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# Report On

Application for Grant of Equipment Authorization of the
CalAmp Wireless Networks Corp.
CalAmp BlueBoard Bluetooth Daughter Board

FCC Part 15 Subpart C §15.247 (DTS)
RSS-247 Issue 1 May 2015

**Report No. SD72115091-0316A** **March 2016**

| | |
|---|---|
| **REPORT ON** | Radio Testing of the<br>CalAmp Wireless Networks Corp.<br>Bluetooth Daughter Board |
| **TEST REPORT NUMBER** | SD72115091-0316A |
| **PREPARED FOR** | CalAmp Wireless Networks Corp.<br>2177 Salk Ave, Suite 200<br>San Diego, CA 92008 |
| **CONTACT PERSON** | Imad Rizk<br>Carrier & Product Certification Manager<br>(760) 814-9697<br>IRizk@CalAmp.com |
| **PREPARED BY** | Ferdinand S. Custodio<br>**Name**<br>Authorized Signatory<br>Title: EMC/Senior Wireless Test Engineer |
| **APPROVED BY** | Chip R. Fleury<br>**Name**<br>Authorized Signatory |
| **DATED** | March 09, 2016 |



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

**Revision History**

| SD72115091-0316A<br>CalAmp Wireless Networks Corp.<br>CalAmp BlueBoard<br>Bluetooth Daughter Board | | | | | |
|---|---|---|---|---|---|
| DATE | OLD REVISION | NEW REVISION | REASON | PAGES AFFECTED | APPROVED BY |
| 03/09/2016 | Initial Release | | | | Chip R. Fleury |
| | | | | | |
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**SECTION 1**

**REPORT SUMMARY**

Radio Testing of the
CalAmp Wireless Networks Corp.
Bluetooth Daughter Board



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## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the CalAmp Wireless Networks Corp. CalAmp BlueBoard Bluetooth Daughter Board to the requirements of FCC Part 15 Subpart C §15.247 and RSS-247 Issue 1 May 2015.

| | |
|---|---|
| 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) | BRD01 |
| FCC ID Number | APV-BRD01 |
| IC Number | 5843C-BRD01 |
| Serial Number(s) | N/A |
| Number of Samples Tested | 2 |
| Test Specification/Issue/Date | • FCC Part 15 Subpart C §15.247 (October 1, 2015).<br>• RSS-247 Issue 1 May 2015 - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.<br>• RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 4, November 2014).<br>• 558074 D01 DTS Meas Guidance v03r04,(January 07,2016) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.<br>• ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| Start of Test | March 01, 2016 |
| Finish of Test | March 08, 2016 |
| Name of Engineer(s) | Ferdinand Custodio |
| Related Document(s) | None. Supporting documents for EUT certification are separate exhibits. |



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## 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/ Base Standard |
|---|---|---|---|---|---|
| 2.1 | §15.247(b)(3) | RSS-247 5.4(4) | Peak Output Power | Compliant | |
| 2.2 | §15.207(a) | RSS-Gen 8.8 | Conducted Emissions | N/A | |
| 2.3 | | RSS-Gen 6.6 | 99% Emission Bandwidth | Compliant | |
| 2.4 | §15.247(a)(2) | RSS-247 5.2(1) | Minimum 6 dB RF Bandwidth | Compliant | |
| 2.5 | §15.247(d) | RSS-247 5.5 | Out-of-Band Emissions - Conducted | Compliant | |
| 2.6 | §15.247(d) | RSS-247 5.5 | Band-edge Compliance of RF Conducted Emissions | Compliant | |
| 2.7 | §15.247(d) | RSS-Gen 8.9 and 8.10 | Spurious Radiated Emissions | Compliant | |
| 2.8 | §15.247(e) | RSS-247 5.2(2) | Power Spectral Density for Digitally Modulated Device | Compliant | |

*N/A Not performed. EUT is a RF module*



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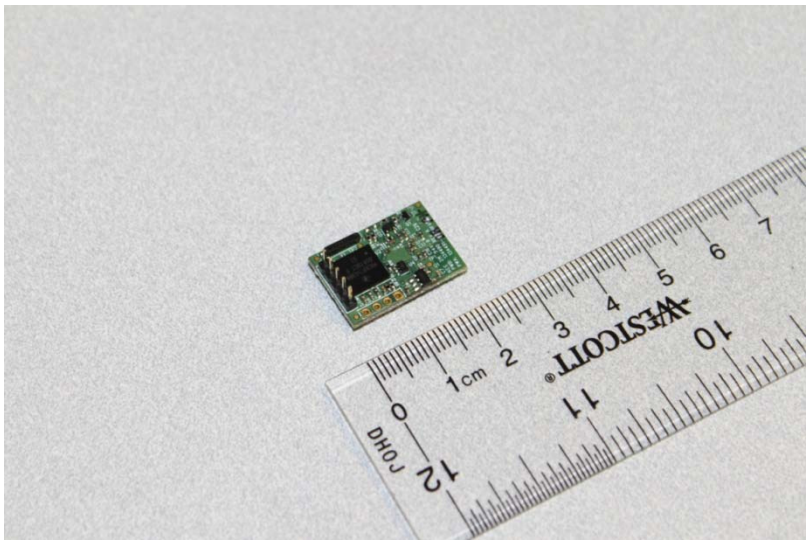
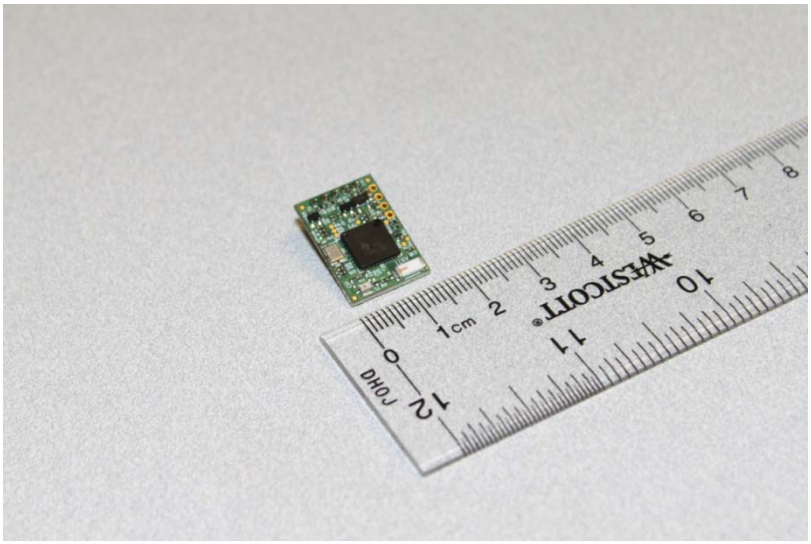
## 1.3 PRODUCT INFORMATION

### 1.3.1 Technical Description

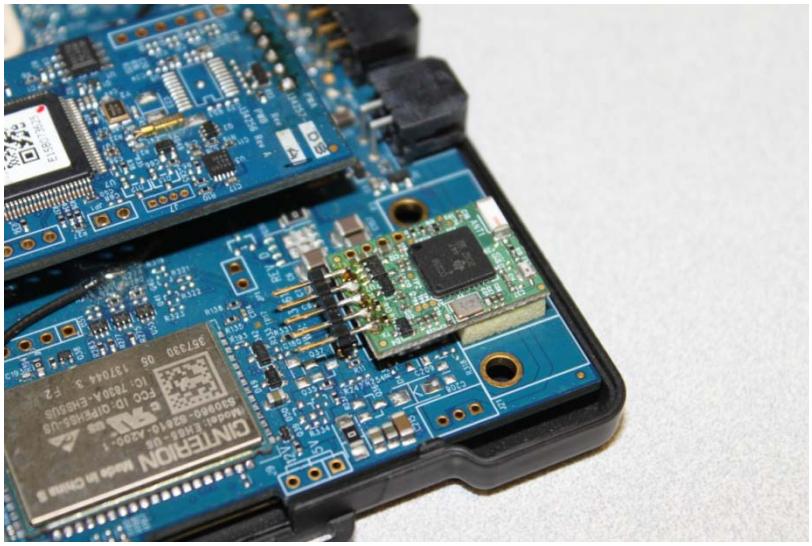
The Equipment Under Test (EUT) was an CalAmp Wireless Networks Corp. CalAmp BlueBoard Bluetooth Daughter Board as shown in the photograph below. The EUT is a Bluetooth module used as an option to add Bluetooth connectivity to CalAmp Devices. The EUT when installed in Calamp LMU/TTU products provides wireless connectivity for programming and configuration purposes. Without this option, LMU/TTU products need to be connected via a serial cable. This can be done inside the vehicle or by physically removing the unit from the vehicle.




**Equipment Under Test**


**LMU4230H used as a host for LMA application**



**Header installed on the EUT to facilitate RF module configuration via USB**

### 1.3.2 EUT General Description

| | |
|---|---|
| EUT Description | Bluetooth Daughter Board |
| Model Name | CalAmp BlueBoard |
| Model Number(s) | BRD01 |
| Rated Voltage | 5VDC via USB |
| Mode Verified | Bluetooth Low Energy (BT LE) |
| Capability | Dual-Mode Bluetooth (Bluetooth Basic Rate (BR), Enhanced Data Rate (EDR) and Low Energy (LE) Support) |
| Primary Unit (EUT) | ☐ Production |
| | ☒ Pre-Production |
| | ☐ Engineering |
| Antenna Type | RF Ceramic Chip antenna |
| Antenna Manufacturer | Johanson Technology |
| Antenna Model Number | 2.45 GHZ Antenna P/N 2450AT42A100 |
| Antenna Dimensions | 5.00mm x 2.00mm x 1.10mm |
| Antenna Gain | 0 dBi (Peak) |

### 1.3.3 Maximum Peak Conducted Output Power

| Mode | Frequency Range (MHz) | Output Power (dBm) | Output Power (mW) |
|---|---|---|---|
| Bluetooth LE | 2402-2480 | 11.515 | 14.17 |



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## 1.4 EUT TEST CONFIGURATION

### 1.4.1 Test Configuration Description

| Test Configuration | Description |
|---|---|
| Default | EUT connected to a support laptop via USB. The CC256x Bluetooth Hardware Evaluation Tool provided by the manufacturer was used to configure RF parameter of the EUT. For BT LE testing, the "Bluetooth_init_cc2564_2.10.bts" service pack was modified (Sleep Mode disable) and loaded. Continuous TX test mode was used with BT LE modulation and PN9 (Pseudo-Random) test pattern. TX power is set to maximum by default and can't be modified. The EUT was verified by itself during antenna conducted port measurements and inside a host for radiated measurements. |

### 1.4.2 EUT Exercise Software

CC256x Bluetooth Hardware Evaluation Tool Version 1.0 Texas Instruments January 2013. User Guide: http://processors.wiki.ti.com/index.php/CC256x_Bluetooth_Hardware_Evaluation_Tool.

### 1.4.3 Support Equipment and I/O cables

| Manufacturer | Equipment/Cable | Description |
|---|---|---|
| HP | Support Laptop | Elitebook 8560p S/N 5CB207539Y |
| HP | AC Adapter for support laptop | Model Series PPP012H-S |
| Armorview | USB to TTL UART RS232 | PL2303HX USB with 0.9m cable (x4 conductors) |
| CalAmp | Fleet Management/Tracking Device | LMU4230H FCC ID:APV-4230HBT /IC: 5843C-4230HBT |
| CalAmp | Power Cable | Power cable for LMU4230H (2.1 meters with 4 conductors and Molex connector. Two cables are fused) |

### 1.4.4 Worst Case Configuration

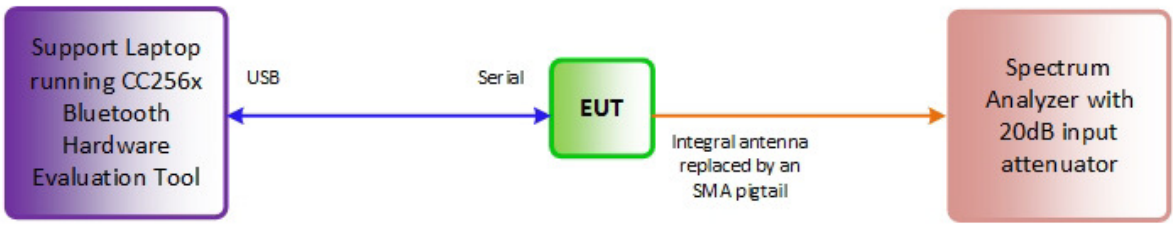
Worst-case configuration used in this test report as per maximum conducted output power measurements:

| Mode | Channel | Data Rate |
|---|---|---|
| Bluetooth LE | 17 (Mid Channel) | 1Mbps |

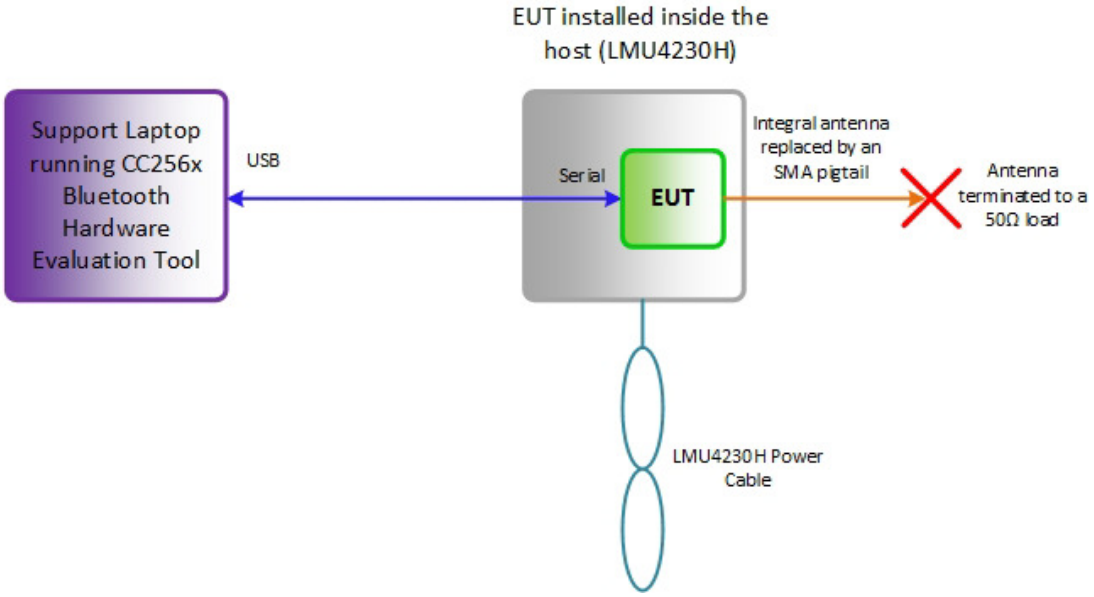
EUT is an RF module. For radiated measurements, the EUT was verified inside a host using the worse case axis ("X") for the host (verified via prescan).

### 1.4.5 **Simplified Test Configuration Diagram**

Antenna Conducted Port Measurements




Radiated Emissions Test Configuration



## 1.5 DEVIATIONS FROM THE STANDARD

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

## 1.6 MODIFICATION RECORD

| Description of Modification | Modification Fitted By | Date Modification Fitted |
|---|---|---|
| Serial Number N/A | | |
| 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 C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

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 C63.4-2014. 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)

16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678 1400 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.
Bluetooth Daughter Board



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## 2.1 PEAK OUTPUT POWER

### 2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3) and RSS-247 5.4(4)

### 2.1.2 Standard Applicable

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

### 2.1.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 01, 2016/FSC

### 2.1.5 Test Equipment Used

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

### 2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 25.2 °C |
| Relative Humidity | 40.9 % |
| ATM Pressure | 99.5 kPa |

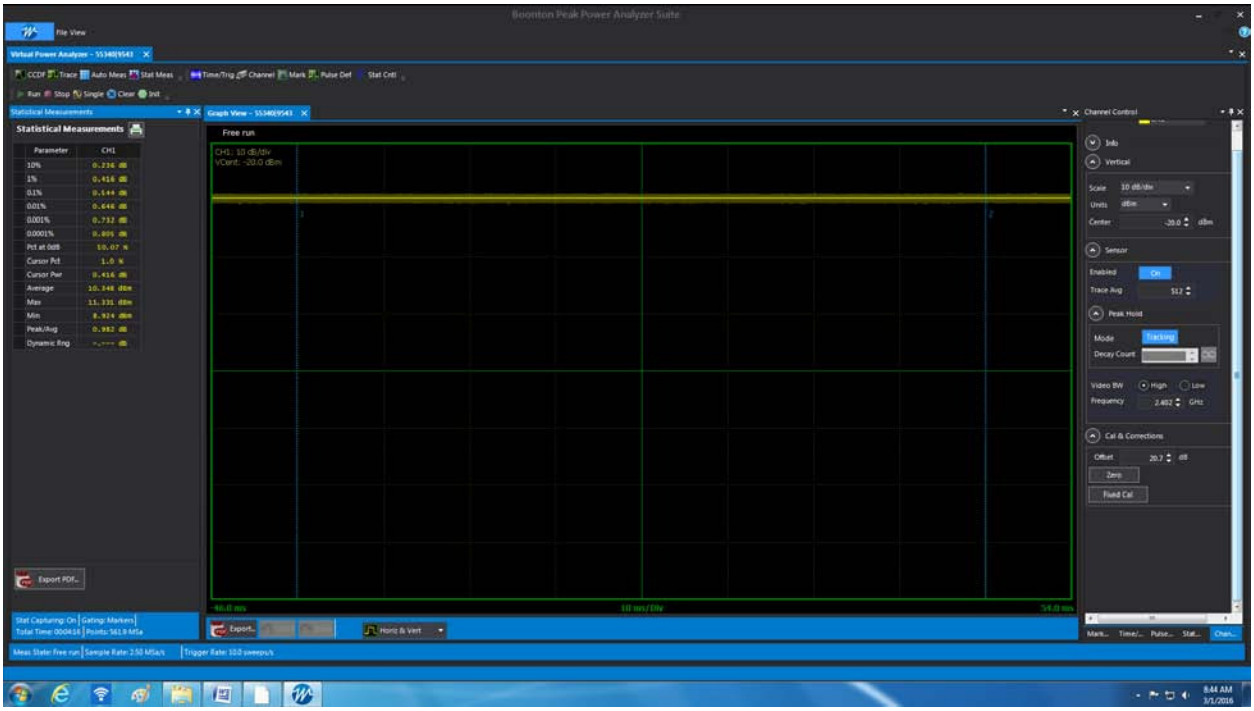
### 2.1.7 Additional Observations

- This is a conducted test (Maximum peak conducted output power) using direct connection to a broadband power meter with a video bandwidth greater than the DTS bandwidth.
- An offset of 20.9dB was added to compensate for the external attenuator and cable used from the antenna port to the power sensor.
- Test methodology is per Clause 9.1.2 of KDB 558074 D01 DTS Meas Guidance v03r04,(January 07,2016) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.
- Both Peak and Average measurements were recorded.

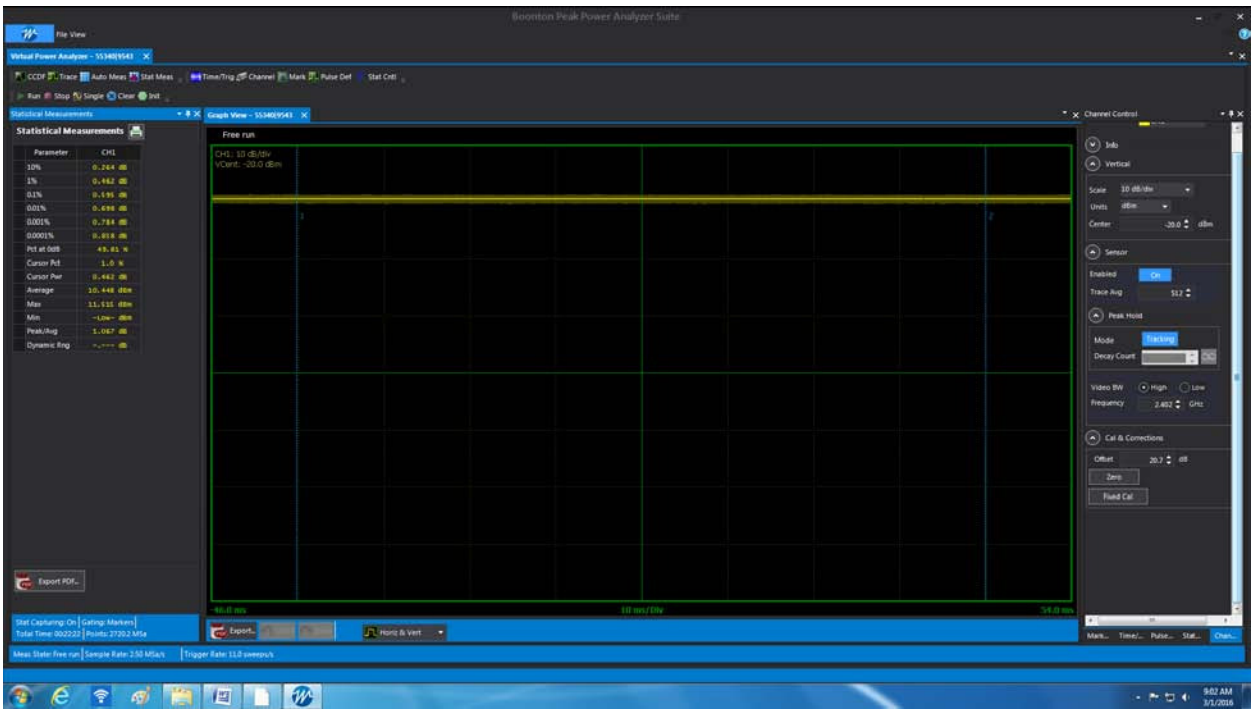
### 2.1.8 Test Results

| Bluetooth Low Energy (LE) | Channel | Modulation | Measured Average Power (dBm) | Measured Peak Power (dBm) |
|---|---|---|---|---|
| | 37 (2402 MHz) | GFSK using PN9 (Pseudo-Random) | 10.348 | 11.331 |
| | 17 (2440 MHz) | | 10.448 | 11.515 |
| | 39 (2480 MHz) | | 10.276 | 11.491 |

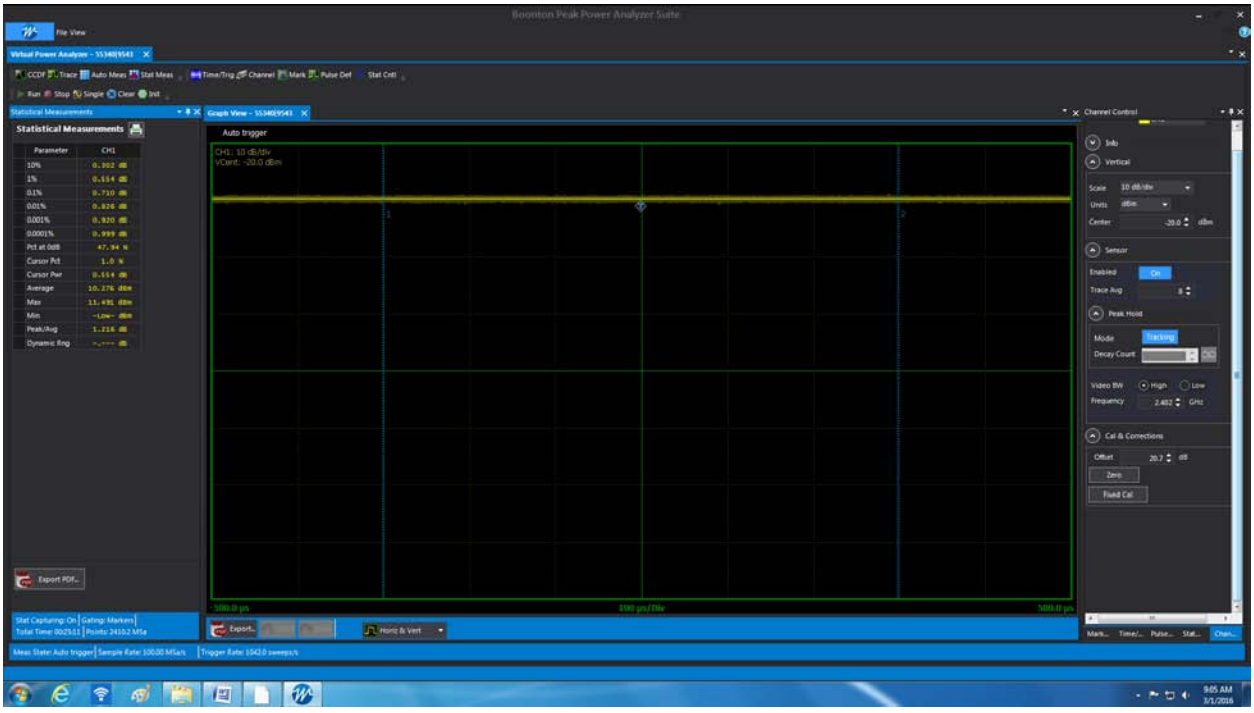
### 2.1.9 Test Plots



**Low Channel BT LE PN9 (Pseudo-Random)**

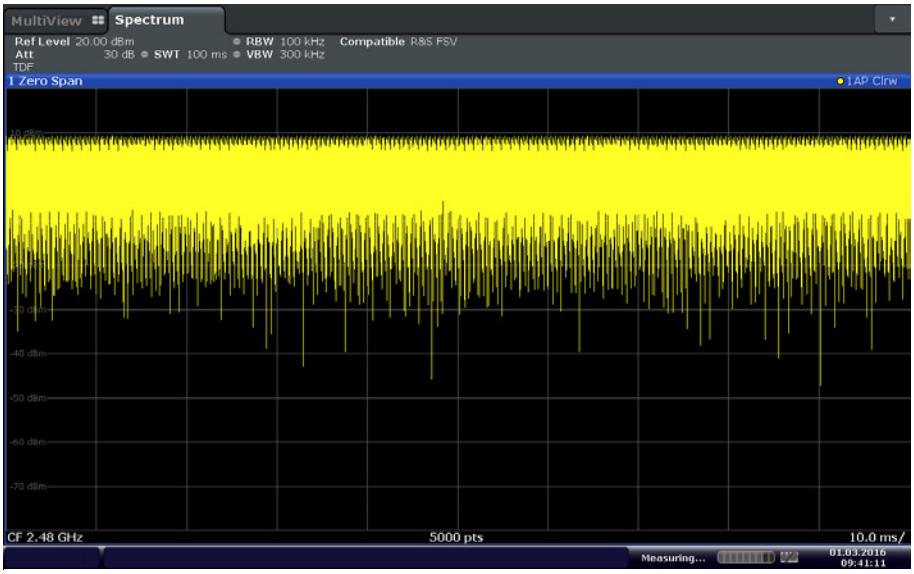


**Mid Channel BT LE PN9 (Pseudo-Random)**



**High Channel BT LE PN9 (Pseudo-Random)**

### 2.1.10 **Duty Cycle Verification**




**100ms sweep plot showing 100% duty cycle (Duty Cycle Measurement Factor calculation not required)**

## 2.2 CONDUCTED EMISSIONS

### 2.2.1 Specification Reference

Part 15 Subpart C §15.207(a) and RSS-Gen 8.8

### 2.2.2 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 µH/50 ohms line impedance stabilization network (LISN).

| Frequency of emission (MHz) | Conducted limit (dBµV) | |
|---|---|---|
| | 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.*

### 2.2.3 Equipment Under Test and Modification State

Not performed. EUT is a RF module. AC Conducted Emissions should be performed on the final host where the EUT will be integrated.

## 2.3 99% EMISSION BANDWIDTH

### 2.3.1 Specification Reference

RSS-Gen Clause 6.6

### 2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 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 (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level 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 (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

### 2.3.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 04, 2016/FSC

### 2.3.5 Test Equipment Used

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

### 2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.6 °C |
| Relative Humidity | 43.8.% |
| ATM Pressure | 99.3 kPa |

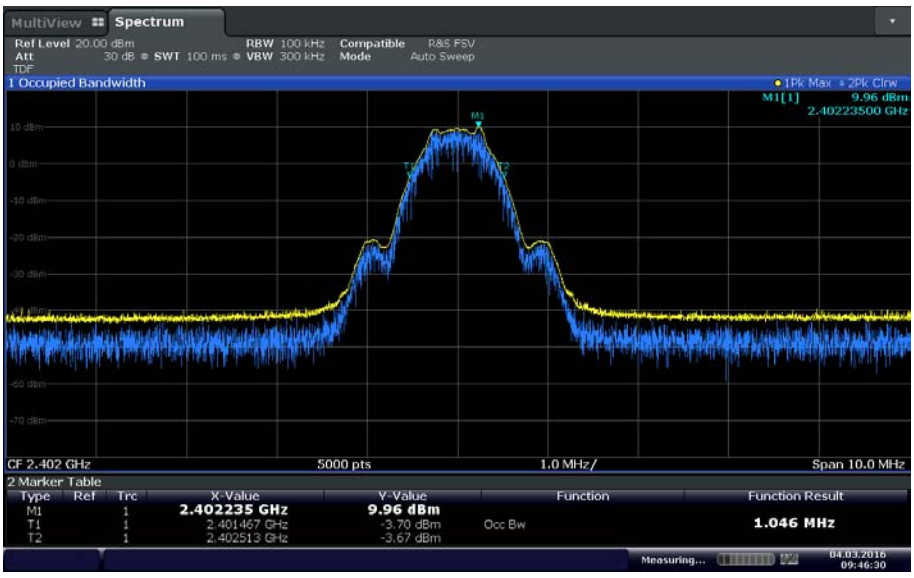
### 2.3.7 Additional Observations

- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- 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 Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

### 2.3.8 Test Results (For reporting purposes only)

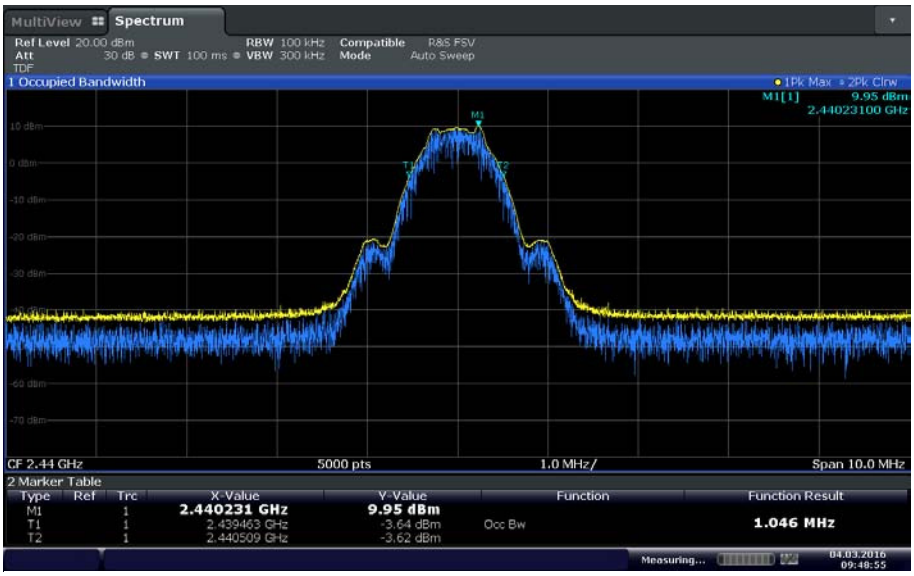
| Mode | Channel | Measured 99% Bandwidth (MHz) |
|---|---|---|
| Bluetooth LE | 37 (2402 MHz) | 1.046 |
| | 17 (2440 MHz) | 1.046 |
| | 39 (2480 MHz) | 1.046 |

### 2.3.9 Test Results Plots



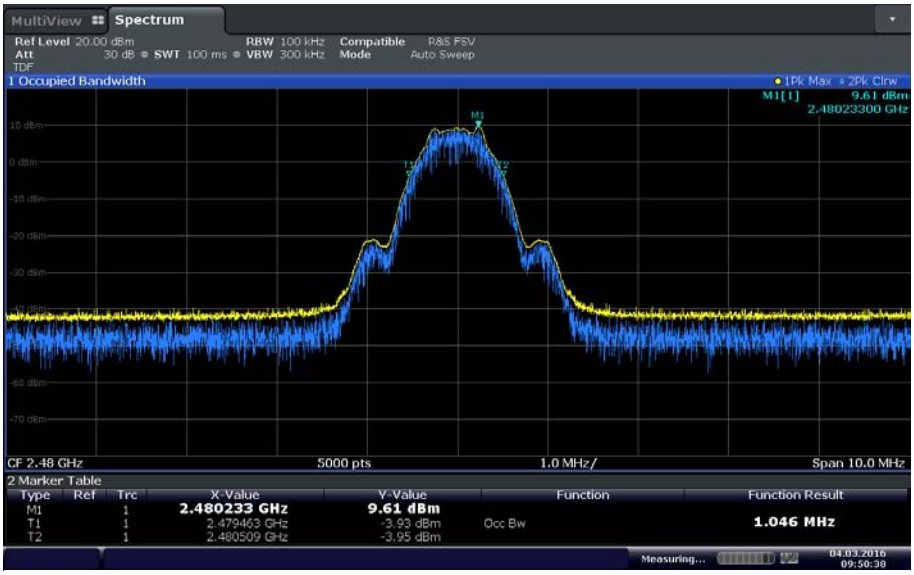

Date: 4.MAR.2016 09:46:30

**Bluetooth LE Low Channel**




Date: 4.MAR.2016 09:48:55

**Bluetooth LE Mid Channel**




Date: 4.MAR.2016 09:50:38

**Bluetooth LE High Channel**

## 2.4 MINIMUM 6 dB RF BANDWIDTH

### 2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(2) and RSS-247 5.2(1)

### 2.4.2 Standard Applicable

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 2.4.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 04, 2016/FSC

### 2.4.5 Test Equipment Used

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

### 2.4.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.6 °C |
| Relative Humidity | 43.8.% |
| ATM Pressure | 99.3 kPa |

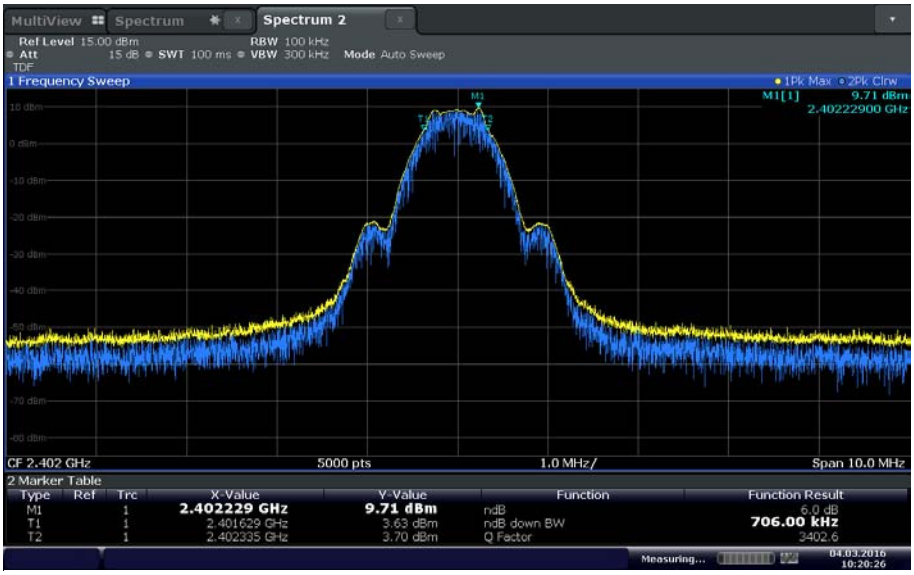
### 2.4.7 Additional Observations

- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW was set to 100 kHz while VBW is ≥3X RBW.
- Sweep is auto while Detector used is peak.
- The “n” dB down marker function of the spectrum analyzer was used for this test.

### 2.4.8 Test Results

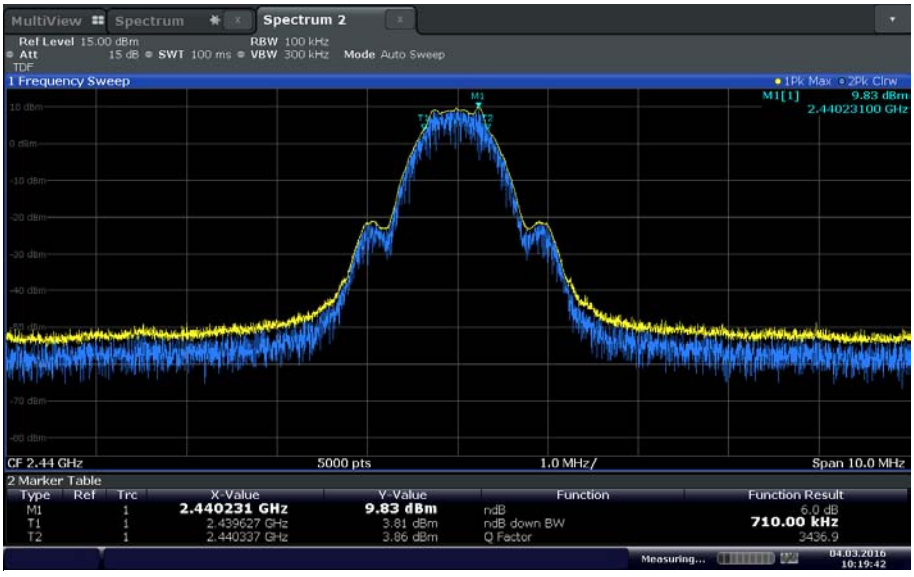
| Mode | Channel | Measured Bandwidth (MHz) | Minimum Bandwidth (MHz) | Compliance |
|---|---|---|---|---|
| Bluetooth LE | 37 (2402 MHz) | 0.706 | 0.500 | Complies |
| | 17 (2440 MHz) | 0.710 | 0.500 | Complies |
| | 39 (2480 MHz) | 0.718 | 0.500 | Complies |

### 2.4.9 **Test Results Plots**



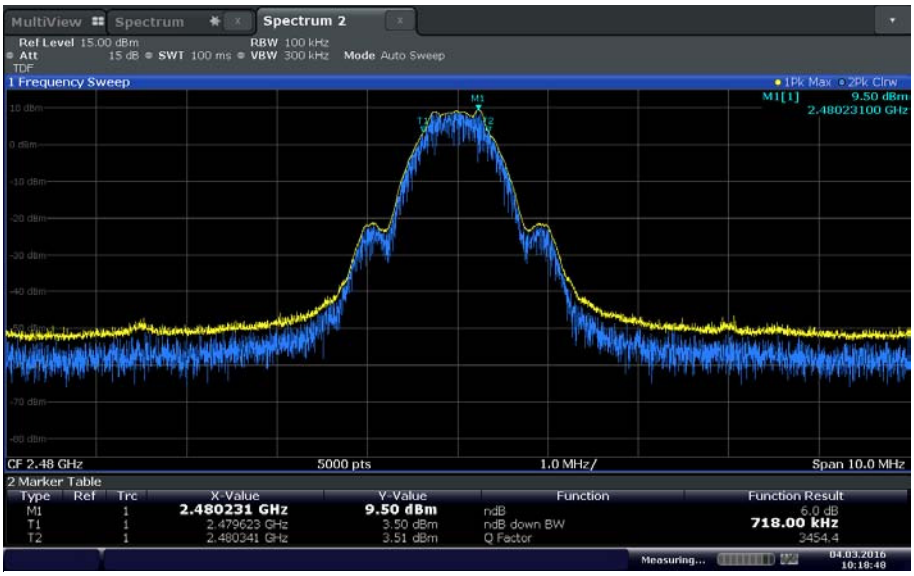

Date: 4.MAR.2016 10:20:26

**Bluetooth LE Low Channel**




Date: 4.MAR.2016 10:19:42

**Bluetooth LE Mid Channel**




Date: 4.MAR.2016 10:18:48

**Bluetooth LE High Channel**

## 2.5 OUT-OF-BAND EMISSIONS - CONDUCTED

### 2.5.1 Specification Reference

Part 15 Subpart C §15.247(d) and RSS-247 5.5

### 2.5.2 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)).

### 2.5.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 04, 2016/FSC

### 2.5.5 Test Equipment Used

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

### 2.5.6 Environmental Conditions/ Test Location

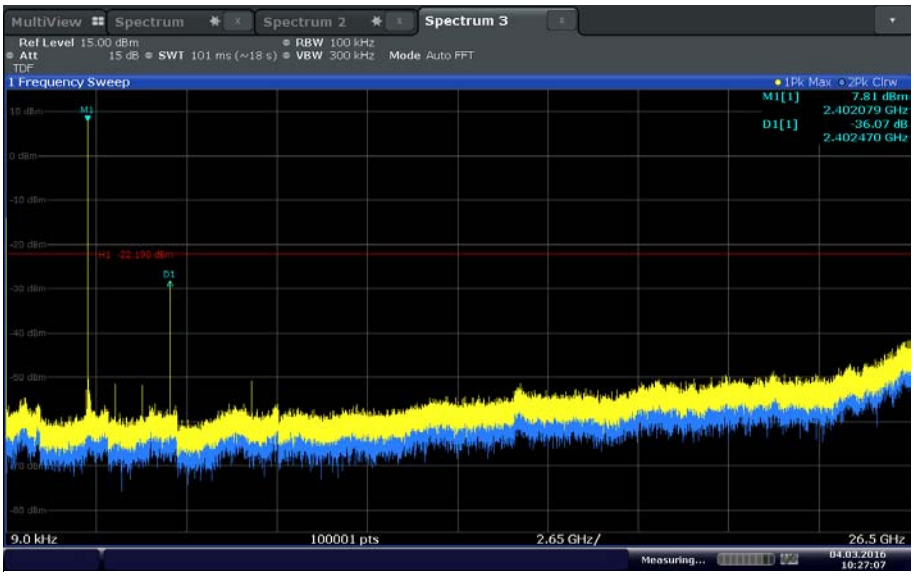
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.6 °C |
| Relative Humidity | 43.8.% |
| ATM Pressure | 99.3 kPa |

### 2.5.7 Additional Observations

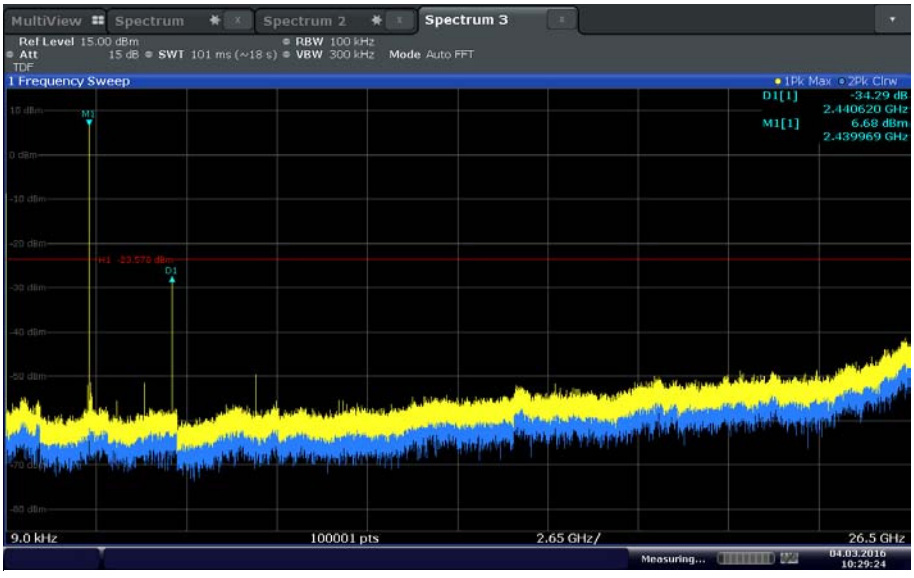
- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Initial scan was performed to determine the highest level of the desired power within the band. Limit (display line) was drawn 30dB below this level (worst case).
- Spectrum was searched from 9 kHz up to 26.5GHz.

### 2.5.8 **Test Results Plots**



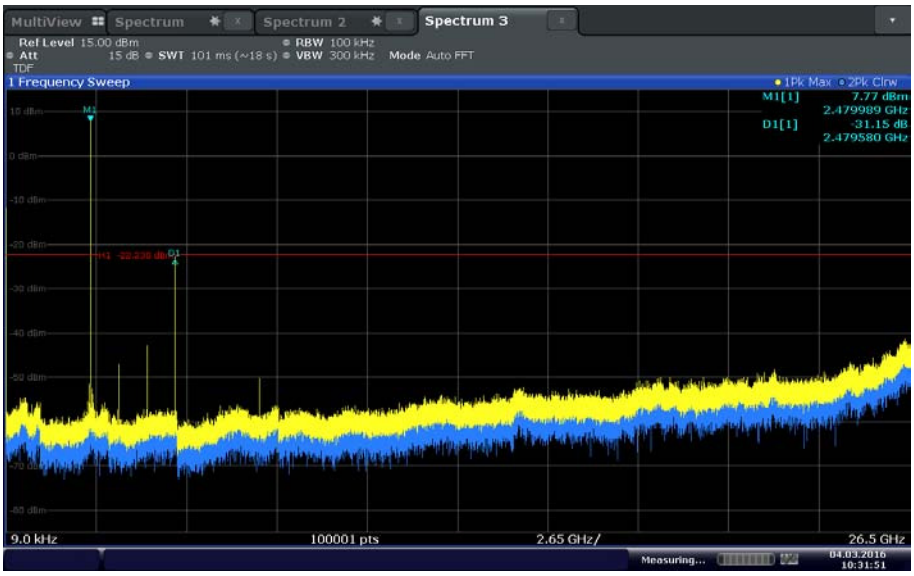

Date: 4.MAR.2016 10:27:07

**Bluetooth LE Low Channel**




Date: 4.MAR.2016 10:29:24

**Bluetooth LE Mid Channel**




Date: 4.MAR.2016 10:31:51

**Bluetooth LE High Channel**

## 2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

### 2.6.1 Specification Reference

Part 15 Subpart C §15.247(d) and RSS-247 5.5

### 2.6.2 Standard Applicable

See previous test.

### 2.6.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 04, 2016/FSC

### 2.6.5 Test Equipment Used

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

### 2.6.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

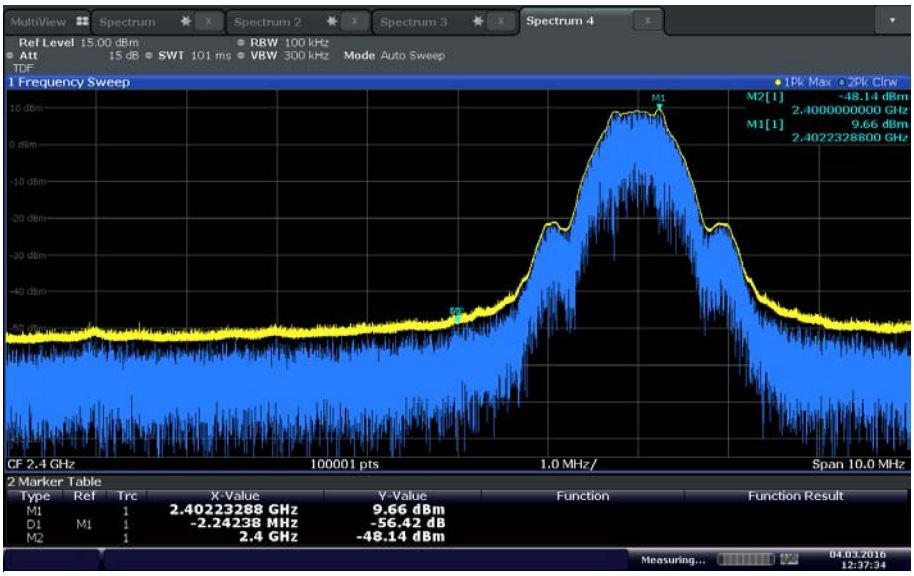
| | |
|---|---|
| Ambient Temperature | 24.6 °C |
| Relative Humidity | 43.8.% |
| ATM Pressure | 99.3 kPa |

### 2.6.7 Additional Observations

- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Trace was centered on the band-edge frequency.
- Span was set to encompass the band-edge frequency and the peak of the emission.
- Using Marker function, peak of the emission was determined and the delta to the band-edge frequency measured (for EUT OBW edge not within 2MHz of the authorized band edge).

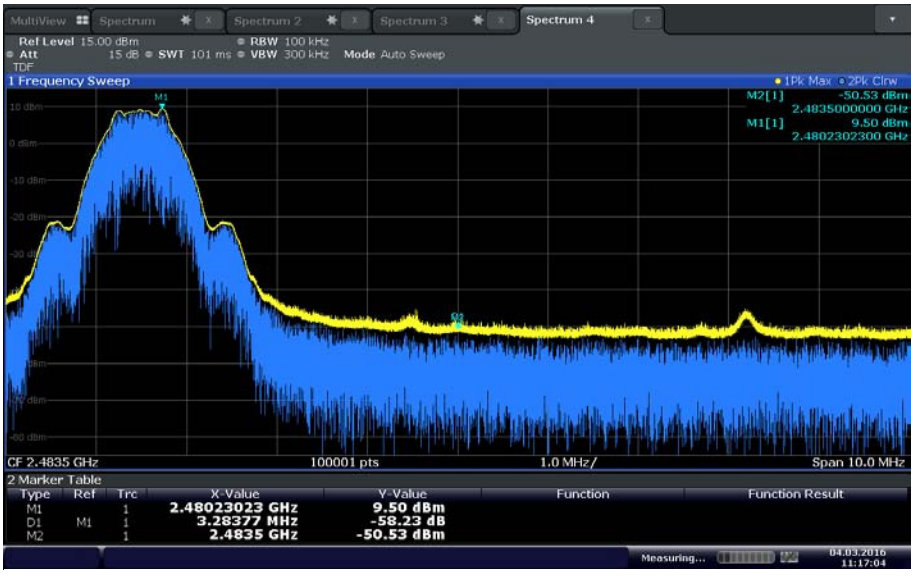
### 2.6.8 Test Results

Complies. See attached plots.




Date: 4.MAR.2016 12:37:35

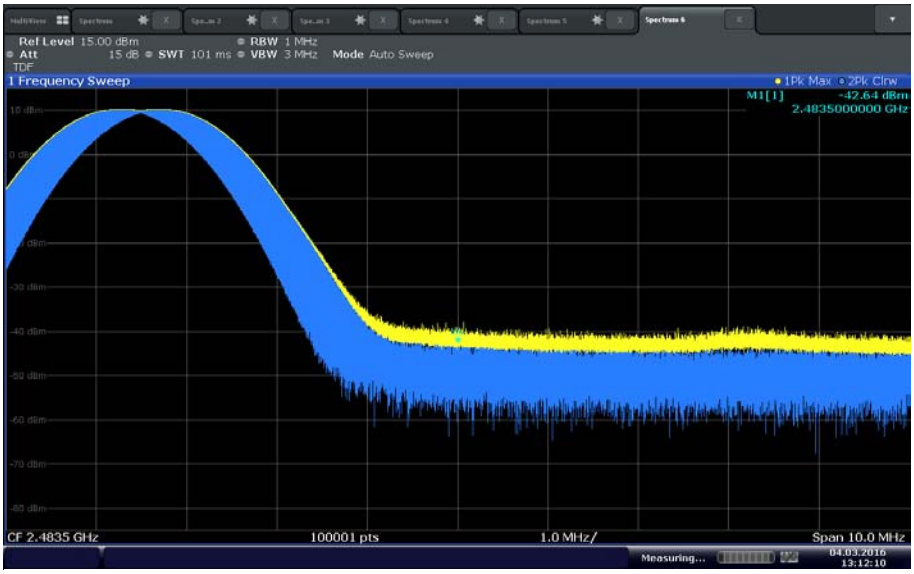
**Bluetooth LE Low Channel (2402 MHz)**




Date: 4.MAR.2016 11:17:04

**Bluetooth LE High Channel (2480 MHz)**

### 2.6.9 Band Edge Verification in the Restricted Band (Conducted Method)




Date: 4.MAR.2016 13:12:10

**Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074**

Measured Peak = -42.64 dBm, since antenna gain is 0dBi then EIRP is the same. Using the formula:

$$E = EIRP - 20\log D + 104.8$$

Where: E = electric field strength in dBµV/m
EIRP = equivalent isotropic radiated power in dBm
D = specific measurement distance in meters

E is therefore = -42.64 dBm – (20log 3 meters) + 104.8
= 52.62 dBµV/m @ 3 meters

Since the peak detected amplitude (52.62 dBµV/m) complies with the average limit (54 dBµV/m), then it's not necessary to perform a separate average measurement. EUT complies restricted band @ 2483.5 MHz.

## 2.7 SPURIOUS RADIATED EMISSIONS

### 2.7.1 Specification Reference

Part 15 Subpart C §15.247(d) and RSS-Gen 8.9 and 8.10

### 2.7.2 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)).

### 2.7.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 08, 2016/FSC

### 2.7.5 Test Equipment Used

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

### 2.7.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 22.8 °C |
| Relative Humidity | 37.7 % |
| ATM Pressure | 99.0 kPa |

### 2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10$^{th}$ harmonic.
- Test Methodology is per Clause 12.2.7 of KDB558074 D01 DTS Meas Guidance v03r04.
- 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 worst case channel presented. EUT has an integrated antenna and can't be terminated for this test (cabinet spurious emissions).



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- Only noise floor measurements observed above 18GHz.
- 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.

### 2.7.8 Sample Computation (Radiated Emission)

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

### 2.7.9 Test Results

See attached plots.



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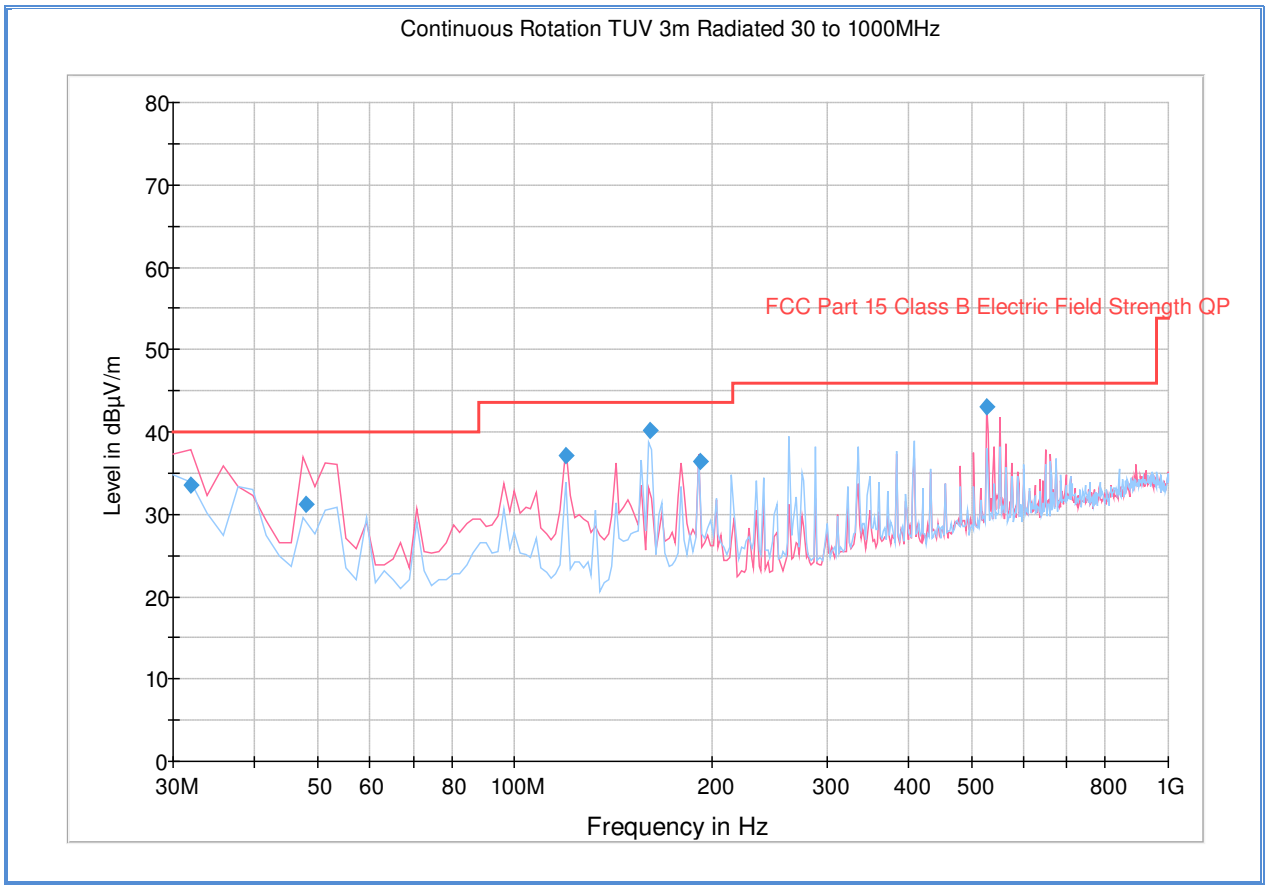
### 2.7.10 Test Results Below 1GHz (Worst Case Channel – Mid Channel)

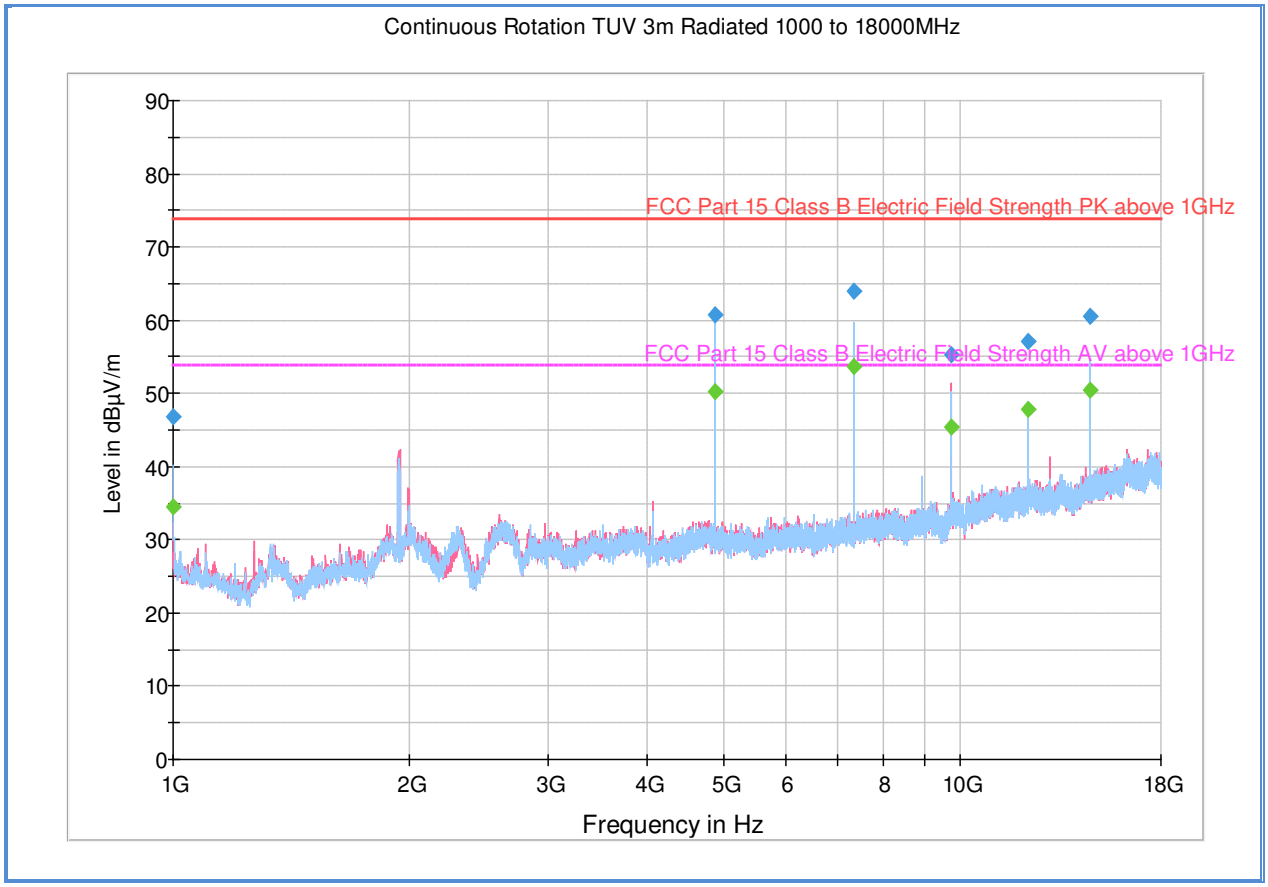



**Quasi Peak Data**

| Frequency (MHz) | QuasiPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 31.920000 | 33.5 | 1000.0 | 120.000 | 110.0 | V | 85.0 | -6.6 | 6.5 | 40.0 |
| 48.014990 | 31.2 | 1000.0 | 120.000 | 100.0 | V | 31.0 | -13.6 | 8.8 | 40.0 |
| 120.018838 | 37.0 | 1000.0 | 120.000 | 106.0 | V | 293.0 | -15.1 | 6.5 | 43.5 |
| 161.080481 | 40.1 | 1000.0 | 120.000 | 106.0 | H | 91.0 | -12.8 | 3.4 | 43.5 |
| 192.022685 | 36.4 | 1000.0 | 120.000 | 100.0 | V | 335.0 | -10.8 | 7.1 | 43.5 |
| 528.035271 | 43.0 | 1000.0 | 120.000 | 100.0 | V | 304.0 | -0.7 | 3.0 | 46.0 |

**Test Notes:** Only worst case channel presented for cabinet spurious emissions.

### 2.7.11 Test Results Above 1GHz (Worst Case Channel – Mid Channel)




**Peak Data**

| Frequency (MHz) | MaxPeak (dBµV/m) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Polarization | Azimuth (deg) | Corr. (dB) | Margin (dB) | Limit (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|
| 1000.000000 | 46.9 | 1000.0 | 1000.000 | 124.7 | H | 186.0 | -7.9 | 27.0 | 73.9 |
| 4879.600000 | 60.8 | 1000.0 | 1000.000 | 228.4 | H | 10.0 | 2.8 | 13.1 | 73.9 |
| 7320.800000 | 63.9 | 1000.0 | 1000.000 | 155.6 | V | 337.0 | 6.6 | 10.0 | 73.9 |
| 9758.766667 | 55.2 | 1000.0 | 1000.000 | 117.7 | V | 236.0 | 9.5 | 18.7 | 73.9 |
| 12201.100000 | 57.1 | 1000.0 | 1000.000 | 132.7 | H | 47.0 | 12.9 | 16.8 | 73.9 |
| 14641.566667 | 60.5 | 1000.0 | 1000.000 | 102.7 | H | 3.0 | 14.8 | 13.4 | 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) |
|---|---|---|---|---|---|---|---|---|---|
| 1000.000000 | 34.5 | 1000.0 | 1000.000 | 124.7 | H | 186.0 | -7.9 | 19.4 | 53.9 |
| 4879.600000 | 50.3 | 1000.0 | 1000.000 | 228.4 | H | 10.0 | 2.8 | 3.6 | 53.9 |
| 7320.800000 | 53.6 | 1000.0 | 1000.000 | 155.6 | V | 337.0 | 6.6 | 0.3 | 53.9 |
| 9758.766667 | 45.4 | 1000.0 | 1000.000 | 117.7 | V | 236.0 | 9.5 | 8.5 | 53.9 |
| 12201.100000 | 47.9 | 1000.0 | 1000.000 | 132.7 | H | 47.0 | 12.9 | 6.0 | 53.9 |
| 14641.566667 | 50.5 | 1000.0 | 1000.000 | 102.7 | H | 3.0 | 14.8 | 3.4 | 53.9 |

**Test Notes:** No significant emissions observed above 18GHz. Measurements above 18GHz were noise floor figures.

## 2.8 POWER SPECTRAL DENSITY

### 2.8.1 Specification Reference

Part 15 Subpart C §15.247(e) and RSS-247 5.2(2)

### 2.8.2 Standard Applicable

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### 2.8.3 Equipment Under Test and Modification State

Serial No: N/A / Default Test Configuration

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

March 04, 2016/FSC

### 2.8.5 Test Equipment Used

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

### 2.8.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

| | |
|---|---|
| Ambient Temperature | 24.6 °C |
| Relative Humidity | 43.8.% |
| ATM Pressure | 99.3 kPa |

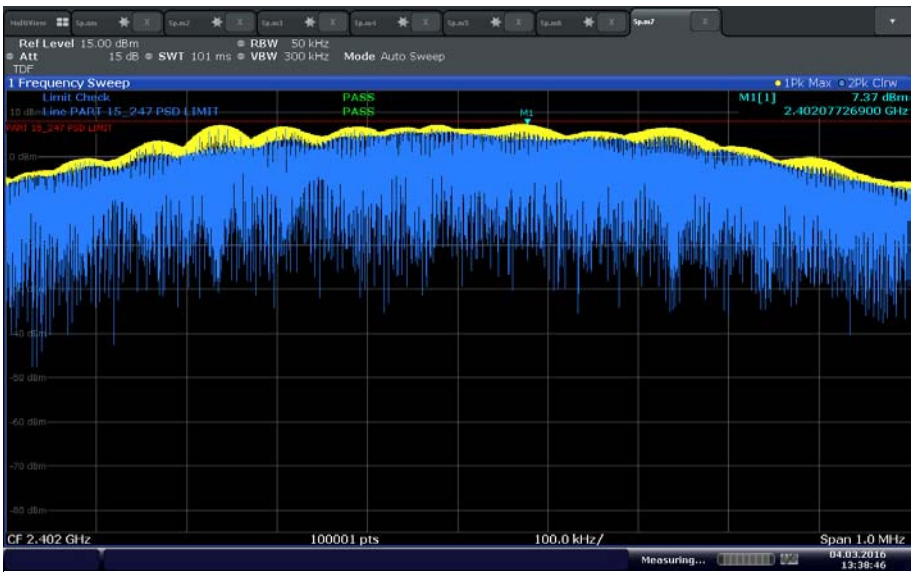
### 2.8.7 Additional Observations

- This is a conducted test.
- Test procedure is per Section 10.2 of KDB 558074 (January 07, 2016).
- Span is 1.5 times the DTS bandwidth.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz
- Set the VBW ≥ 3 x RBW
- Detector is Peak
- Sweep time is Auto Couple.
- Trace mode is max hold
- Trace allowed to fully stabilize.
- EUT complies with 50 kHz RBW.

### 2.8.8 Test Results Summary

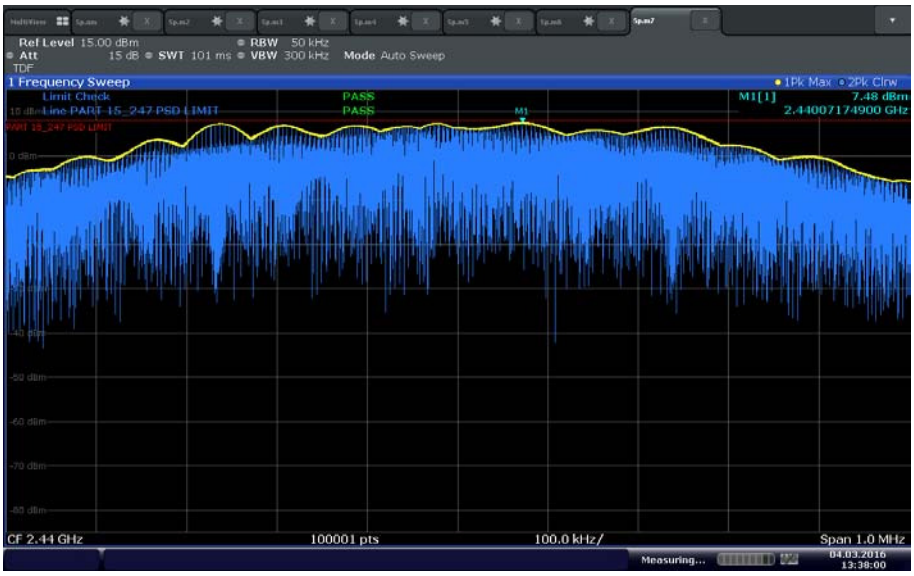
| Mode | Channel | Marker Reading using 50 kHz RBW (dBm) | PSD Limit (dBm) | Margin (dB) | Compliance |
|---|---|---|---|---|---|
| Bluetooth LE | 37 (2402 MHz) | 7.37 | 8 | 0.63 | Complies |
| | 17 (2440 MHz) | 7.48 | 8 | 0.52 | Complies |
| | 39 (2480 MHz) | 7.17 | 8 | 0.83 | Complies |

### 2.8.9 Test Results Plots



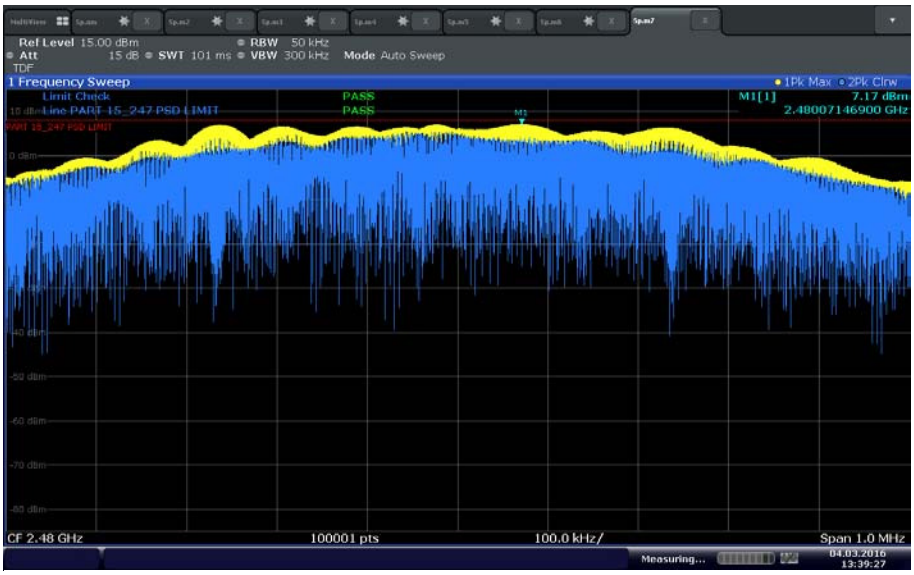

Date: 4.MAR.2016 13:38:46

**Bluetooth LE LowChannel**




Date: 4.MAR.2016 13:38:00

**Bluetooth LE Mid Channel**




Date: 4.MAR.2016 13:39:27

**Bluetooth LE High Channel**

**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 |
|---|---|---|---|---|---|---|
| Antenna Conducted Port Setup | | | | | | |
| 7624 | USB Wideband Power Sensor | 55340 | 9543 | Boonton | 02/12/16 | 02/12/18 |
| 7611 | Signal/Spectrum Analyzer | FSW26 | 102017 | Rhode & Schwarz | 02/01/16 | 02/01/17 |
| 7608 | Vector Signal Generator | SMBV100A | 259021 | Rhode & Schwarz | 07/29/15 | 07/29/16 |
| 8825 | 20dB Attenuator | 46-20-34 | BK5773 | Weinschel Corp. | Verified by 7608 and 7611 | |
| Radiated Test Setup | | | | | | |
| 1002 | Bilog Antenna | 3142C | 00058717 | ETS-Lindgren | 01/30/14 | 01/30/16 |
| 1040 | EMI Test Receiver | ESIB40 | 100292 | Rhode & Schwarz | 08/29/14 | 08/29/15 |
| 1016 | Pre-amplifier | PAM-0202 | 187 | PAM | 12/10/14 | 12/10/15 |
| 1051 | Double-ridged waveguide horn antenna | 3115 | 9408-4329 | EMCO | 02/28/14 | 02/28/16 |
| 1049 | EMI Test Receiver | ESU | 100133 | Rhode & Schwarz | 03/11/15 | 03/11/16 |
| 8628 | Pre-amplifier | QLJ 01182835-JO | 8986002 | QuinStar Technologies Inc. | 03/20/15 | 03/20/16 |
| 1150 | Horn antenna | 3160-09 | 012054-004 | ETS | 07/16/15 | 07/16/17 |
| 1151 | Pre-amplifier | TS-PR26 | 100026 | Rhode & Schwarz | 05/08/15 | 05/08/16 |
| 1153 | High-frequency cable | SucoFlex 100 SX | N/A | Suhner | Verified by 7608 and 7611 | |
| 8543 | High-frequency cable | Micropore 19057793 | N/A | United Microwave Products | Verified by 7608 and 7611 | |
| 6815 | 2.4GHz Band Notch Filter | BRM50702 | 008 | Micro-Tronics | Verified by 7608 and 7611 | |
| Miscellaneous | | | | | | |
| 6792 | Multimeter | 3478A | 2911A70964 | Hewlett Packard | 08/14/15 | 08/14/16 |
| 7560 | Barometer/Temperature/Humidity Transmitter | iBTHX-W | 1240476 | Omega | 10/19/15 | 10/19/16 |
| | 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 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 | 2.70 | 1.56 | 2.43 |
| 6 | EUT Setup | Rectangular | 1.00 | 0.58 | 0.33 |
| | | | | Combined Uncertainty ($u_c$): | 1.78 |
| | | | | Coverage Factor (k): | 2 |
| | | | | Expanded Uncertainty: | 3.57 |

### 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 | 2.70 | 1.56 | 2.43 |
| 6 | EUT Setup | Rectangular | 1.00 | 0.58 | 0.33 |
| | | | | Combined Uncertainty ($u_c$): | 1.78 |
| | | | | Coverage Factor (k): | 2 |
| | | | | Expanded Uncertainty: | 3.56 |

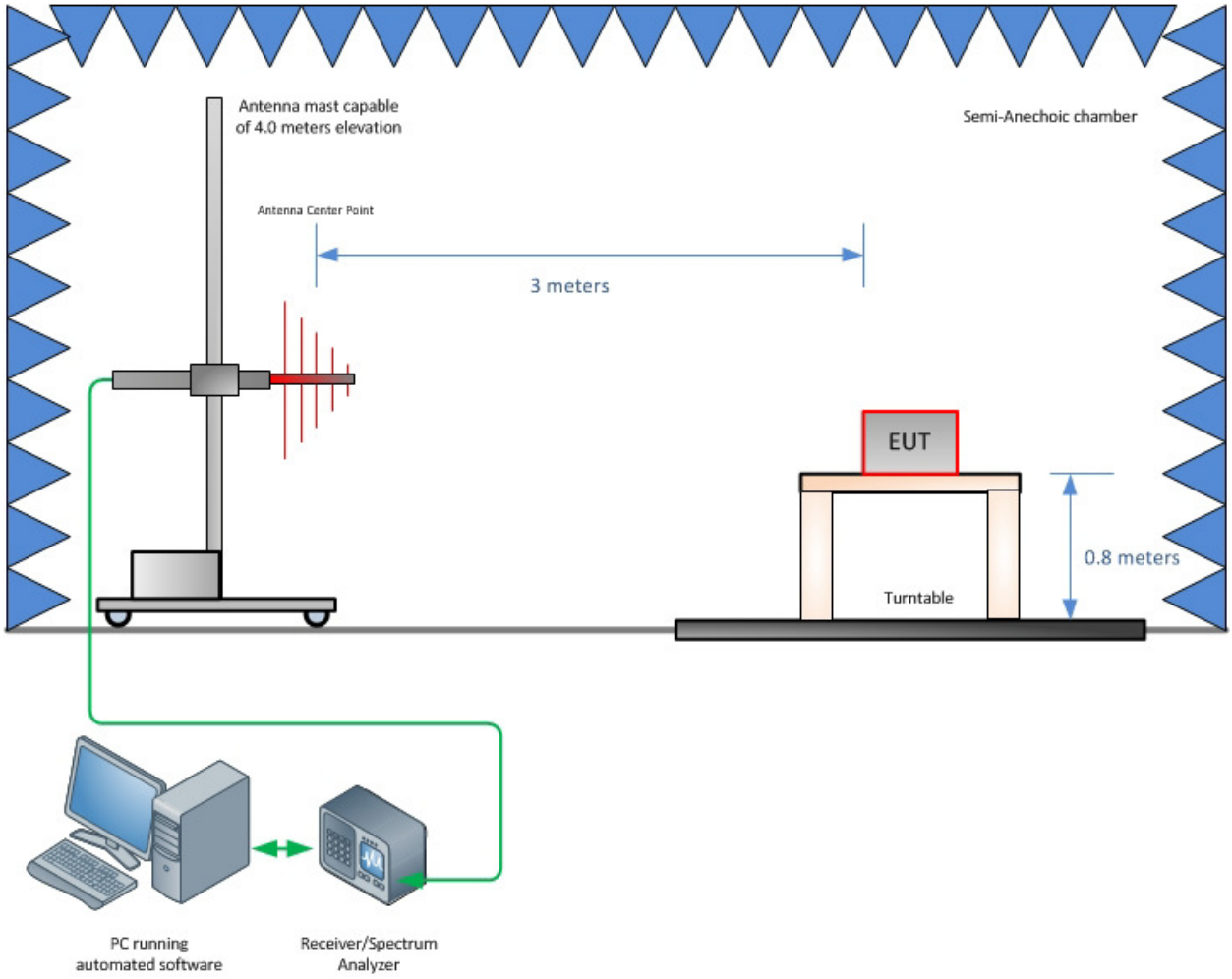
### 3.2.3 Conducted Antenna Port Measurement

| | 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 | 0.50 | 0.29 | 0.08 |
| 3 | EUT Setup | Rectangular | 1.00 | 0.58 | 0.33 |
| | | | | Combined Uncertainty ($u_c$): | 0.72 |
| | | | | Coverage Factor (k): | 2 |
| | | | | Expanded Uncertainty: | 1.45 |

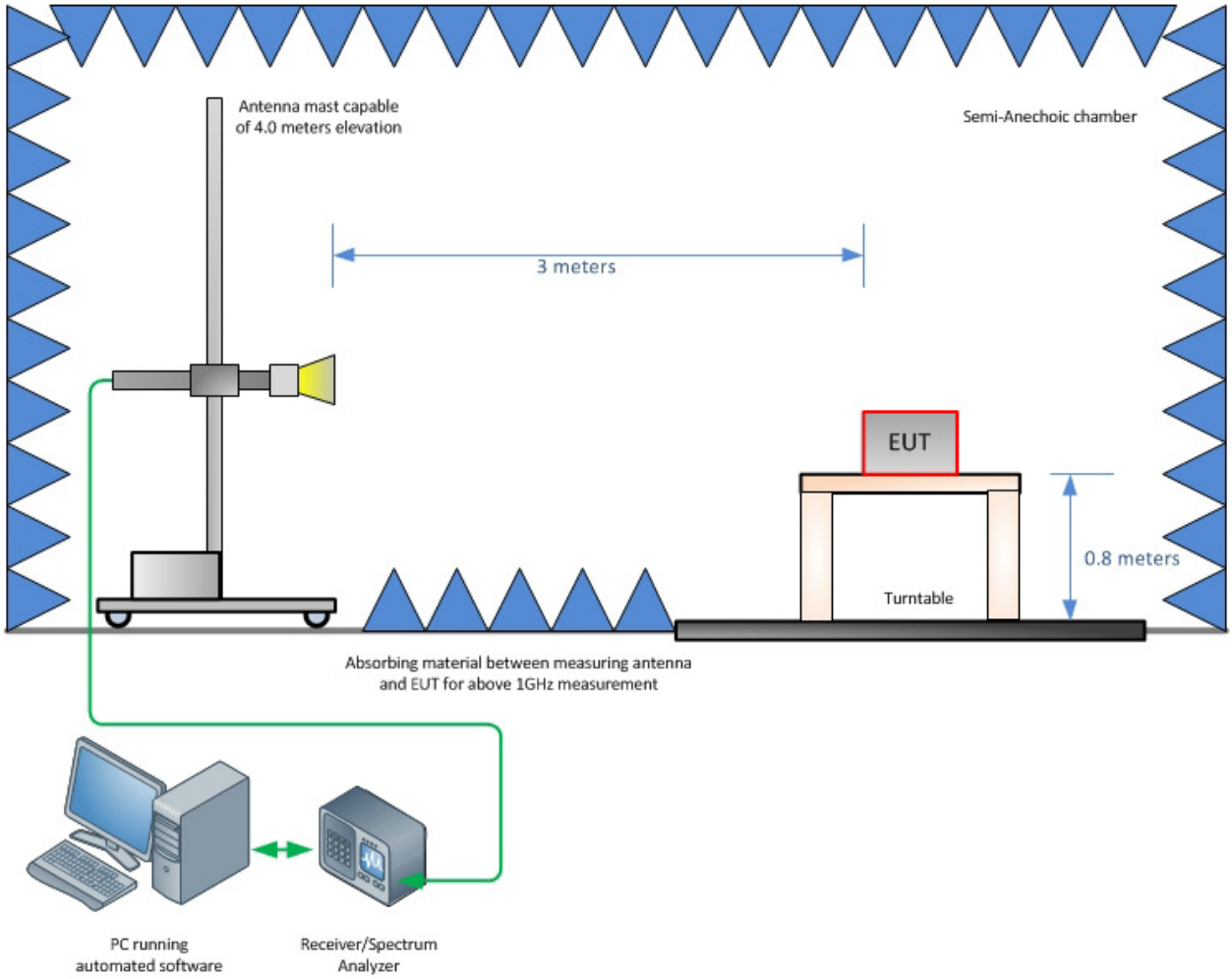
**SECTION 4**

**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**



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