost General Manager |
| **DATED** | March 02, 2015 |

**Revision History**

| SC1411653<br>On Ramp Wireless<br>Sectorized AP<br>Sectorized RPMA Access Point | | | | | |
|---|---|---|---|---|---|
| DATE | OLD REVISION | NEW REVISION | REASON | PAGES AFFECTED | APPROVED BY |
| 03/02/15 | Initial Release | | | | Juan M Gonzalez |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**CONTENTS**

**SECTION 1**

**REPORT SUMMARY**

Radio Testing of the
On Ramp Wireless
Sectorized RPMA Access Point.

## 1.1 INTRODUCTION

The information contained in this report is intended to show limited* verification of the On Ramp Wireless Sectorized RPMA Access Point to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-210 Issue 8 December 2010. (*Radiated power and radiated Spurious Emissions Only)

| | |
|---|---|
| Objective | To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out. |
| Manufacturer | On Ramp Wireless |
| Model Number(s) | TRN AP-1000 (Tested) |
| FCC ID Number | * The Sectorized AP FCC ID#: XTE-ULPAP210<br>* The APs by themselves are certified as FCC: XTE-ULPAP110 |
| IC Number | 8655A-ULPAP110 |
| Serial Number(s) | Engineering Sample |
| Number of Samples Tested | 2 |
| Test Specification/Issue/Date | • FCC Part 15 Subpart C §15.247 (December 23, 2014).<br>• RSS-210 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment (Issue 8, December 2010).<br>• RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 4, November 2014).<br>• 558074 D01 DTS Meas Guidance v03r01, (April 09, 2013) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.<br>• KDB 412172 D01 Determining ERP and EIRP v01. Guidelines for Determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of a RF Transmitting System. |
| Start of Test | December 11, 2014 |
| Finish of Test | December 11, 2014 |
| Name of Engineer(s) | Juan Manuel Gonzalez |
| Related Document(s) | Original FCC 15.247 Report: 2010 10157899 FCC, Nemko USA. |

## 1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to the corresponding IC RSS standard is shown below.

| Section | §15.247 Spec Clause | RSS | Test Description | Result |
|---|---|---|---|---|
| 2.1 | §15.247(b)(3) | RSS-210 A8.4 (4) | Peak Output Power | Compliant |
| 2.2 | §15.247(d) | RSS-210 A8.5 | Spurious Radiated Emissions | Compliant |
| 2.3 | §15.247(d) | RSS-210 A8.5 | Radiated Immediate Restricted bands | Compliant |

## 1.3 PRODUCT INFORMATION

### 1.3.1 Technical Description

The Equipment Under Test (EUT) was a Sectorized AP model number TRN AP-1000 used as a Sectorized RPMA Access as shown in the photograph below.
The FCC number for the Dual Sector Boxer is: XTE-ULPAP210 and the APs by themselves are certified with FCC Number: XTE-ULPAP110.



TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

### 1.3.2 EUT General Description

| | |
|---|---|
| EUT Description | Sectorized RPMA Access Point |
| Model Number(s) | TRN AP-1000 |
| EUT Rated Voltage | 48VDC POE |
| Output Power | 189.23 mW |
| Frequency Range | 2402 MHz to 2475.63 MHz |
| Number of Operating Frequencies | 38 |
| Channels Verified | Channel 1 (Low Channel 2402 MHz)<br>Channel 20 (Mid Channel 2439.81 MHz)<br>Channel 38 (High Channel 2475.63 MHz) |
| Modulation Used | DSSS-DBPSK |

### 1.3.3 Test Antenna Details (External)

| | |
|---|---|
| Antenna Type | Sector Panel |
| External Antenna Gain | 17 dBi |
| Model | HG2417P-090 |
| Manufacturer | LCOM |
| Antenna Connector | N Type |
| General Description | 2.4GHz 17dBi 90 Degree Sector Panel |
| Dimensions | 39 x 6 x 2.5 inches |

### 1.3.4 Maximum Peak Output Power (EIRP)

| Mode | Frequency Range (MHz) | Conducted Output Power (dBm) | Conducted Output Power (mW) |
|---|---|---|---|
| Default ANT 1 and ANT 2 Tx Simultaniusly | 2402-2475.5 | **25.07** | **321.36** |

## 1.4 EUT TEST CONFIGURATION

### 1.4.1 Test Configuration Description

| Test Configuration | Description |
|---|---|
| Default | Both EUT Transmitters transmitting at Max Calibrated power to the external test antenna in different test cases.(For Radiated power and radiated Spurious Emissions) The EUT is programmed via Ethernet cable using emc_tool.exe application. The client provided detailed programming guide in order to exercise the Tx function and change channels. Channels power is assumed to default at max power. |

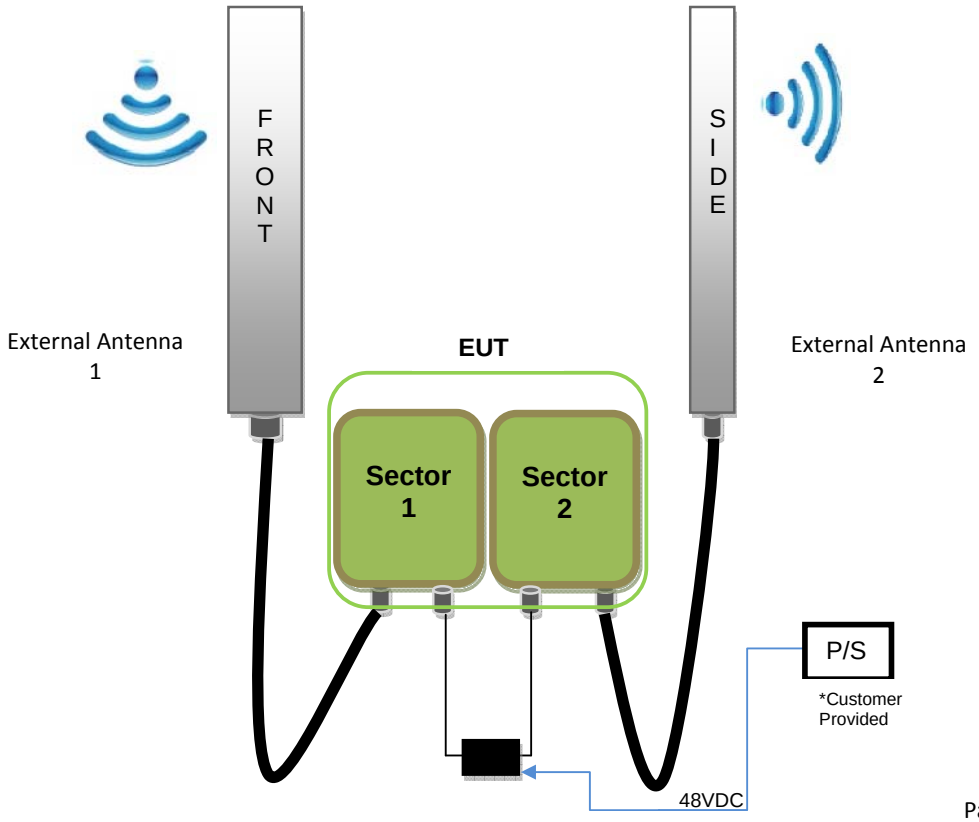
### 1.4.2 EUT Exercise Software

Software is “EMC Certification Tool 0.4.3”.

### 1.4.3 Support Equipment and I/O cables

| Manufacturer | Equipment/Cable | Description |
|---|---|---|
| Dell | Test Laptop | Windows based laptop (Model E6520) |
| | Ethernet cable | Cable used to program the EUT (EUT-laptop) |

### 1.4.4 Simplified Test Configuration Diagram



## 1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

## 1.6 MODIFICATION RECORD

| Description of Modification | Modification Fitted By | Date Modification Fitted |
|---|---|---|
| Serial Number Engineering Sample | | |
| N/A | | |

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

## 1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.
For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.4-2009. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

## 1.8 TEST FACILITY LOCATION

### 1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 FAX: 858-546 0364

### 1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

Sony Electronics Inc., Building #8 16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 942 5542 FAX: 858-546 0364

## 1.9 TEST FACILITY REGISTRATION

### 1.9.1 FCC – Registration No.: US1146

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.

### 1.9.2 Industry Canada (IC) Registration No.: 3067A

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No. 3067A.

**SECTION 2**

**TEST DETAILS**

Radio Testing of the
On Ramp Wireless
Sectorized RPMA Access Point



TÜV SÜD AMERICA INC 10040 Mesa Rim Road San Diego, CA 92121-2912 Phone: 858 678 1400 FAX: 858 546 0364

## 2.1 PEAK OUTPUT POWER

### 2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3)

### 2.1.2 Standard Applicable

2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(b) (3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

### 2.1.3 Equipment Under Test and Modification State

Serial No: Engineering Sample / Default Test Configuration

### 2.1.4 Date of Test/Initial of test personnel who performed the test

December 11, 2014 /IR

### 2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.8°C |
| Relative Humidity | 24.8% |
| ATM Pressure | 99.1 kPa |

### 2.1.7 Additional Observations

- This is a radiated test. The spectrum was searched from 2400MHz to 2484MHz to cover immediate restricted bands (masked by the notch filter during Radiated Spurious Emissions test), upper band edges and the fundamental frequency.

- Fundamental measurements were used to calculate EIRP using Field Strength Approach – linear terms (Section 1.3.1 of KDB 412172 D01 Determining ERP and EIRP v01):

$$eirp = \frac{(\mathrm{E\ x\ d})^2}{30}$$

Where: E= electric field strength in V/m
d= measurement distance in meters.

- Field strength in dBµV/m was converted to V/m using the following formula::

$$V/m = 10^{\left(\frac{\left(db\mu\frac{V}{m}\right)-120}{20}\right)}$$

Computation Example:

$$V/m = 10^{\left(\frac{\left(84.9db\mu\frac{V}{m}\right)-120}{20}\right)}$$

$$V/m = 0.01757923$$

$$eirp = \frac{(0.01757923\ \mathrm{x}\ 3)^2}{30}$$

$$eirp = \frac{(0.0527377)^2}{30}$$

$$eirp = 0.0000927 \text{ watt}$$

$$eirp\ (dBm) = 10\log(0.0000927) + 30$$

$$eirp\ (dBm) = -10.330$$

- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column on plots starting at Section 2.1.11 is for informational purposes only. See Section 2.1.8 for sample computation.

### 2.1.8 Sample Computation (Radiated Emission)

| | | | |
|---|---|---|---|
| Measuring equipment raw measurement (dbµV) @ 2400 MHz | | | 53.9 |
| Correction Factor (dB) | Asset# 1153 (cable) | 3.4 | -0.4 |
| | Asset# 8628(preamplifier) | -36.5 | |
| | Asset#7575 (antenna) | 32.7 | |
| **Reported Max Peak Final Measurement (dbµV/m) @** 2400 MHz | | | **53.5** |

### 2.1.9 Test Results

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Modulation** | **Frequency (MHz)** | **Measured Field Strength (dBµV/m @ 3 meters)** | **Calculated Radiated Peak Output Power (dBm)** | **Calculated Peak Output Power at the antenna port (dBm) {Peak power-17dBi "ANT gain"}** | **Limit (dBm)=30-(3.7dBm*) =26.3** | **Margin (dBm)** | **Result** |
| | 2402 | 134.1 | 38.87 | 21.87 | 26.3 | 4.43 | Complies |
| | 2440 | 137.3 | 42.07 | **25.07** | 26.3 | 1.23 | Complies |
| | 2480 | 137.0 | 41.77 | 24.77 | 26.3 | 1.53 | Complies |

**Additional Notes**:

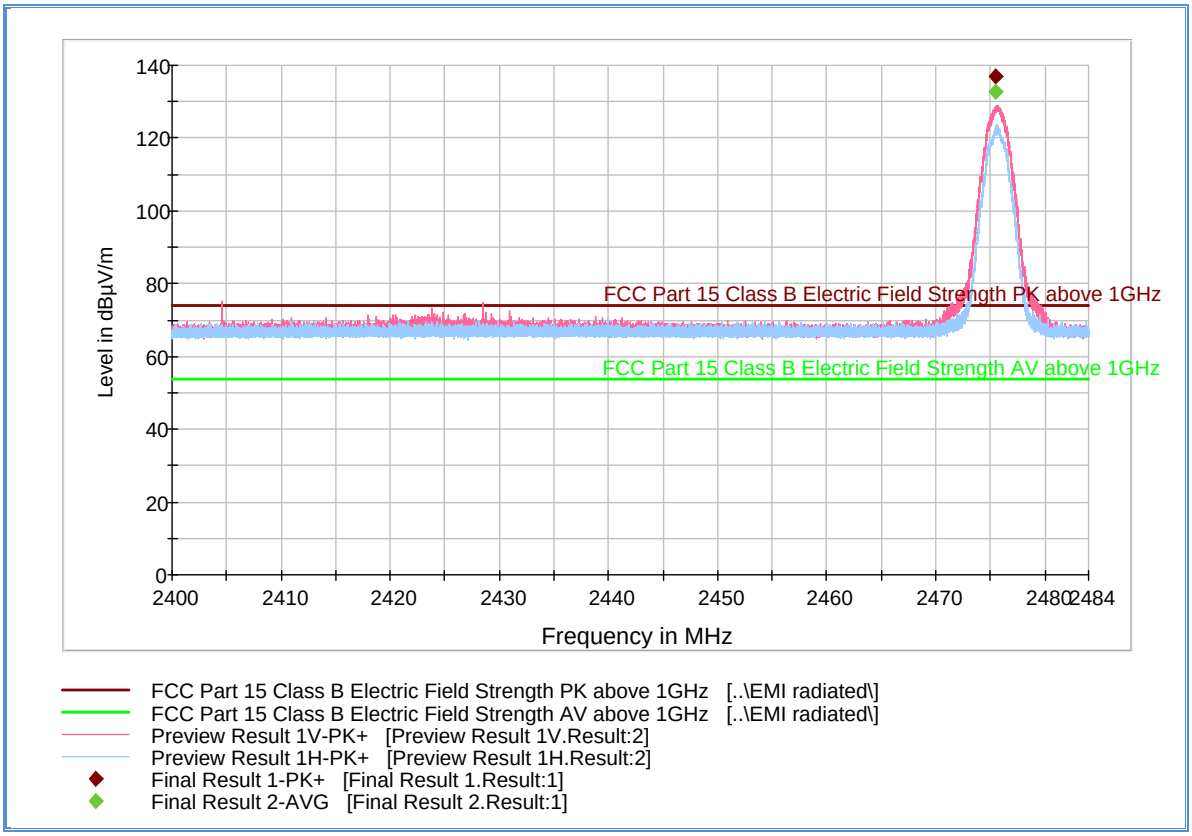
*Limit for this test is 1 watt (30dBm) from 15.247(b)(3) reduced by 1 dB for each 3dB that the directional gain of the antenna exceeds 6 dBi 15.247 (2) (ii), per KDB response (section 7 of this report).

Since the directional gain (17dBi) exceeds 11 times the limit (6dBi), 11/3 dB=3.7
Therefore the final conducted port limit for this test is 30dBm-3.7=**26.3dBm**

The EUT was tested with each transmitter of the smart antenna system set to the maximum allowed power (26dBm) delivered to each 90 degree 17dBi antenna. The conducted port measurement was confirmed with a power meter directly at the antenna port and found to be at 26dBm.

The control setting for all three channels was the same: 43dBi EIRP, 1dB cable loss, 17dBi antenna gain, Cavity Filter selected. The tool computes and sets the power to be 26dBm (confirmed) at the antenna port based on these settings.

### 2.1.10 Test Results (ANT 1 High Ch ANT 2 High Ch RSE 2.4-2.484 GHZ)




**Peak Data**

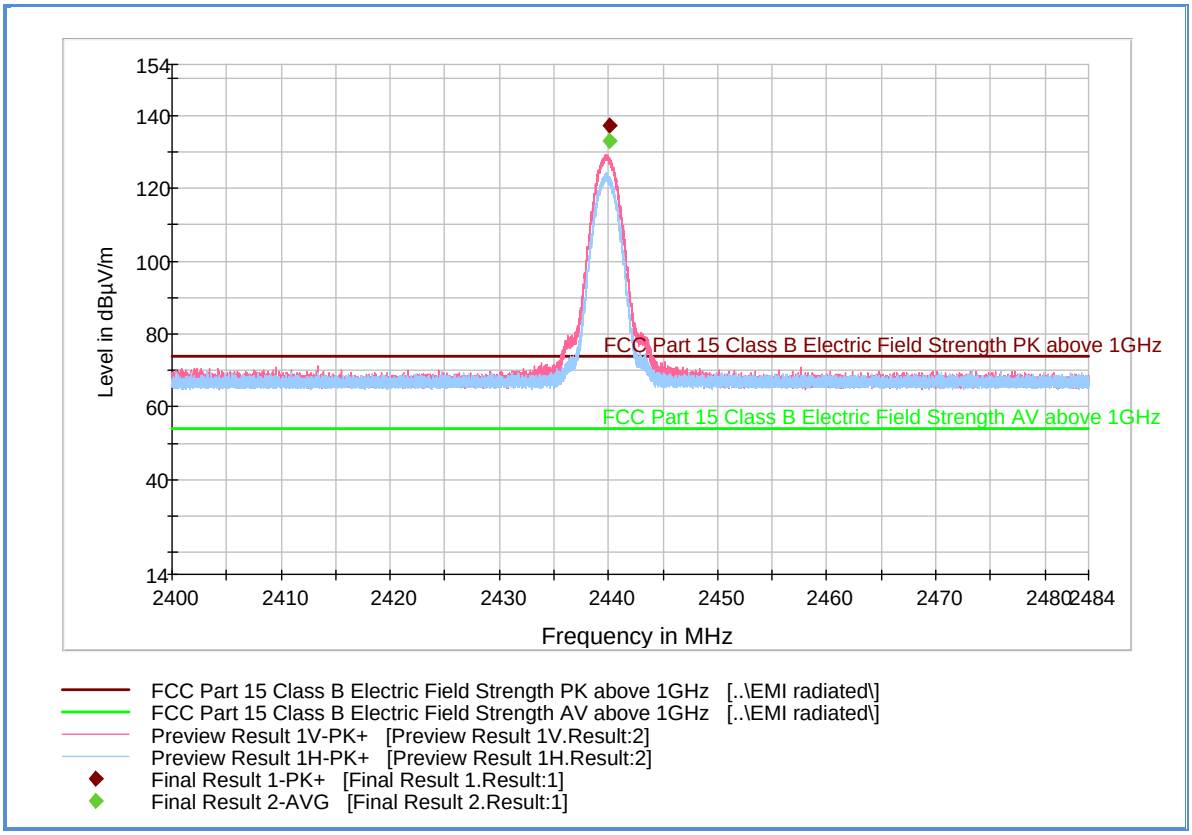
| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Comments |
|---|---|---|---|---|---|---|---|---|
| 2475.484000 | 137.0 | 1000.0 | 1000.000 | 155.6 | V | 76.0 | 35.4 | Fundamental |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | |
|---|---|---|---|---|---|---|---|---|
| 2475.484000 | 132.8 | 1000.0 | 1000.000 | 155.6 | V | 76.0 | 35.4 | Fundamental |

**Test Notes**: Both EUT Transmitters Tx in High Channel.

### 2.1.11 Test Results (ANT 1 Mid Ch ANT 2 Mid Ch RSE 2.4-2.484 GHZ)




**Peak Data**

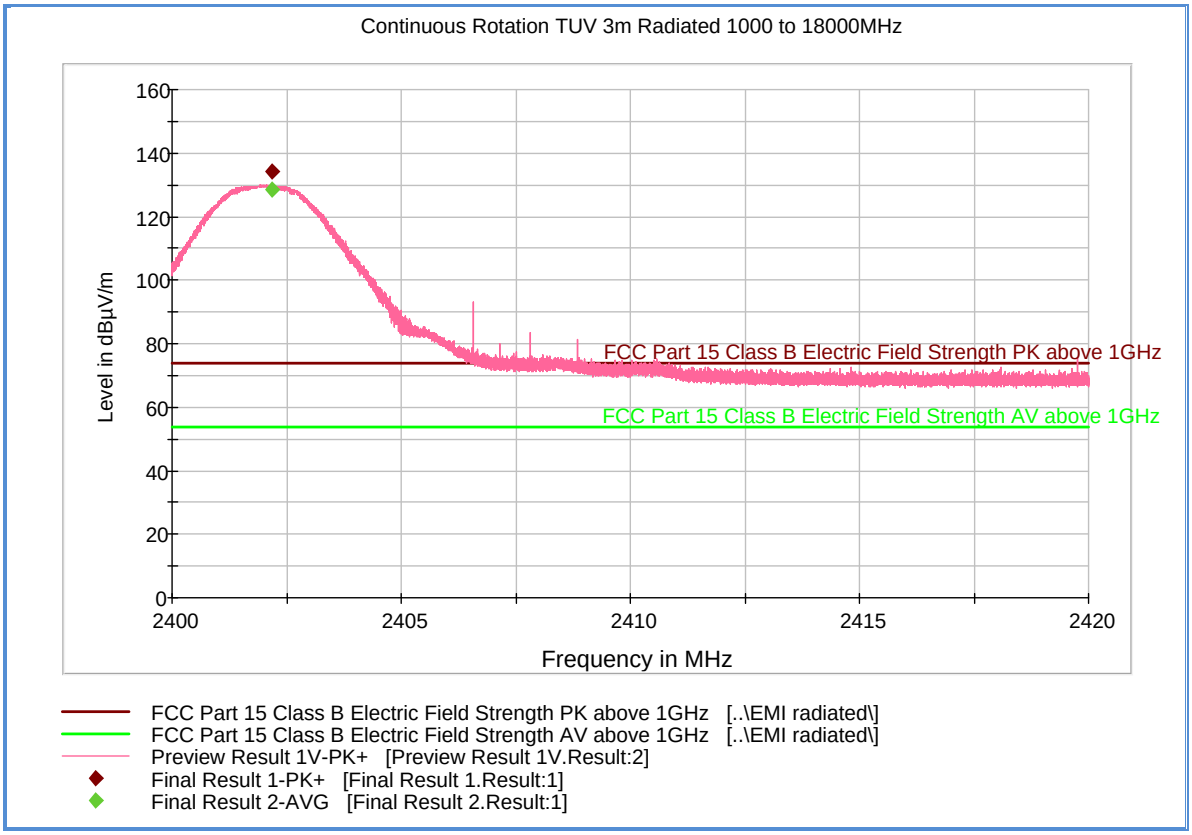
| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Comments |
|---|---|---|---|---|---|---|---|---|
| 2440.055200 | **137.3** | 1000.0 | 1000.000 | 167.6 | V | 73.0 | 35.4 | Fundamental |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | |
|---|---|---|---|---|---|---|---|---|
| 2440.055200 | 133.2 | 1000.0 | 1000.000 | 167.6 | V | 73.0 | 35.4 | Fundamental |

**Test Notes**: Both EUT Transmitters Tx in Middle Channel.

### 2.1.12 Test Results (ANT 1 Low Ch ANT 2 Low Ch RSE 2.4-2.484 GHZ)




**Peak Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Comments |
|---|---|---|---|---|---|---|---|---|
| 2402.169333 | 134.1 | 1000.0 | 1000.000 | 204.0 | V | 46.0 | 34.8 | Fundamental |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | |
|---|---|---|---|---|---|---|---|---|
| 2402.169333 | 128.3 | 1000.0 | 1000.000 | 204.0 | V | 46.0 | 34.8 | Fundamental |

**Test Notes**: Both EUT Transmitters Tx in Low Channel.

## 2.2 SPURIOUS RADIATED EMISSIONS

### 2.2.1 Specification Reference

Part 15 Subpart C §15.247(d)

### 2.2.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### 2.2.3 Equipment Under Test and Modification State

Serial No: Engineering Sample / Default Test Configuration

### 2.2.4 Date of Test/Initial of test personnel who performed the test

December 11, 2014, 2014/IR

### 2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.2.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.8°C |
| Relative Humidity | 44.1% |
| ATM Pressure | 99.1 kPa |

### 2.2.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10$^{th}$ harmonic (25GHz).
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).

- Only considered worst case channel presented for radiated emissions below 1GHz. There are no significant differences in radiated emissions below 1GHz between Low, Mid and High channels.

- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

### 2.2.8 Sample Computation (Radiated Emission)

| | | | |
|---|---|---|---|
| Measuring equipment raw measurement (dbµV) @ 30 MHz | | | 24.4 |
| Correction Factor (dB) | Asset# 1066 (cable) | 0.3 | -12.6 |
| | Asset# 1172 (cable) | 0.3 | |
| | Asset# 1016 (preamplifier) | -30.7 | |
| | Asset# 1175(cable) | 0.3 | |
| | Asset# 1002 (antenna) | 17.2 | |
| **Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz** | | | **11.8** |

### 2.2.9 Test Results

See attached plots.



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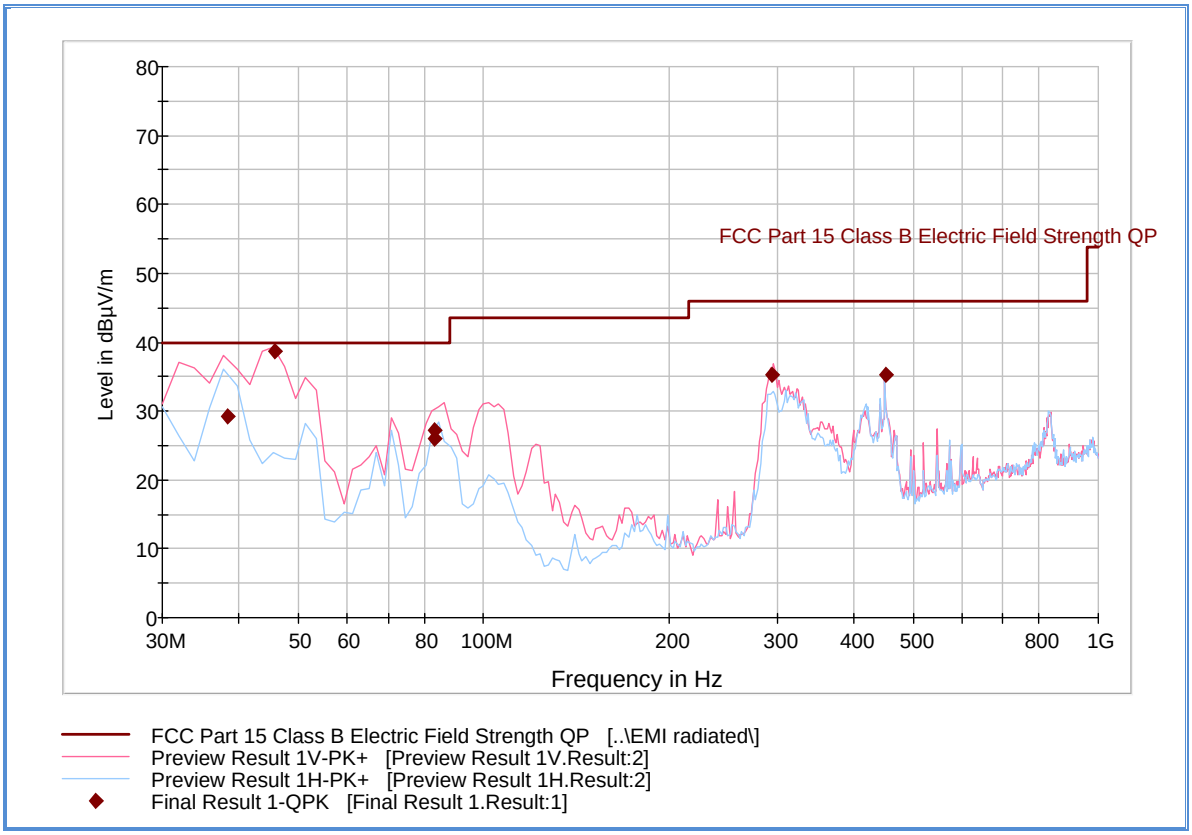
### 2.2.10 Test Results Below 1GHz (Worst case: ANT 1 Low Ch ANT 2 High Ch)

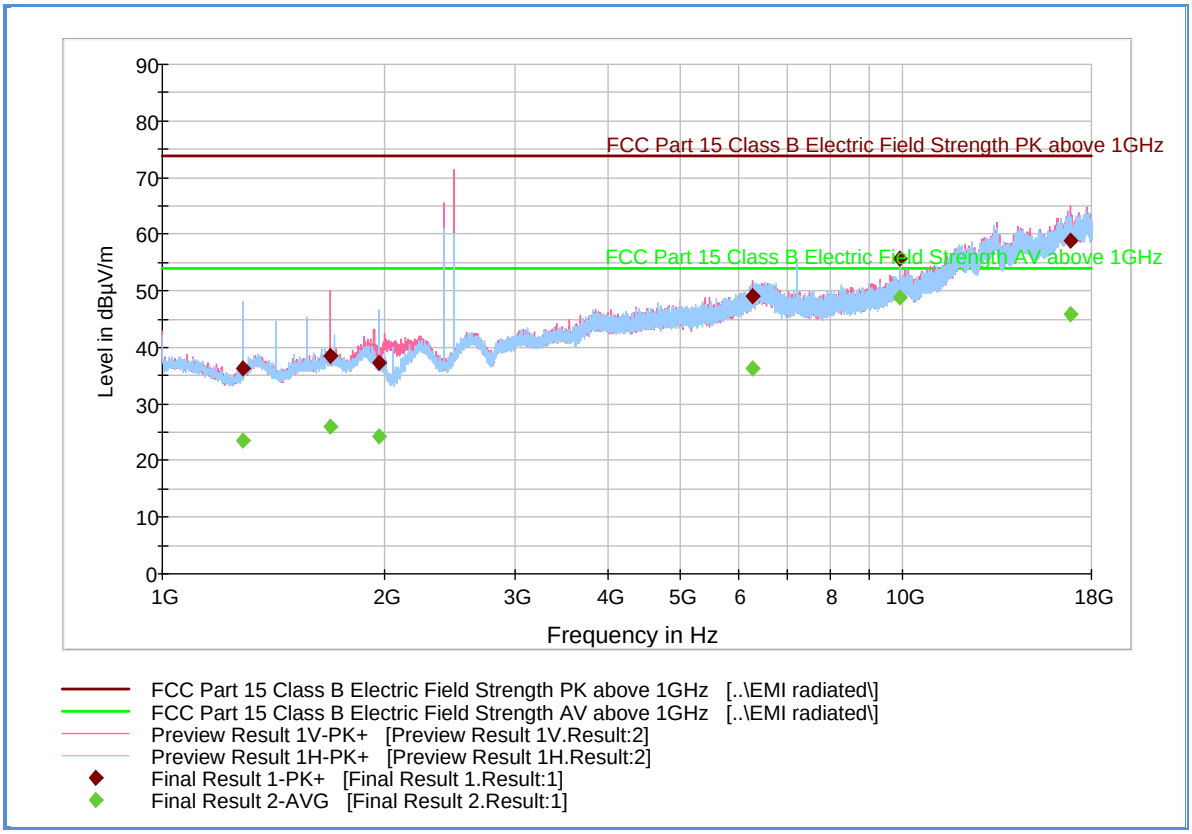



**Quasi Peak Data**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 38.295551 | 29.3 | 1000.0 | 120.000 | 122.0 | V | 18.0 | -15.4 | 10.7 | 40.0 |
| 45.791102 | 38.7 | 1000.0 | 120.000 | 100.0 | V | 195.0 | -18.3 | 1.3 | 40.0 |
| 83.092745 | 27.2 | 1000.0 | 120.000 | 150.0 | V | 342.0 | -21.5 | 12.8 | 40.0 |
| 83.108858 | 26.0 | 1000.0 | 120.000 | 170.0 | V | 342.0 | -21.5 | 14.0 | 40.0 |
| 295.152625 | 35.2 | 1000.0 | 120.000 | 106.0 | V | 167.0 | -12.6 | 10.8 | 46.0 |
| 449.999760 | 35.2 | 1000.0 | 120.000 | 202.0 | H | 292.0 | -7.8 | 10.8 | 46.0 |

**Test Notes:** Both EUT Transmitters Tx ANT 1 Low Ch & ANT 2 High Ch.

### 2.2.11 Test Results Above 1GHz (ANT 1 Low Ch ANT 2 High Ch)




**Peak Data**

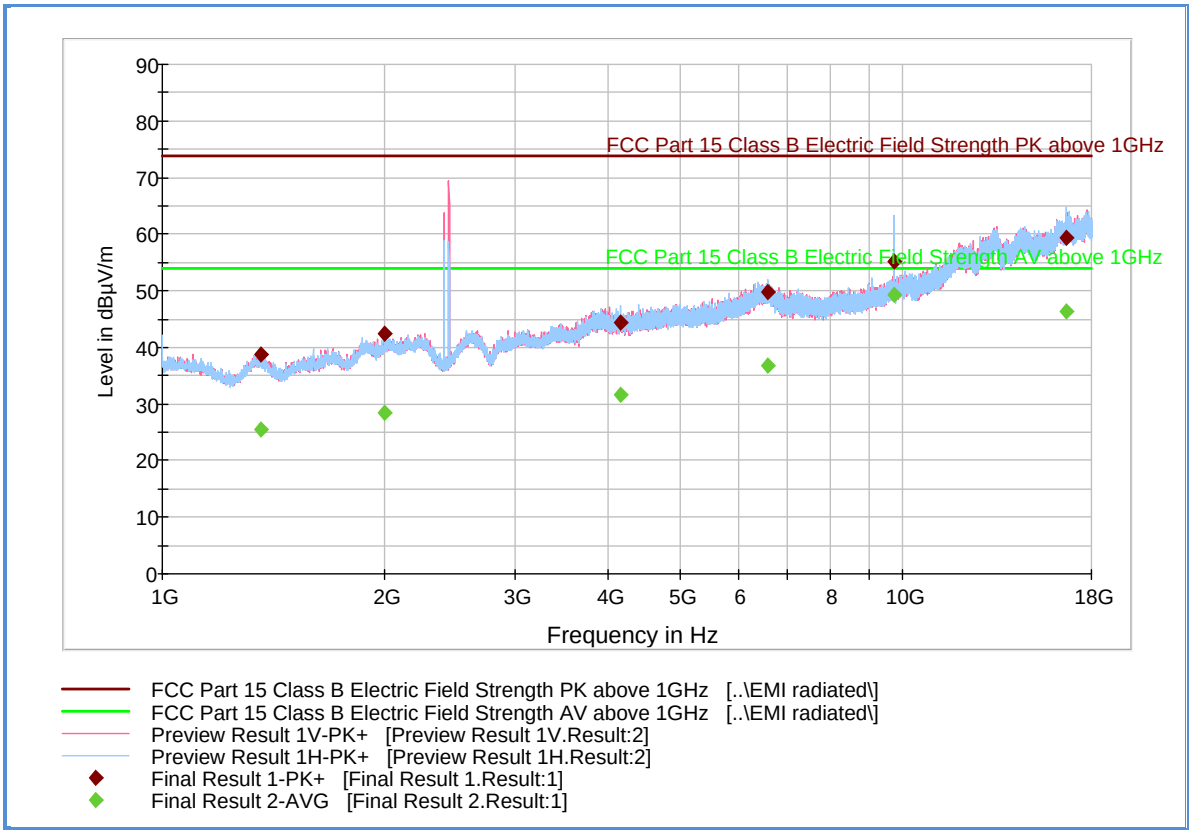
| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1283.30000 | 36.4 | 1000.0 | 1000.000 | 139.7 | H | 266.0 | -5.1 | 37.5 | 73.9 |
| 1689.06666 | 38.4 | 1000.0 | 1000.000 | 247.3 | V | 311.0 | -3.8 | 35.5 | 73.9 |
| 1959.96666 | 37.3 | 1000.0 | 1000.000 | 102.8 | H | 262.0 | -1.2 | 36.6 | 73.9 |
| 6261.50000 | 49.1 | 1000.0 | 1000.000 | 215.5 | V | 0.0 | 11.7 | 24.8 | 73.9 |
| 9902.53333 | 55.7 | 1000.0 | 1000.000 | 115.8 | H | 60.0 | 14.2 | 18.2 | 73.9 |
| 16839.4666 | 58.9 | 1000.0 | 1000.000 | 406.7 | V | 243.0 | 25.2 | 15.0 | 73.9 |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1283.30000 | 23.4 | 1000.0 | 1000.000 | 139.7 | H | 266.0 | -5.1 | 30.5 | 53.9 |
| 1689.06666 | 25.9 | 1000.0 | 1000.000 | 247.3 | V | 311.0 | -3.8 | 28.0 | 53.9 |
| 1959.96666 | 24.2 | 1000.0 | 1000.000 | 102.8 | H | 262.0 | -1.2 | 29.7 | 53.9 |
| 6261.50000 | 36.2 | 1000.0 | 1000.000 | 215.5 | V | 0.0 | 11.7 | 17.7 | 53.9 |
| 9902.53333 | 48.7 | 1000.0 | 1000.000 | 115.8 | H | 60.0 | 14.2 | 5.2 | 53.9 |
| 16839.4666 | 45.8 | 1000.0 | 1000.000 | 406.7 | V | 243.0 | 25.2 | 8.1 | 53.9 |

**Test Notes:** Both EUT Transmitters Tx ANT 1 Low Ch & ANT 2 High Ch.

### 2.2.12 Test Results Above 1GHz (ANT 1 High Ch ANT 2 Mid Ch)




**Peak Data**

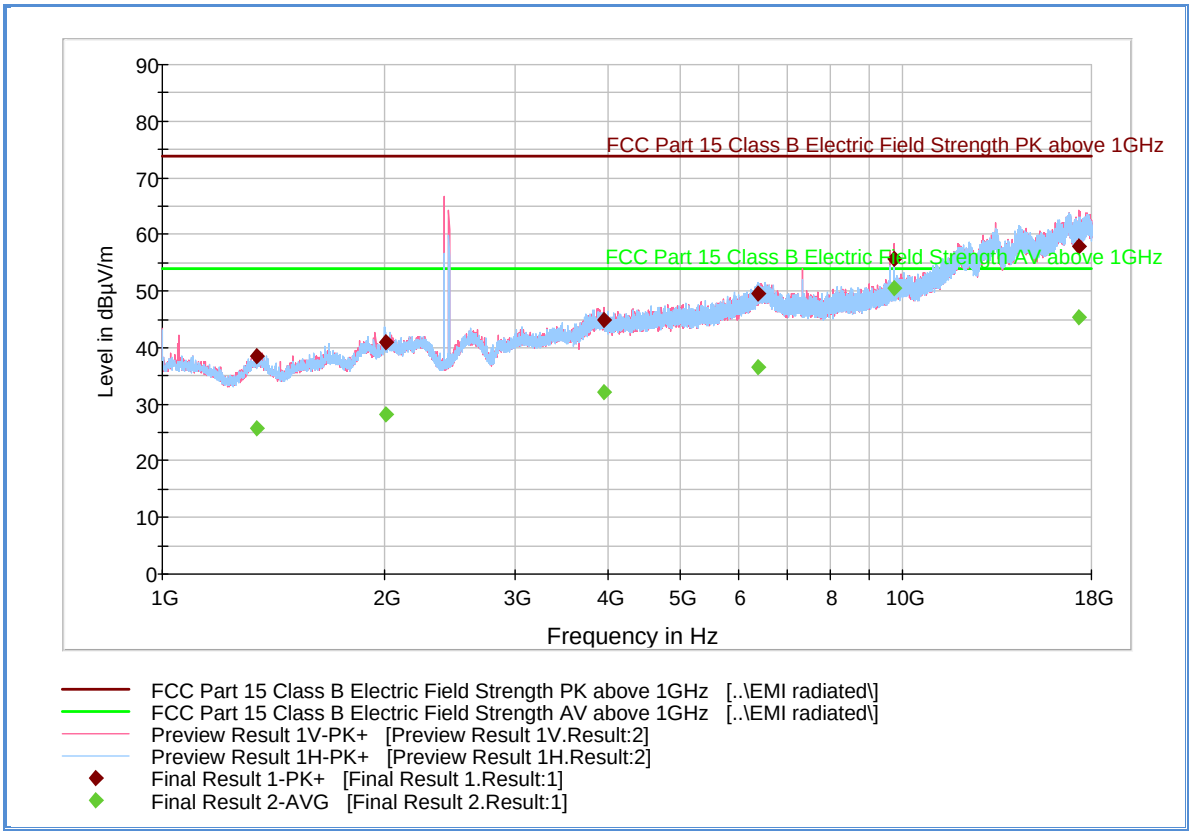
| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1361.33333 | 38.8 | 1000.0 | 1000.000 | 173.6 | V | 258.0 | -5.0 | 35.1 | 73.9 |
| 1996.03333 | 42.3 | 1000.0 | 1000.000 | 333.1 | H | 208.0 | -1.0 | 31.6 | 73.9 |
| 4152.50000 | 44.3 | 1000.0 | 1000.000 | 141.7 | H | 108.0 | 6.2 | 29.6 | 73.9 |
| 6577.10000 | 49.7 | 1000.0 | 1000.000 | 246.3 | H | 138.0 | 12.8 | 24.2 | 73.9 |
| 9759.33333 | 55.1 | 1000.0 | 1000.000 | 189.5 | H | 36.0 | 13.7 | 18.8 | 73.9 |
| 16679.3333 | 59.3 | 1000.0 | 1000.000 | 401.7 | H | 84.0 | 25.6 | 14.6 | 73.9 |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1361.33333 | 25.6 | 1000.0 | 1000.000 | 173.6 | V | 258.0 | -5.0 | 28.3 | 53.9 |
| 1996.03333 | 28.5 | 1000.0 | 1000.000 | 333.1 | H | 208.0 | -1.0 | 25.4 | 53.9 |
| 4152.50000 | 31.8 | 1000.0 | 1000.000 | 141.7 | H | 108.0 | 6.2 | 22.1 | 53.9 |
| 6577.10000 | 36.8 | 1000.0 | 1000.000 | 246.3 | H | 138.0 | 12.8 | 17.1 | 53.9 |
| 9759.33333 | 49.3 | 1000.0 | 1000.000 | 189.5 | H | 36.0 | 13.7 | 4.6 | 53.9 |
| 16679.3333 | 46.4 | 1000.0 | 1000.000 | 401.7 | H | 84.0 | 25.6 | 7.5 | 53.9 |

**Test Notes:** Both EUT Transmitters Tx ANT 1 High Ch & ANT 2 Mid Ch.

### 2.2.13 Test Results Above 1GHz (ANT 1 Mid Ch ANT 2 Low Ch)




**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1339.30000 | 38.5 | 1000.0 | 1000.000 | 153.7 | V | 116.0 | -5.0 | 35.4 | 73.9 |
| 2008.30000 | 41.0 | 1000.0 | 1000.000 | 182.6 | V | 41.0 | -1.0 | 32.9 | 73.9 |
| 3955.30000 | 44.8 | 1000.0 | 1000.000 | 367.1 | V | 20.0 | 6.0 | 29.1 | 73.9 |
| 6388.06666 | 49.5 | 1000.0 | 1000.000 | 401.7 | H | 134.0 | 12.7 | 24.4 | 73.9 |
| 9759.16666 | 55.7 | 1000.0 | 1000.000 | 124.7 | V | 317.0 | 13.7 | 18.2 | 73.9 |
| 17344.9666 | 57.9 | 1000.0 | 1000.000 | 138.7 | V | 281.0 | 24.7 | 16.0 | 73.9 |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1339.30000 | 25.8 | 1000.0 | 1000.000 | 153.7 | V | 116.0 | -5.0 | 28.1 | 53.9 |
| 2008.30000 | 28.3 | 1000.0 | 1000.000 | 182.6 | V | 41.0 | -1.0 | 25.6 | 53.9 |
| 3955.30000 | 32.2 | 1000.0 | 1000.000 | 367.1 | V | 20.0 | 6.0 | 21.7 | 53.9 |
| 6388.06666 | 36.7 | 1000.0 | 1000.000 | 401.7 | H | 134.0 | 12.7 | 17.2 | 53.9 |
| 9759.16666 | 50.6 | 1000.0 | 1000.000 | 124.7 | V | 317.0 | 13.7 | 3.3 | 53.9 |
| 17344.9666 | 45.4 | 1000.0 | 1000.000 | 138.7 | V | 281.0 | 24.7 | 8.5 | 53.9 |

**Test Notes:** Both EUT Transmitters Tx ANT 1 Mid Ch & ANT 2 Low Ch.

## 2.3 RADIATED IMMEDIATE RESTRICTED BANDS

### 2.3.1 Specification Reference

Part 15 Subpart C §15.247(d)

### 2.3.2 Standard Applicable

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### 2.3.3 Equipment Under Test and Modification State

Serial No: Engineering Sample / Default Test Configuration

### 2.3.4 Date of Test/Initial of test personnel who performed the test

December 11, 2014, 2014/IR

### 2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.3.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.8°C |
| Relative Humidity | 44.1% |
| ATM Pressure | 99.1 kPa |

### 2.3.7 Additional Observations

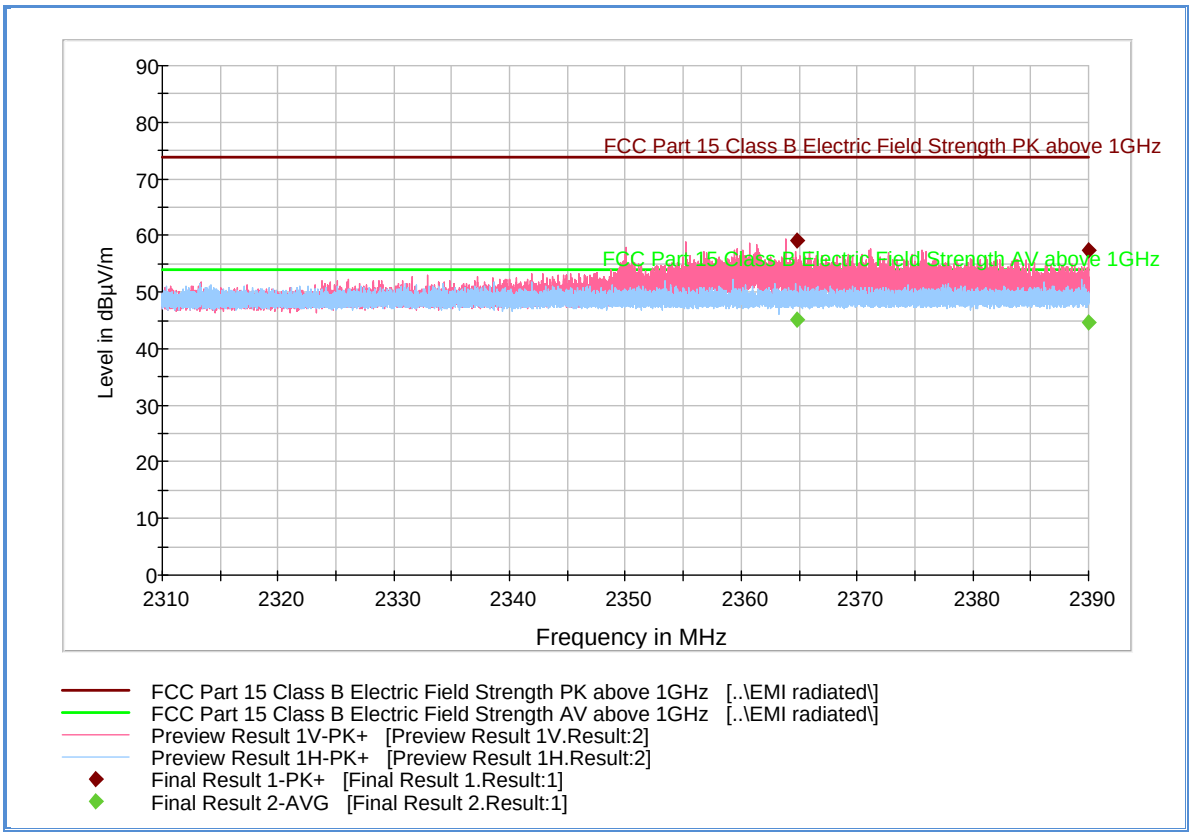
- This is a radiated test. The spectrum was searched when Both EUT Transmitters TX in Low channel from 2310MHz to 2390MHz and when Both EUT Transmitters Tx in High Channel from 2400MHz to 2410MHz.

- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).

### 2.3.8 Test Results

See attached plots.

### 2.3.9 Test Results low restricted band 2310MHz to 2390MHz (Both EUT Transmitters Tx in Low Channel)




**Peak Data**

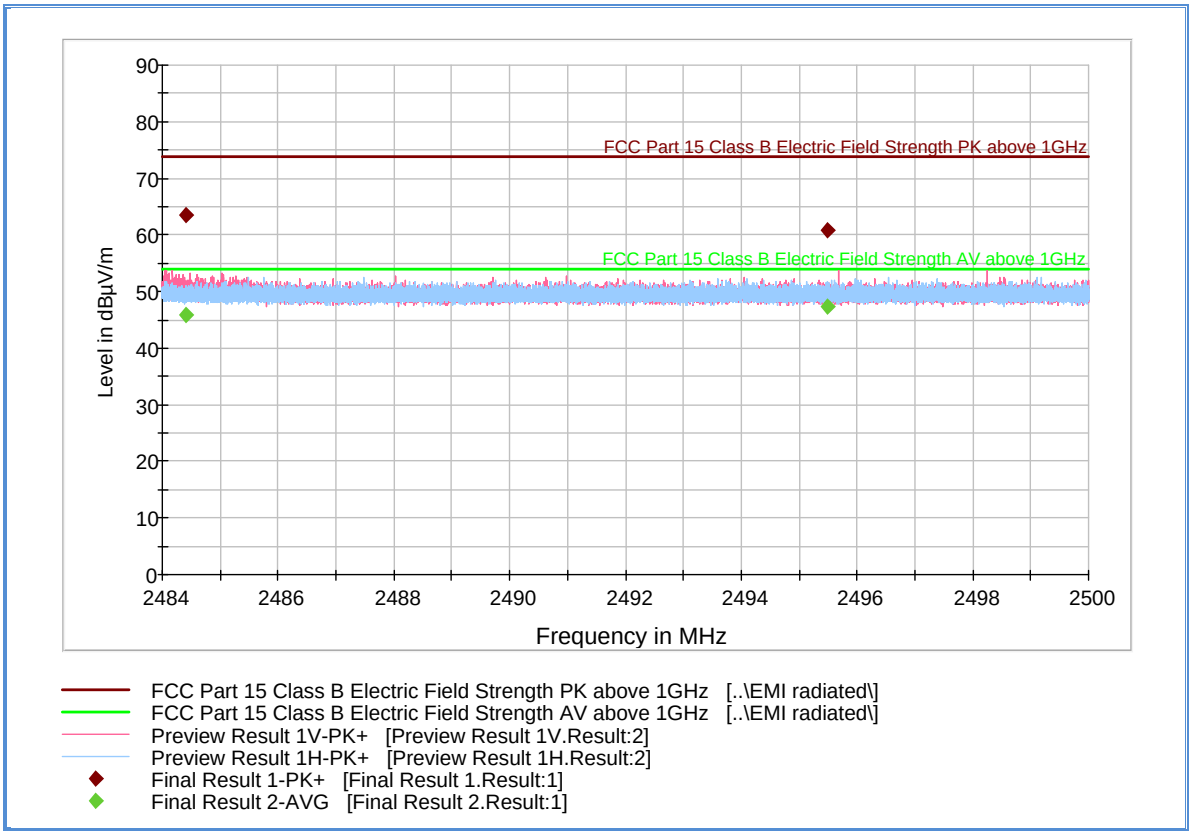
| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 2364.86666 | 59.0 | 1000.0 | 1000.000 | 197.5 | V | 77.0 | 9.6 | 14.9 | 73.9 |
| 2390.00000 | 57.3 | 1000.0 | 1000.000 | 205.5 | V | 77.0 | 9.8 | 16.6 | 73.9 |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 2364.86666 | 45.0 | 1000.0 | 1000.000 | 197.5 | V | 77.0 | 9.6 | 8.9 | 53.9 |
| 2390.00000 | 44.6 | 1000.0 | 1000.000 | 205.5 | V | 77.0 | 9.8 | 9.3 | 53.9 |

**Test Notes:** Both EUT Transmitters Tx in Low Ch.

### 2.3.10 Test Results high restricted band 2484MHz to 2500MHz (Both EUT Transmitters Tx in High Channel)




**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 2484.40000 | 63.5 | 1000.0 | 1000.000 | 179.6 | V | 62.0 | 10.2 | 10.4 | 73.9 |
| 2495.47840 | 60.9 | 1000.0 | 1000.000 | 171.6 | V | 74.0 | 10.2 | 13.0 | 73.9 |

**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 2484.40000 | 45.8 | 1000.0 | 1000.000 | 179.6 | V | 62.0 | 10.2 | 8.1 | 53.9 |
| 2495.47840 | 47.3 | 1000.0 | 1000.000 | 171.6 | V | 74.0 | 10.2 | 6.6 | 53.9 |

**Test Notes:** Both EUT Transmitters Tx in high Ch.

**SECTION 3**

**TEST EQUIPMENT USED**

## 3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

| ID Number (SDGE/SDRB) | Test Equipment | Type | Serial Number | Manufacturer | Cal Date | Cal Due Date |
|---|---|---|---|---|---|---|
| Radiated Test Setup | | | | | | |
| 1184 | Spectrum Analyzer | FSEM | 849718/025 | Rhode & Schwarz | 06/27/14 | 06/27/15 |
| 1002 | Bilog Antenna | 3142C | 00058717 | ETS-Lindgren | 01/30/14 | 01/30/16 |
| 7575 | Double-ridged waveguide horn antenna | 3117 | 00155511 | EMCO | 04/08/14 | 04/08/15 |
| 8628 | Pre-amplifier | QLJ 01182835-JO | 8986002 | QuinStar Technologies Inc. | 04/03/14 | 04/03/15 |
| 1150 | Horn antenna | 3160-09 | 012054-004 | ETS | 04/26/13 | 04/26/15 |
| 1151 | Pre-amplifier | TS-PR26 | 100026 | Rhode & Schwarz | 05/02/13 | 05/02/15 |
| 8760 | Pre-amplifier | ZKL-2 | 1001 | Mini-Circuits | 09/04/14 | 09/04/15 |
| 1153 | High-frequency cable | SucoFlex 100 SX | N/A | Suhner | 04/03/14 | 04/03/15 |
| 8543 | High-frequency cable | Micropore 19057793 | N/A | United Microwave Products | 09/04/14 | 09/04/15 |
| 1040 | EMI Test Receiver | ESIB40 | 100292 | Rhode & Schwarz | 08/29/14 | 08/29/15 |
| 1049 | EMI Test Receiver | ESU | 100133 | Rhode & Schwarz | 03/17/14 | 03/17/15 |
| 6815 | 2.4GHz Band Notch Filter | BRM50702 | 008 | Micro-Tronics | Verified by 1003and 1049 | |
| 1016 | Pre-amplifier | PAM-0202 | 187 | PAM | 05/05/14 | 05/05/15 |
| 1003 | Signal Generator | SMR-40 | 1104.0002.40 | Rhode & Schwarz | 01/20/14 | 01/20/15 |
| Miscellaneous | | | | | | |
| 6792 | Multimeter | 3478A | 2911A70964 | Hewlett Packard | 08/12/14 | 08/12/15 |
| 7554 | Barometer/Temperature /Humidity Transmitter | iBTHX-W | 0400706 | Omega | 01/30/14 | 01/30/15 |
| | Test Software | EMC32 | V8.53 | Rhode & Schwarz | N/A | |

**SECTION 4**

**UNCERTAINTY**

## 4.1 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

### 4.1.1 Radiated Emission Measurements (Below 1GHz)

| | Contribution | Probability Distribution Type | Probability Distribution $x_i$ | Standard Uncertainty $u(x_i)$ | $[u(x_i)]^2$ |
|---|---|---|---|---|---|
| 1 | Receiver/Spectrum Analyzer | Rectangular | 0.45 | 0.26 | 0.07 |
| 2 | Cables | Rectangular | 0.50 | 0.29 | 0.08 |
| 3 | Preamp | Rectangular | 0.50 | 0.29 | 0.08 |
| 4 | Antenna | Rectangular | 0.75 | 0.43 | 0.19 |
| 5 | Site | Rectangular | 3.89 | 2.25 | 5.04 |
| 6 | EUT Setup | Rectangular | 1.00 | 0.58 | 0.33 |
| | | | | Combined Uncertainty ($u_c$): | 2.41 |
| | | | | Coverage Factor (k): | 2 |
| | | | | Expanded Uncertainty: | 4.82 |

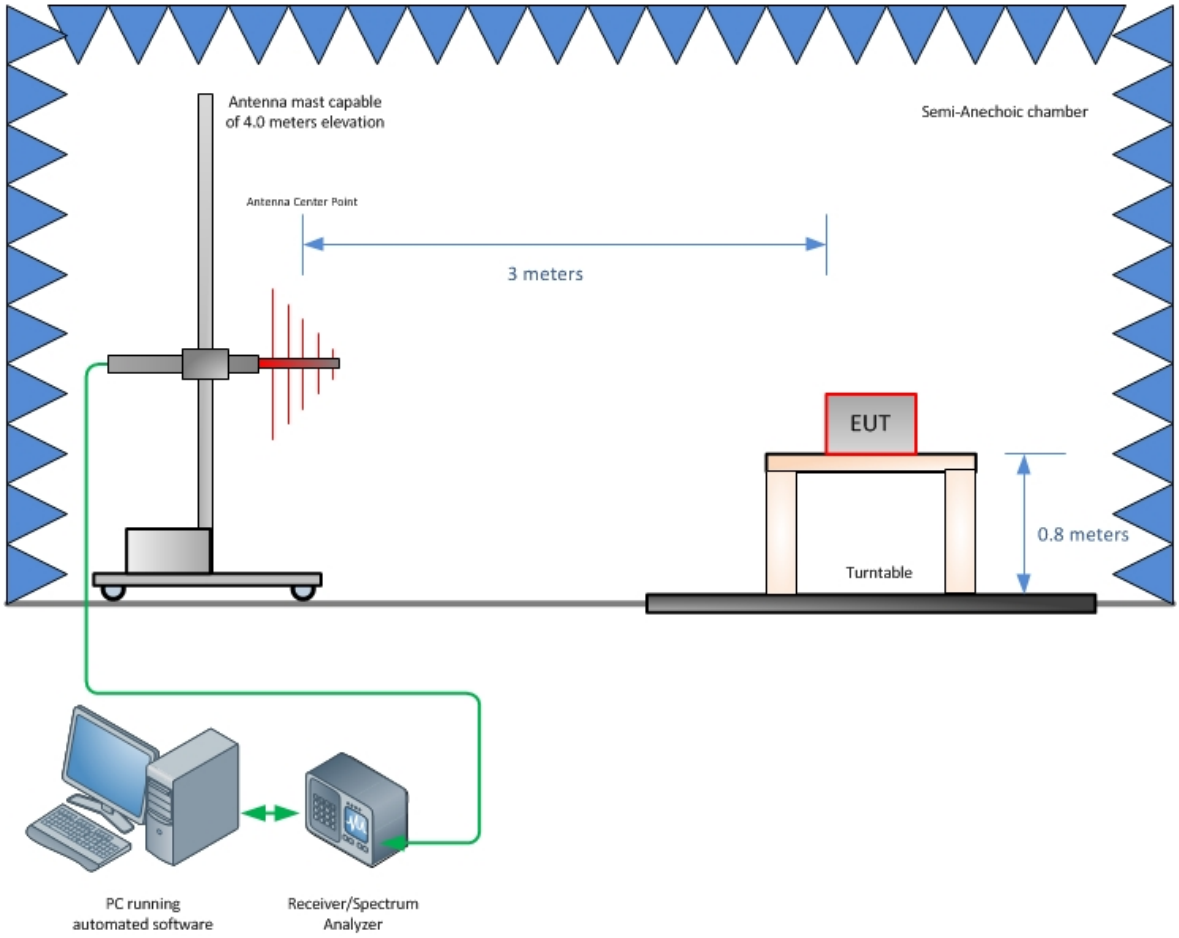
### 4.1.2 Radiated Emission Measurements (Above 1GHz)

| | Contribution | Probability Distribution Type | Probability Distribution $x_i$ | Standard Uncertainty $u(x_i)$ | $[u(x_i)]^2$ |
|---|---|---|---|---|---|
| 1 | Receiver/Spectrum Analyzer | Rectangular | 0.57 | 0.33 | 0.11 |
| 2 | Cables | Rectangular | 0.70 | 0.40 | 0.16 |
| 3 | Preamp | Rectangular | 0.50 | 0.29 | 0.08 |
| 4 | Antenna | Rectangular | 0.37 | 0.21 | 0.05 |
| 5 | Site | Rectangular | 3.89 | 2.25 | 5.04 |
| 6 | EUT Setup | Rectangular | 1.00 | 0.58 | 0.33 |
| | | | | Combined Uncertainty ($u_c$): | 2.40 |
| | | | | Coverage Factor (k): | 2 |
| | | | | Expanded Uncertainty: | 4.81 |

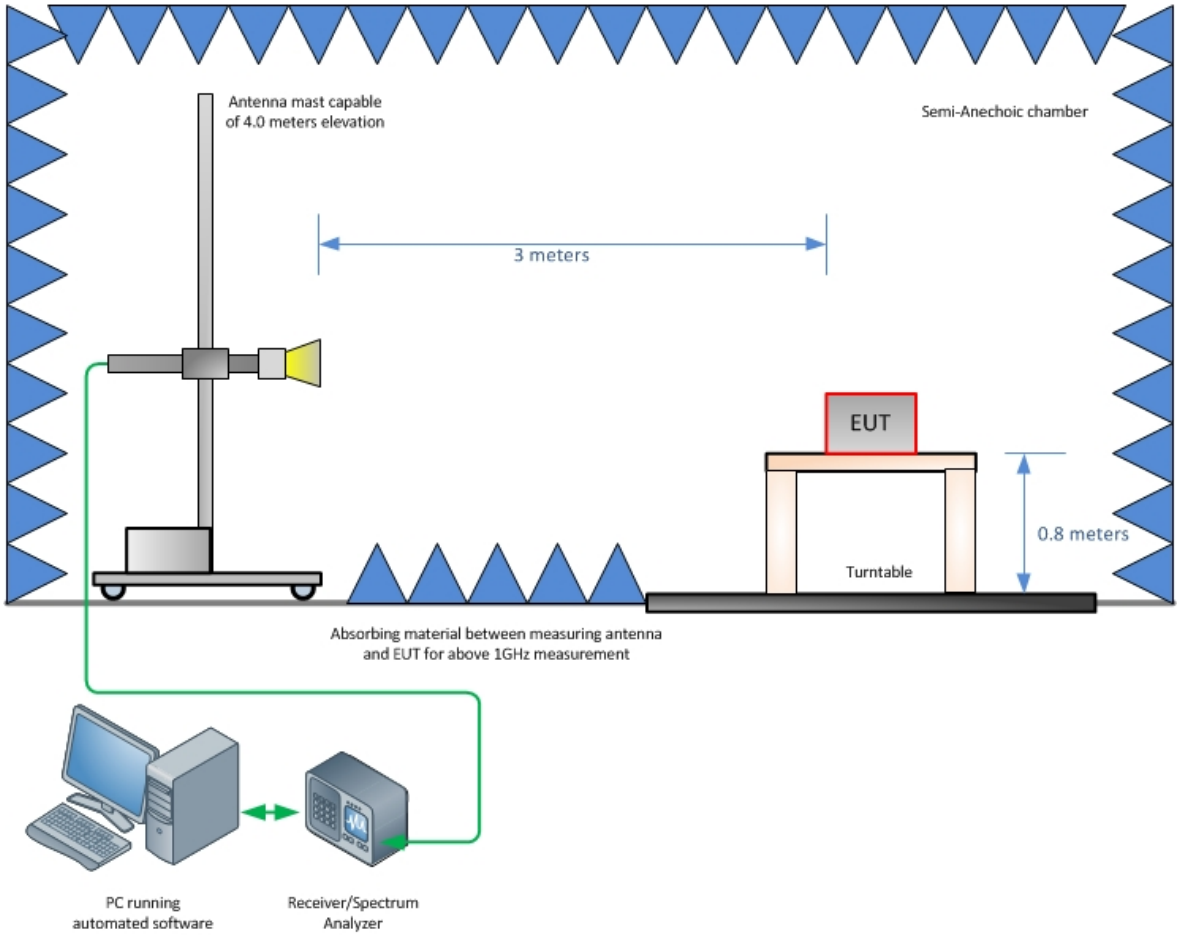
**SECTION 5**

**DIAGRAM OF TEST SETUP**

## 5.1 TEST SETUP DIAGRAM




**Radiated Emission Test Setup (Below 1GHz)**




**Radiated Emission Test Setup (Above 1GHz)**

**SECTION 6**

**ACCREDITATION, DISCLAIMERS AND COPYRIGHT**

## 6.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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**SECTION 7**

## KDB RESPONSE (09/22/2014)

## KDB RESPONSE:

FCC response on 09/22/2014

Your test/certification is acceptable by the FCC. Following is the summary of your system according to 15.247(c)(2)(ii) and 15.247(c)(2)(iii):

1. Simultaneous transmission.
2. Operation with directional antennas greater than 6 dBi.
3. Non-overlapping 3dB-beamwidth.
4. Power supplied to each emission beam is subject to the power limit specified in 15.247(c)(2)(ii).



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