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## Report On

Application for Grant of Equipment Authorization of the  
CalAmp Wireless Networks Corp.

LMU-3030 Tracking Unit with OBD-II Interface

FCC Part 15 Subpart C §15.247

IC RSS-210 Issue 8 December 2010

Report No. SC1409996A

October 2014



**REPORT ON** Radio Testing of the  
CalAmp Wireless Networks Corp.  
Tracking Unit with OBD-II Interface

**TEST REPORT NUMBER** SC1409996A

**PREPARED FOR** CalAmp Wireless Networks Corp.  
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**APPROVED BY**   
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**Name**  
Authorized Signatory

**DATED** October 14, 2014



**Revision History**

| SC1409996A<br>CalAmp Wireless Networks Corp.<br>LMU-3030<br>Tracking Unit with OBD-II Interface |                 |              |        |                |                |
|---|-----------------|--------------|--------|----------------|----------------|
| DATE  | OLD REVISION    | NEW REVISION | REASON | PAGES AFFECTED | APPROVED BY    |
| 10/14/2014  | Initial Release |              |        |                | Chip R. Fleury |
|   |                 |              |        |                |                |
|   |                 |              |        |                |                |
|   |                 |              |        |                |                |
|   |                 |              |        |                |                |



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## **SECTION 1**

### **REPORT SUMMARY**

Radio Testing of the  
CalAmp Wireless Networks Corp.  
Tracking Unit with OBD-II Interface



## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the CalAmp Wireless Networks Corp. LMU-3030 Tracking Unit with OBD-II Interface to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-210 Issue 8 December 2010.

|                               |   |
|-------------------------------|---|
| 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                  | CalAmp Wireless Networks Corp.  |
| Model Number(s)               | LMU30H30BT3   |
| FCC ID Number                 | APV-3030HBT   |
| IC Number                     | 5843C-3030HBT   |
| Serial Number(s)              | 4532000604 and 4632081643   |
| Number of Samples Tested      | 2   |
| Test Specification/Issue/Date | <ul style="list-style-type: none"><li>• FCC Part 15 Subpart C §15.247 (October 1, 2013).</li><li>• RSS-210 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment (Issue 8, December 2010).</li><li>• RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 3, December 2010).</li><li>• Public Notice (DA 00-705 Released March 30, 2000) Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems</li></ul> |
| Start of Test                 | July 03, 2014   |
| Finish of Test                | October 02, 2014  |
| Name of Engineer(s)           | Ferdinand Custodio  |
| Related Document(s)           | <ul style="list-style-type: none"><li>• Supporting documents for EUT certification are separate exhibits.</li><li>• Bluetooth Daughterboard Test Mode Setup.docx</li></ul>  |



## 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           | Comments/<br>Base Standard |
|---------|---------------------|-----------------|--|------------------|----------------------------|
| 2.1     | §15.207 (a)         | RSS-Gen 7.2.4   | Conducted Emissions                            | N/A <sup>1</sup> |                            |
| 2.2     | §15.247(a)(1)       | RSS-210 A8.1(b) | Carrier Frequency Separation                   | Compliant        |                            |
| 2.3     | §15.247(a)(1)(iii)  | RSS-210 A8.1(d) | Number of Hopping Frequencies                  | Compliant        |                            |
| 2.4     | §15.247(a)(1)(iii)  | RSS-210 A8.1(d) | Time of Occupancy (Dwell Time)                 | Compliant        |                            |
| 2.5     | §15.215(c)          | RSS-210 A8.1(a) | 20 dB Bandwidth                                | Compliant        |                            |
| 2.6     |                     | RSS-Gen 4.6.1   | 99% Emission Bandwidth                         | Compliant        |                            |
| 2.7     | §15.247(b)(1)       | RSS-210 A8.4(2) | Peak Output Power                              | Compliant        |                            |
| 2.8     | §15.247(d)          | RSS-210 A8.5    | Band-edge Compliance of RF Conducted Emissions | Compliant        |                            |
| 2.9     | §15.247(d)          | RSS-210 A8.5    | Spurious RF Conducted Emissions                | N/A <sup>2</sup> |                            |
| 2.10    | §15.247(d)          | RSS-210 2.2     | Spurious Radiated Emissions                    | Compliant        |                            |
| 2.11    | §15.247(d)          | RSS-210 2.2     | Radiated Immediate Restricted Bands            | Compliant        |                            |
| 2.12    |                     | RSS-Gen 6.0     | Receiver Spurious Emissions                    | Compliant        |                            |

N/A<sup>1</sup> Not applicable. EUT is battery operated only and designed for vehicular use.

N/A<sup>2</sup> Not applicable. EUT has an integral antenna. Spurious Emissions is covered under Section 2.10 of this test report.

### 1.3 PRODUCT INFORMATION

#### 1.3.1 Technical Description

The Equipment Under Test (EUT) was a CalAmp Wireless Networks Corp. LMU-3030 Tracking Unit with OBD-II Interface as shown in the photograph below. The EUT is a tracking unit with GPS, Bluetooth, OBD-II interface, backup battery, and a 3-axis accelerometer. The EUT can access vehicle diagnostic interface data, track vehicle speed and location, detect hard braking, cornering, acceleration and capture pre and post-impact data. Messages are transported across the cellular network using enhanced SMS or UDP messaging providing communications link between the EUT and application servers. The EUT is designed to reduce cost, power and size while improving field reliability in 12 volt passenger or light-duty vehicles. This test report covers verification of the Bluetooth module.



**Equipment Under Test**





**1.3.2 EUT General Description**

|                    |   |
|--------------------|---|
| EUT Description    | Tracking Unit with OBD-II Interface   |
| Model Name         | LMU-3030  |
| Model Number(s)    | LMU30H30BT3   |
| Rated Voltage      | 9-16VDC Vehicle Systems with internal 3.7VDC Li-Ion Polymer Battery 200 mAh   |
| Mode Verified      | Bluetooth Classic   |
| Capability         | GSM/GPRS/EDGE/UMTS/HSPA and Bluetooth 4.0 Dual Mode   |
| Primary Unit (EUT) | <input checked="" type="checkbox"/> Production<br><input type="checkbox"/> Pre-Production<br><input type="checkbox"/> Engineering |
| Antenna Type       | 2.4GHz Antenna (Johanson Technology P/N 2450AT42A100)   |
| Antenna Gain       | 0 dBi   |

**1.3.3 Maximum Peak Output Power (EIRP)**

| Modulation | Frequency Range (MHz) | Field Strength (Peak - dBμV/m @ 3 meters) | Peak Output Power EIRP (dBm) | Peak Output Power EIRP (mW) |
|------------|-----------------------|---|------------------------------|-----------------------------|
| GFSK       | 2402-2480             | 99.0                                      | 3.703                        | 2.346                       |
| π/4-DQPSK  | 2402-2480             | 99.9                                      | 4.803                        | 3.022                       |
| 8DPSK      | 2402-2480             | 100.4                                     | 5.803                        | 3.805                       |

**1.4 EUT TEST CONFIGURATION**

**1.4.1 Test Configuration Description**

| Test Configuration | Description  |
|--------------------|--|
| Default            | Radiated emissions test configuration. The EUT is connected with a support call box. All RF parameters of the EUT are configured within the call box in Master/Slave mode. |

**1.4.2 EUT Exercise Software**

None. No special software was used to exercise the EUT. The firmware however was modified to allow test mode thus permitting connection with a call box (CMW500).

**1.4.3 Support Equipment and I/O cables**

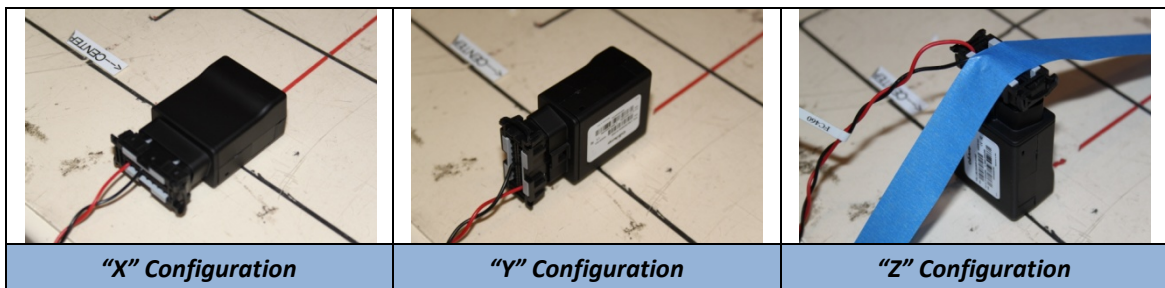
| Manufacturer    | Equipment/Cable                     | Description                               |
|-----------------|-------------------------------------|---|
| Protek          | Laboratory DC Power Supply          | M/N 35010M S/N D102007S                   |
| GM              | Wiring Harness Connector            | OBD2 OBDII ALDL (4.5m power cable only)   |
| Duralast        | Marine Battery                      | 12VDC P/N 24MD-DL, 685 MCA, 550 CCA, 85Ah |
| Rhode & Schwarz | Wideband Radio Communication Tester | M/N CMW 500 S/N 1201.0002k50/103829       |

**1.4.4 Worst Case Configuration**

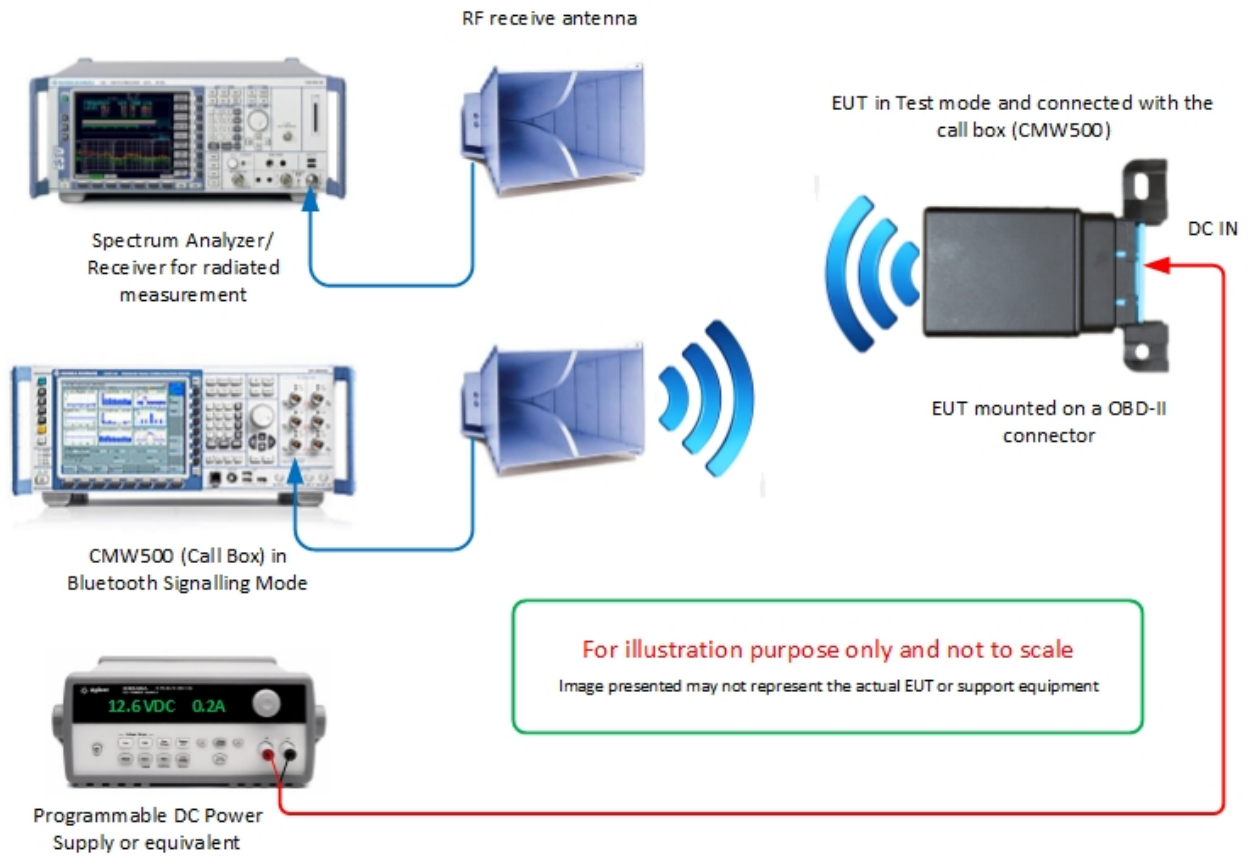
Worst-case configuration used in this test report as per maximum peak EIRP output power measurements:

| Modulation | Channel/Packet Type | Mode        |
|------------|---------------------|-------------|
| 8DPSK      | 38 (Mid Channel)    | Non-hopping |
| 8DPSK      | -                   | Hopping     |

EUT is a mobile device. For radiated measurements X, Y and Z orientations were verified. Worst case position are "X" and "Z". Verification performed using "X" configuration.



### 1.4.5 Simplified Test Configuration Diagram





**1.5 DEVIATIONS FROM THE STANDARD**

No deviations from the applicable test standards or test plan were made during testing. Two samples were used during verifications with different model numbers (M/N LMU30H30BT3 and M/N LMU30G60BT). Both models are identical except the licensed RF module used. The Bluetooth module, RF path and antenna used are identical between the two models. Only the worst test results presented.

**1.6 MODIFICATION RECORD**

| Description of Modification             | Modification Fitted By | Date Modification Fitted |
|---|------------------------|--------------------------|
| Serial Number 4532000604 and 4632081643 |                        |                          |
| 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  
CalAmp Wireless Networks Corp.  
Tracking Unit with OBD-II Interface



**2.1 CONDUCTED EMISSIONS**

**2.1.1 Specification Reference**

Part 15 Subpart C §15.207(a)

**2.1.2 Standard Applicable**

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN).

| Frequency of emission (MHz) | Conducted limit (dB $\mu$ V) |           |
|-----------------------------|------------------------------|-----------|
|                             | Quasi-peak                   | Average   |
| 0.15–0.5                    | 66 to 56*                    | 56 to 46* |
| 0.5–5                       | 56                           | 46        |
| 5–30                        | 60                           | 50        |

*\*Decreases with the logarithm of the frequency.*

**2.1.3 Equipment Under Test and Modification State**

Not performed. EUT is battery operated only and designed for vehicular use.



## **2.2 CARRIER FREQUENCY SEPARATION**

### **2.2.1 Specification Reference**

Part 15 Subpart C §15.247(a)(1)

### **2.2.2 Standard Applicable**

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

### **2.2.3 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

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

July 16, 2014/FSC

### **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 | 26.1°C   |
| Relative Humidity   | 52.3%    |
| ATM Pressure        | 99.2 kPa |

### **2.2.7 Additional Observations**

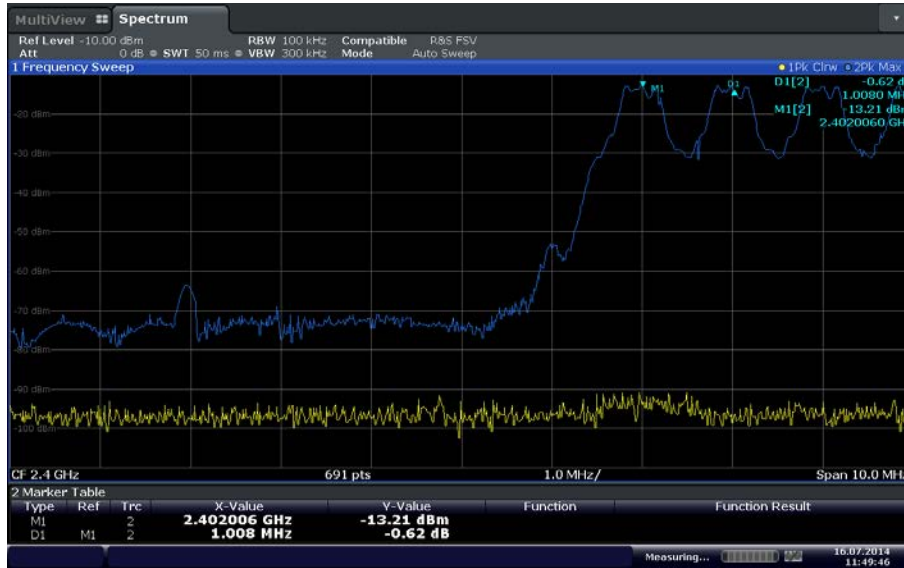
- This is a radiated test.
- Hopping function enabled.
- Span is wide enough to capture the peaks of two adjacent channels.
- RBW is 1% of the span.
- VBW is 3x RBW
- Sweep is auto





- Detector is peak.
- Trace is max hold.
- Marker-delta function is used between the peaks of the adjacent channels.
- Limit used is >960.0 kHz (2/3 of worst case 20dB BW).

**2.2.8 Test Results**



Date: 16 JUL 2014 11:49:47

**Observed carrier frequency separation between Channel 0 and Channel 1 = 1.0 MHz (Complies. Greater than 960.0 kHz, this is 2/3 of 1.44MHz 20 dB BW)**



## 2.3 NUMBER OF HOPPING FREQUENCIES

### 2.3.1 Specification Reference

Part 15 Subpart C §15.247(a)(1)(iii)

### 2.3.2 Standard Applicable

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

### 2.3.1 Equipment Under Test and Modification State

Serial No: 4532000604 and 4632081643/ Default Test Configuration

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

July 16 and 17, 2014/FSC

### 2.3.3 Test Equipment Used

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

### 2.3.4 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

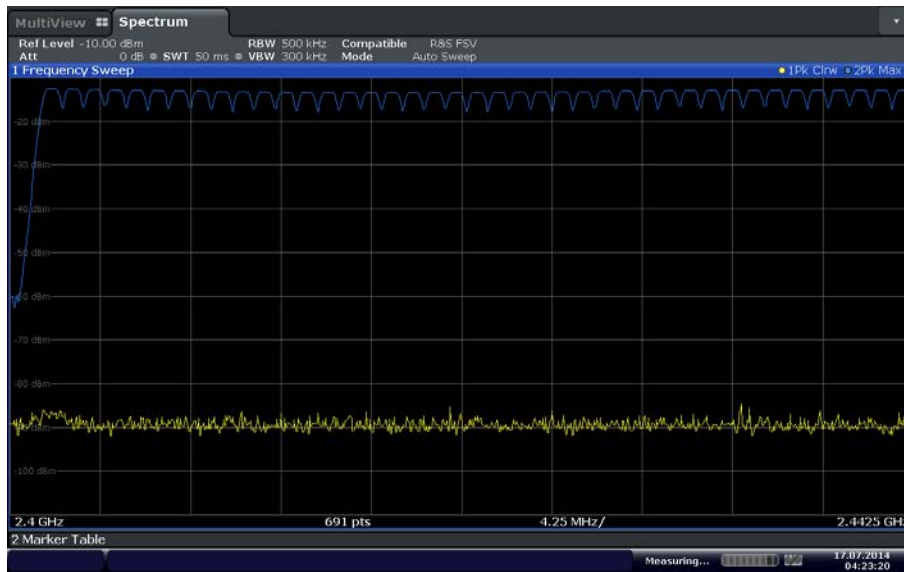
|                     |          |
|---------------------|----------|
| Ambient Temperature | 26.1°C   |
| Relative Humidity   | 52.3%    |
| ATM Pressure        | 99.2 kPa |

### 2.3.5 Additional Observations

- This is a radiated test.
- Hopping function enabled.
- Span is wide enough to capture the channels of interests.
- The span was broken up to two sections in order to clearly show all of the hopping frequencies.
- Detector is peak, trace is max hold.
- Trace in max hold was allowed to stabilize until all hopping frequencies were discernible.

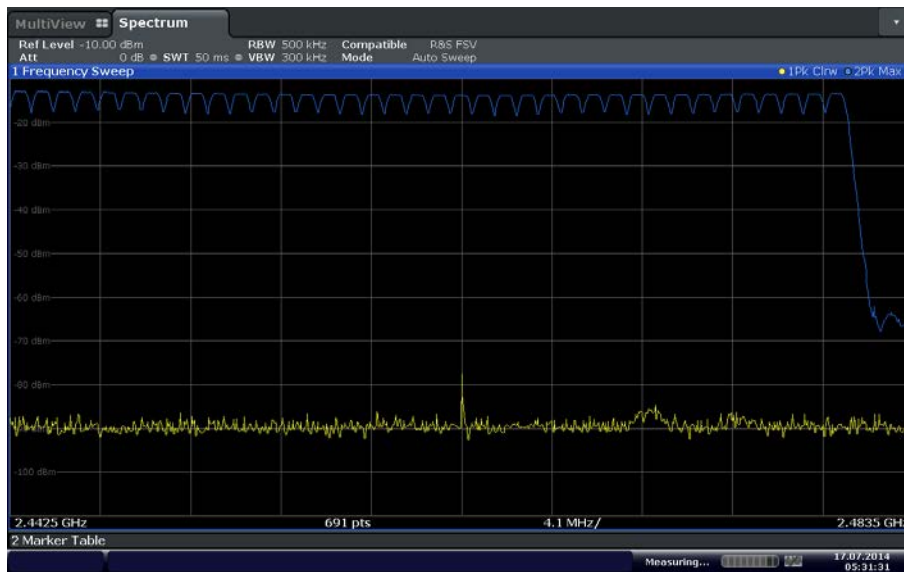
### 2.3.6 Test Results

Observed Number of Hopping Frequencies is = **79 (Complies)**  
= Plot #1 + Plot #2  
= 41 + 38



Date: 17 JUL 2014 04:23:20

Plot #1



Date: 17 JUL 2014 05:31:31

Plot #2



## **2.4 TIME OF OCCUPANCY (DWEELL TIME)**

### **2.4.1 Specification Reference**

Part 15 Subpart C §15.247(a)(1)(iii)

### **2.4.2 Standard Applicable**

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

### **2.4.1 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.4.2 Date of Test/Initial of test personnel who performed the test**

August 08, 2014/FSC

### **2.4.3 Test Equipment Used**

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

### **2.4.4 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |          |
|---------------------|----------|
| Ambient Temperature | 24.3°C   |
| Relative Humidity   | 52.1%    |
| ATM Pressure        | 98.9 kPa |

### **2.4.5 Additional Observations**

- Hopping function enabled.
- Span = zero span, centered on a hopping channel.
- Detector is peak.
- A single pulse is first measured. This measurement is then used to compute the average time of occupancy in the required period (no. of channels x 0.4 second).
- All packet types verified.
- Spectrum analyzer used is limited to 3.2 seconds sweep time instead of the required 3.16 seconds, therefore computation of average time of occupancy was modified from # of pulses in 3.16 seconds multiplied by 10 to # of pulses in 3.20 seconds multiplied by 9.875. The result is then multiplied to the pulse width.



**2.4.6 Test Results**

| Modulation     | Packet Type | Measured time of occupancy | Requirement            |
|----------------|-------------|----------------------------|------------------------|
| GFSK           | DH1         | 126.4 ms                   | <400 ms (EUT Complies) |
|                | DH3         | 262.3 ms                   |                        |
|                | DH5         | 286.4 ms                   |                        |
| $\pi/4$ -DQPSK | 2DH1        | 126.4 ms                   |                        |
|                | 2DH3        | 196.7 ms                   |                        |
|                | 2DH5        | 229.1 ms                   |                        |
| 8DPSK          | 3DH1        | 126.4 ms                   |                        |
|                | 3DH3        | 180.3 ms                   |                        |
|                | 3DH5        | 286.4 ms                   |                        |

**2.4.7 Sample Computation (GFSK DH5)**

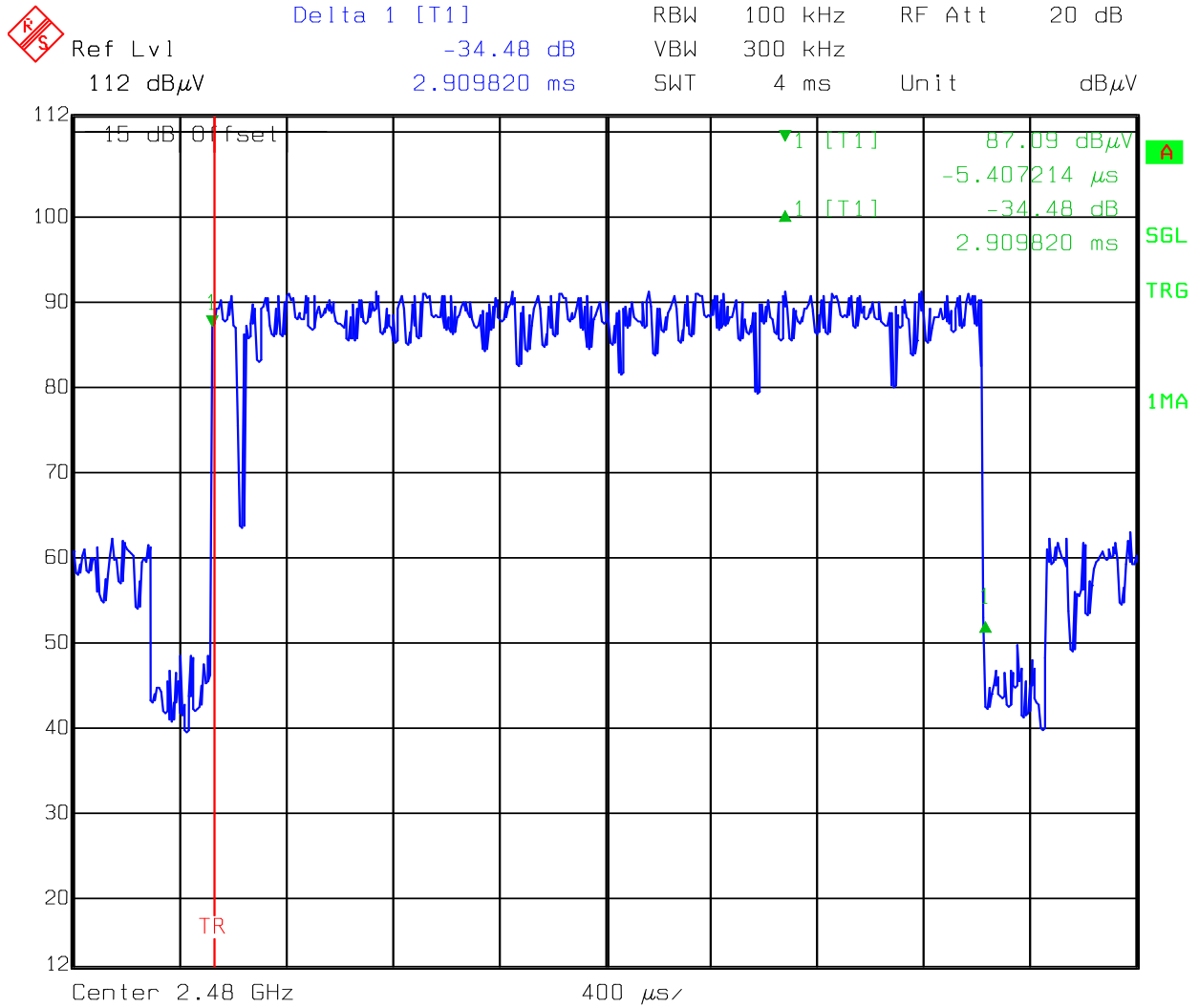
Width of single pulse = 0.0029 second  
 Observed occurrence = 10 pulses/3.20seconds  
 Required period = 79 channels x 0.4 second  
 = 31.6 seconds

Average time of occupancy = Pulse width x #pulses in 3.2seconds x 9.875  
 = 0.0029 second x 10 x 9.875  
 = 0.28637 second

Compliance = **Complies.** 0.28637 second < 0.4 second



2.4.8 Sample Test Results Plots



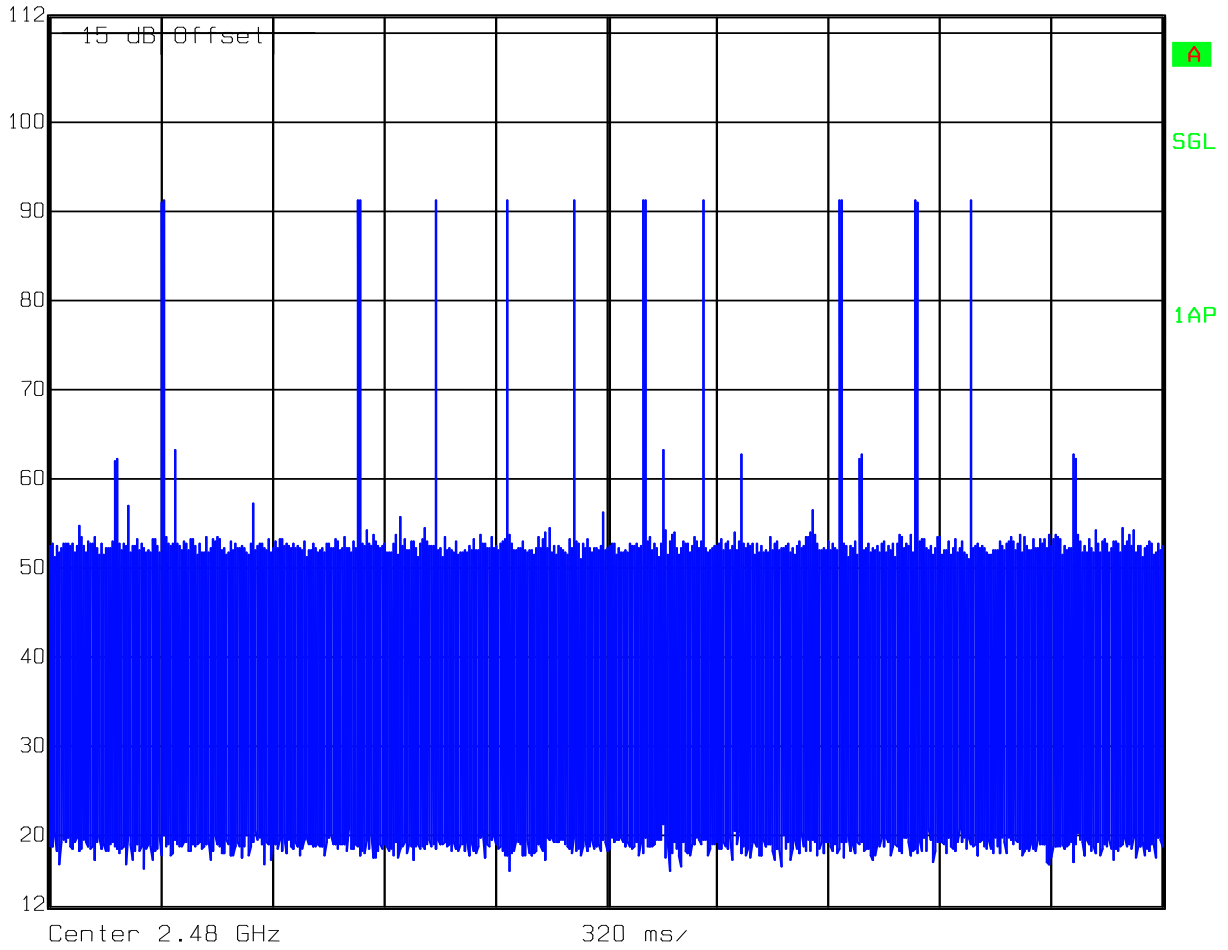
Date: 08.AUG.2014 11:17:40

GFSK DH5 width of single pulse (2.9ms)



Ref Lvl  
112 dB $\mu$ V

RBW 100 kHz RF Att 20 dB  
VBW 300 kHz  
SWT 3.2 s Unit dB $\mu$ V

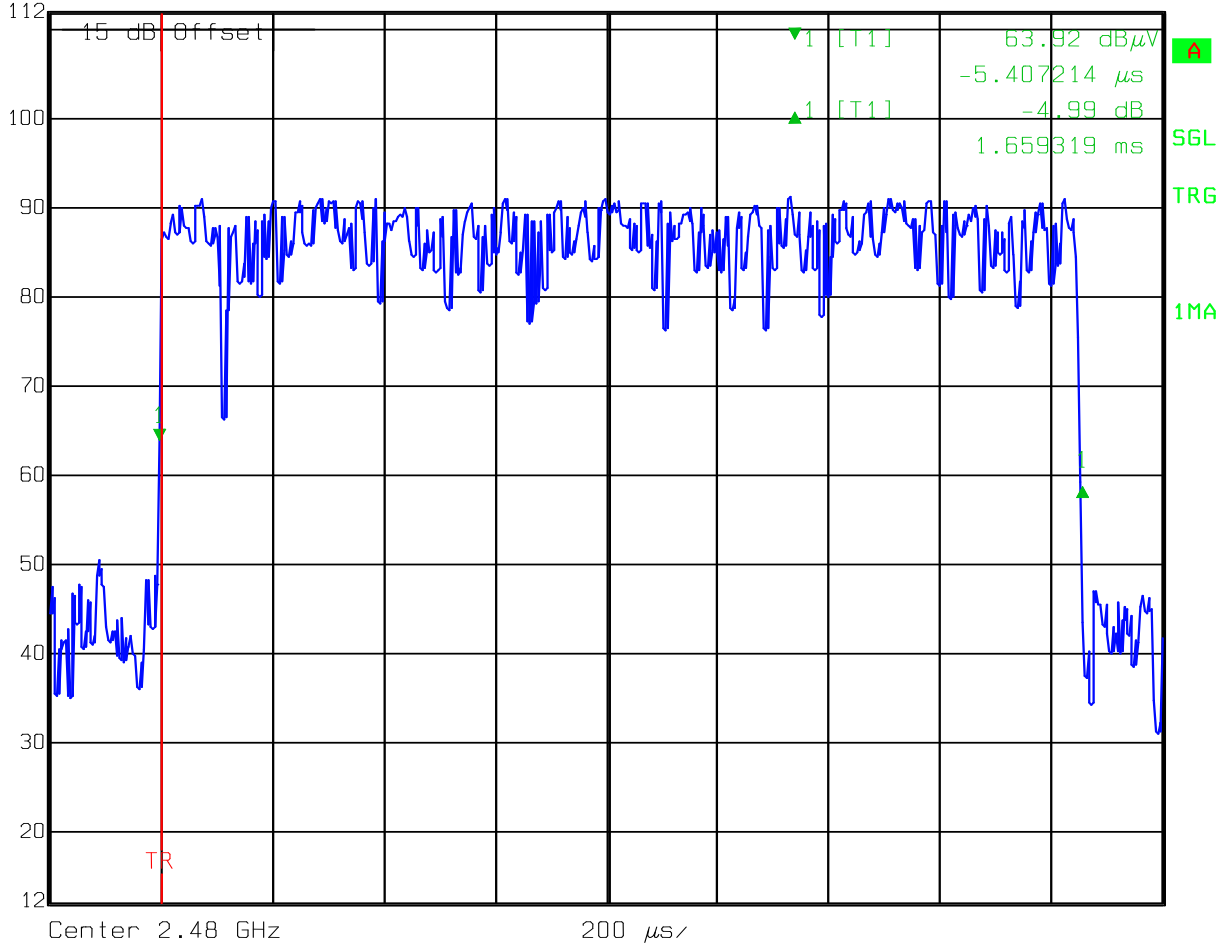


Date: 08.AUG.2014 11:20:20

**10 pulses/3.2 seconds (DH5)**



Delta 1 [T1] RBW 100 kHz RF Att 20 dB  
 Ref Lvl -4.99 dB VBW 300 kHz  
 112 dB $\mu$ V 1.659319 ms SWT 2 ms Unit dB $\mu$ V



Date: 08.AUG.2014 11:15:29

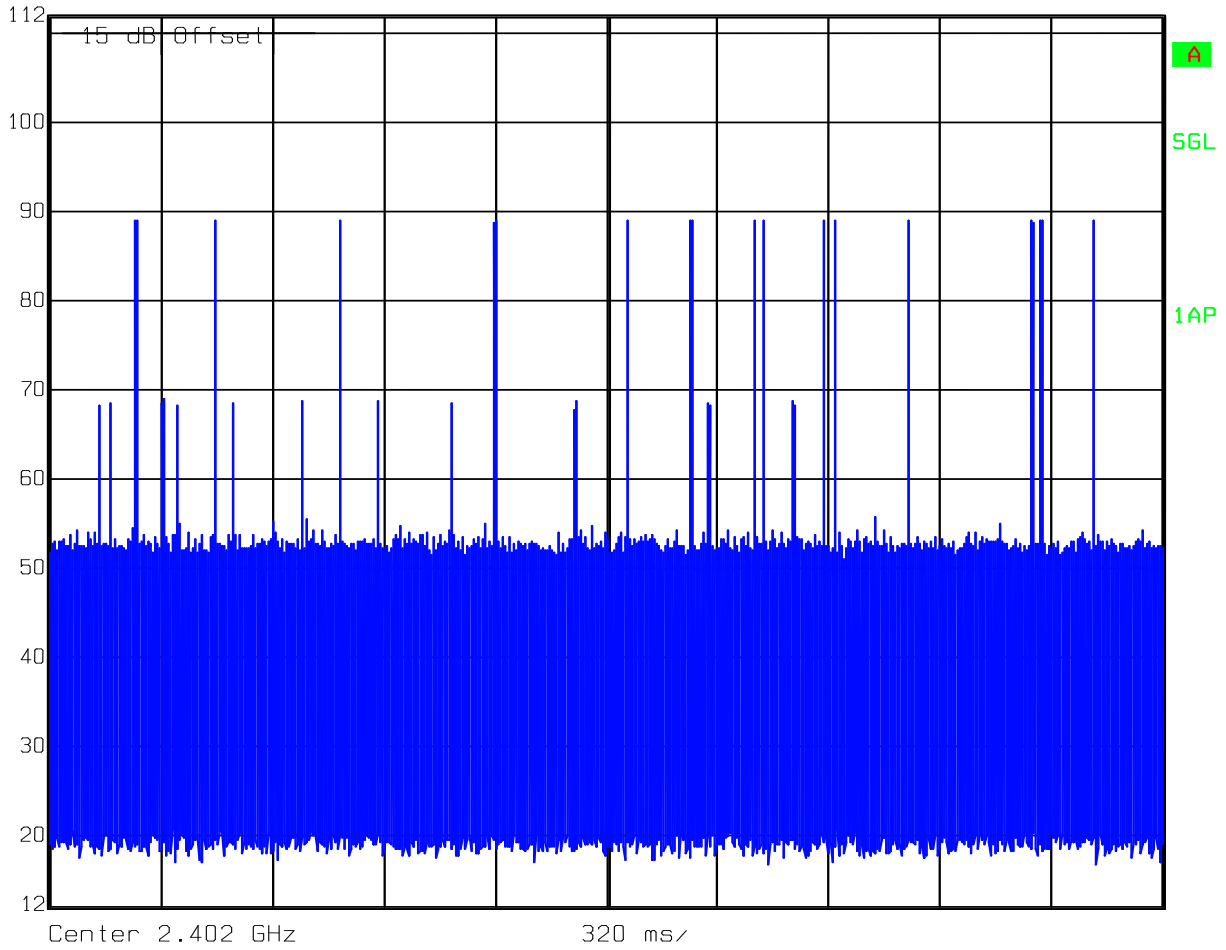
**GFSK DH3 width of single pulse (1.66ms)**





Ref Lvl  
112 dB $\mu$ V

RBW 100 kHz RF Att 20 dB  
VBW 300 kHz  
SWT 3.2 s Unit dB $\mu$ V

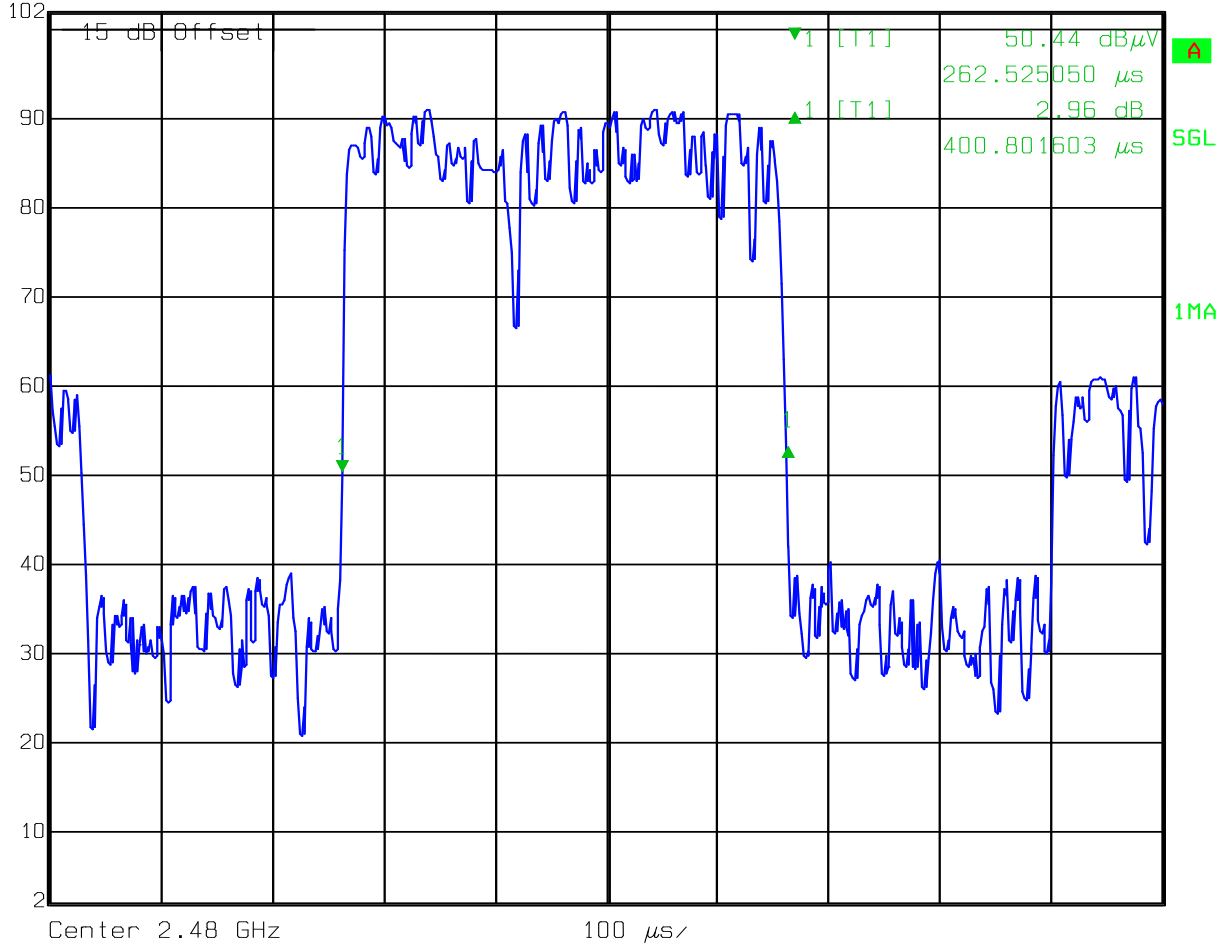


Date: 08.AUG.2014 11:25:55

16 pulses/3.2 seconds (DH3)



Delta 1 [T1] RBW 100 kHz RF Att 10 dB  
 Ref Lvl 2.96 dB VBW 300 kHz  
 102 dBμV 400.801603 μs SWT 1 ms Unit dBμV



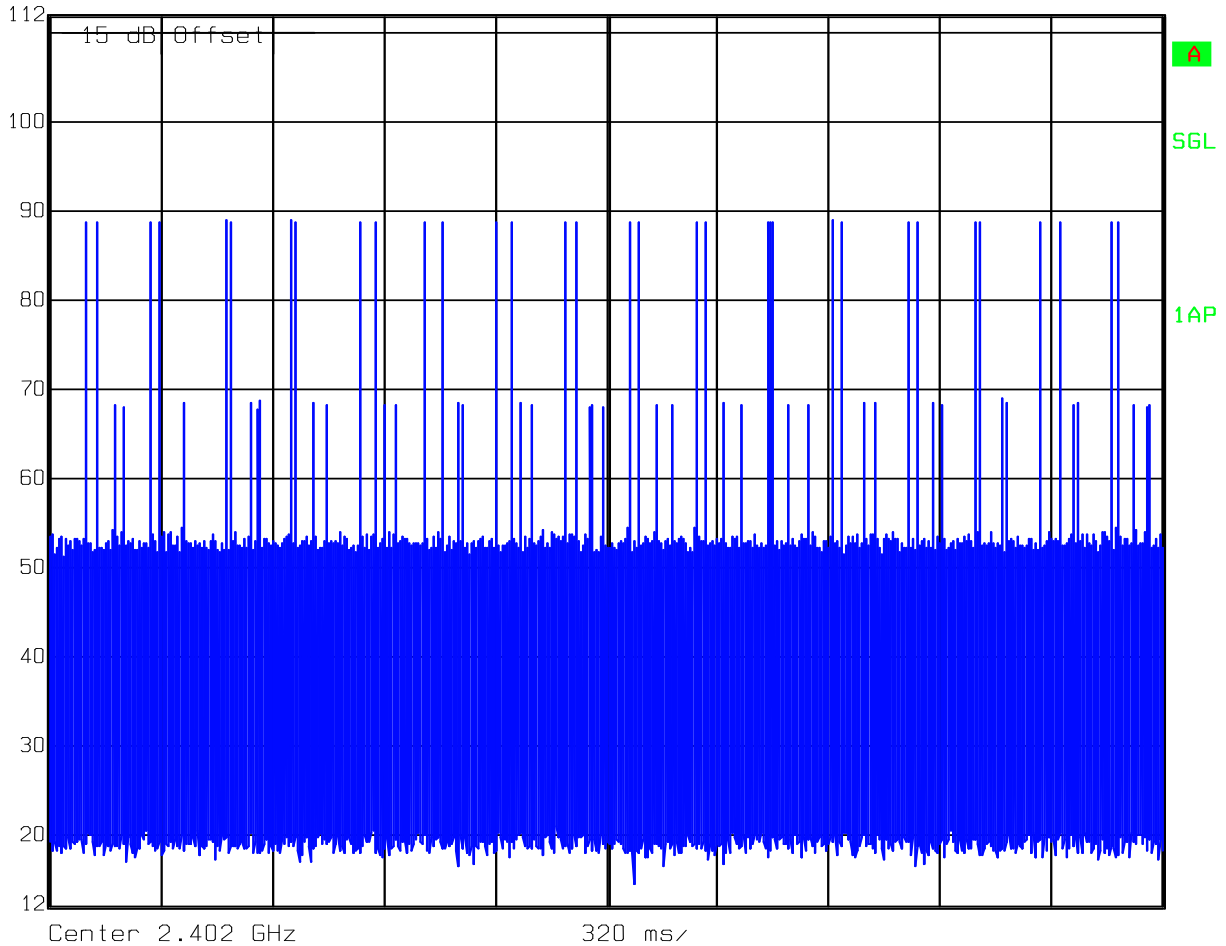
Date: 08.AUG.2014 11:07:47

**GFSK DH1 width of single pulse (0.4ms)**



Ref Lvl  
112 dB $\mu$ V

RBW 100 kHz RF Att 20 dB  
VBW 300 kHz  
SWT 3.2 s Unit dB $\mu$ V



Date: 08.AUG.2014 11:24:42

**32 pulses/3.2 seconds (DH1)**



## **2.5 20 dB BANDWIDTH**

### **2.5.1 Specification Reference**

Part 15 Subpart C §15.215(c)

### **2.5.2 Standard Applicable**

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

### **2.5.1 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.5.2 Date of Test/Initial of test personnel who performed the test**

August 08, 2014/FSC

### **2.5.3 Test Equipment Used**

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

### **2.5.4 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |          |
|---------------------|----------|
| Ambient Temperature | 24.3°C   |
| Relative Humidity   | 52.1%    |
| ATM Pressure        | 98.9 kPa |

### **2.5.5 Additional Observations**

- This is a radiated test.
- An offset was added to compensate for the receiving antenna factor, preamp gain and cable loss.
- Span is approximately 2 to 3 times the expected 20dB bandwidth.
- RBW is  $\geq 1\%$  of the expected 20dB bandwidth while VBW is  $\geq$  RBW.
- Sweep is auto.
- Detector is peak.



- Max hold function activated.
- “n dB down” marker function (20dB) of the spectrum analyzer was used for this test.

**2.5.6 Test Results**

| Modulation     | Channel | Frequency (MHz) | Measured 20dB Bandwidth (MHz) |
|----------------|---------|-----------------|-------------------------------|
| GFSK           | 0       | 2402            | 1.11                          |
|                | 38      | 2440            | 1.11                          |
|                | 78      | 2480            | 1.10                          |
| $\pi/4$ -DQPSK | 0       | 2402            | 1.43                          |
|                | 38      | 2440            | 1.44                          |
|                | 78      | 2480            | 1.43                          |
| 8DPSK          | 0       | 2402            | 1.41                          |
|                | 38      | 2440            | 1.36                          |
|                | 78      | 2480            | 1.37                          |

**Worst case configuration (Low Channel  $\pi/4$ -DQPSK)**

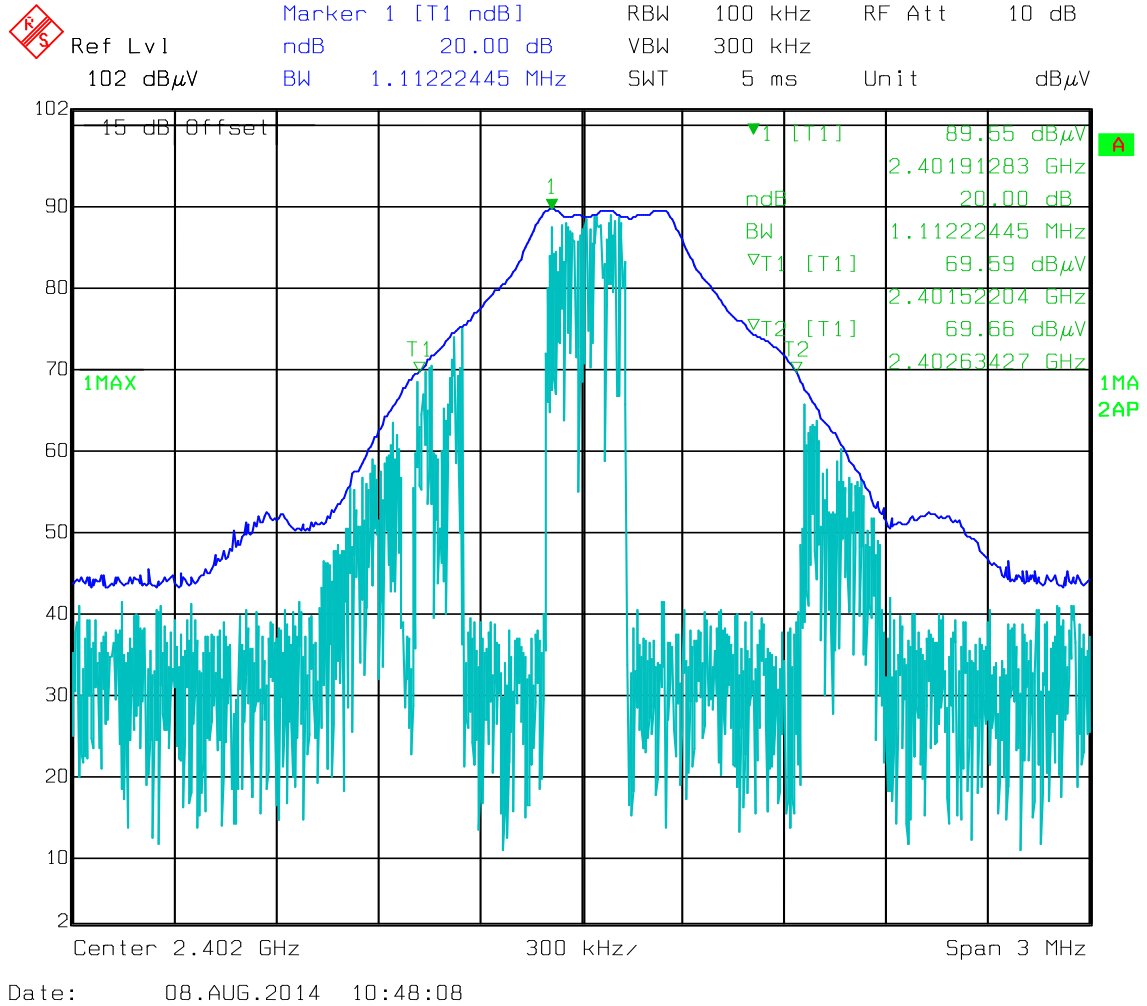
2402 MHz – (20dB BW/2) = 2401.285 MHz (within the frequency band - **Compliant**)

**Worst case configuration (High Channel  $\pi/4$ -DQPSK)**

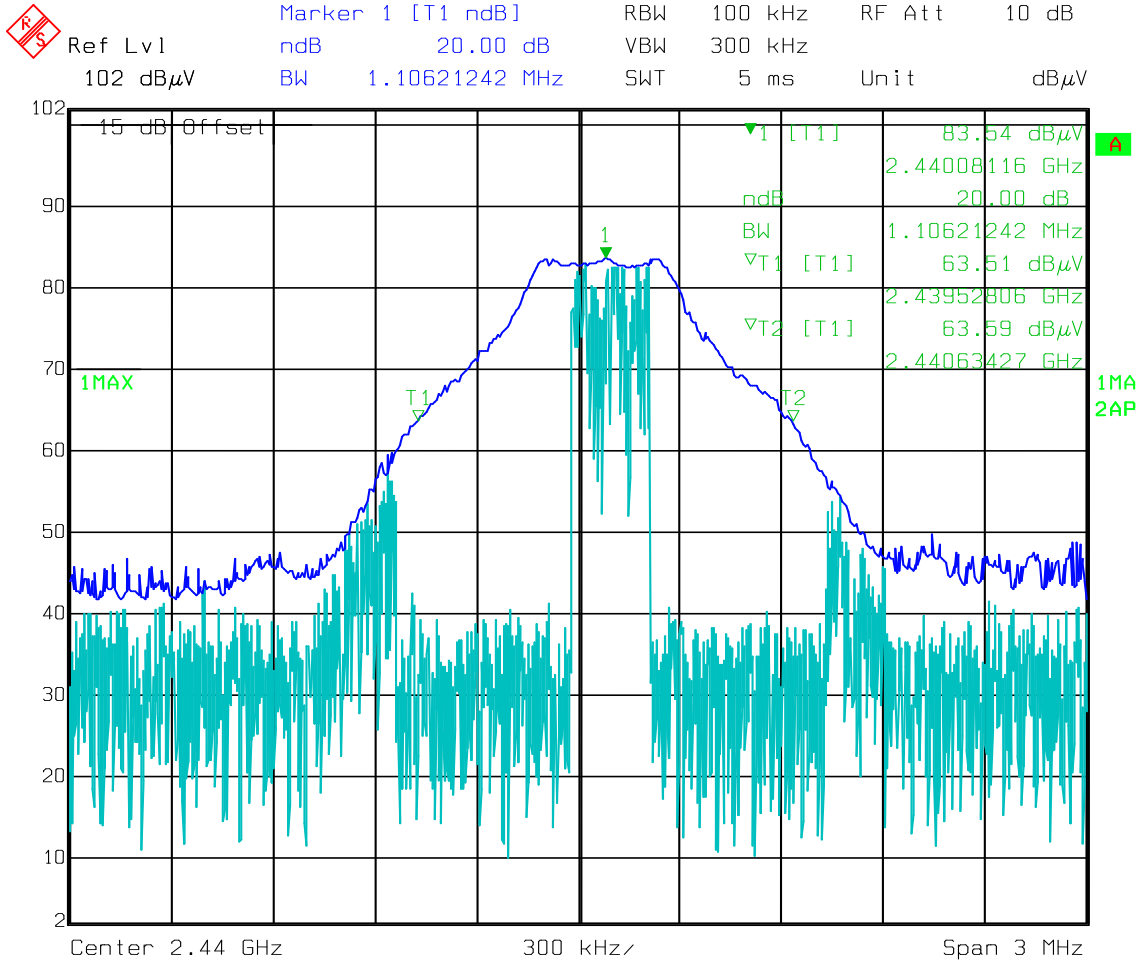
2480 MHz + (20dB BW/2) = 2480.715 MHz (within the frequency band - **Compliant**)



2.5.7 Test Results Plots

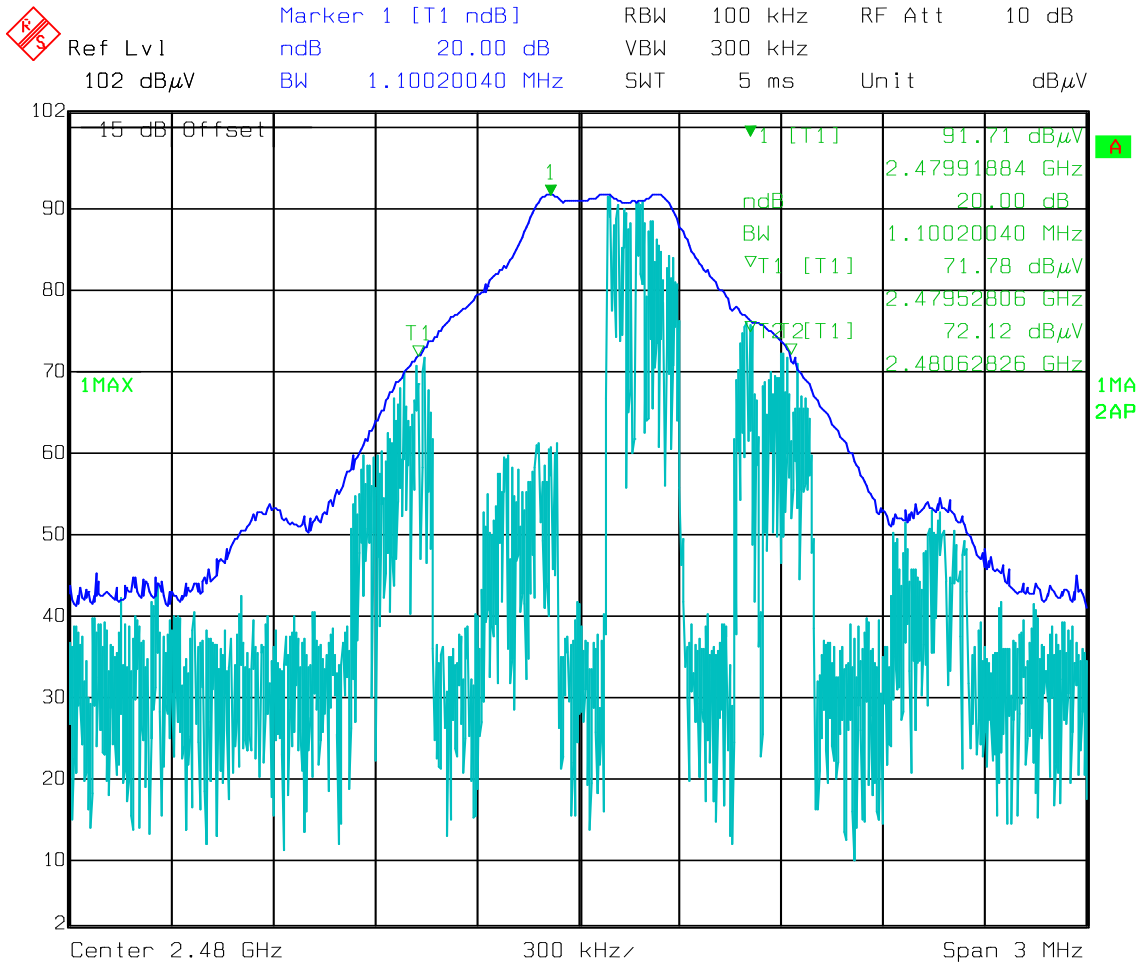


GFSK Low Channel



Date: 08.AUG.2014 10:49:20

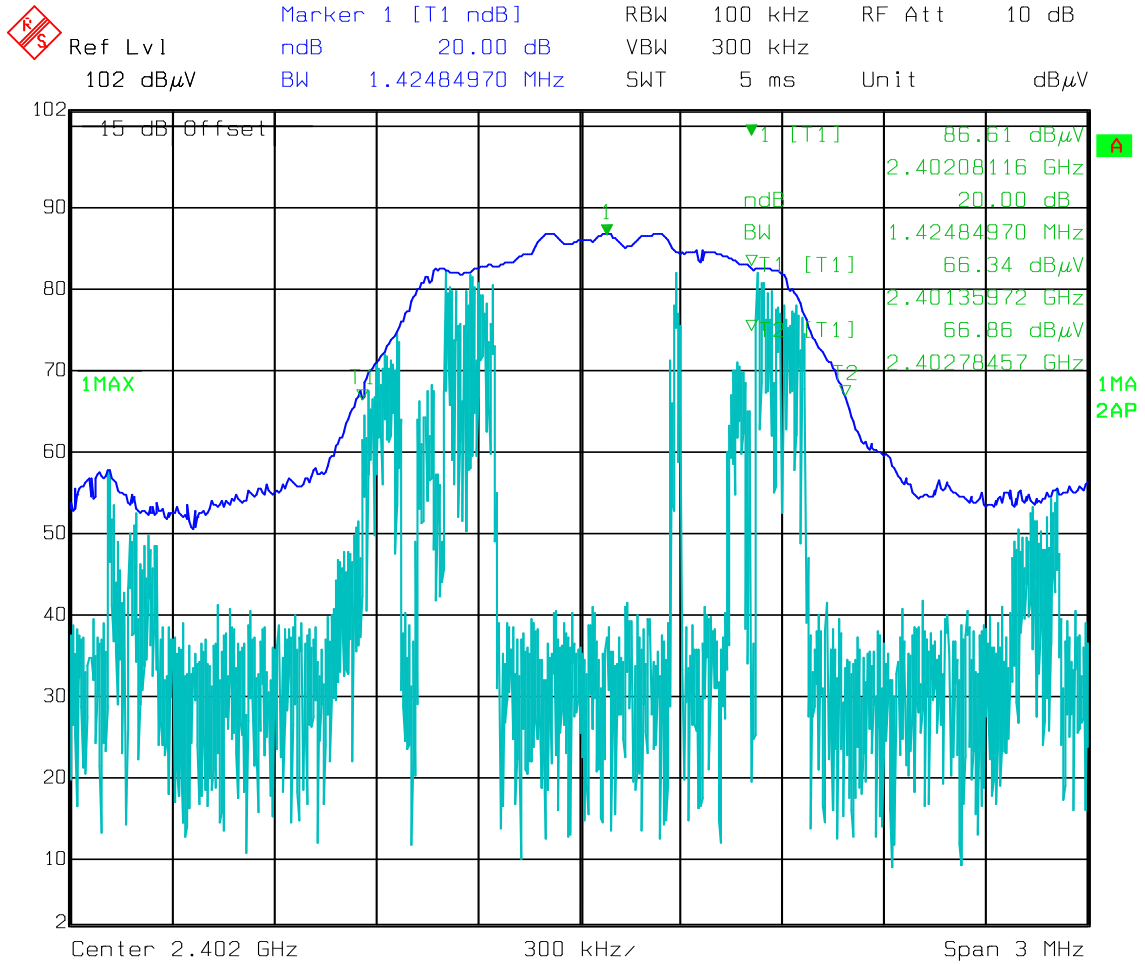
**GFSK Mid Channel**



Date: 08.AUG.2014 10:50:13

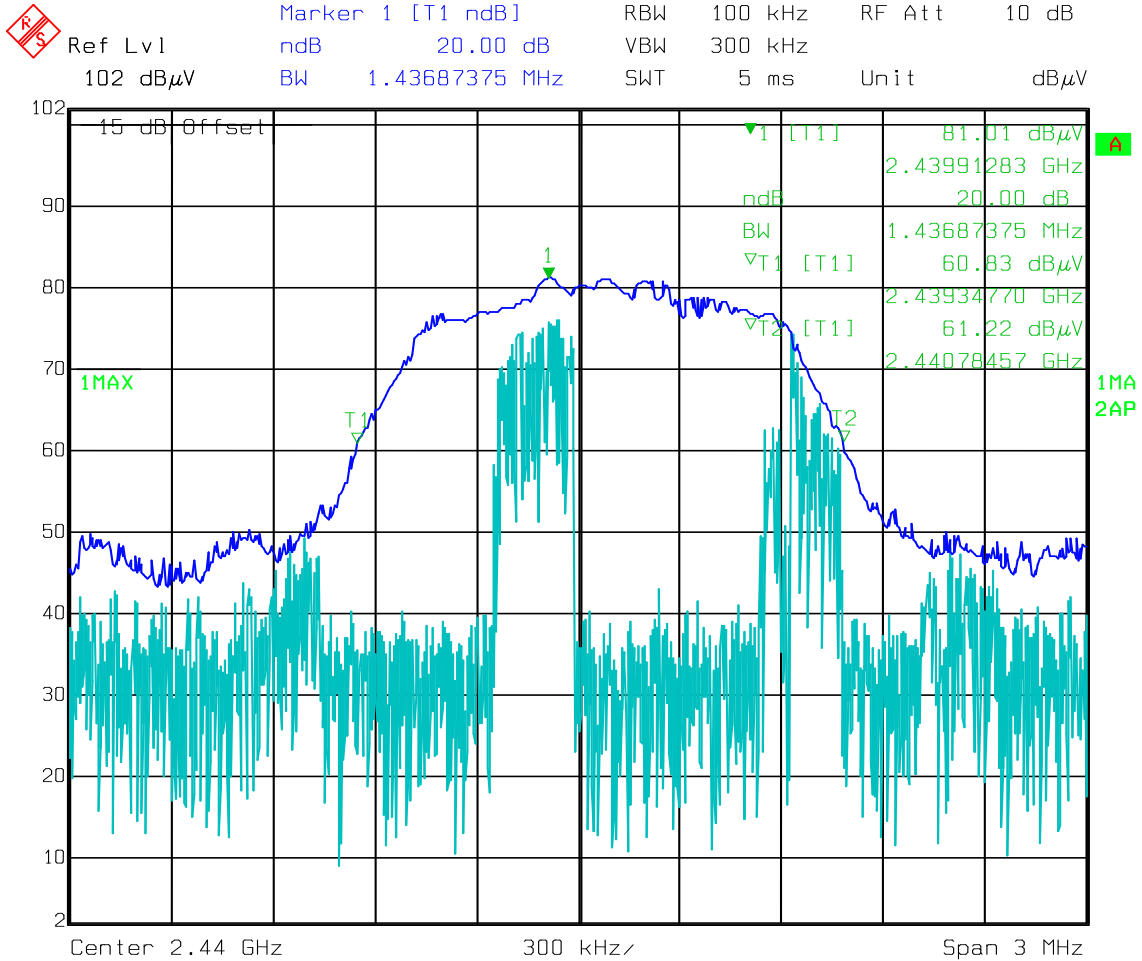
**GFSK High Channel**





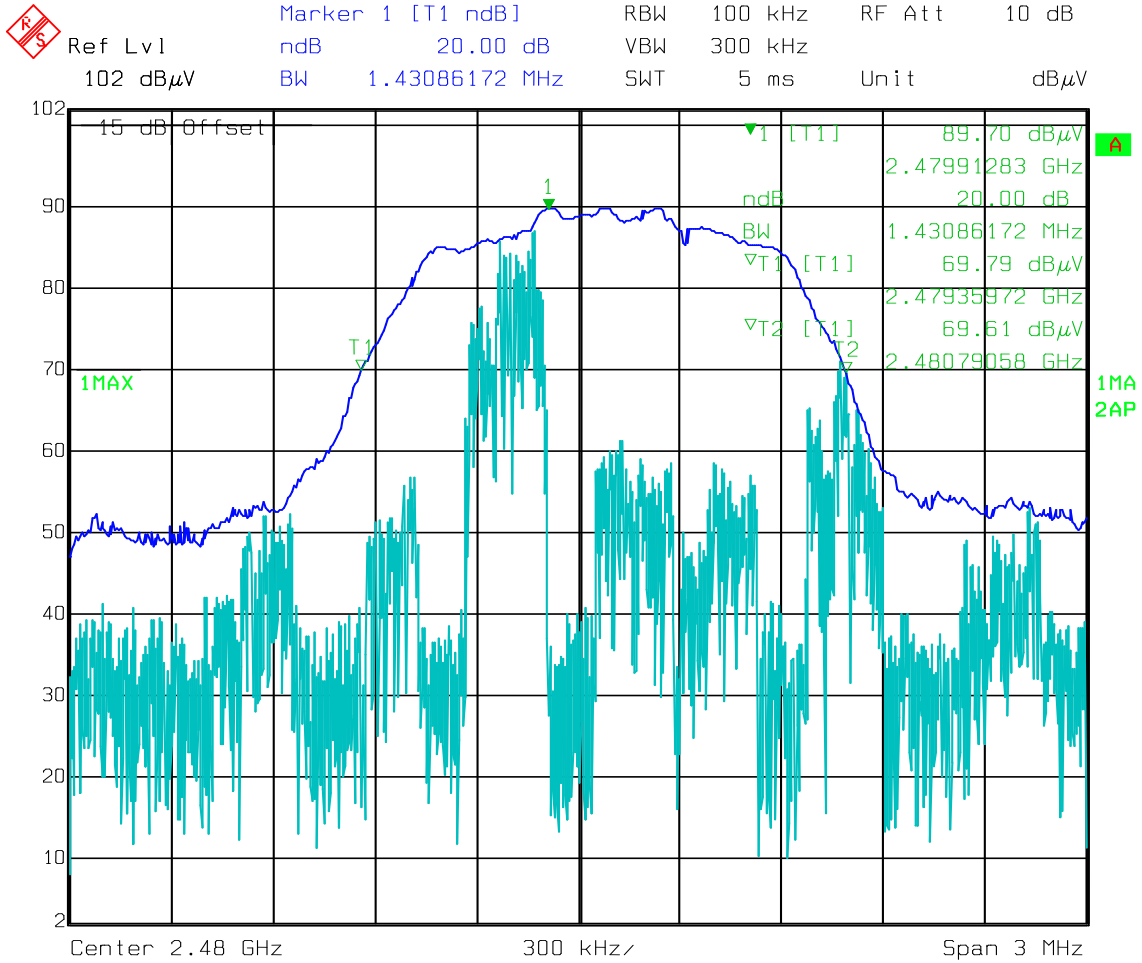
Date: 08.AUG.2014 10:53:30

**$\pi/4$ -DQPSK Low Channel**



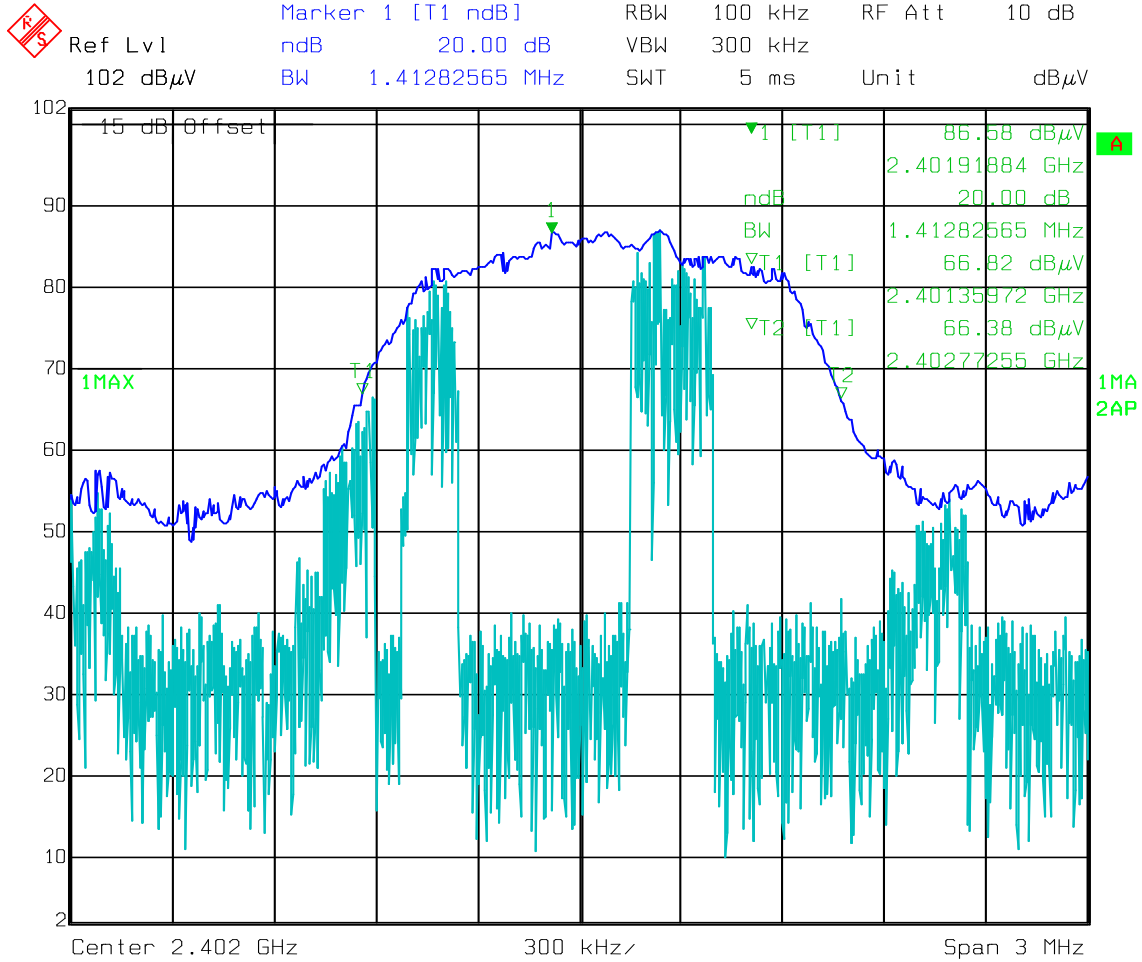
Date: 08.AUG.2014 10:52:24

**π/4-DQPSK Mid Channel**

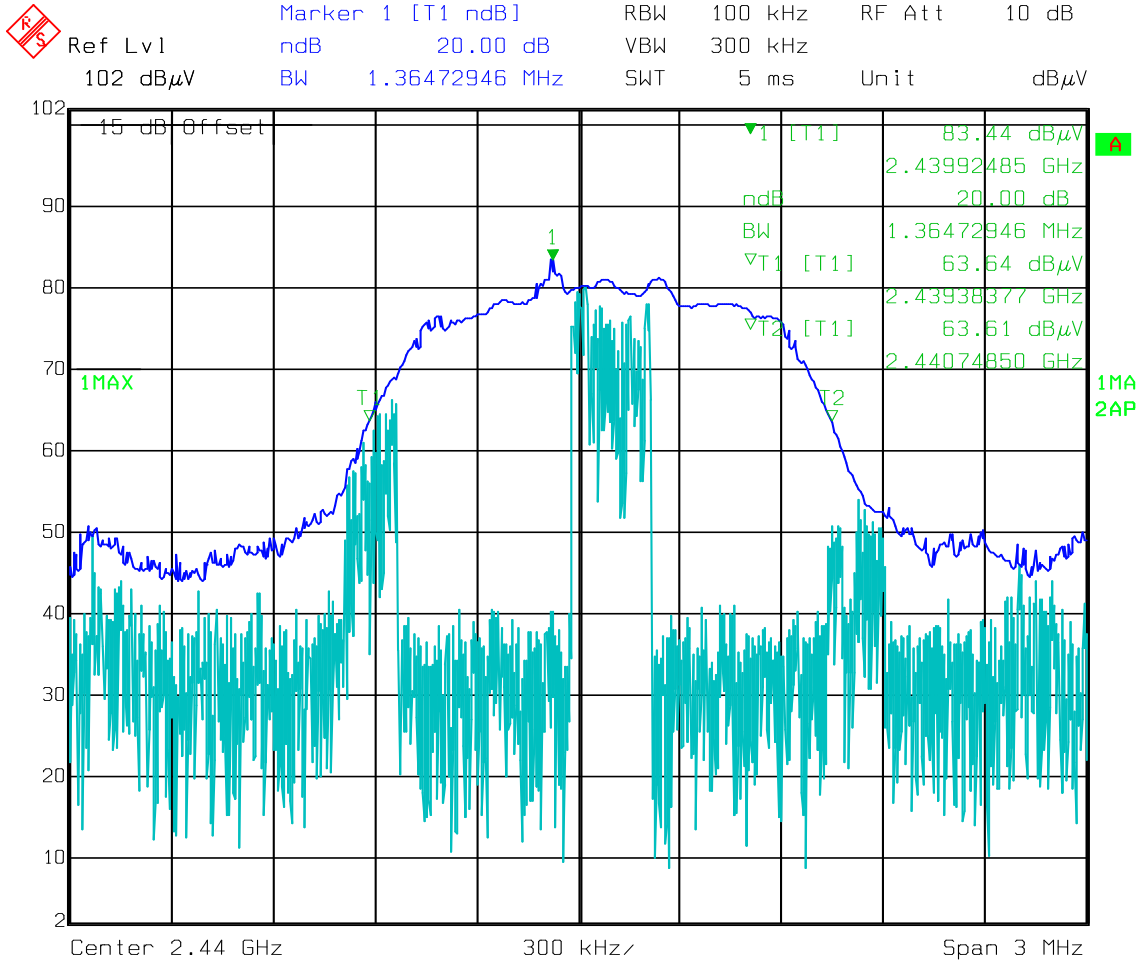


Date: 08.AUG.2014 10:51:27

**$\pi/4$ -DQPSK High Channel**

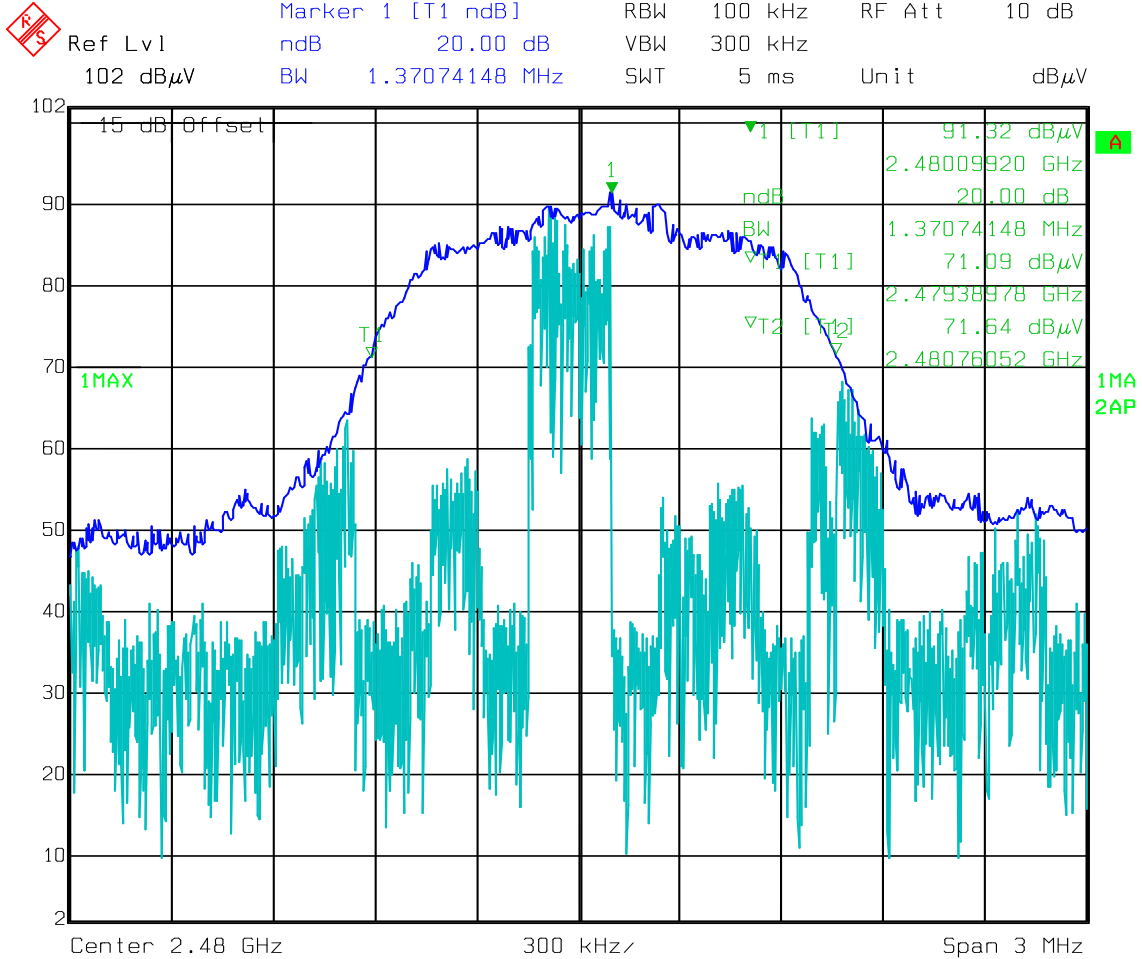


**8DPSK Low Channel**



Date: 08.AUG.2014 10:55:50

**8DPSK Mid Channel**



Date: 08.AUG.2014 10:57:07

**8DPSK High Channel**



## **2.6 99% EMISSION BANDWIDTH**

### **2.6.1 Specification Reference**

RSS-Gen Clause 4.6.1

### **2.6.2 Standard Applicable**

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth.

### **2.6.1 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.6.2 Date of Test/Initial of test personnel who performed the test**

August 08, 2014/FSC

### **2.6.3 Test Equipment Used**

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

### **2.6.4 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |          |
|---------------------|----------|
| Ambient Temperature | 24.3°C   |
| Relative Humidity   | 52.1%    |
| ATM Pressure        | 98.9 kPa |

### **2.6.5 Additional Observations**

- This is a radiated test.
- An offset was added to compensate for the receiving antenna factor, preamp gain and cable loss.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.



- Sweep is auto.
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The OBW power measurement function of the spectrum analyzer was used for this test.

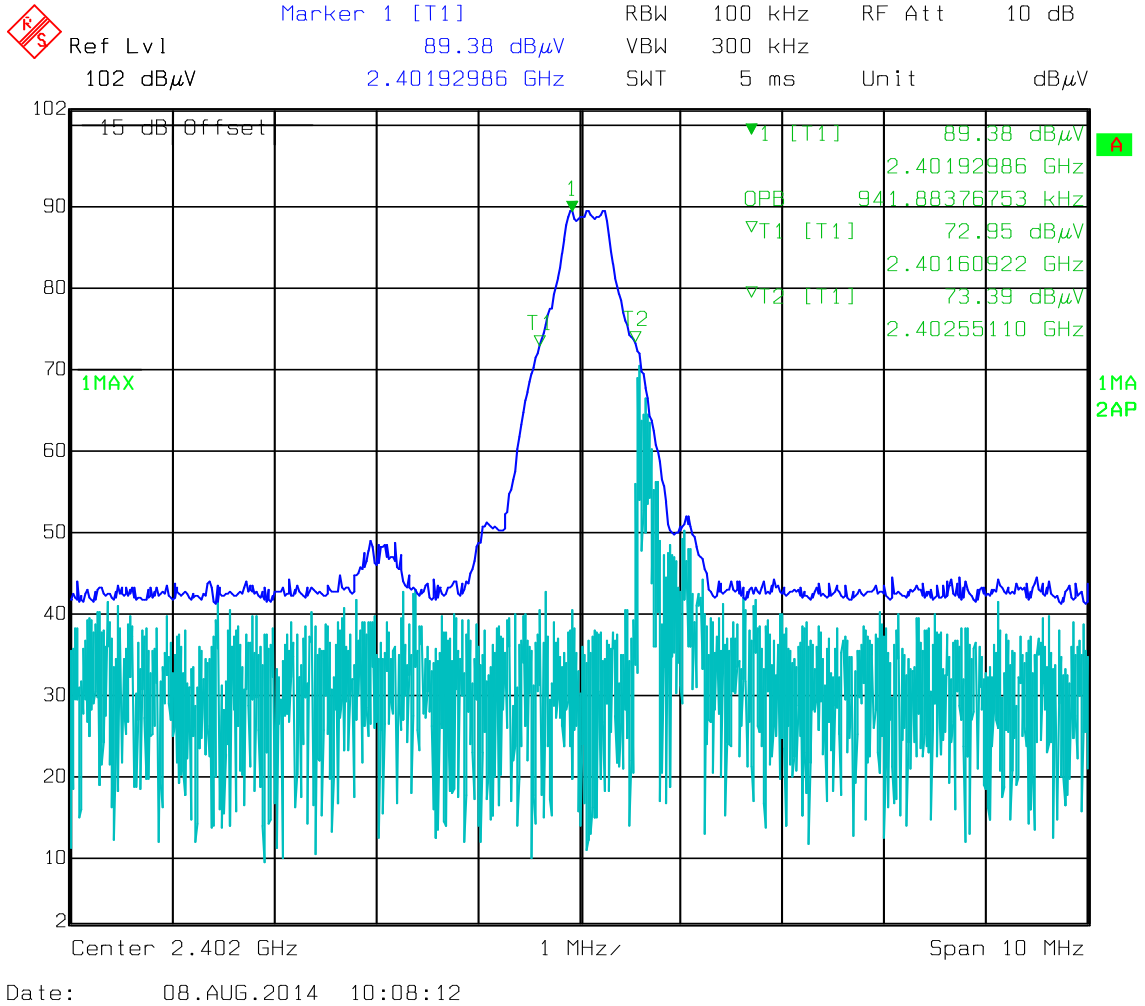
**2.6.6 Test Results (For reporting purposes only)**

| Modulation     | Channel | Frequency (MHz) | Measured 99% OBW (MHz) |
|----------------|---------|-----------------|------------------------|
| GFSK           | 0       | 2402            | 0.942                  |
|                | 38      | 2440            | 0.982                  |
|                | 78      | 2480            | 0.962                  |
| $\pi/4$ -DQPSK | 0       | 2402            | 1.263                  |
|                | 38      | 2440            | 1.283                  |
|                | 78      | 2480            | 1.242                  |
| 8DPSK          | 0       | 2402            | 1.263                  |
|                | 38      | 2440            | 1.263                  |
|                | 78      | 2480            | 1.242                  |

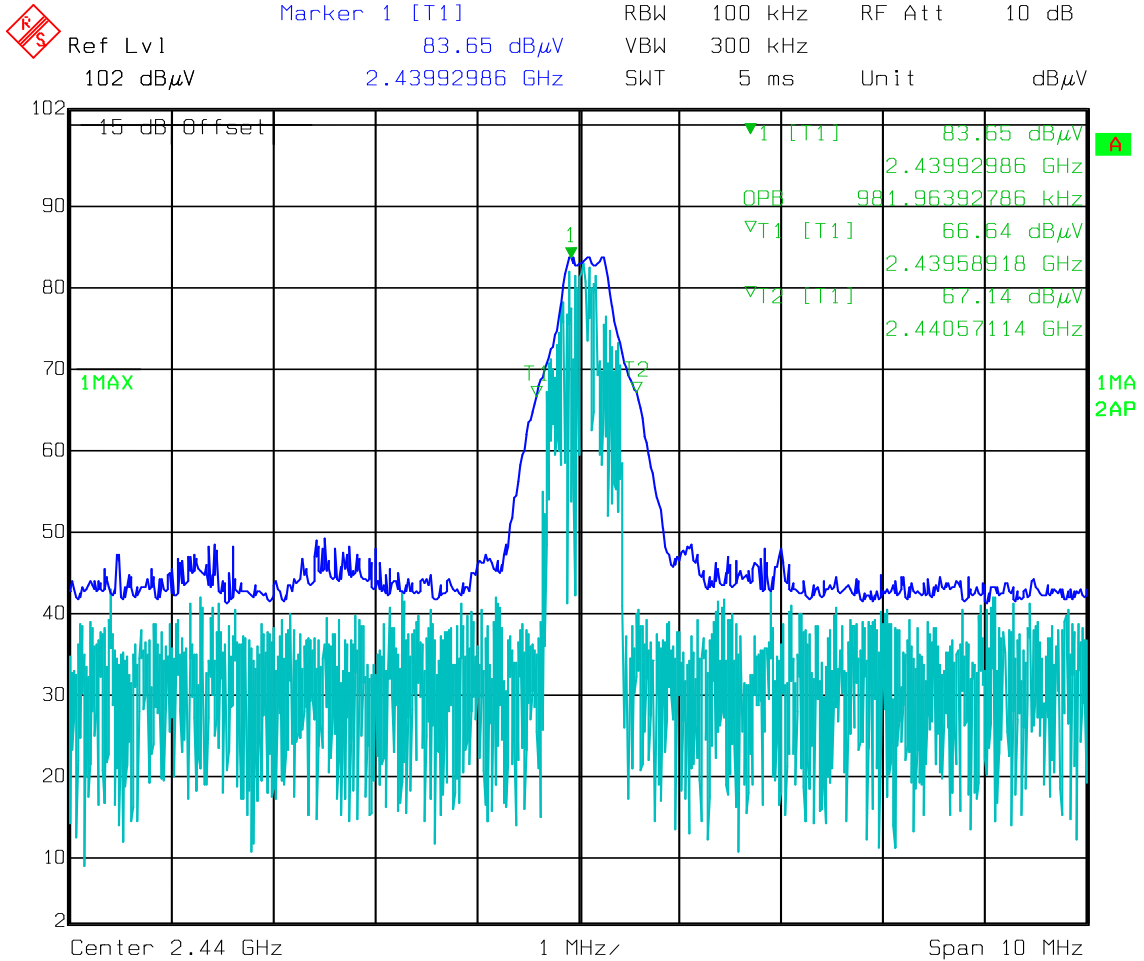




2.6.7 Test Results Plots

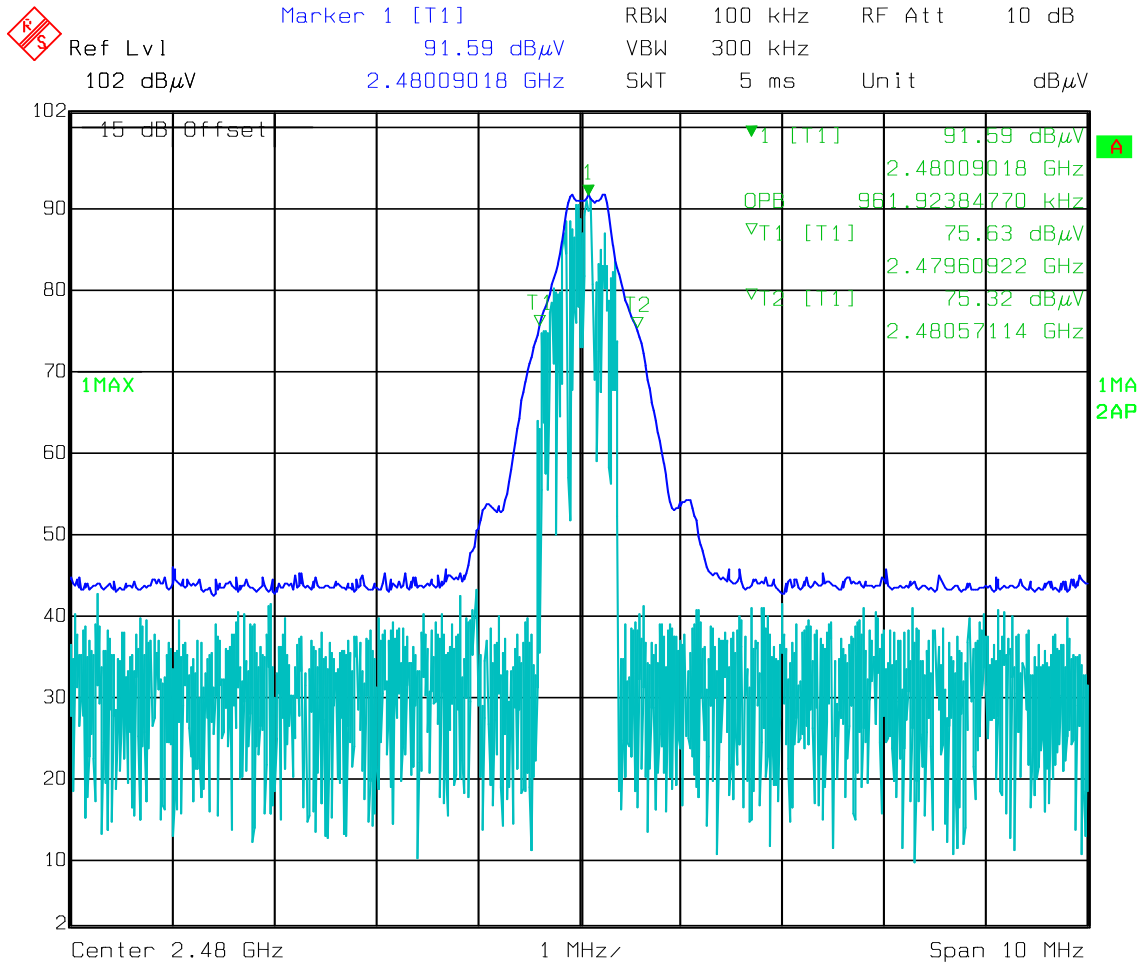


GFSK Low Channel



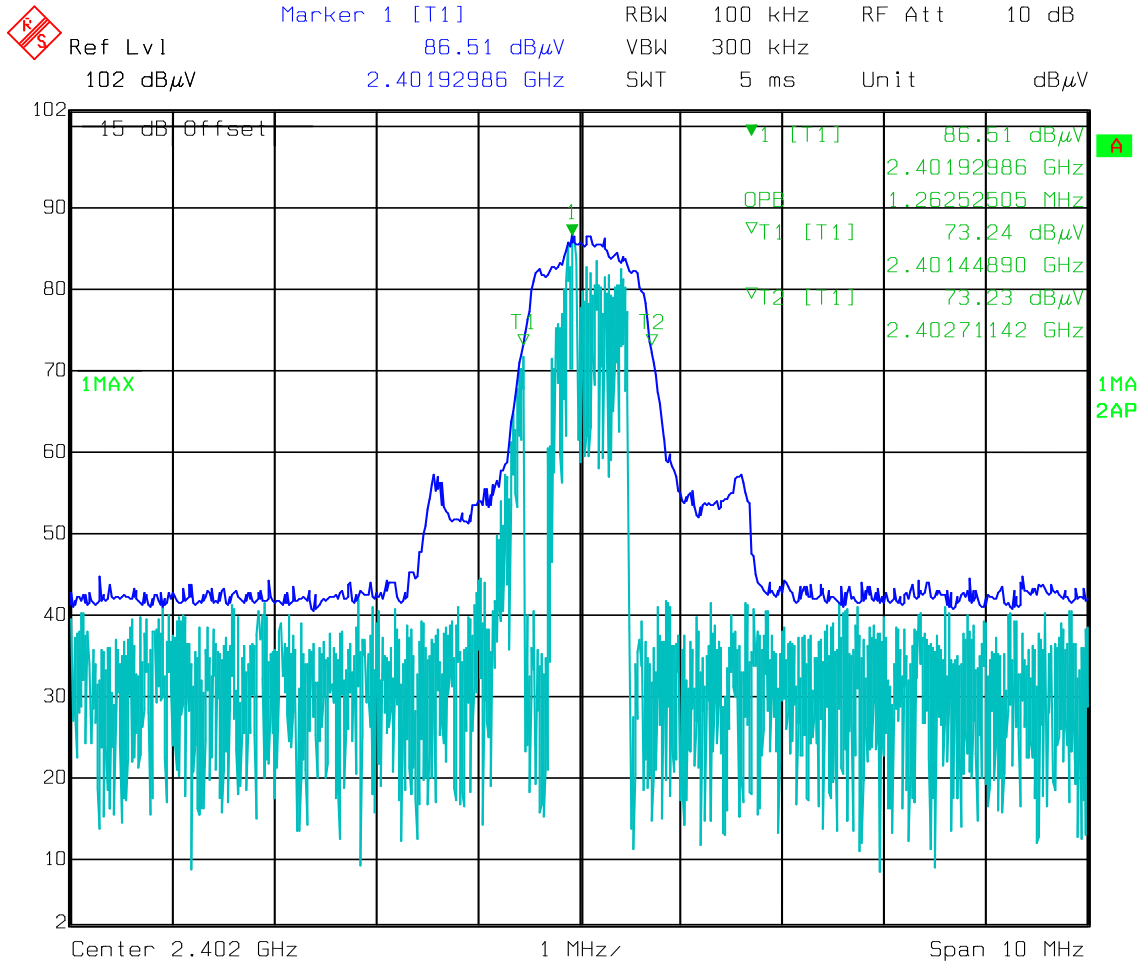
Date: 08.AUG.2014 10:06:42

**GFSK Mid Channel**



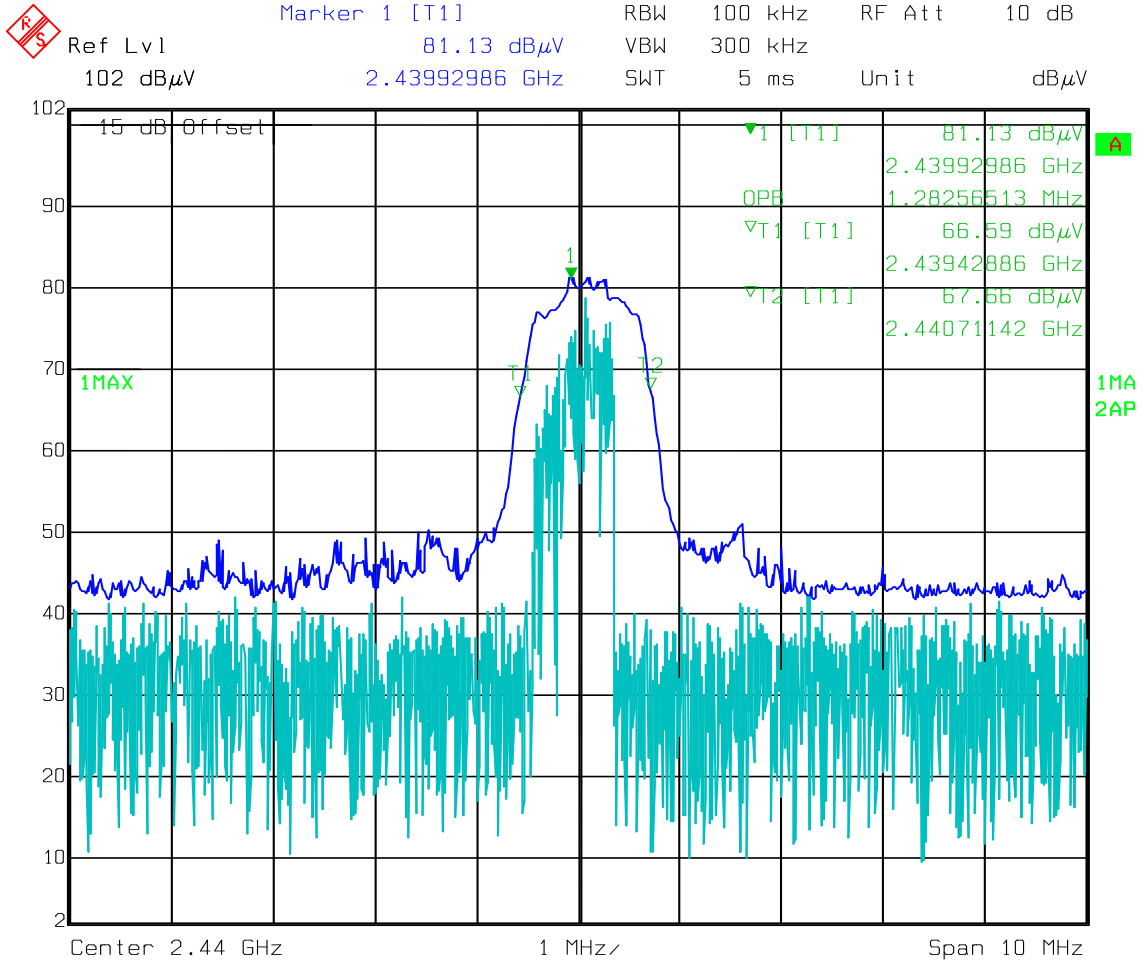
Date: 08.AUG.2014 10:05:27

**GFSK High Channel**



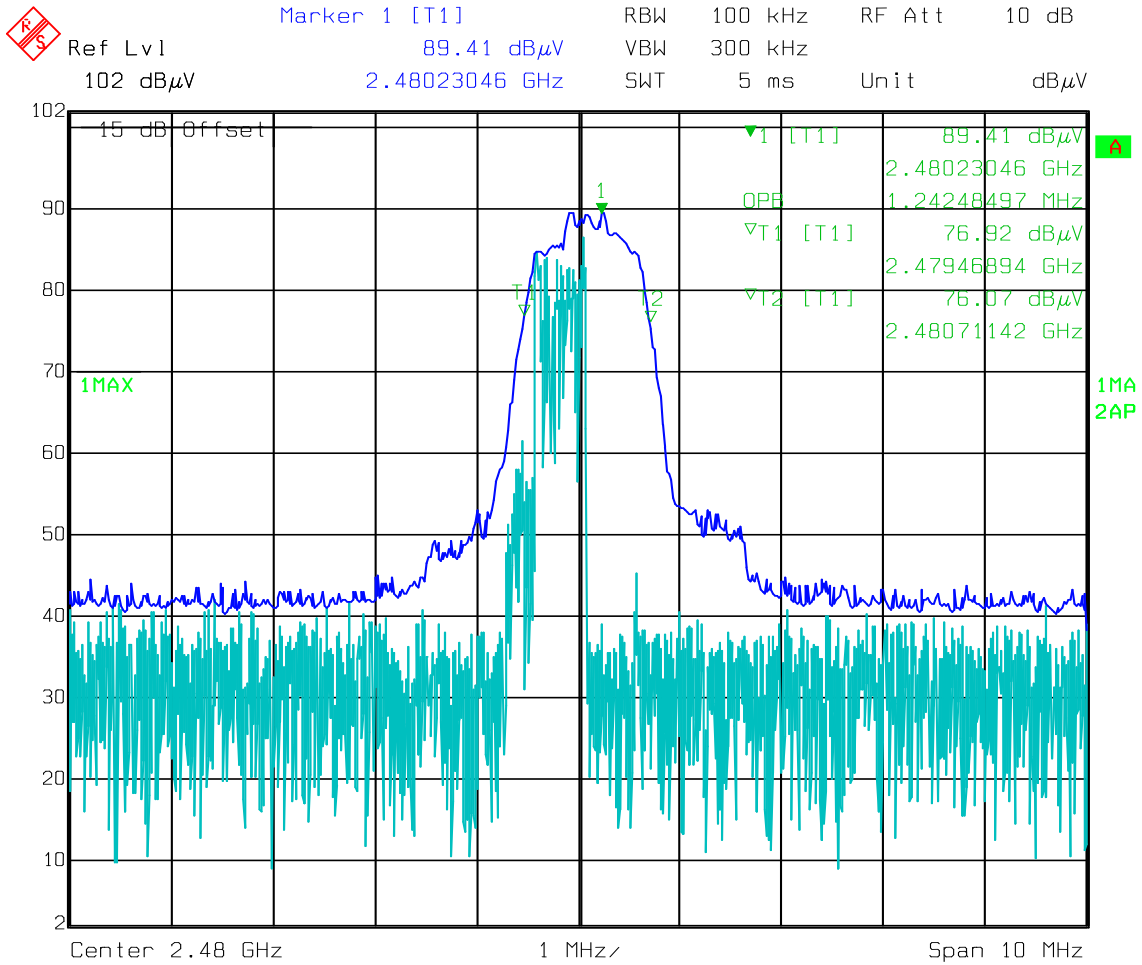
Date: 08.AUG.2014 10:10:52

**π/4-DQPSK Low Channel**



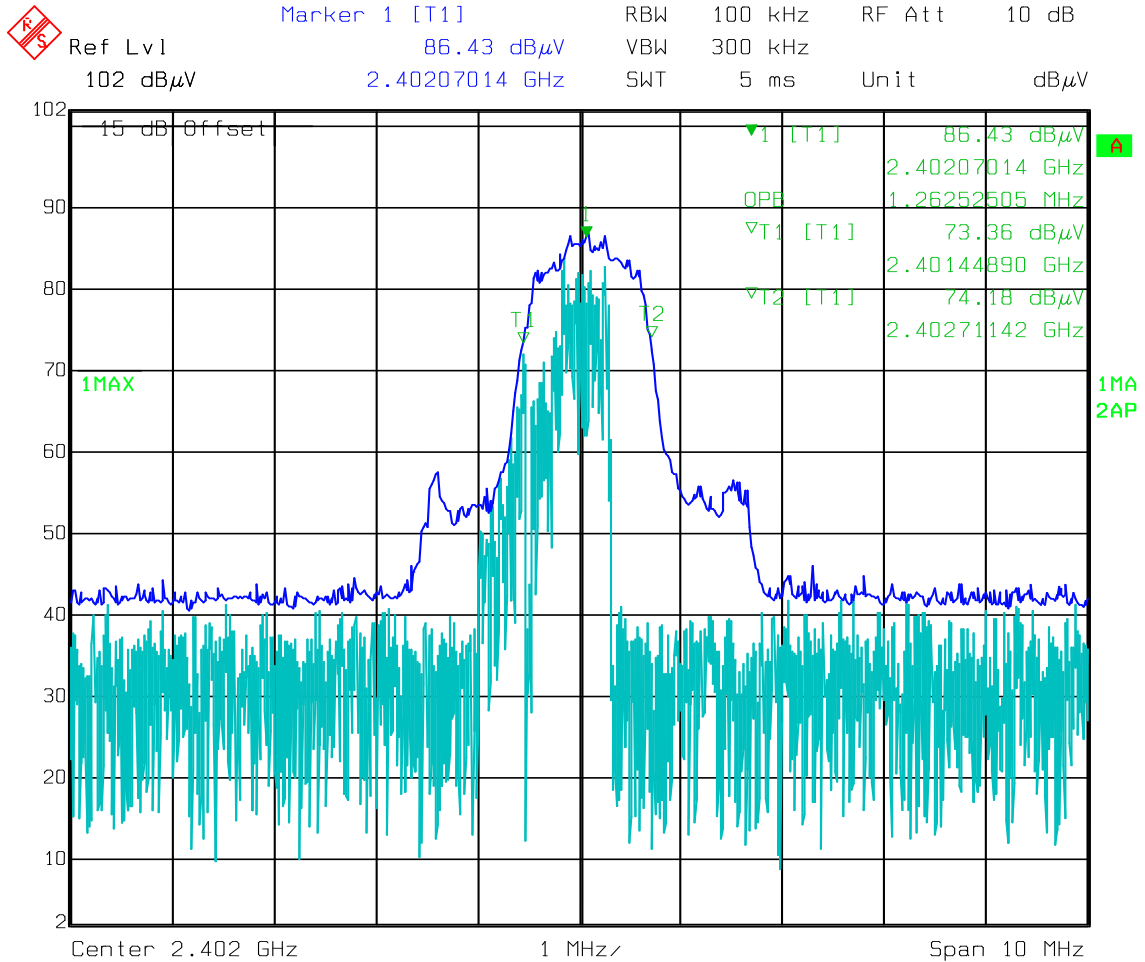
Date: 08.AUG.2014 10:12:18

**π/4-DQPSK Mid Channel**



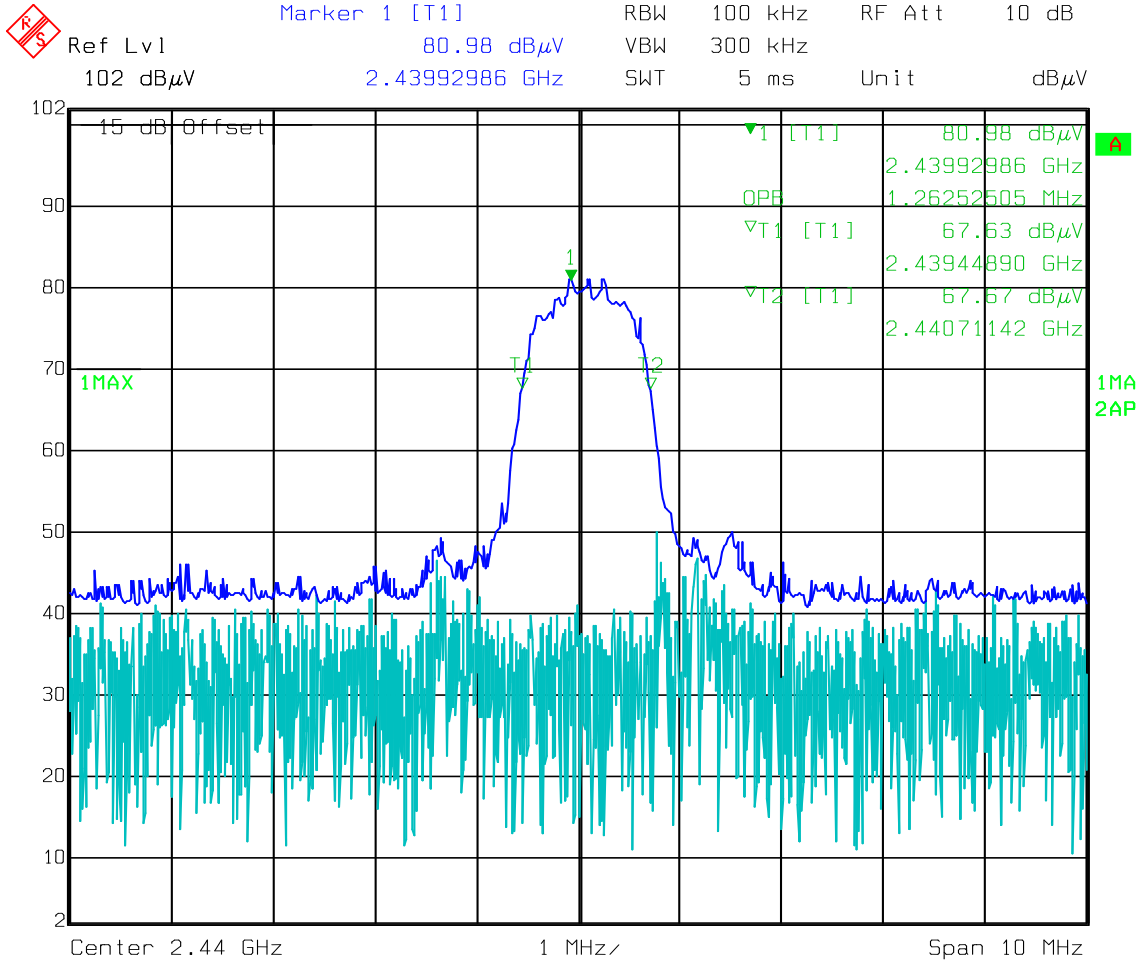
Date: 08.AUG.2014 10:13:05

**π/4-DQPSK High Channel**



Date: 08.AUG.2014 10:18:00

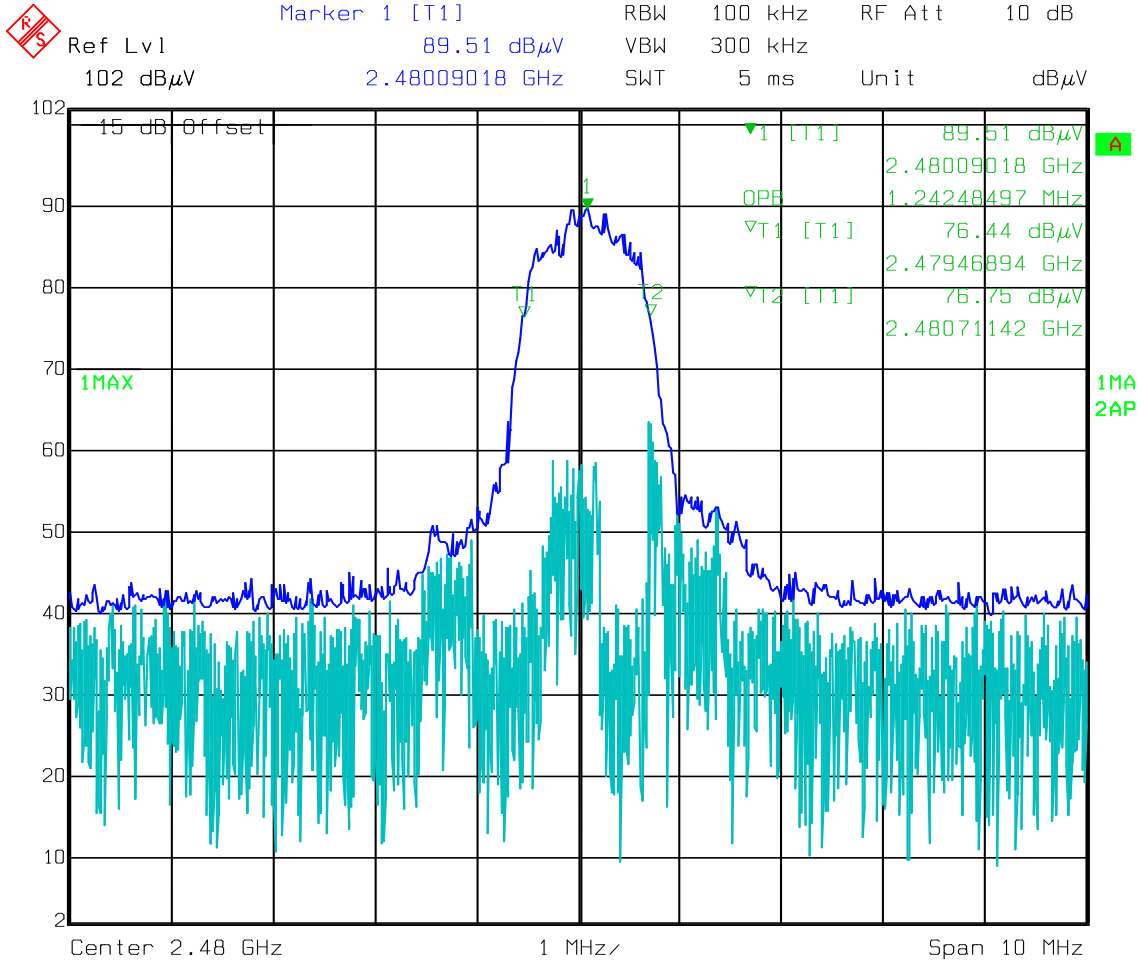
**8DPSK Low Channel**



Date: 08.AUG.2014 10:17:09

**8DPSK Mid Channel**





Date: 08.AUG.2014 10:16:06

**8DPSK High Channel**



## **2.7 PEAK OUTPUT POWER**

### **2.7.1 Specification Reference**

Part 15 Subpart C §15.247(b)(1)

### **2.7.2 Standard Applicable**

(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

### **2.7.1 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.7.2 Date of Test/Initial of test personnel who performed the test**

August 06, 2014/FSC

### **2.7.3 Test Equipment Used**

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

### **2.7.4 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |          |
|---------------------|----------|
| Ambient Temperature | 24.8°C   |
| Relative Humidity   | 50.8%    |
| ATM Pressure        | 99.2 kPa |

### **2.7.5 Additional Observations**

- This is a radiated test. The spectrum was searched from 2390MHz to 2500MHz to cover immediate restricted bands (masked by the notch filter during Radiated Spurious Emissions test), upper band edges and the fundamental frequency.
- All packet types verified, only worst case presented.
- Fundamental measurements will be proven by Substitution Method.
- Verifications were performed on two samples, only the worst results presented.
- 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.



**2.7.6 Sample Computation (Radiated Emission)**

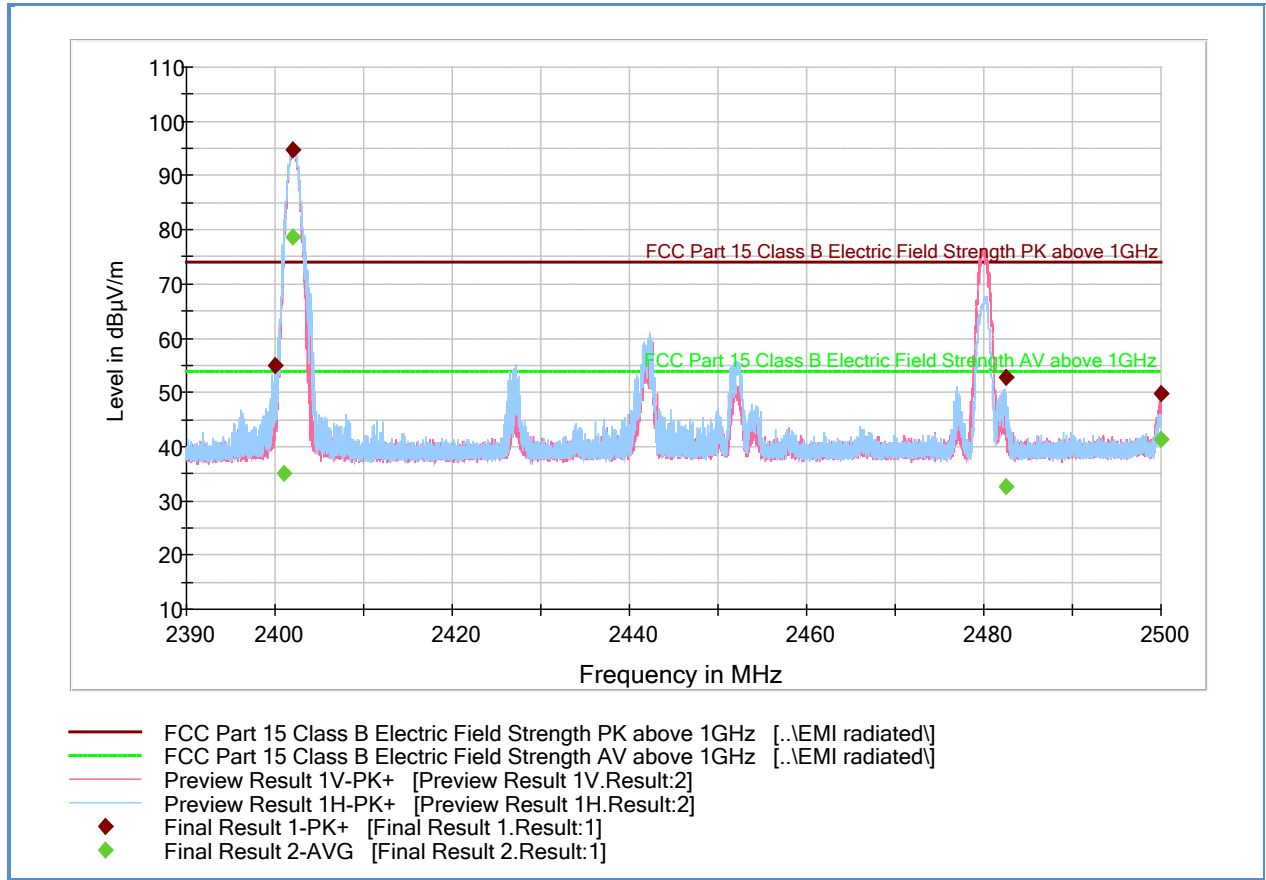
|   |                            |       |             |
|---|----------------------------|-------|-------------|
| Measuring equipment raw measurement (db $\mu$ V) @ 2400 MHz                   |                            |       | 53.9        |
| Correction Factor (dB)  | Asset# 1153 (cable)        | 3.4   | -0.4        |
|   | Asset# 8628 (preamplifier) | -36.5 |             |
|   | Asset#7575 (antenna)       | 32.7  |             |
| <b>Reported Max Peak Final Measurement (db<math>\mu</math>V/m) @ 2400 MHz</b> |                            |       | <b>53.5</b> |

**2.7.7 Test Results (EIRP Limit)**

| Modulation     | Channel   | Frequency (MHz) | Measured Field Strength (db $\mu$ V/m @ 3 meters) | Substitution Peak Output Power (dBm) | Substitution Peak Output Power (mW) | Limit (mW)    |
|----------------|-----------|-----------------|---|--------------------------------------|-------------------------------------|---------------|
| GFSK           | 0         | 2402            | 94.8  | -0.197                               | 0.956                               | 1000.0        |
|                | 38        | 2440            | 98.6  | 3.803                                | 2.400                               | 1000.0        |
|                | <b>78</b> | <b>2480</b>     | <b>99.0</b>                                       | <b>3.703</b>                         | <b>2.346</b>                        | <b>1000.0</b> |
| $\pi/4$ -DQPSK | <b>0</b>  | <b>2402</b>     | <b>99.9</b>                                       | <b>4.803</b>                         | <b>3.022</b>                        | <b>1000.0</b> |
|                | 38        | 2440            | 96.6  | 1.803                                | 1.515                               | 1000.0        |
|                | 78        | 2480            | 99.7  | 4.703                                | 2.953                               | 1000.0        |
| 8DPSK          | 0         | 2402            | 95.1  | -0.197                               | 0.956                               | 1000.0        |
|                | <b>38</b> | <b>2440</b>     | <b>100.4</b>                                      | <b>5.803</b>                         | <b>3.805</b>                        | <b>1000.0</b> |
|                | 78        | 2480            | 99.5  | 4.703                                | 2.953                               | 1000.0        |



2.7.8 Test Results GFSK Low Channel



Peak Data

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 55.0              | 1000.0          | 1000.000        | 100.8       | H            | 142.0         | -0.2       | 18.9        | 73.9           |
| 2402.000000     | 94.8              | 1000.0          | 1000.000        | 101.7       | H            | 143.0         | -0.2       | Fundamental |                |
| 2483.500000     | 52.8              | 1000.0          | 1000.000        | 136.7       | H            | 138.0         | 0.1        | 21.1        | 73.9           |
| 2500.000000     | 49.8              | 1000.0          | 1000.000        | 99.7        | V            | 47.0          | 0.2        | 24.1        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 35.1             | 1000.0          | 1000.000        | 100.8       | H            | 142.0         | -0.2       | 18.6        | 53.9           |
| 2402.000000     | 78.8             | 1000.0          | 1000.000        | 101.7       | H            | 143.0         | -0.2       | Fundamental |                |
| 2483.500000     | 32.7             | 1000.0          | 1000.000        | 136.7       | H            | 138.0         | 0.1        | 21.2        | 53.9           |
| 2500.000000     | 41.4             | 1000.0          | 1000.000        | 99.7        | V            | 47.0          | 0.2        | 12.5        | 53.9           |

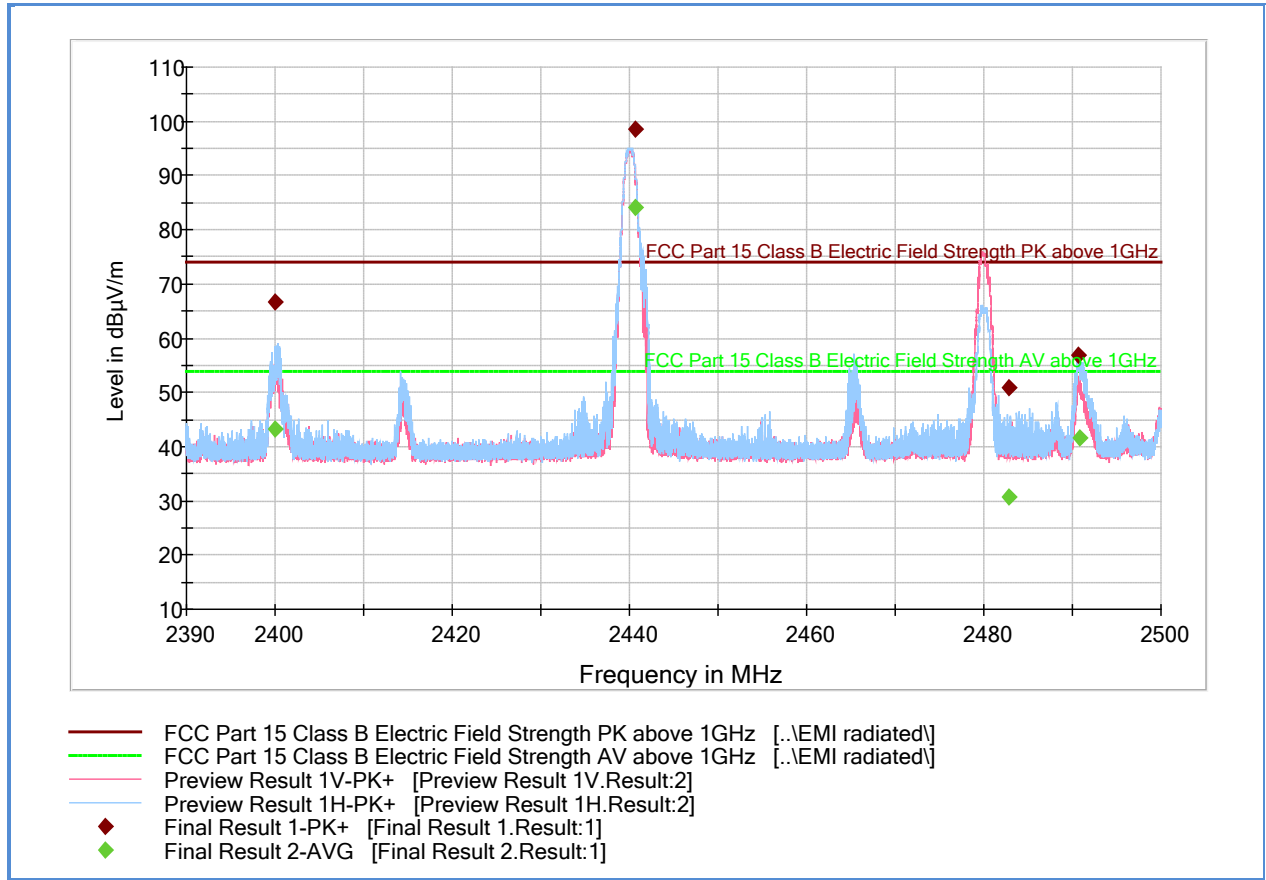
Substitution Data

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2402.000000     | 94.8              | 9.503                           | -3.7            | -6.0                         | -0.197                   | 30          | 30.197      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



2.7.9 Test Results GFSK Mid Channel



Peak Data

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 66.6              | 1000.0          | 1000.000        | 101.7       | H            | 144.0         | -0.2       | 7.3         | 73.9           |
| 2440.000000     | 98.6              | 1000.0          | 1000.000        | 99.7        | H            | 143.0         | 0.0        | Fundamental |                |
| 2483.500000     | 50.7              | 1000.0          | 1000.000        | 100.7       | H            | 146.0         | 0.1        | 23.2        | 73.9           |
| 2490.585333     | 56.7              | 1000.0          | 1000.000        | 100.7       | H            | 146.0         | 0.1        | 17.2        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 43.2             | 1000.0          | 1000.000        | 101.7       | H            | 144.0         | -0.2       | 10.7        | 53.9           |
| 2440.000000     | 84.2             | 1000.0          | 1000.000        | 99.7        | H            | 143.0         | 0.0        | Fundamental |                |
| 2483.500000     | 30.7             | 1000.0          | 1000.000        | 100.7       | H            | 146.0         | 0.1        | 23.2        | 53.9           |
| 2490.885333     | 41.7             | 1000.0          | 1000.000        | 100.7       | H            | 146.0         | 0.1        | 12.2        | 53.9           |

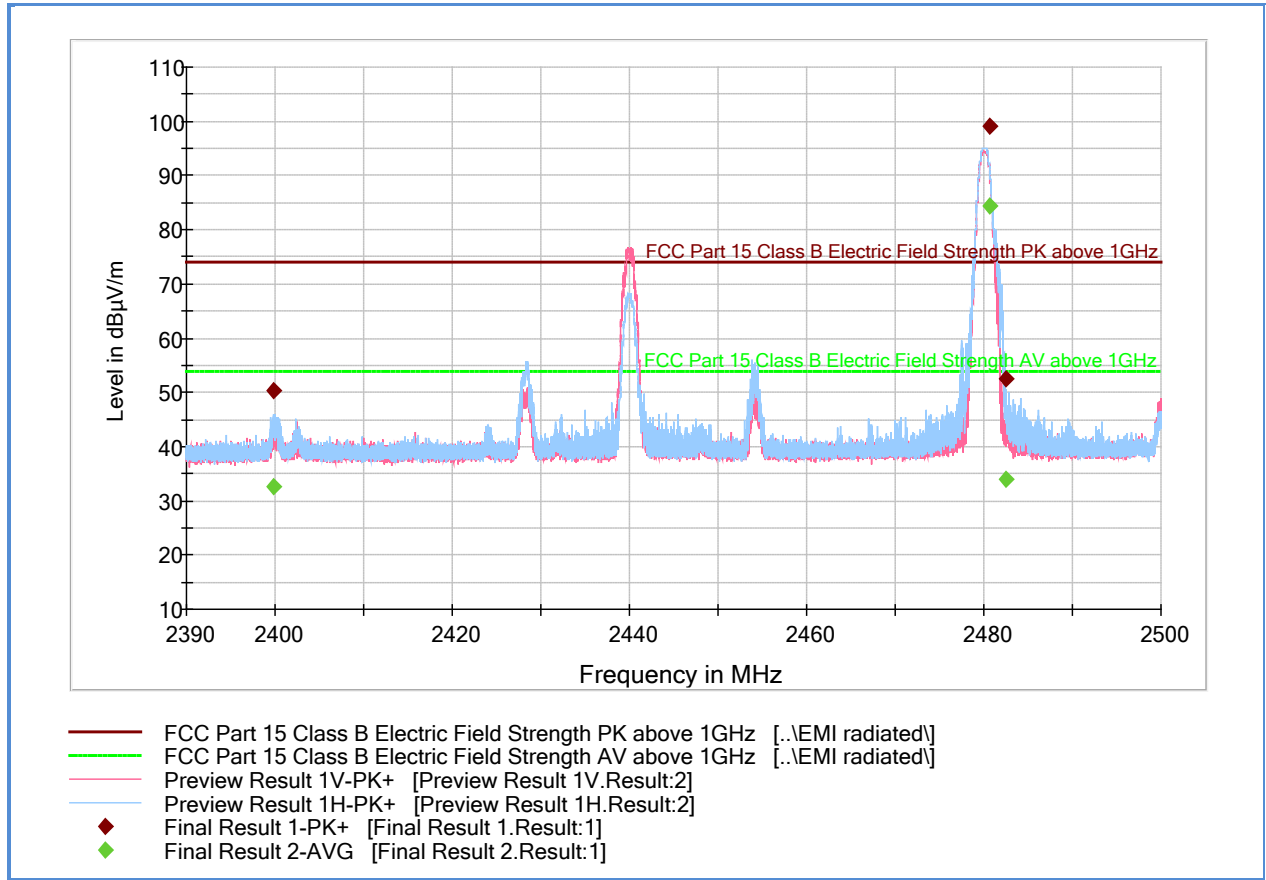
Substitution Data

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2440.000000     | 98.6              | 9.503                           | -3.7            | -2.0                         | 3.803                    | 30          | 26.197      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



**2.7.10 Test Results GFSK High Channel**



**Peak Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.00000      | 50.4              | 1000.0          | 1000.000        | 100.7       | V            | 69.0          | -0.2       | 23.5        | 73.9           |
| 2480.00000      | 99.0              | 1000.0          | 1000.000        | 99.7        | H            | 145.0         | 0.1        | Fundamental |                |
| 2483.50000      | 52.6              | 1000.0          | 1000.000        | 101.7       | H            | 144.0         | 0.1        | 21.3        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.00000      | 32.5             | 1000.0          | 1000.000        | 100.7       | V            | 69.0          | -0.2       | 21.4        | 53.9           |
| 2480.00000      | 84.4             | 1000.0          | 1000.000        | 99.7        | H            | 145.0         | 0.1        | Fundamental |                |
| 2483.50000      | 33.9             | 1000.0          | 1000.000        | 101.7       | H            | 144.0         | 0.1        | 20.0        | 53.9           |

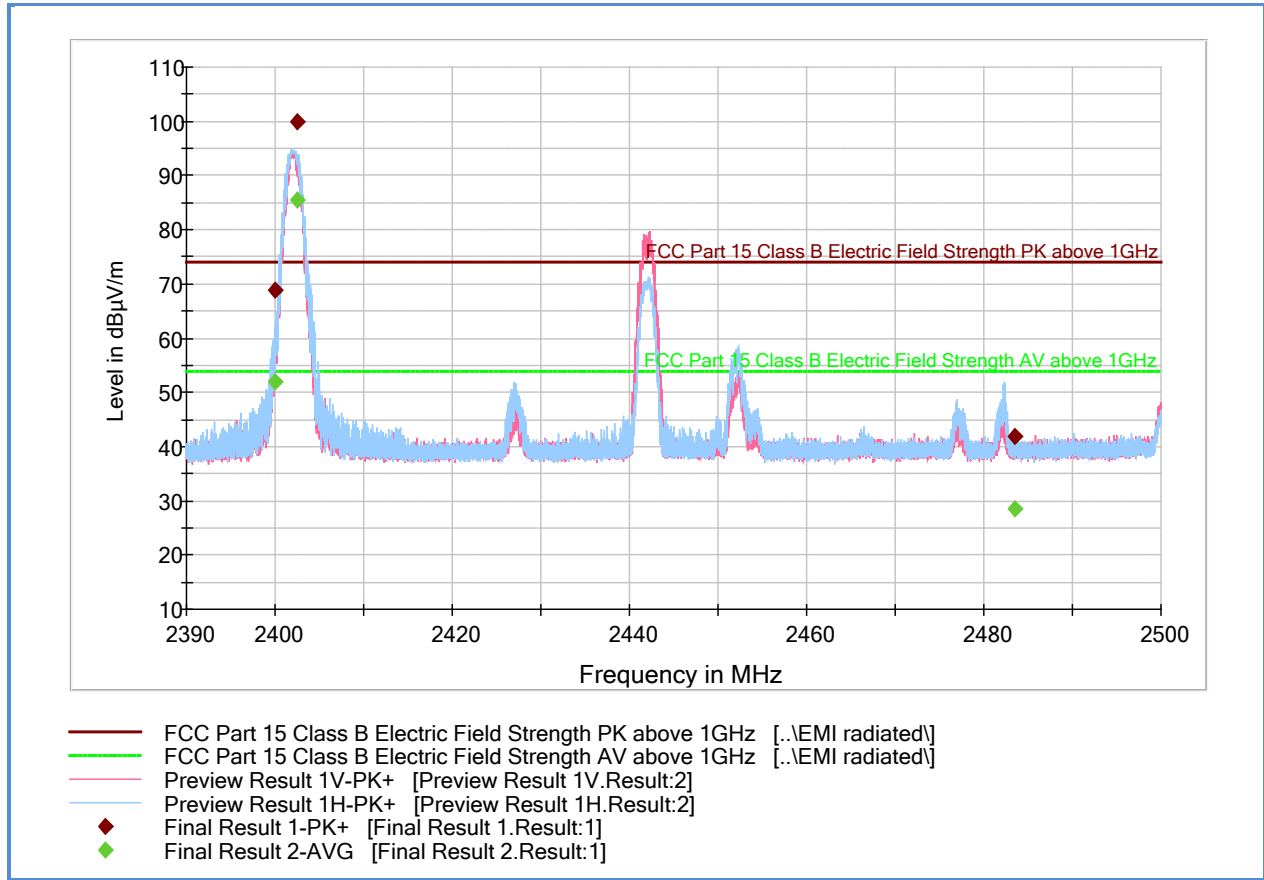
**Substitution Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2480.00000      | 99.0              | 9.503                           | -3.8            | -2.0                         | 3.703                    | 30          | 26.297      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



2.7.11 Test Results  $\pi/4$ -DQPSK Low Channel



Peak Data

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.00000      | 68.8              | 1000.0          | 1000.000        | 104.7       | H            | 142.0         | -0.2       | 5.9         | 73.9           |
| 2402.000000     | 99.9              | 1000.0          | 1000.000        | 103.7       | H            | 141.0         | -0.2       | Fundamental |                |
| 2483.500000     | 41.8              | 1000.0          | 1000.000        | 404.9       | H            | 94.0          | 0.1        | 32.1        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.00000      | 52.0             | 1000.0          | 1000.000        | 104.7       | H            | 142.0         | -0.2       | 1.9         | 53.9           |
| 2402.000000     | 85.5             | 1000.0          | 1000.000        | 103.7       | H            | 141.0         | -0.2       | Fundamental |                |
| 2483.500000     | 28.6             | 1000.0          | 1000.000        | 404.9       | H            | 94.0          | 0.1        | 25.3        | 53.9           |

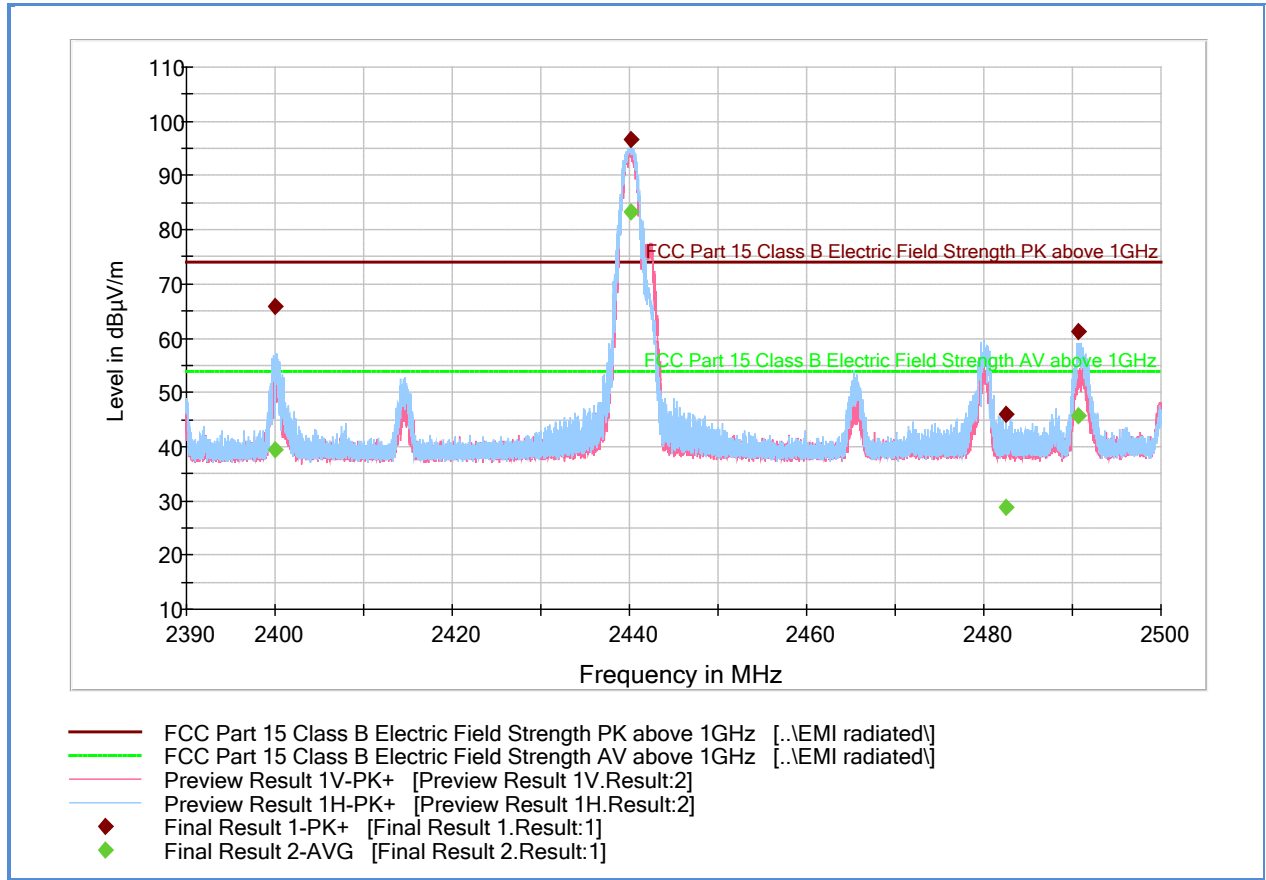
Substitution Data

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2402.000000     | 99.9              | 9.503                           | -3.7            | -1.0                         | 4.803                    | 30          | 25.197      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be  $\leq$  Peak if duty cycle correction is applied. Downlink from the call box is ignored.



2.7.12 Test Results  $\pi/4$ -DQPSK Mid Channel



Peak Data

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 65.8              | 1000.0          | 1000.000        | 99.7        | H            | 140.0         | -0.2       | 8.1         | 73.9           |
| 2440.000000     | 96.6              | 1000.0          | 1000.000        | 112.7       | H            | 93.0          | 0.0        | Fundamental |                |
| 2483.500000     | 46.0              | 1000.0          | 1000.000        | 332.1       | H            | 142.0         | 0.1        | 27.9        | 73.9           |
| 2490.717667     | 61.1              | 1000.0          | 1000.000        | 100.7       | H            | 145.0         | 0.2        | 12.8        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 39.4             | 1000.0          | 1000.000        | 99.7        | H            | 140.0         | -0.2       | 14.5        | 53.9           |
| 2440.000000     | 83.3             | 1000.0          | 1000.000        | 112.7       | H            | 93.0          | 0.0        | Fundamental |                |
| 2483.500000     | 28.9             | 1000.0          | 1000.000        | 332.1       | H            | 142.0         | 0.1        | 25.0        | 53.9           |
| 2490.717667     | 45.6             | 1000.0          | 1000.000        | 100.7       | H            | 145.0         | 0.2        | 8.3         | 53.9           |

Substitution Data

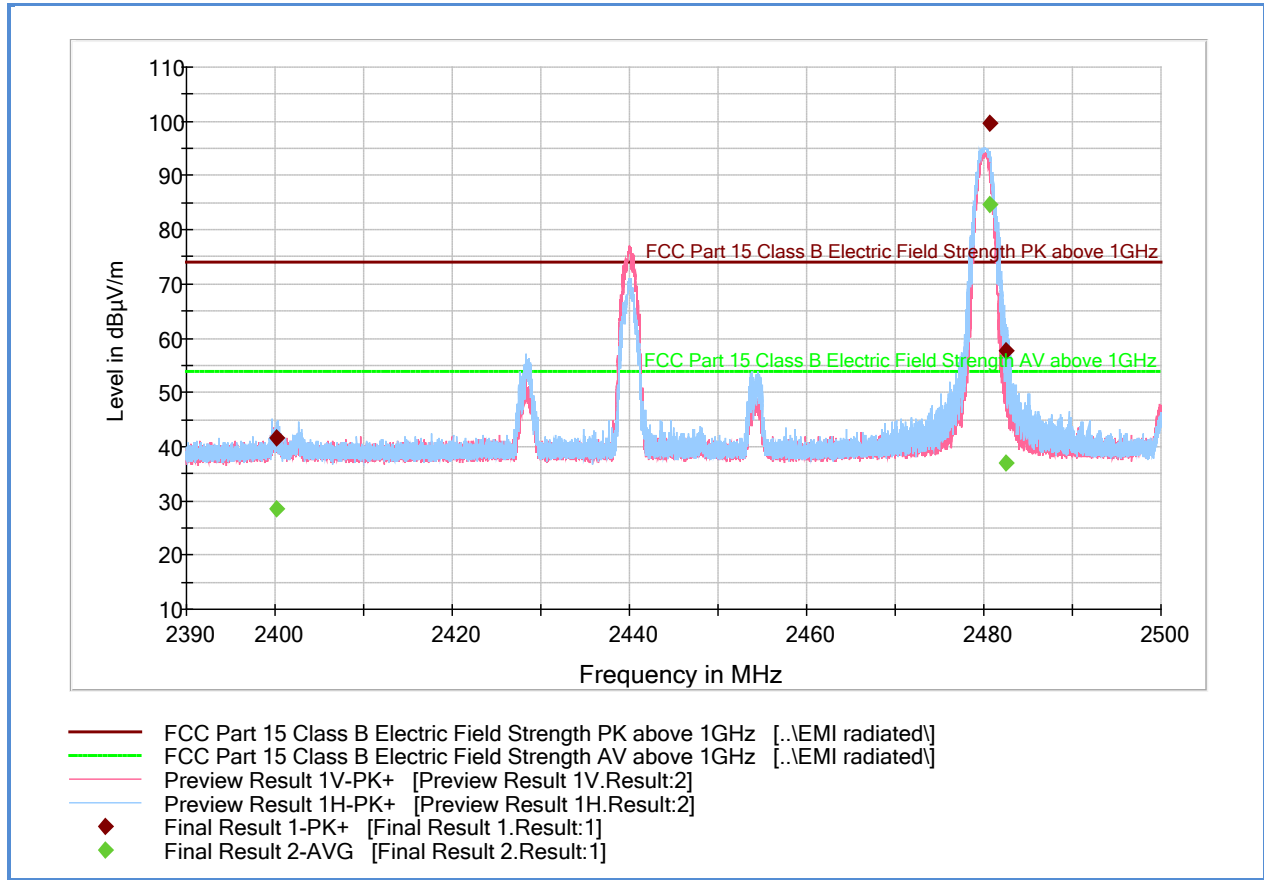
| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2440.000000     | 96.6              | 9.503                           | -3.7            | -4.0                         | 1.803                    | 30          | 28.197      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.





2.7.13 Test Results  $\pi/4$ -DQPSK High Channel



Peak Data

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 41.5              | 1000.0          | 1000.000        | 129.7       | V            | 29.0          | -0.2       | 32.4        | 73.9           |
| 2480.000000     | 99.7              | 1000.0          | 1000.000        | 99.7        | H            | 149.0         | 0.1        | Fundamental |                |
| 2483.500000     | 57.7              | 1000.0          | 1000.000        | 101.7       | H            | 94.0          | 0.1        | 16.2        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 28.6             | 1000.0          | 1000.000        | 129.7       | V            | 29.0          | -0.2       | 25.3        | 53.9           |
| 2480.000000     | 84.7             | 1000.0          | 1000.000        | 99.7        | H            | 149.0         | 0.1        | Fundamental |                |
| 2483.500000     | 37.1             | 1000.0          | 1000.000        | 101.7       | H            | 94.0          | 0.1        | 16.8        | 53.9           |

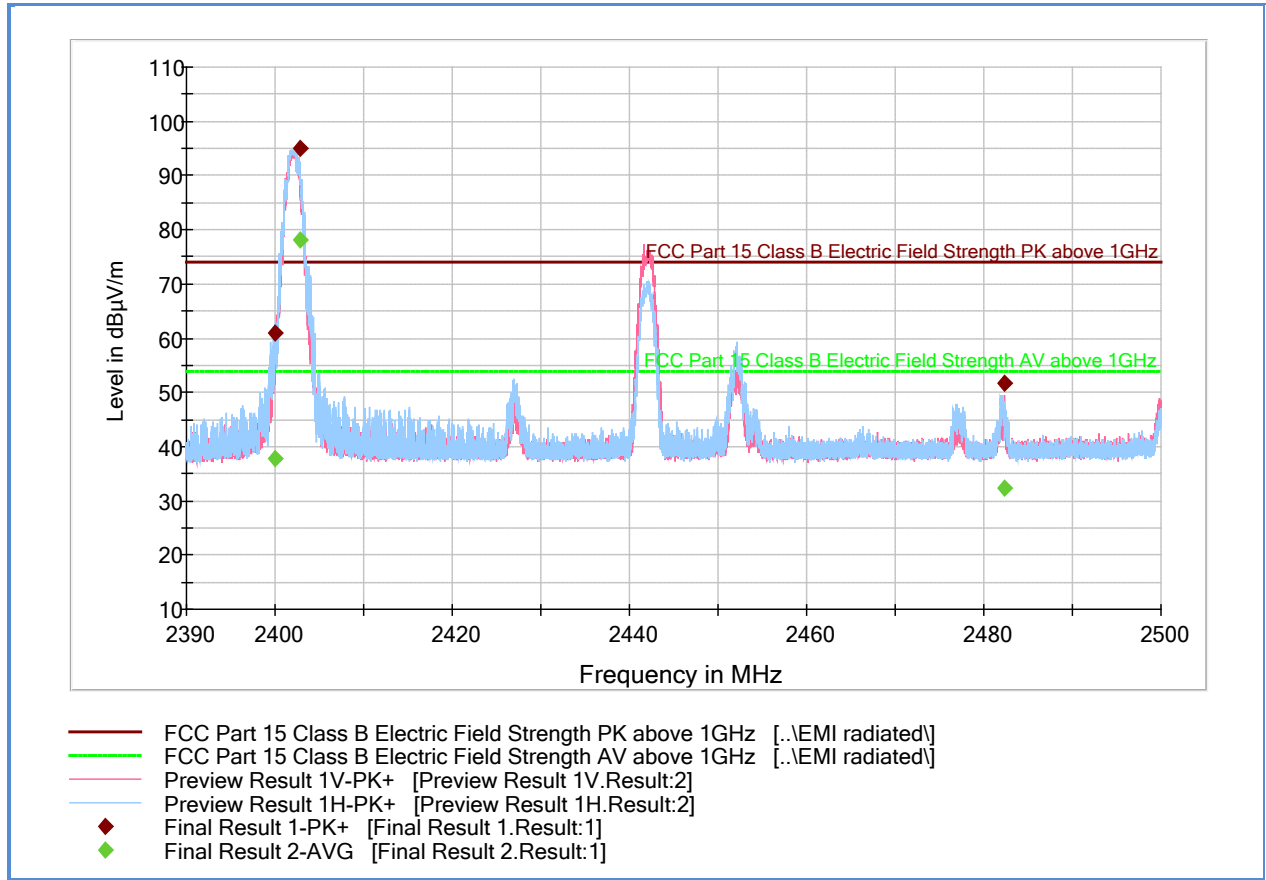
Substitution Data

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2480.000000     | 99.7              | 9.503                           | -3.8            | -1.0                         | 4.703                    | 30          | 25.297      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



**2.7.14 Test Results 8DPSK Low Channel**



**Peak Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 60.8              | 1000.0          | 1000.000        | 165.6       | V            | 77.0          | -0.2       | 13.1        | 73.9           |
| 2402.000000     | 95.1              | 1000.0          | 1000.000        | 102.7       | H            | 142.0         | -0.2       | Fundamental |                |
| 2483.500000     | 51.7              | 1000.0          | 1000.000        | 302.2       | V            | 87.0          | 0.1        | 22.2        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 37.9             | 1000.0          | 1000.000        | 165.6       | V            | 77.0          | -0.2       | 16.0        | 53.9           |
| 2402.000000     | 78.0             | 1000.0          | 1000.000        | 102.7       | H            | 142.0         | -0.2       | Fundamental |                |
| 2483.500000     | 32.2             | 1000.0          | 1000.000        | 302.2       | V            | 87.0          | 0.1        | 21.7        | 53.9           |

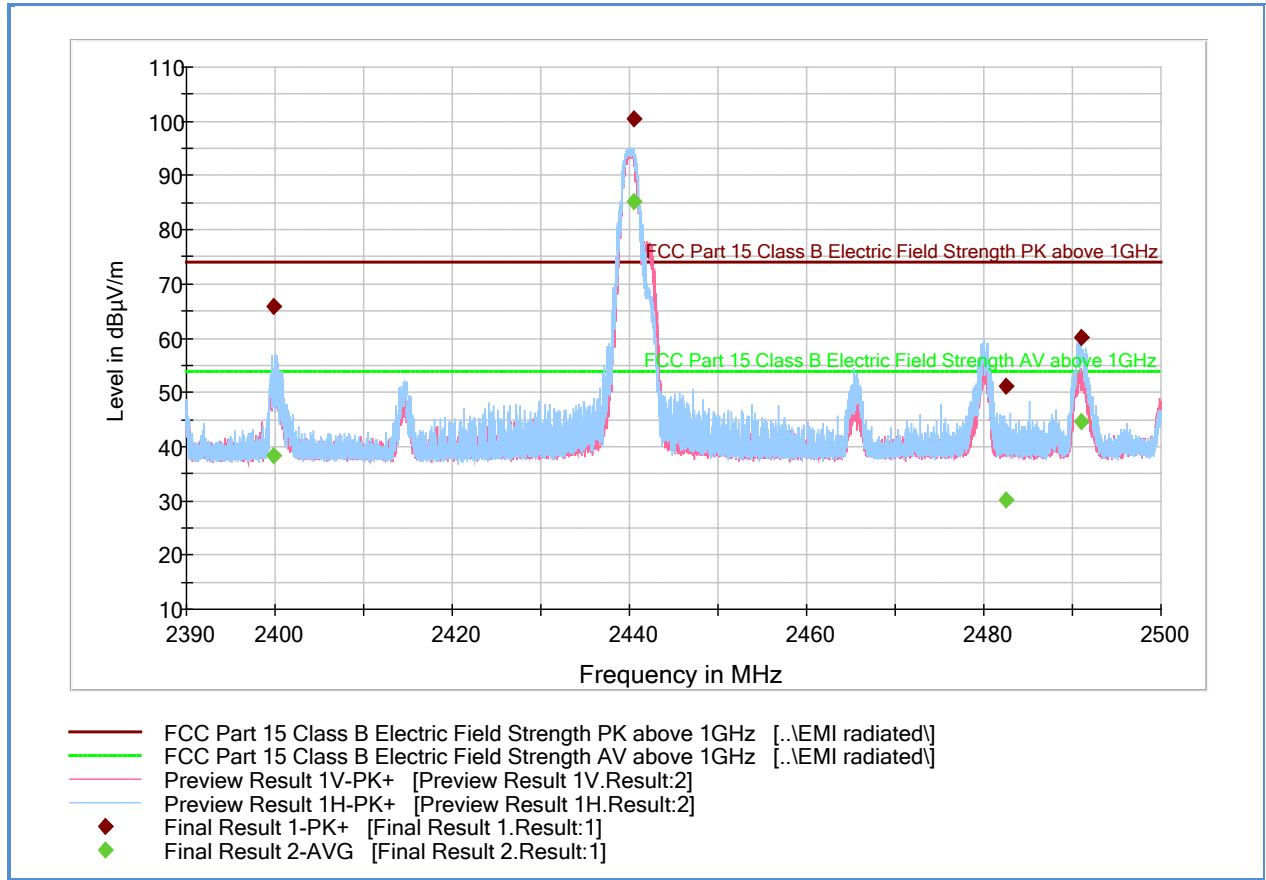
**Substitution Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2402.000000     | 95.1              | 9.503                           | -3.7            | -6.0                         | -0.197                   | 30          | 30.197      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



2.7.15 Test Results 8DPSK Mid Channel



Peak Data

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 65.7              | 1000.0          | 1000.000        | 101.7       | H            | 144.0         | -0.2       | 8.2         | 73.9           |
| 2440.000000     | 100.4             | 1000.0          | 1000.000        | 100.7       | H            | 140.0         | 0.0        | Fundamental |                |
| 2483.500000     | 51.2              | 1000.0          | 1000.000        | 99.7        | H            | 150.0         | 0.1        | 22.7        | 73.9           |
| 2491.037000     | 60.0              | 1000.0          | 1000.000        | 101.7       | H            | 149.0         | 0.2        | 13.9        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 38.4             | 1000.0          | 1000.000        | 101.7       | H            | 144.0         | -0.2       | 15.5        | 53.9           |
| 2440.000000     | 85.1             | 1000.0          | 1000.000        | 100.7       | H            | 140.0         | 0.0        | Fundamental |                |
| 2483.500000     | 30.3             | 1000.0          | 1000.000        | 99.7        | H            | 150.0         | 0.1        | 23.6        | 53.9           |
| 2500.000000     | 44.7             | 1000.0          | 1000.000        | 101.7       | H            | 149.0         | 0.2        | 9.2         | 53.9           |

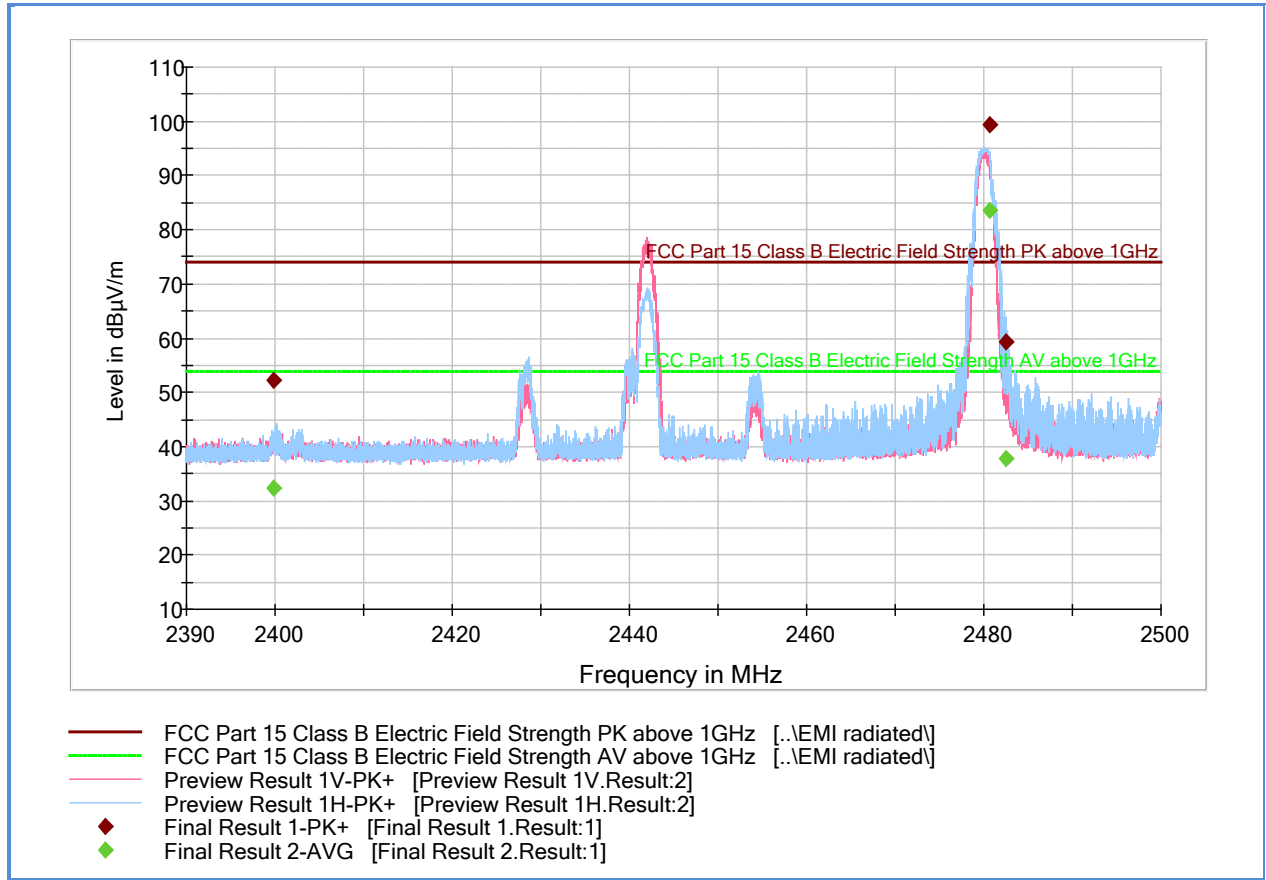
Substitution Data

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2402.000000     | 100.4             | 9.503                           | -3.7            | 0.0                          | 5.803                    | 30          | 24.197      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



**2.7.16 Test Results 8DPSK High Channel**



**Peak Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|-------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 52.2              | 1000.0          | 1000.000        | 101.7       | H            | 138.0         | -0.2       | 21.7        | 73.9           |
| 2480.000000     | 99.5              | 1000.0          | 1000.000        | 99.7        | H            | 147.0         | 0.1        | Fundamental |                |
| 2483.500000     | 59.4              | 1000.0          | 1000.000        | 100.7       | H            | 148.0         | 0.1        | 14.5        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2400.000000     | 32.3             | 1000.0          | 1000.000        | 101.7       | H            | 138.0         | -0.2       | 21.6        | 53.9           |
| 2480.000000     | 83.4             | 1000.0          | 1000.000        | 99.7        | H            | 147.0         | 0.1        | Fundamental |                |
| 2483.500000     | 37.9             | 1000.0          | 1000.000        | 100.7       | H            | 148.0         | 0.1        | 16.0        | 53.9           |

**Substitution Data**

| Frequency (MHz) | Max Peak (dBµV/m) | Substitution Antenna Gain (dBi) | Cable Loss (dB) | Signal Generator Level (dBm) | Substitution Level (dBm) | Limit (dBm) | Margin (dB) |
|-----------------|-------------------|---------------------------------|-----------------|------------------------------|--------------------------|-------------|-------------|
| 2480.000000     | 99.5              | 9.503                           | -3.8            | -1.0                         | 4.703                    | 30          | 25.297      |

**Test Notes:** Peak data used for Substitution since EUT is not transmitting @ 100% duty cycle. Average will be ≤ Peak if duty cycle correction is applied. Downlink from the call box is ignored.



## **2.8 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS**

### **2.8.1 Specification Reference**

Part 15 Subpart C §15.247(d)

### **2.8.2 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)).

### **2.8.1 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.8.2 Date of Test/Initial of test personnel who performed the test**

August 08, 2014/FSC

### **2.8.3 Test Equipment Used**

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

### **2.8.4 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |          |
|---------------------|----------|
| Ambient Temperature | 24.3°C   |
| Relative Humidity   | 52.1%    |
| ATM Pressure        | 98.9 kPa |

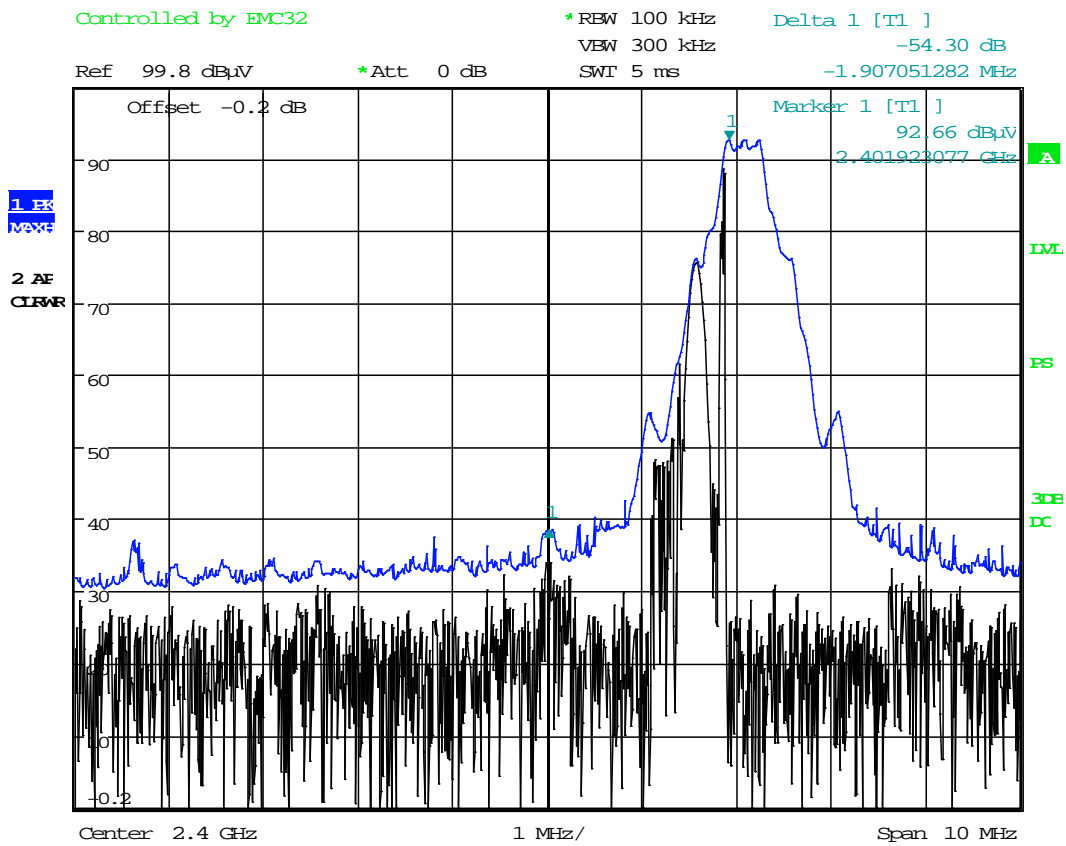
### **2.8.5 Additional Observations**

- This is a radiated test.
- An offset of -0.2dB was added manually as the correction factor for the Radiated Emissions Setup using a semi-anechoic chamber (antenna factor, pre-amp gain and cable loss).
- Span is wide enough to capture the peak level of the emission operating on the channel closest to the band edge.
- RBW is 100kHz, VBW is 3X RBW.



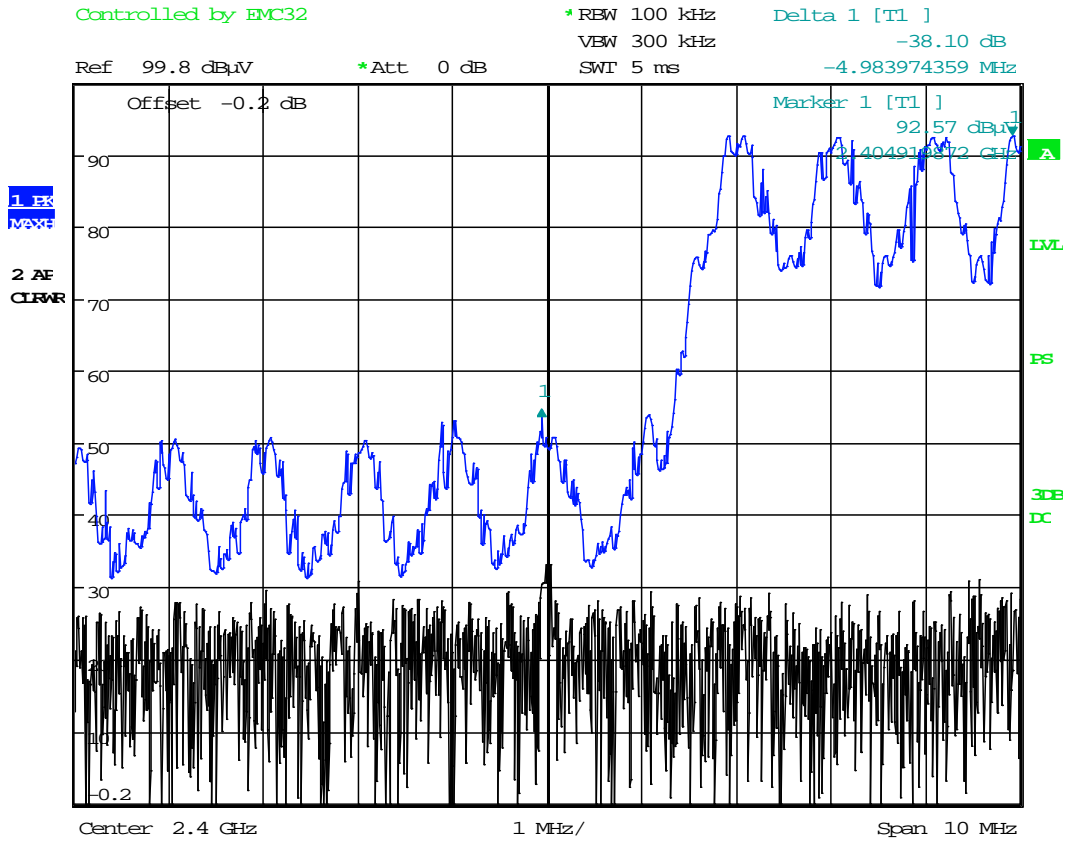
- Sweep is auto, detector is peak, trace is max hold.
- Trace allowed to stabilize. Marker-delta function used to verify compliance.
- Limit is 30dBc.
- Both Hopping and Non-Hopping mode verified.
- Only Lower Bandedges presented, Upper Bandedge test results are covered under Section 2.7 of this test report since it falls under the restricted bands.
- Verifications were performed on two samples, only the worst results presented.

**2.8.6 Test Results**



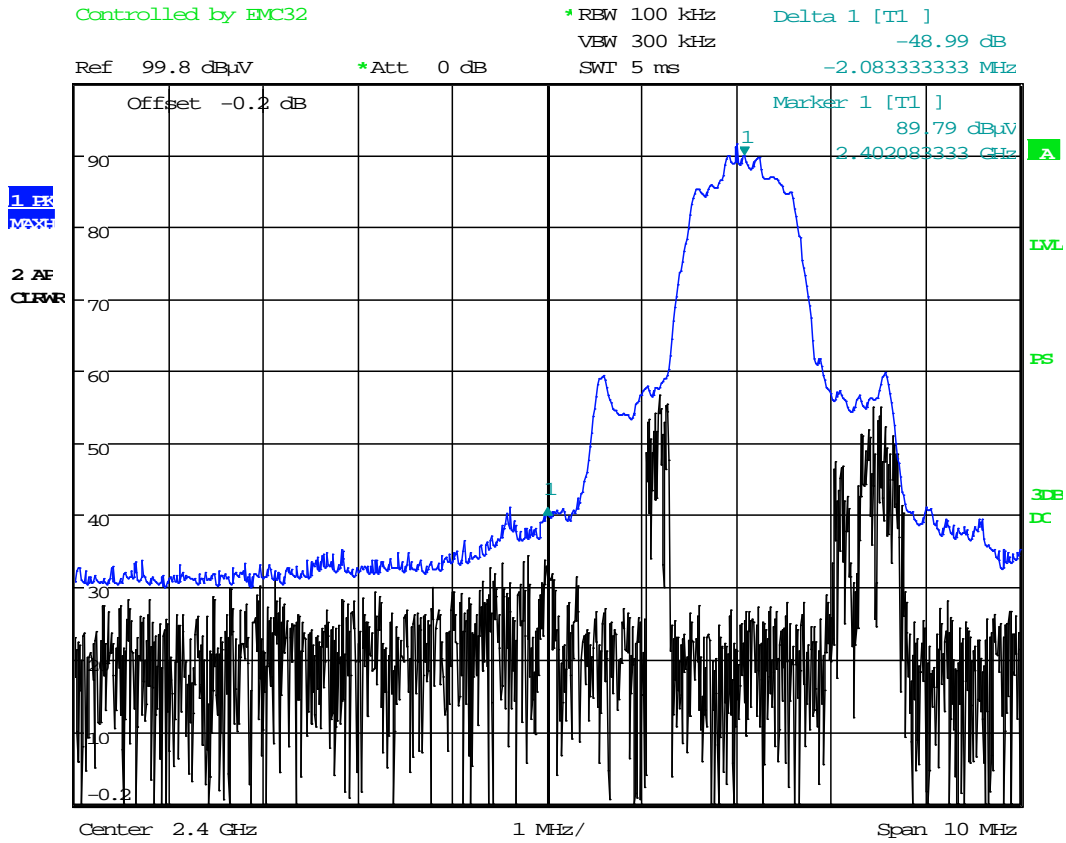
Date: 8.AUG.2014 07:31:27

**Lower Bandedge (GFSK)**



Date: 8.AUG.2014 07:36:28

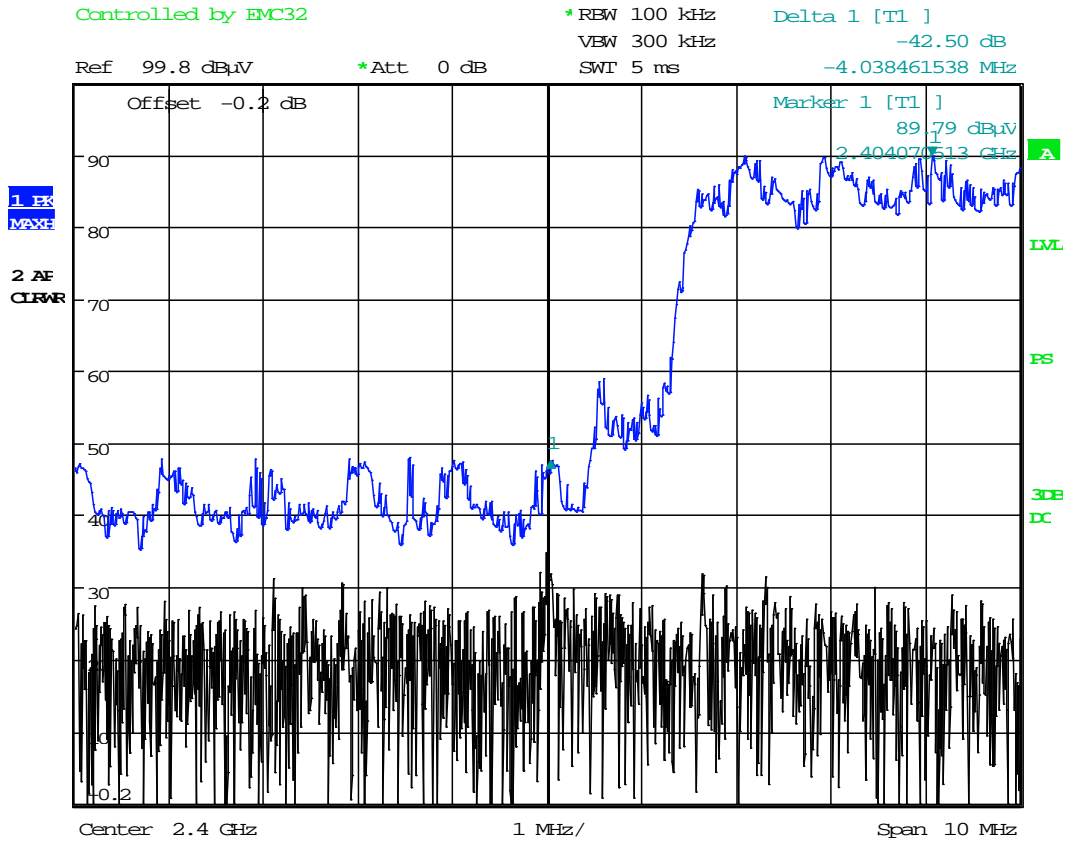
**Hopping Lower Bandedge (GFSK)**



Date: 8.AUG.2014 07:32:36

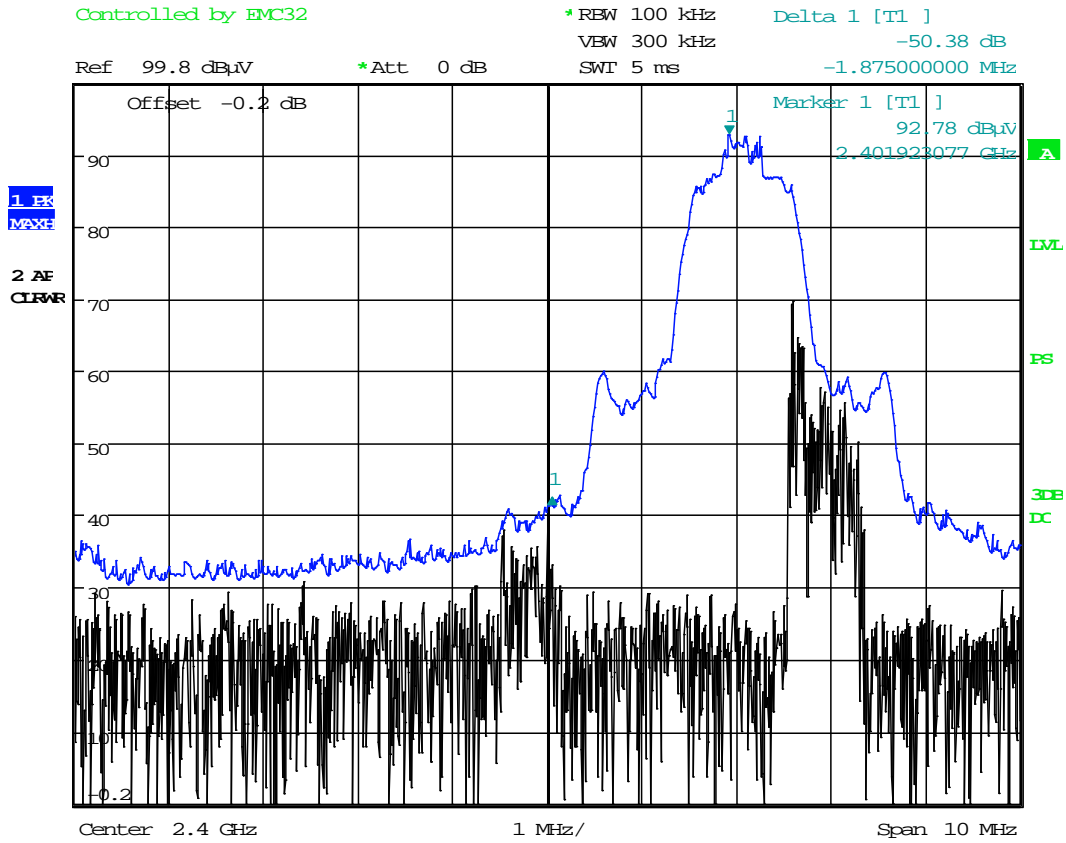
Lower Bandedge ( $\pi/4$ -DQPSK)





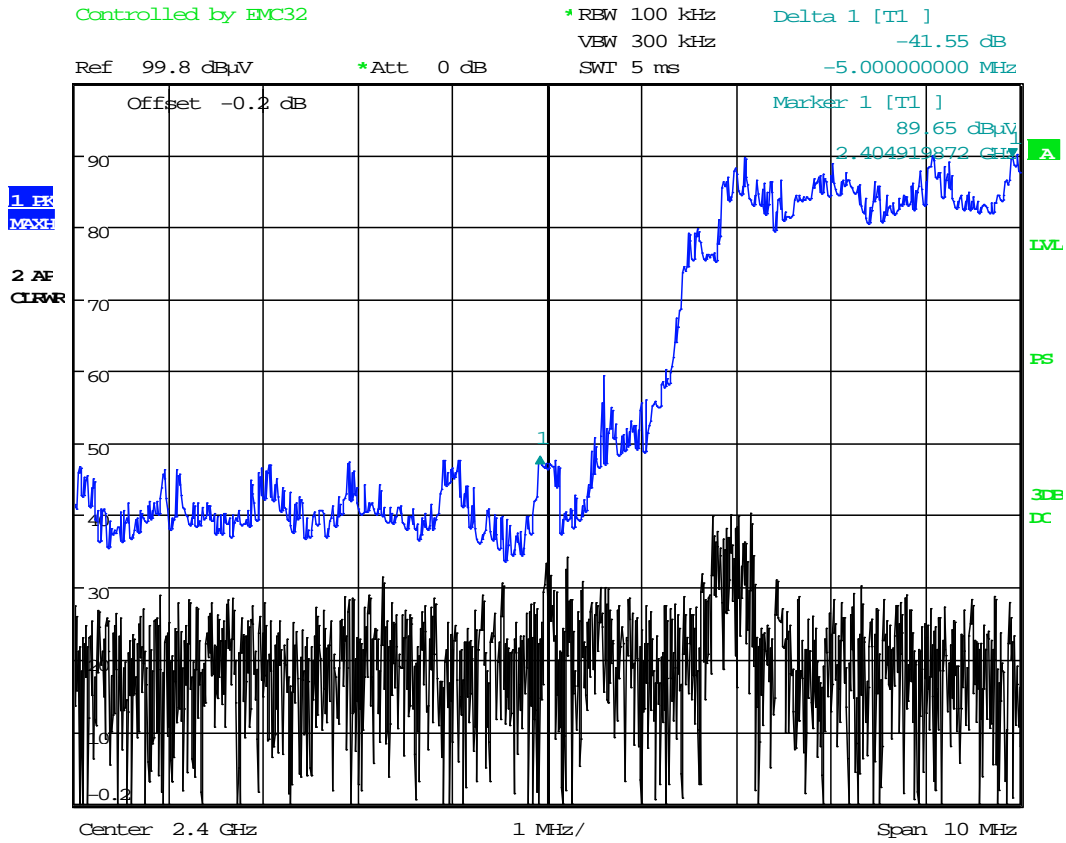
Date: 8.AUG.2014 07:56:26

### Hopping Lower Bandedge ( $\pi/4$ -DQPSK)



Date: 8.AUG.2014 07:34:00

**Lower Bandedge (8DPSK)**



Date: 8.AUG.2014 07:53:05

### Hopping Lower Bandedge (8DPSK)



## **2.9 SPURIOUS RF CONDUCTED EMISSIONS**

### **2.9.1 Specification Reference**

Part 15 Subpart C §15.247(d)

### **2.9.2 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)).

### **2.9.3 Equipment Under Test and Modification State**

Not performed. EUT has an integral antenna. Spurious Emissions is covered under Section 2.10 of this test report.



## **2.10 SPURIOUS RADIATED EMISSIONS**

### **2.10.1 Specification Reference**

Part 15 Subpart C §15.247(d)

### **2.10.2 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)).

### **2.10.3 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.10.4 Date of Test/Initial of test personnel who performed the test**

July 03, 09 and October 02, 2014/FSC

### **2.10.5 Test Equipment Used**

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

### **2.10.6 Environmental Conditions/ Test Location**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |               |
|---------------------|---------------|
| Ambient Temperature | 20.9-25.7°C   |
| Relative Humidity   | 44.6-56.4%    |
| ATM Pressure        | 99.1-99.4 kPa |

### **2.10.7 Additional Observations**

- This is a radiated test. The spectrum was searched from 30MHz to the 10<sup>th</sup> 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 the considered worst case configuration (8DPSK) presented for radiated emissions when not hopping. There are no significant differences in radiated emissions between the three modulation and packet types.



- Verifications were performed on two samples, only the worst results presented. For Receive Mode, only M/N LMU30H30BT3 was verified.
- 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 2.10.8 for sample computation.

**2.10.8 Sample Computation (Radiated Emission)**

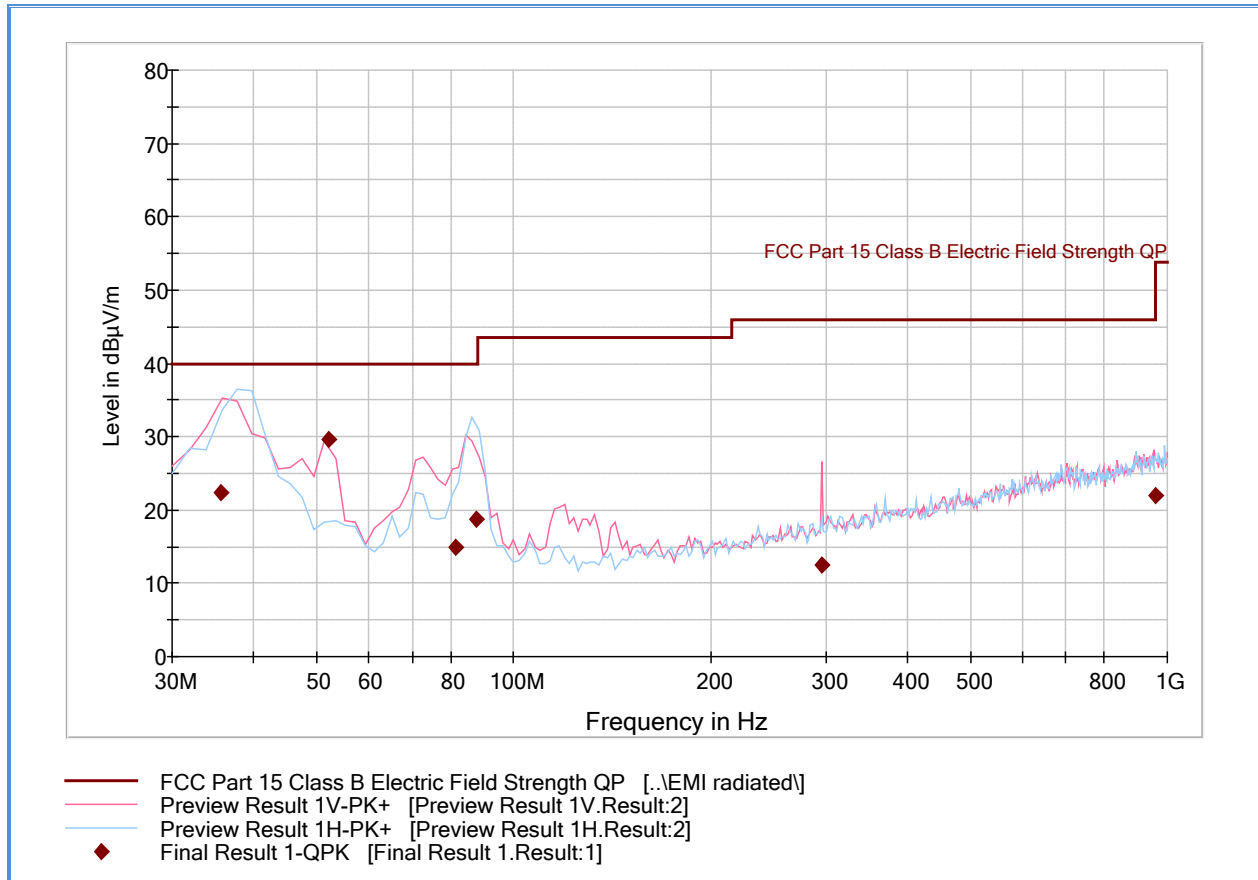
|   |                            |             |
|---|----------------------------|-------------|
| Measuring equipment raw measurement (db $\mu$ V) @ 30 MHz                   |                            | 24.4        |
| Correction Factor (dB)  | Asset# 1066 (cable)        | 0.3         |
|   | Asset# 1172 (cable)        | 0.3         |
|   | Asset# 1016 (preamplifier) | -30.7       |
|   | Asset# 1175(cable)         | 0.3         |
|   | Asset# 1002 (antenna)      | 17.2        |
| <b>Reported QuasiPeak Final Measurement (db<math>\mu</math>V/m) @ 30MHz</b> |                            | <b>11.8</b> |

**2.10.9 Test Results**

See attached plots.



**2.10.10 Test Results Below 1GHz (Receive Mode)**



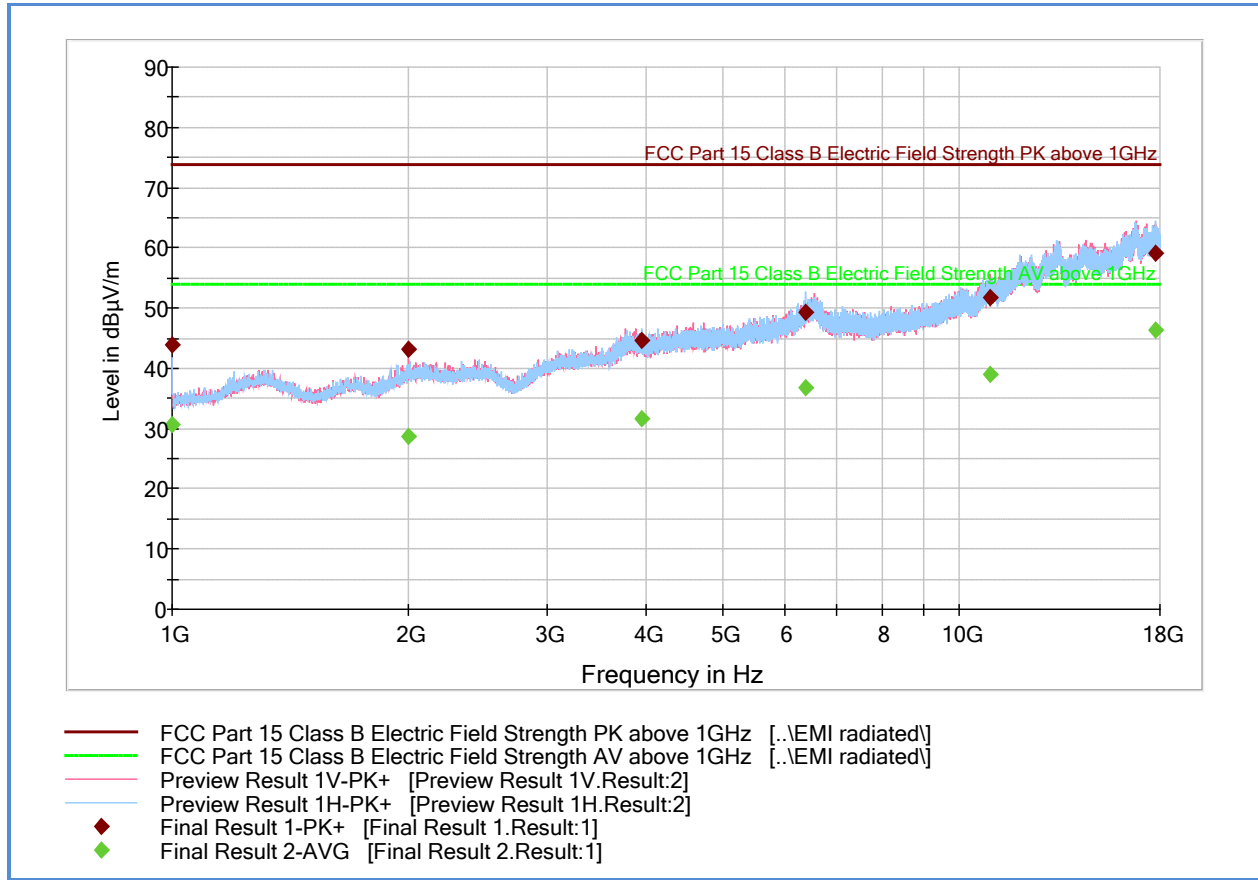
**Quasi Peak Data**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol   | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-------|---------------|------------|
| 35.615551       | 22.4               | 1000.0         | 120.000     | 350.0           | H               | -8.0        | -13.6 | 17.6          | 40.0       |
| 52.062766       | 29.6               | 1000.0         | 120.000     | 100.0           | V               | 243.0       | -19.2 | 10.4          | 40.0       |
| 81.268858       | 14.9               | 1000.0         | 120.000     | 166.0           | V               | 349.0       | -21.0 | 25.1          | 40.0       |
| 87.652745       | 18.7               | 1000.0         | 120.000     | 105.0           | H               | 342.0       | -20.3 | 21.3          | 40.0       |
| 296.552625      | 12.5               | 1000.0         | 120.000     | 150.0           | V               | 231.0       | -11.6 | 33.5          | 46.0       |
| 957.610581      | 22.1               | 1000.0         | 120.000     | 150.0           | V               | 231.0       | 2.4   | 23.9          | 46.0       |

**Test Notes:**



**2.10.11 Test Results Above 1GHz (Receive Mode)**



**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1000.00000      | 43.8             | 1000.0          | 1000.000        | 115.7       | H            | 15.0          | -7.0       | 30.1        | 73.9           |
| 1999.56666      | 43.2             | 1000.0          | 1000.000        | 406.7       | V            | 16.0          | -1.0       | 30.7        | 73.9           |
| 3955.93333      | 44.7             | 1000.0          | 1000.000        | 410.2       | H            | 0.0           | 6.0        | 29.2        | 73.9           |
| 6388.83333      | 49.2             | 1000.0          | 1000.000        | 250.3       | H            | 276.0         | 12.7       | 24.7        | 73.9           |
| 10973.56666     | 51.8             | 1000.0          | 1000.000        | 116.7       | V            | 240.0         | 17.0       | 22.1        | 73.9           |
| 17752.76666     | 59.1             | 1000.0          | 1000.000        | 313.2       | H            | 256.0         | 25.8       | 14.8        | 73.9           |

**Average Data**

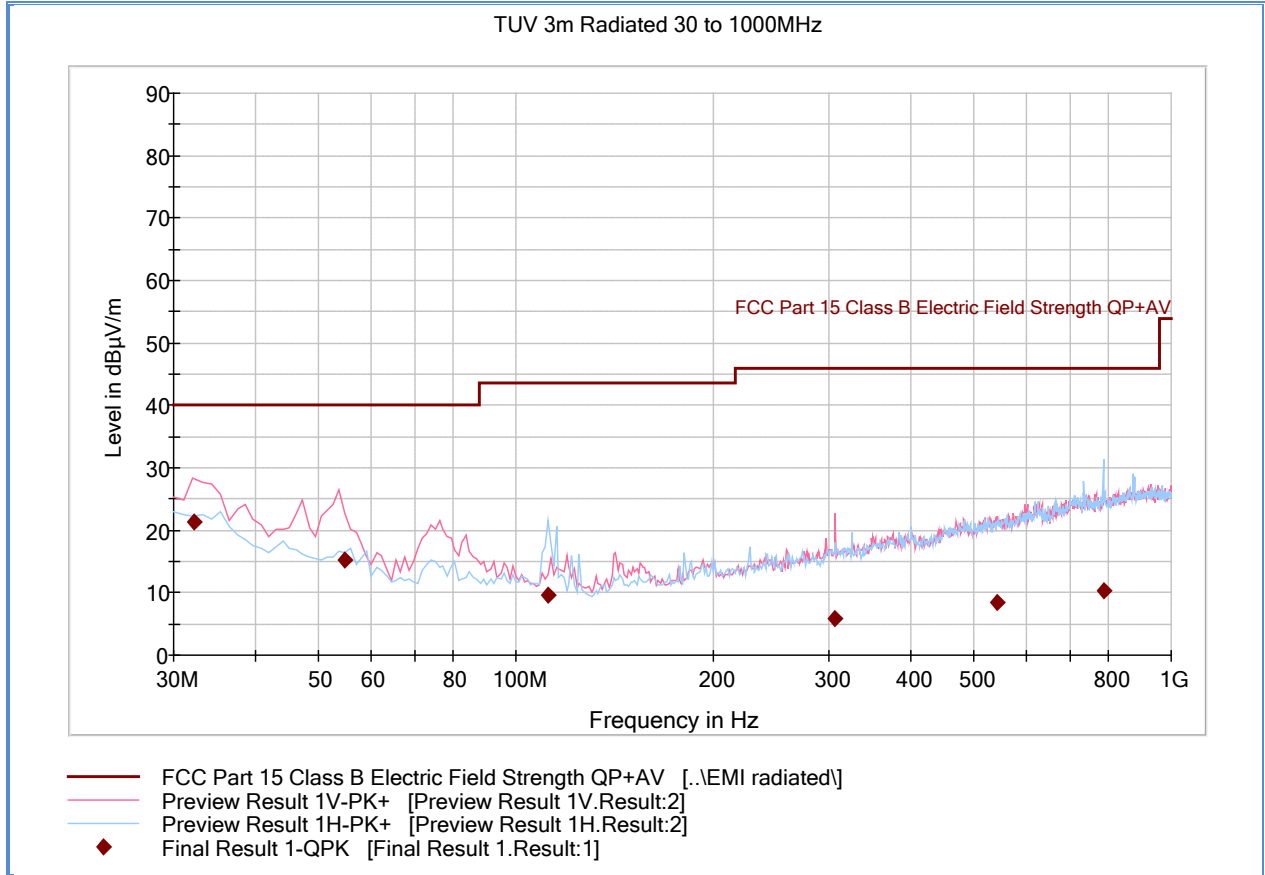
| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1000.00000      | 30.7             | 1000.0          | 1000.000        | 115.7       | H            | 15.0          | -7.0       | 23.2        | 53.9           |
| 1999.56666      | 28.6             | 1000.0          | 1000.000        | 406.7       | V            | 16.0          | -1.0       | 25.3        | 53.9           |
| 3955.93333      | 31.7             | 1000.0          | 1000.000        | 410.2       | H            | 0.0           | 6.0        | 22.2        | 53.9           |
| 6388.83333      | 36.7             | 1000.0          | 1000.000        | 250.3       | H            | 276.0         | 12.7       | 17.2        | 53.9           |
| 10973.56666     | 38.9             | 1000.0          | 1000.000        | 116.7       | V            | 240.0         | 17.0       | 15.0        | 53.9           |
| 17752.76666     | 46.4             | 1000.0          | 1000.000        | 313.2       | H            | 256.0         | 25.8       | 7.5         | 53.9           |

**Test Notes:**





**2.10.12 Test Results Below 1GHz (Bluetooth TX Worst Case – Non-hopping)**



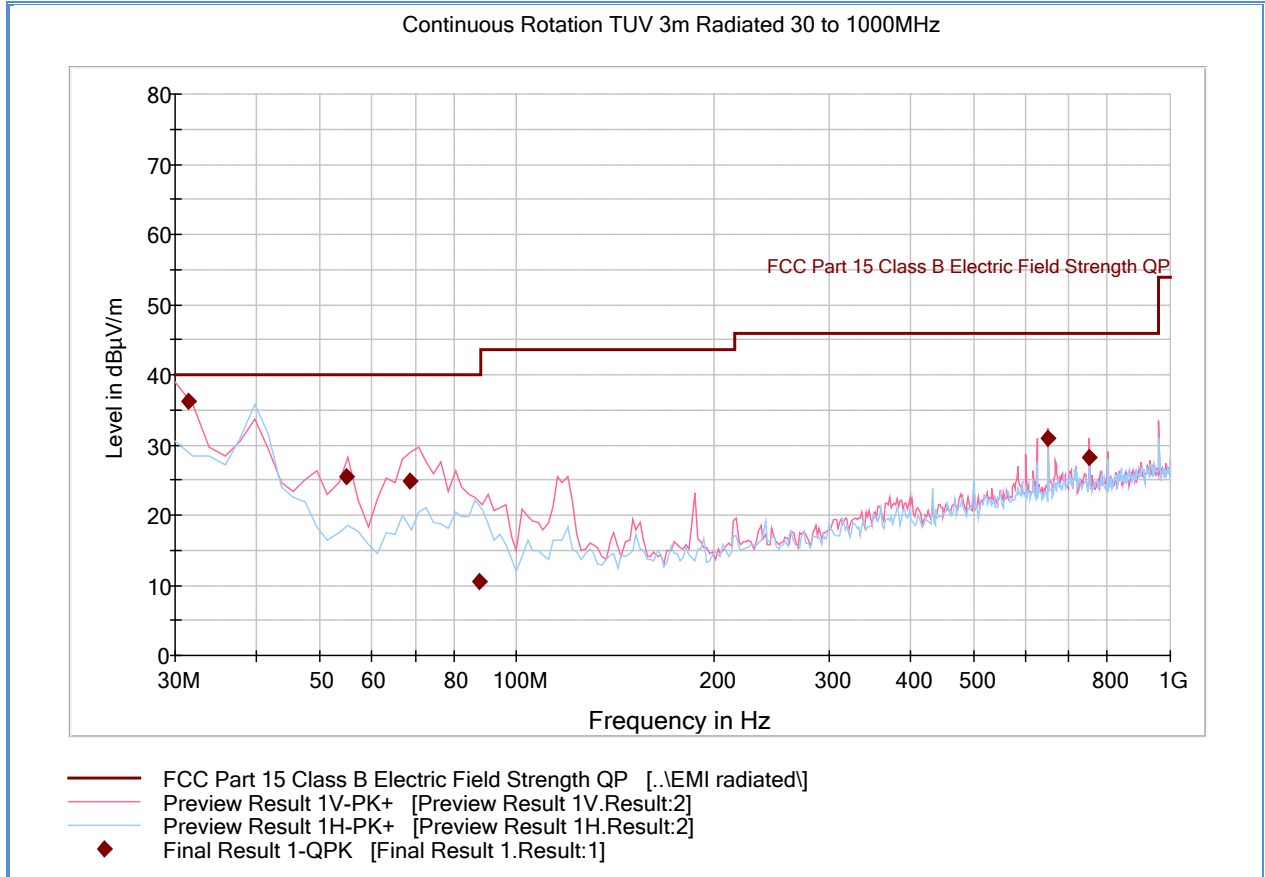
**Quasi Peak Data**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|--------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 32.195556       | 21.4               | 1000.0          | 120.000         | 100.0       | V            | 348.0         | -15.4      | 18.6        | 40.0           |
| 54.708889       | 15.2               | 1000.0          | 120.000         | 100.0       | V            | 312.0         | -24.3      | 24.8        | 40.0           |
| 111.831111      | 9.7                | 1000.0          | 120.000         | 103.0       | H            | 267.0         | -24.7      | 33.8        | 43.5           |
| 307.028889      | 6.0                | 1000.0          | 120.000         | 100.0       | V            | 318.0         | -19.4      | 40.0        | 46.0           |
| 543.022222      | 8.4                | 1000.0          | 120.000         | 100.0       | V            | 45.0          | -14.8      | 37.6        | 46.0           |
| 787.637778      | 10.2               | 1000.0          | 120.000         | 103.0       | H            | 114.0         | -11.1      | 35.8        | 46.0           |

**Test Notes:** Only worst case channel presented for spurious emissions below 1GHz.



**2.10.13 Test Results Below 1GHz (Bluetooth TX Hopping)**



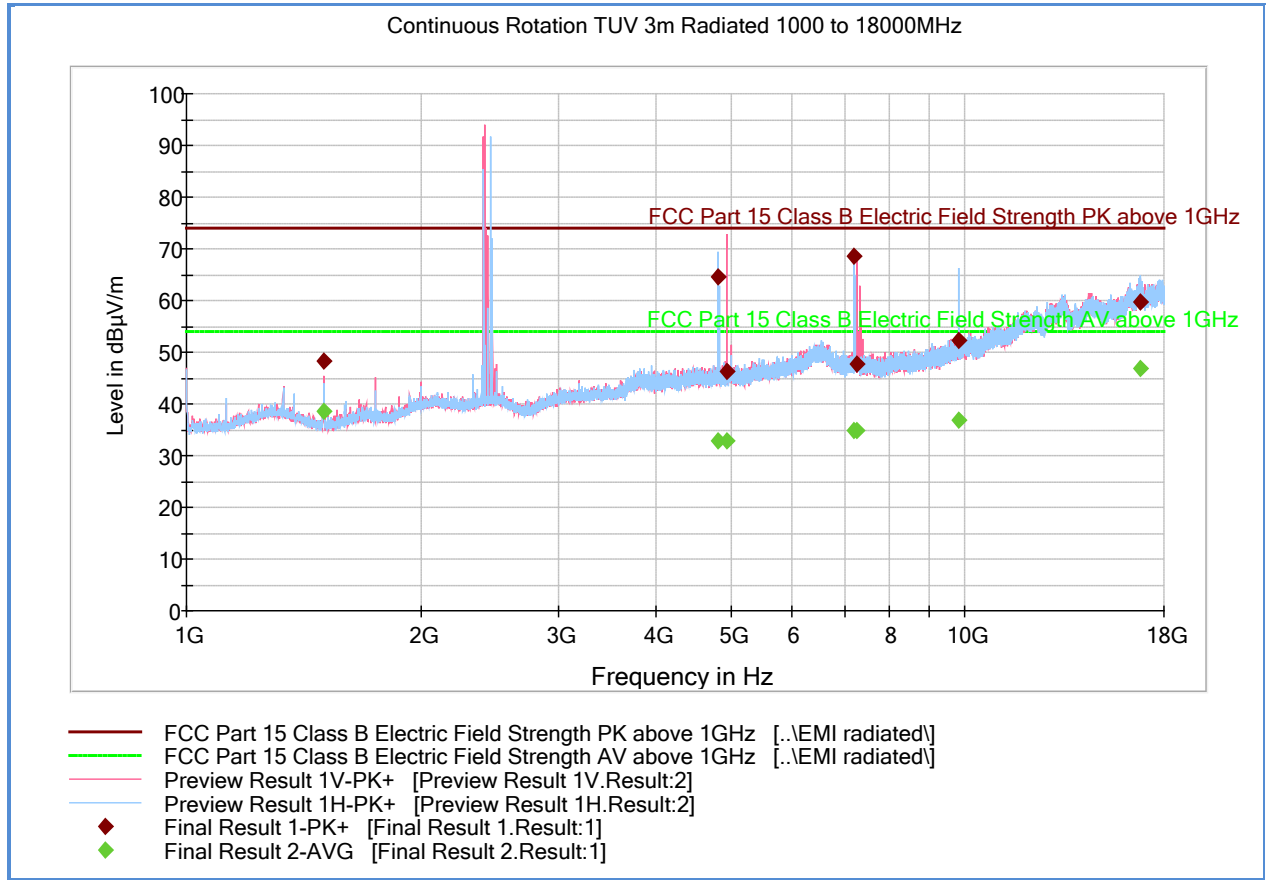
**Quasi Peak Data**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|--------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 31.360000       | 36.3               | 1000.0          | 120.000         | 100.0       | V            | 104.0         | -11.3      | 3.8         | 40.0           |
| 54.790541       | 25.5               | 1000.0          | 120.000         | 100.0       | V            | 180.0         | -19.9      | 14.5        | 40.0           |
| 68.741643       | 24.8               | 1000.0          | 120.000         | 100.0       | V            | 184.0         | -21.4      | 15.2        | 40.0           |
| 87.652745       | 10.5               | 1000.0          | 120.000         | 100.0       | V            | 293.0         | -20.3      | 29.5        | 40.0           |
| 650.020200      | 30.9               | 1000.0          | 120.000         | 109.0       | V            | 42.0          | -2.7       | 15.1        | 46.0           |
| 750.022365      | 28.3               | 1000.0          | 120.000         | 159.0       | V            | 270.0         | -0.8       | 17.7        | 46.0           |

**Test Notes:**



2.10.14 Test Results Above 1GHz (Bluetooth TX Hopping)



Peak Data

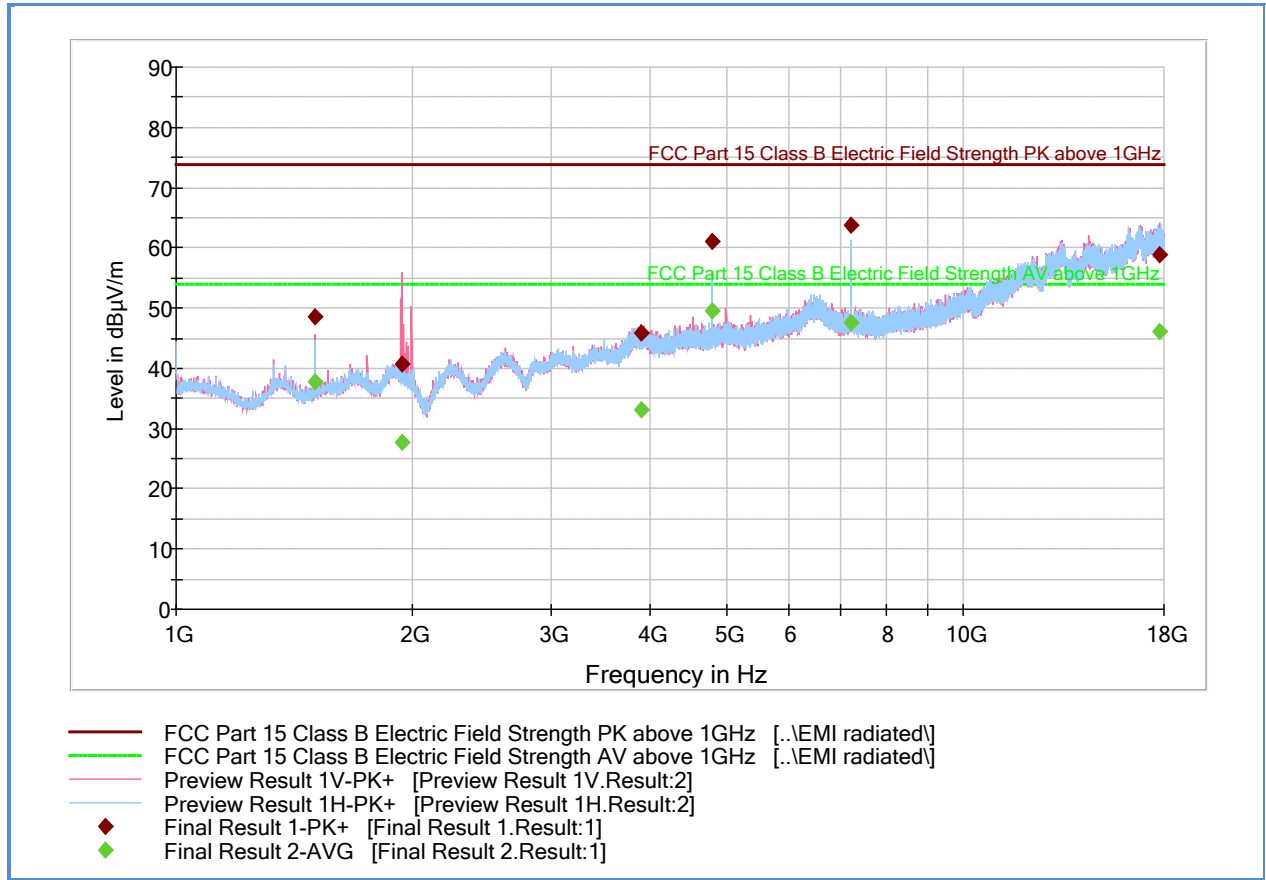
| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 48.3             | 1000.0          | 1000.000        | 122.0       | V            | 349.0         | -5.1       | 25.6        | 73.9           |
| 4812.900000     | 64.5             | 1000.0          | 1000.000        | 98.0        | H            | 27.0          | 6.8        | 9.4         | 73.9           |
| 4947.400000     | 46.2             | 1000.0          | 1000.000        | 137.0       | V            | 123.0         | 7.4        | 27.8        | 73.9           |
| 7208.600000     | 68.6             | 1000.0          | 1000.000        | 300.0       | H            | 70.0          | 11.3       | 5.3         | 73.9           |
| 7253.933333     | 47.7             | 1000.0          | 1000.000        | 263.0       | V            | 41.0          | 11.3       | 26.2        | 73.9           |
| 9823.600000     | 52.4             | 1000.0          | 1000.000        | 164.0       | H            | 91.0          | 13.9       | 21.5        | 73.9           |
| 16771.666667    | 59.7             | 1000.0          | 1000.000        | 191.0       | H            | 165.0         | 25.9       | 14.2        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 38.5             | 1000.0          | 1000.000        | 122.0       | V            | 349.0         | -5.1       | 15.4        | 53.9           |
| 4812.900000     | 32.7             | 1000.0          | 1000.000        | 98.0        | H            | 27.0          | 6.8        | 21.2        | 53.9           |
| 4947.400000     | 32.8             | 1000.0          | 1000.000        | 137.0       | V            | 123.0         | 7.4        | 21.1        | 53.9           |
| 7208.600000     | 34.9             | 1000.0          | 1000.000        | 300.0       | H            | 70.0          | 11.3       | 19.0        | 53.9           |
| 7253.933333     | 34.9             | 1000.0          | 1000.000        | 263.0       | V            | 41.0          | 11.3       | 19.0        | 53.9           |
| 9823.600000     | 36.8             | 1000.0          | 1000.000        | 164.0       | H            | 91.0          | 13.9       | 17.1        | 53.9           |

Test Notes: No significant emissions observed above 10GHz. Measurements above 10GHz are noise floor figures.

**2.10.15 Test Results Above 1GHz Low Channel (Bluetooth TX Worst Case)**



**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 48.5             | 1000.0          | 1000.000        | 165.6       | V            | -16.0         | -5.1       | 25.4        | 73.9           |
| 1937.466667     | 40.7             | 1000.0          | 1000.000        | 356.1       | V            | 0.0           | -1.4       | 33.2        | 73.9           |
| 3892.500000     | 45.9             | 1000.0          | 1000.000        | 350.6       | V            | 240.0         | 6.0        | 28.0        | 73.9           |
| 4804.233333     | 61.0             | 1000.0          | 1000.000        | 100.1       | V            | 56.0          | 6.8        | 12.9        | 73.9           |
| 7206.733333     | 63.8             | 1000.0          | 1000.000        | 228.4       | H            | 142.0         | 11.3       | 10.1        | 73.9           |
| 17755.033333    | 58.9             | 1000.0          | 1000.000        | 113.7       | V            | 62.0          | 25.8       | 15.0        | 73.9           |

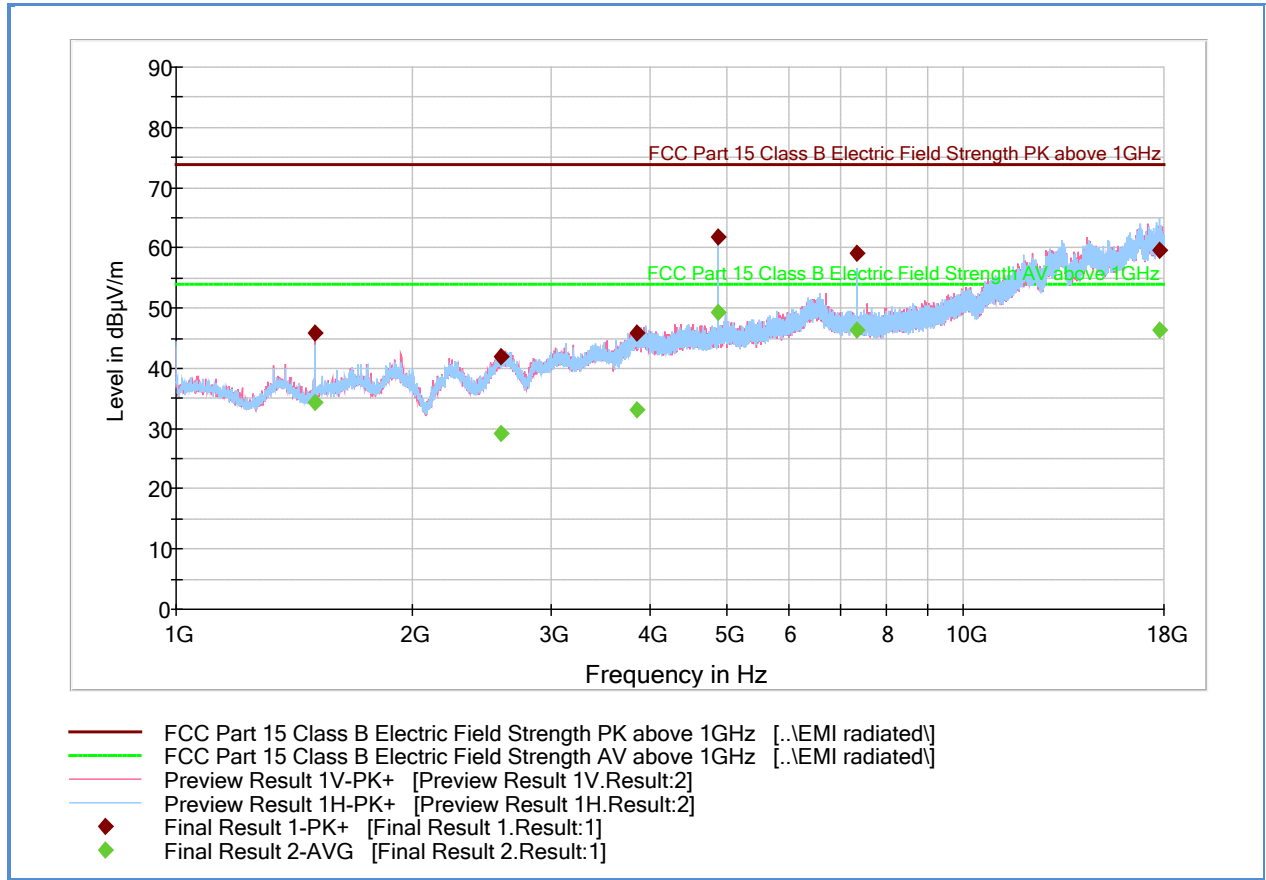
**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 37.8             | 1000.0          | 1000.000        | 165.6       | V            | -16.0         | -5.1       | 16.1        | 53.9           |
| 1937.466667     | 27.7             | 1000.0          | 1000.000        | 356.1       | V            | 0.0           | -1.4       | 26.2        | 53.9           |
| 3892.500000     | 33.2             | 1000.0          | 1000.000        | 350.6       | V            | 240.0         | 6.0        | 20.7        | 53.9           |
| 4804.233333     | 49.4             | 1000.0          | 1000.000        | 100.1       | V            | 56.0          | 6.8        | 4.5         | 53.9           |
| 7206.733333     | 47.5             | 1000.0          | 1000.000        | 228.4       | H            | 142.0         | 11.3       | 6.4         | 53.9           |
| 17755.033333    | 46.0             | 1000.0          | 1000.000        | 113.7       | V            | 62.0          | 25.8       | 7.9         | 53.9           |

**Test Notes:** Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.



**2.10.16 Test Results Above 1GHz Mid Channel (Bluetooth TX Worst Case)**



**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 45.8             | 1000.0          | 1000.000        | 103.7       | V            | 138.0         | -5.1       | 28.1        | 73.9           |
| 2590.466667     | 41.9             | 1000.0          | 1000.000        | 192.5       | V            | 204.0         | -0.2       | 32.0        | 73.9           |
| 3846.333333     | 45.9             | 1000.0          | 1000.000        | 219.4       | H            | 60.0          | 6.0        | 28.0        | 73.9           |
| 4880.366667     | 61.8             | 1000.0          | 1000.000        | 229.4       | V            | 257.0         | 7.1        | 12.1        | 73.9           |
| 7320.000000     | 59.1             | 1000.0          | 1000.000        | 182.6       | H            | 259.0         | 11.1       | 14.8        | 73.9           |
| 17757.466667    | 59.5             | 1000.0          | 1000.000        | 407.1       | H            | 232.0         | 25.8       | 14.4        | 73.9           |

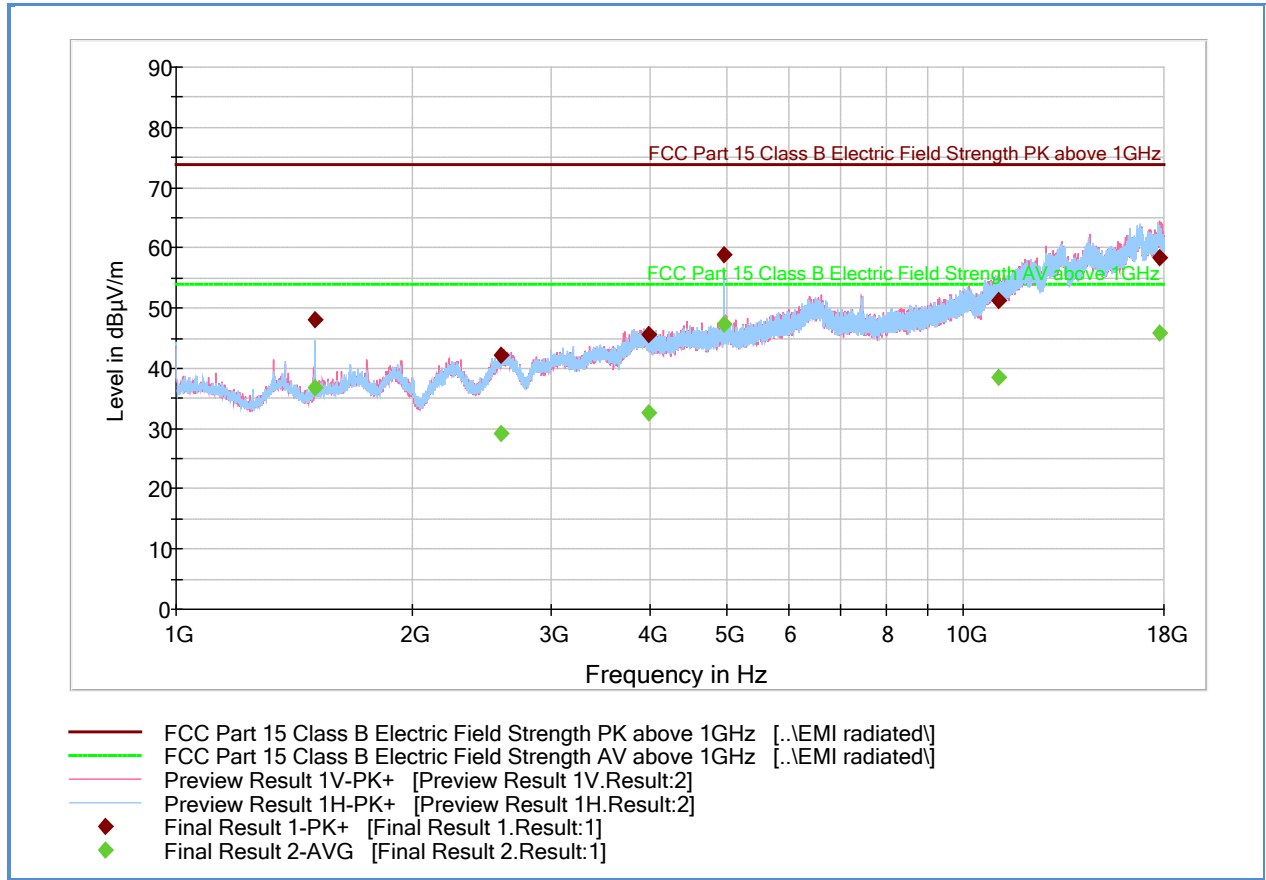
**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 34.2             | 1000.0          | 1000.000        | 103.7       | V            | 138.0         | -5.1       | 19.7        | 53.9           |
| 2590.466667     | 29.1             | 1000.0          | 1000.000        | 192.5       | V            | 204.0         | -0.2       | 24.8        | 53.9           |
| 3846.333333     | 33.0             | 1000.0          | 1000.000        | 219.4       | H            | 60.0          | 6.0        | 20.9        | 53.9           |
| 4880.366667     | 49.3             | 1000.0          | 1000.000        | 229.4       | V            | 257.0         | 7.1        | 4.6         | 53.9           |
| 7320.000000     | 46.4             | 1000.0          | 1000.000        | 182.6       | H            | 259.0         | 11.1       | 7.5         | 53.9           |
| 17757.466667    | 46.3             | 1000.0          | 1000.000        | 407.1       | H            | 232.0         | 25.8       | 7.6         | 53.9           |

**Test Notes:** Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.



**2.10.17 Test Results Above 1GHz High Channel (Bluetooth TX Worst Case)**



**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 48.0             | 1000.0          | 1000.000        | 99.7        | H            | 134.0         | -5.1       | 25.9        | 73.9           |
| 2585.566667     | 42.2             | 1000.0          | 1000.000        | 403.0       | H            | 37.0          | -0.2       | 31.7        | 73.9           |
| 3979.333333     | 45.7             | 1000.0          | 1000.000        | 121.7       | H            | 92.0          | 5.9        | 28.2        | 73.9           |
| 4960.066667     | 58.7             | 1000.0          | 1000.000        | 258.3       | V            | 224.0         | 7.4        | 15.2        | 73.9           |
| 11073.100000    | 51.3             | 1000.0          | 1000.000        | 151.6       | V            | 13.0          | 16.7       | 22.6        | 73.9           |
| 17780.900000    | 58.3             | 1000.0          | 1000.000        | 188.5       | V            | 51.0          | 25.8       | 15.6        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 1500.000000     | 36.8             | 1000.0          | 1000.000        | 99.7        | H            | 134.0         | -5.1       | 17.1        | 53.9           |
| 2585.566667     | 29.1             | 1000.0          | 1000.000        | 403.0       | H            | 37.0          | -0.2       | 24.8        | 53.9           |
| 3979.333333     | 32.7             | 1000.0          | 1000.000        | 121.7       | H            | 92.0          | 5.9        | 21.2        | 53.9           |
| 4960.066667     | 47.3             | 1000.0          | 1000.000        | 258.3       | V            | 224.0         | 7.4        | 6.6         | 53.9           |
| 11073.100000    | 38.5             | 1000.0          | 1000.000        | 151.6       | V            | 13.0          | 16.7       | 15.4        | 53.9           |
| 17780.900000    | 45.8             | 1000.0          | 1000.000        | 188.5       | V            | 51.0          | 25.8       | 8.1         | 53.9           |

**Test Notes:** Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.



## **2.11 RADIATED IMMEDIATE RESTRICTED BANDS**

### **2.11.1 Specification Reference**

Part 15 Subpart C §15.247(d)

### **2.11.2 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)).

### **2.11.1 Equipment Under Test and Modification State**

Serial No: 4532000604 and 4632081643/ Default Test Configuration

### **2.11.2 Date of Test/Initial of test personnel who performed the test**

July 03 and 09, 2014/FSC

### **2.11.3 Test Equipment Used**

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

### **2.11.4 Environmental Conditions/ Test Location**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |               |
|---------------------|---------------|
| Ambient Temperature | 20.9-25.3°C   |
| Relative Humidity   | 44.3-56.4%    |
| ATM Pressure        | 99.1-99.3 kPa |

### **2.11.5 Additional Observations**

- This is a radiated test. The spectrum was searched from 2310MHz to 2390MHz for lower immediate restricted band and 2483.5MHz to 2500MHz for the upper immediate restricted band.
- There are no emissions found that do not comply with the restricted bands defined in FCC Part 15 Subpart C, 15.205.
- Only Hopping modes presented. Non-hopping mode is covered under section 2.7 of this test report.



- 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 2.11.8 for sample computation.

**2.11.6 Sample Computation (Radiated Emission)**

|   |                           |             |
|---|---------------------------|-------------|
| Measuring equipment raw measurement (db $\mu$ V) @ 2400 MHz                   |                           | 53.9        |
| Correction Factor (dB)  | Asset# 1153 (cable)       | 3.4         |
|   | Asset# 8628(preamplifier) | -36.5       |
|   | Asset#7575 (antenna)      | 32.7        |
| <b>Reported Max Peak Final Measurement (db<math>\mu</math>V/m) @ 2400 MHz</b> |                           | <b>53.5</b> |

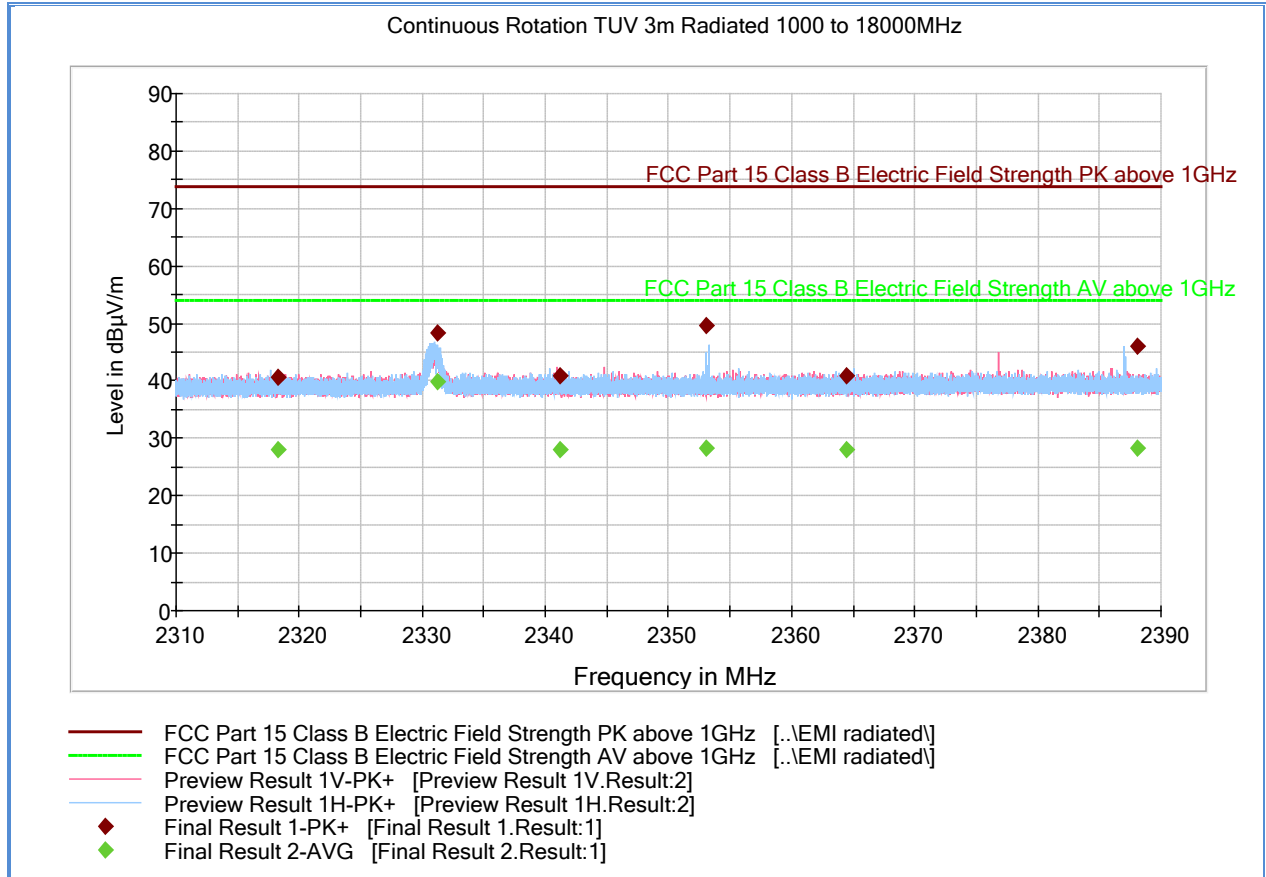
**2.11.7 Test Results**

See attached plots.





**2.11.8 Test Results Restricted Band 2310MHz to 2390MHz (Hopping)**



**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2318.325333     | 40.6             | 1000.0          | 1000.000        | 100.0       | H            | -6.0          | -0.5       | 33.3        | 73.9           |
| 2331.192000     | 48.3             | 1000.0          | 1000.000        | 100.1       | H            | 302.0         | -0.4       | 25.6        | 73.9           |
| 2341.165333     | 41.0             | 1000.0          | 1000.000        | 300.0       | V            | 316.0         | -0.4       | 32.9        | 73.9           |
| 2353.069333     | 49.5             | 1000.0          | 1000.000        | 100.0       | H            | 79.0          | -0.4       | 24.4        | 73.9           |
| 2364.429333     | 40.8             | 1000.0          | 1000.000        | 247.0       | H            | 15.0          | -0.4       | 33.1        | 73.9           |
| 2388.040000     | 46.0             | 1000.0          | 1000.000        | 100.0       | H            | 84.0          | -0.2       | 27.9        | 73.9           |

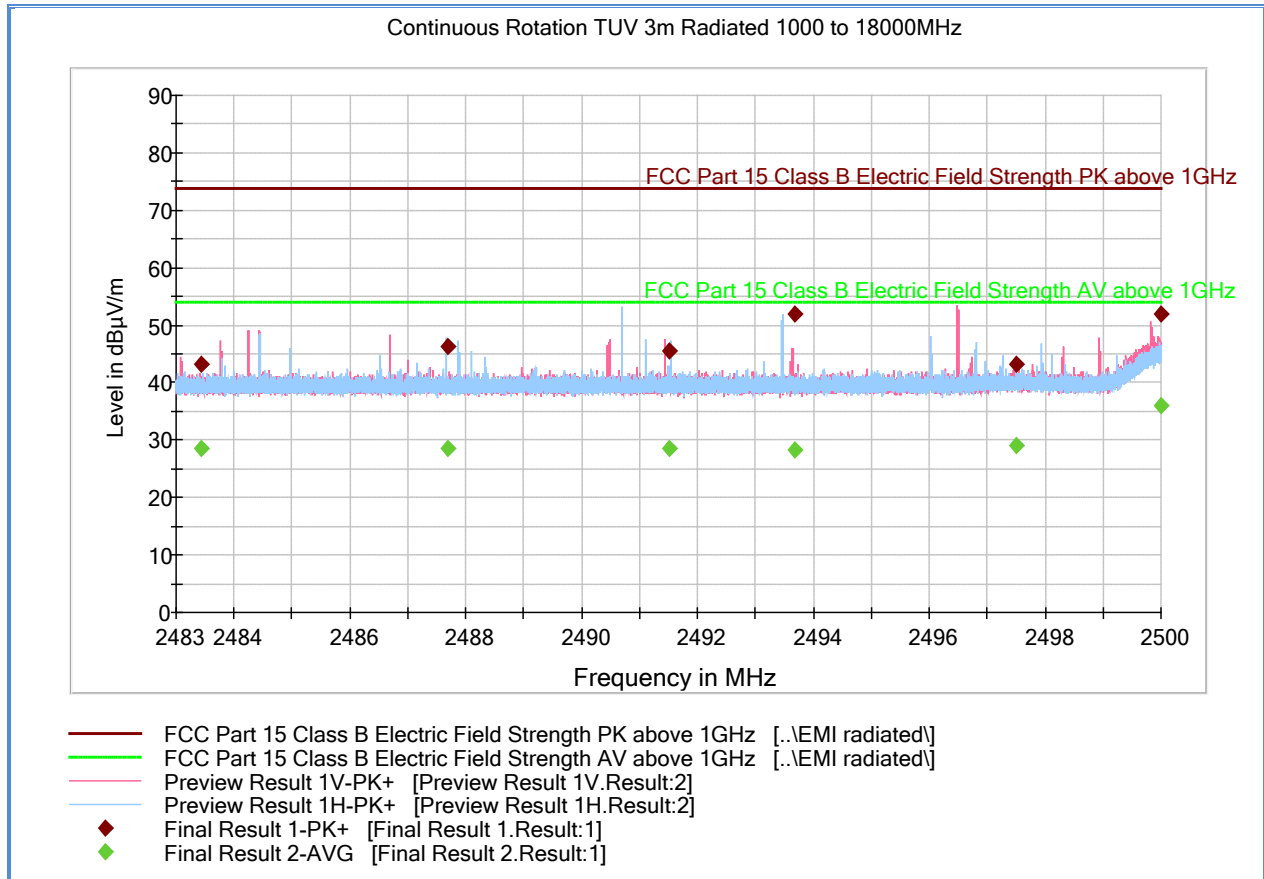
**Average Data**

| Frequency (MHz) | Average (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2318.325333     | 28.0             | 1000.0          | 1000.000        | 100.0       | H            | -6.0          | -0.5       | 25.9        | 53.9           |
| 2331.192000     | 39.7             | 1000.0          | 1000.000        | 100.1       | H            | 302.0         | -0.4       | 14.2        | 53.9           |
| 2341.165333     | 28.0             | 1000.0          | 1000.000        | 300.0       | V            | 316.0         | -0.4       | 25.9        | 53.9           |
| 2353.069333     | 28.3             | 1000.0          | 1000.000        | 100.0       | H            | 79.0          | -0.4       | 25.6        | 53.9           |
| 2364.429333     | 28.0             | 1000.0          | 1000.000        | 247.0       | H            | 15.0          | -0.4       | 25.9        | 53.9           |
| 2388.040000     | 28.4             | 1000.0          | 1000.000        | 100.0       | H            | 84.0          | -0.2       | 25.5        | 53.9           |

**Test Notes:** 2.4GHz notch filter removed for this test.



**2.11.9 Test Results Restricted Band 2483.5MHz to 2500MHz (Hopping)**



**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2483.439333     | 43.3             | 1000.0          | 1000.000        | 200.0       | V            | 172.0         | 0.1        | 30.6        | 73.9           |
| 2487.684467     | 46.3             | 1000.0          | 1000.000        | 200.0       | V            | 20.0          | 0.2        | 27.6        | 73.9           |
| 2491.507233     | 45.5             | 1000.0          | 1000.000        | 191.0       | H            | 39.0          | 0.2        | 28.4        | 73.9           |
| 2493.680500     | 52.0             | 1000.0          | 1000.000        | 191.0       | H            | 71.0          | 0.2        | 21.9        | 73.9           |
| 2497.494600     | 43.1             | 1000.0          | 1000.000        | 100.0       | V            | 111.0         | 0.2        | 30.8        | 73.9           |
| 2500.000000     | 52.1             | 1000.0          | 1000.000        | 100.0       | V            | 19.0          | 0.2        | 21.8        | 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) |
|-----------------|------------------|-----------------|-----------------|-------------|--------------|---------------|------------|-------------|----------------|
| 2483.439333     | 28.6             | 1000.0          | 1000.000        | 200.0       | V            | 172.0         | 0.1        | 25.3        | 53.9           |
| 2487.684467     | 28.5             | 1000.0          | 1000.000        | 200.0       | V            | 20.0          | 0.2        | 25.4        | 53.9           |
| 2491.507233     | 28.6             | 1000.0          | 1000.000        | 191.0       | H            | 39.0          | 0.2        | 25.3        | 53.9           |
| 2493.680500     | 28.4             | 1000.0          | 1000.000        | 191.0       | H            | 71.0          | 0.2        | 25.5        | 53.9           |
| 2497.494600     | 29.0             | 1000.0          | 1000.000        | 100.0       | V            | 111.0         | 0.2        | 24.9        | 53.9           |
| 2500.000000     | 35.9             | 1000.0          | 1000.000        | 100.0       | V            | 19.0          | 0.2        | 18.0        | 53.9           |

**Test Notes:** 2.4GHz notch filter removed for this test.



**2.12 RECEIVER SPURIOUS EMISSIONS**

**2.12.1 Specification Reference**

RSS-Gen 6.0

**2.12.2 Standard Applicable**

Receivers shall comply with the limits of spurious emissions set out in this section, measured over the frequency range determined in accordance with Section 4.10 of RSS-Gen.

**Table 2: Radiated Limits of Receiver Spurious Emissions**

| Frequency (MHz) | Field Strength (microvolts/m at 3 metres)* |
|-----------------|--|
| 30-88           | 100  |
| 88-216          | 150  |
| 216-960         | 200  |
| Above 960       | 500  |

\*Measurements for compliance with limits in the above table may be performed at distances other than 3 metres, in accordance with Section 7.2.7 of RSS-Gen.

**2.12.1 Equipment Under Test and Modification State**

Serial No: 4532000604/Default Test Configuration

**2.12.2 Date of Test/Initial of test personnel who performed the test**

July 03 and 09, 2014/FSC

**2.12.3 Test Equipment Used**

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

**2.12.4 Environmental Conditions/ Test Location**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

|                     |               |
|---------------------|---------------|
| Ambient Temperature | 20.9-25.3°C   |
| Relative Humidity   | 44.3-56.4%    |
| ATM Pressure        | 99.1-99.3 kPa |

**2.12.5 Additional Observations**

- This is a radiated test. The spectrum was searched from 30MHz to the 3<sup>rd</sup> harmonic (up to 10<sup>th</sup> performed).
- Result identical to Section 2.10.10 and 2.10.11 of this test report.
- EUT in RX (Receive) mode configuration.



### **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 1188 and 1049 |              |
| 1016                  | Pre-amplifier                               | PAM-0202           | 187           | PAM                        | 10/08/13                  | 10/08/14     |
| 1188                  | Signal Generator                            | 2024               | 112282/488    | Marconi                    | 09/05/13                  | 09/05/14     |
| 1003                  | Signal Generator                            | SMR-40             | 1104.0002.40  | Rhode & Schwarz            | 01/20/14                  | 01/20/15     |
| Miscellaneous         |   |                    |               |                            |                           |              |
| 6452                  | Multimeter                                  | 3478A              | 2911A52177    | Hewlett Packard            | 08/02/13                  | 09/02/14     |
| 7554                  | Barometer/Temperature /Humidity Transmitter | iBTHX-W            | 0400706       | Omega                      | 01/30/14                  | 01/30/15     |
| 1123                  | DC Power Supply                             | E3631A             | N/A           | Hewlett Packard            | Verified by 6452          |              |
|                       | Test Software                               | EMC32              | V8.53         | Rhode & Schwarz            | N/A                       |              |



### 3.2 MEASUREMENT UNCERTAINTY

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

#### 3.2.1 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         |

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

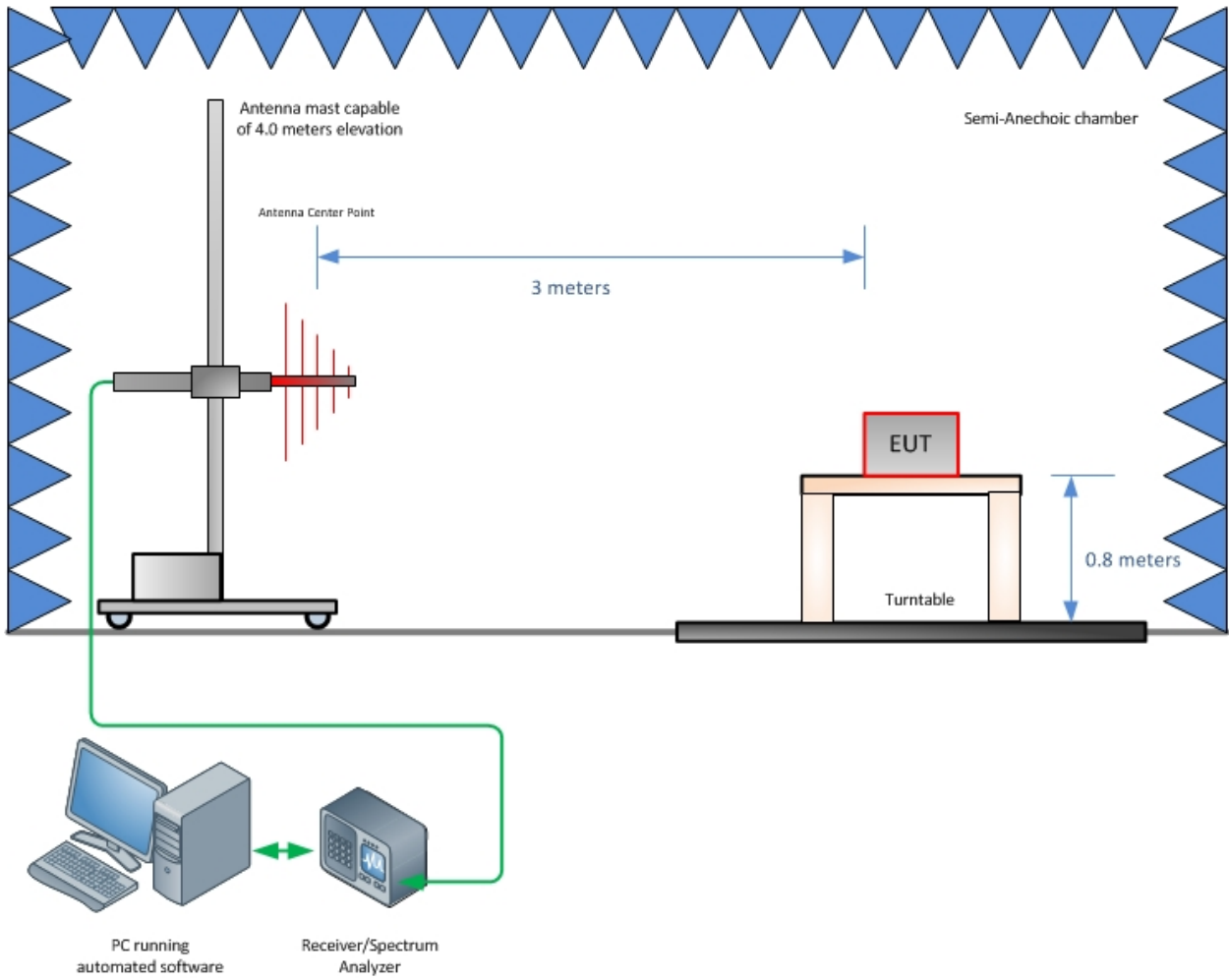
| Contribution                    |                            | Probability Distribution Type | Probability Distribution $x_i$ | Standard Uncertainty $u(x_i)$ | $[u(x_i)]^2$ |
|---------------------------------|----------------------------|-------------------------------|--------------------------------|-------------------------------|--------------|
| 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 4

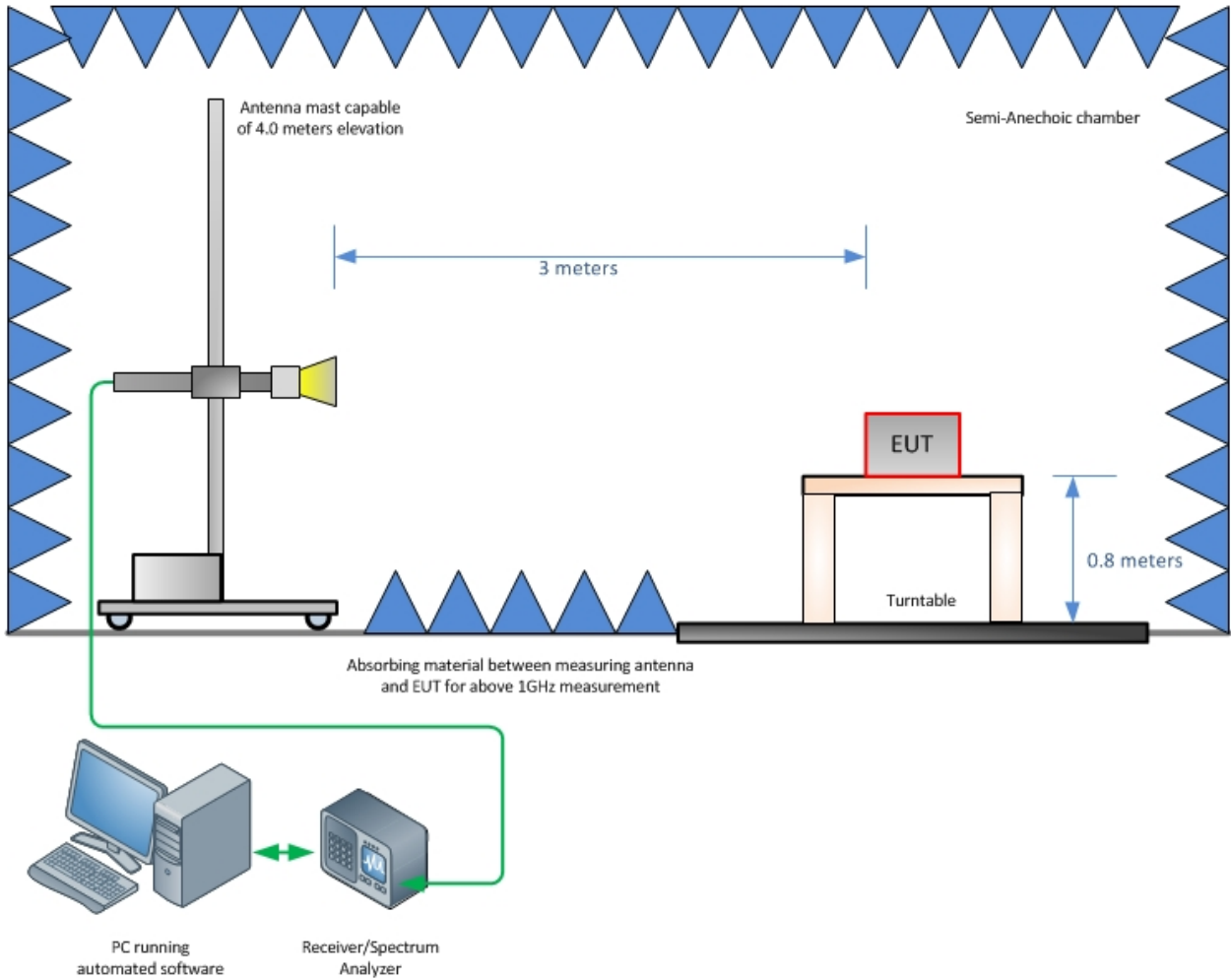
### DIAGRAM OF TEST SETUP

#### 4.1 TEST SETUP DIAGRAM



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





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



## SECTION 5

### ACCREDITATION, DISCLAIMERS AND COPYRIGHT



## 5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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