Choose certainty.
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Report On

Application for Grant of Equipment Authorization of the
St. Jude Medical
External Pulse Generator 3599

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

Report No. SC1405817B **August 2014**

REPORT ON	Radio Testing of the St. Jude Medical External Pulse Generator
TEST REPORT NUMBER	SC1405817B
PREPARED FOR	St. Jude Medical 6901 Preston Road Plano, TX 75024 USA
CONTACT PERSON	Rebecca Wilkins Senior Manager, Electrical Engineering (972) 526-9686 rwilkins@sjm.com
PREPARED BY	Kathy MacKenzie **Name** Title: EMC/Wireless Test Technician
APPROVED BY	Juan M. Gonzalez **Name** Authorized Signatory Title: EMC/ Wireless Lab Manager
DATED	August 7, 2014

Revision History

SC1405817B St. Jude Medical External Pulse Generator 3599					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
08/07/2014	Initial Release				Juan Manuel Gonzalez

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SECTION 1

REPORT SUMMARY

Radio Testing of the
St. Jude Medical
External Pulse Generator

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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the St. Jude Medical External Pulse Generator 3599 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	St. Jude Medical
Model Number(s)	3599
FCC ID Number	PX2SJMX599EPG
IC Number	8454A-SJMX599EPG
Serial Number(s)	142500148 with EPG Header142200170
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2012). • RSS-210 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment (Issue 8, December 2010). • RSS-Gen - General Requirements and Information for the Certification of Radio Apparatus (Issue 3, December 2010). • 558074 D01 DTS Meas Guidance v03r02,(June 5,2014) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.
Start of Test	July 14, 2014
Finish of Test	July 22, 2014
Name of Engineer(s)	Kathy MacKenzie
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-210 A8.4 (4)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 7.2.4	Conducted Emissions	N/A*	
2.3		RSS-Gen 4.6.1	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-210 A8.2(a)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-210 A8.5	Out-of-Band Emissions - Conducted	N/A**	
2.6	§15.247(d)	RSS-210 A8.5	Band-edge Compliance of RF Conducted Emissions	N/A**	
2.7	§15.247(d)	RSS-210 A8.5	Spurious Radiated Emissions	Compliant	
2.7		RSS-Gen 4.10	Receiver Spurious Emissions	Compliant	
2.8	§15.247(d)	RSS-210 A8.5	Radiated Band Edge Measurements	Compliant	
2.9	§15.247(e)	RSS-210 A8.2(b)	Power Spectral Density for Digitally Modulated Device	N/A***	

* EUT is a battery powered device
** Not performed since the EUT does not have a conducted port.
*** Not Performed. EUT complies with the requirement since the measured total power (peak conducted output power or maximum conducted output power) complies with the PSD limit.

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1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a St. Jude Medical External Pulse Generator 3599. The external pulse generator (EPG) is an external trial generator that when connected to trial neurostimulation leads delivers therapeutic stimulation to parts of the body. The EPG communicates wirelessly with system programmers and controllers. The EPG header connects directly to the EPG for a neurostimulation trial. The EPG header can hold one or more leads or extensions with up to 16 electrodes total.

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1.3.2 EUT General Description

EUT Description	External Pulse Generator
Model Name	External Pulse Generator
Model Number(s)	3599
Rated Voltage	6VDC Supplied by two (2) nonrechargeable Panasonic CR2450 3V coin cell batteries
Mode Verified	BT LE
Capability	Bluetooth 4.0
Primary Unit (EUT)	☒ Production
	☐ Pre-Production
	☐ Engineering
Antenna Type	antenova m2m Fusca A10192 2.4 GHz SMD Embedded Ceramic
Antenna Gain	0.8dBi

1.3.3 Maximum Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
Bluetooth LE	2402-2480	0.2	1.05

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1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	The EUT(equipment under test) is programmed using an EPG Breakout (also known as "Bob-Lite") Board STJ0000588 connected via a STJ0000580 flex cable to the EPG test connector. Radio commands are programmed using Terminal v1.9b client software.

1.4.2 EUT Exercise Software

HQTS Software in EUT; St. Jude part number 75-0206;
Terminal v1.9b in laptop used to program channel and test mode into EUT.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
IBM	Support Laptop	Think Pad X60 S/N LV-B7085 06/08
St. Jude	Break Out Board Lite	SJ Part # 95-0851
St. Jude	Resistance Load Box	SJ part # 95-0506-03
	(2) Octrode Leads	90cm; SJ Part # 45-0041

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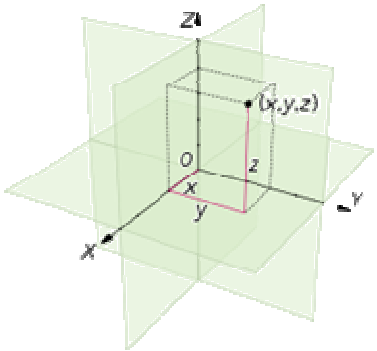
1.4.4 Worst Case Configuration

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

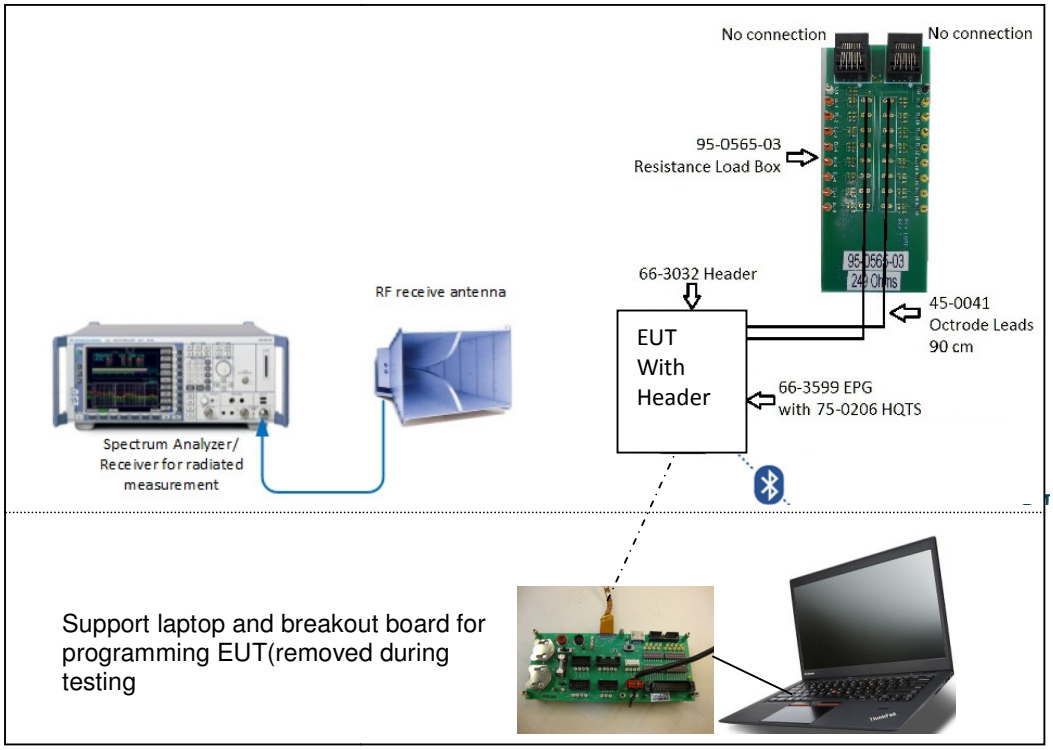
Mode	Channel	Data Rate
Bluetooth LE	37 (Low Channel)	1Mbps

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



1.4.5 Simplified Test Configuration Diagram

Radiated 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 142500148 with EPG Header S/N 142200170		
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.

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SECTION 2

TEST DETAILS

Radio Testing of the
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External Pulse Generator

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2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3)

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: 142500148 / Default Test Configuration

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

July 21, 2014/KAM

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	25.1°C
Relative Humidity	47.8%
ATM Pressure	99.1 kPa

2.1.7 Additional Observations

- This is a radiated test
- 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.
- Test methodology is per Clause 3.0 of KDB 558074 D01 (DTS Meas Guidance v03r02, June 5, 2014).
- Substitution method was used to determine final power measurement in dBm.

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2.1.8 Sample Computation (Radiated Emission)

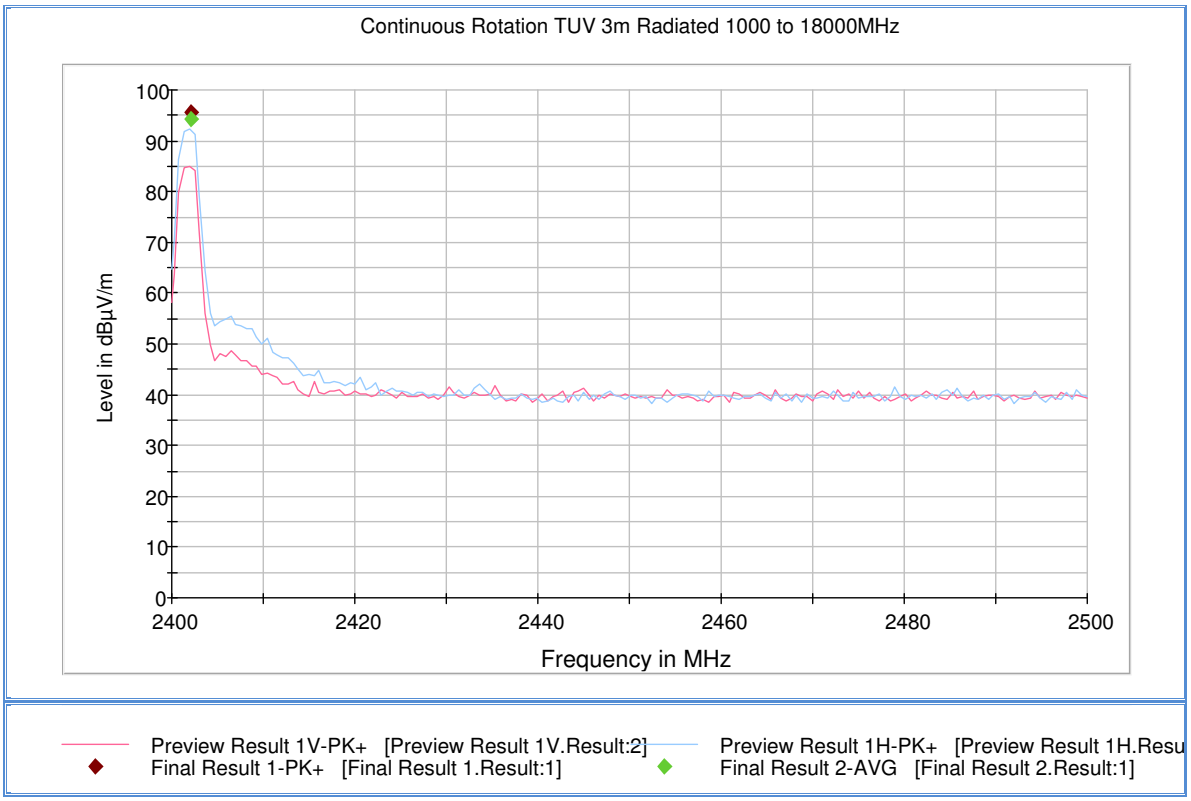
Measuring equipment raw measurement (dbµV) @ 2400 MHz			53.9
Correction Factor (dB)	Asset# 1153 (cable)	3.4	-0.4
	Asset# 8628(preamplifier)	-36.5	
	Asset#7575 (antenna)	32.7	
Reported Max Peak Final Measurement (dbµV/m) @ 2400 MHz			**53.5**

2.1.9 Test Results

Bluetooth Low Energy (LE)	Channel	Modulation	Measured Average Power (dBm)
	37 (2402 MHz)	GFSK @ 1Mbps	**0.2**
	17 (2440 MHz)		-3.4
	39 (2480 MHz)		-3.8

2.1.10 Peak Output Power Test Results

Bluetooth LE. Low Channel 1Mbps



Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2402.133333	94.3	1000.0	1000.000	116.7	H	351.0	-0.2

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dbµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance
2402.133333	94.3	3.7	9.503	-6.0	0.2	30	Compliant

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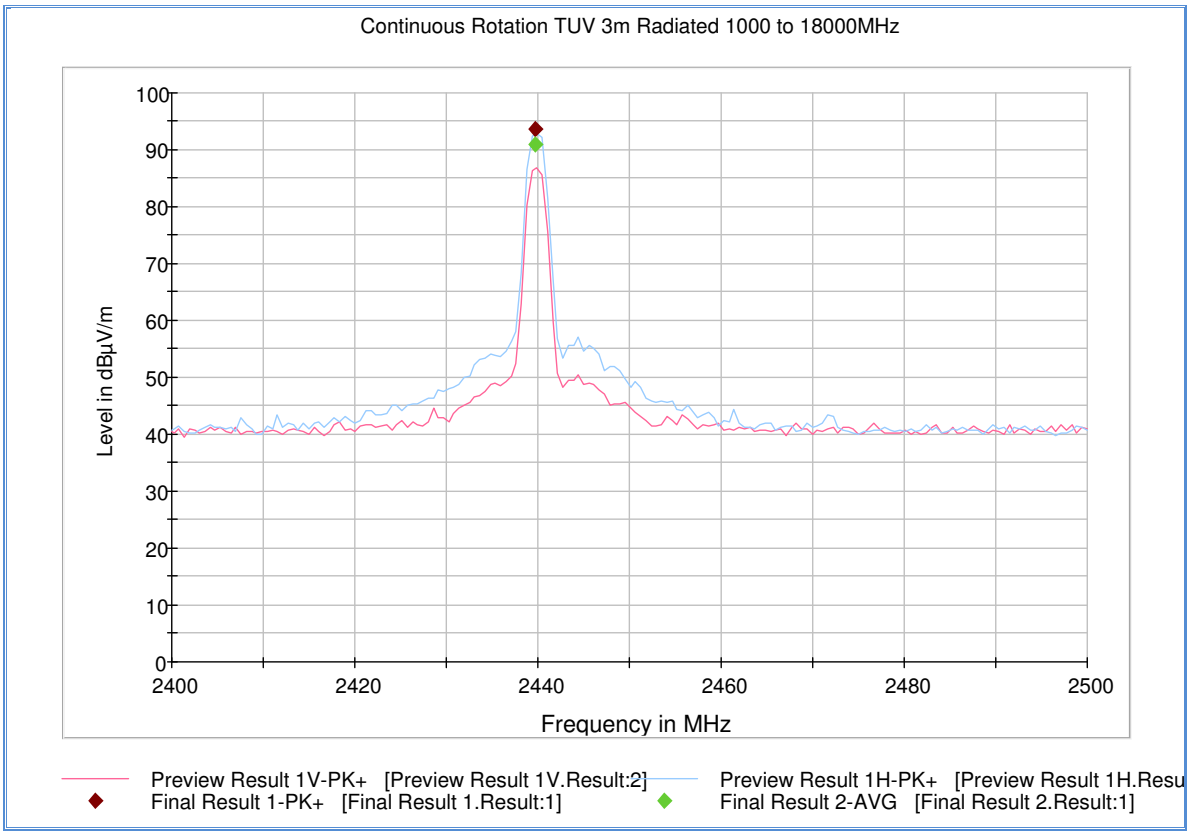
Bluetooth LE. Mid Channel 1Mbps



Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2439.700000	91.0	1000.0	1000.000	113.7	H	86.0	0.0

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dbµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance
2439.700000	91.0	3.7	9.503	-9.2	-3.4	30	Compliant

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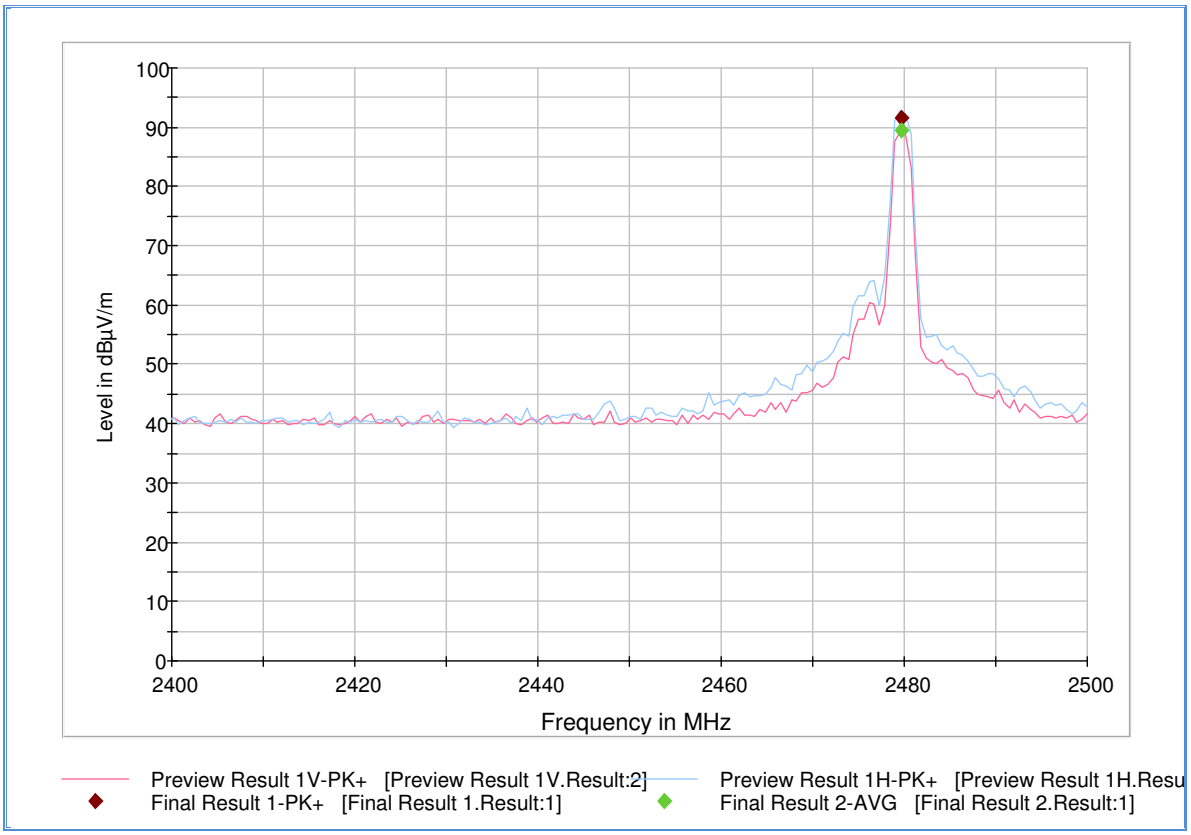
Bluetooth LE. High Channel 1Mbps



Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2479.766667	89.5	1000.0	1000.000	203.3	H	228.0	0.1

Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dbµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance
2479.766667	89.5	3.8	9.503	-9.5	-3.8	30	Compliant

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2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

Part 15 Subpart C §15.207(a)

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

N/A EUT is battery powered

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2.3 99% EMISSION BANDWIDTH

2.3.1 Specification Reference

RSS-Gen Clause 4.6.1

2.3.2 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.

2.3.3 Equipment Under Test and Modification State

Serial No: 142500148 / Default Test Configuration

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

July 22, 2014/KAM

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.5°C
Relative Humidity	53.7%
ATM Pressure	99.2 kPa

2.3.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.

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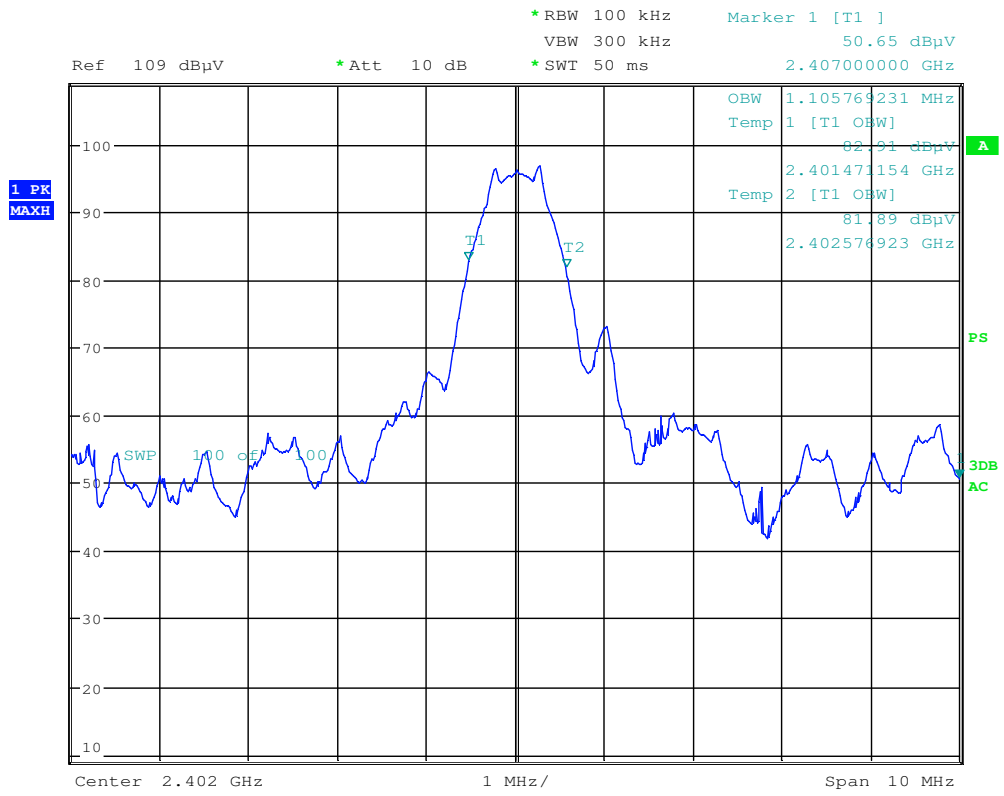
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyzer was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyzer was used for this test.

2.3.8 Test Results (For reporting purposes only)

Mode	Channel	Measured 99% Bandwidth (MHz)
Bluetooth LE	37 (2402 MHz)	1.106
	17 (2440 MHz)	1.106
	39 (2480 MHz)	1.154

2.3.9 Test Results Plots



Date: 22.JUL.2014 15:55:46

Bluetooth LE Low Channel

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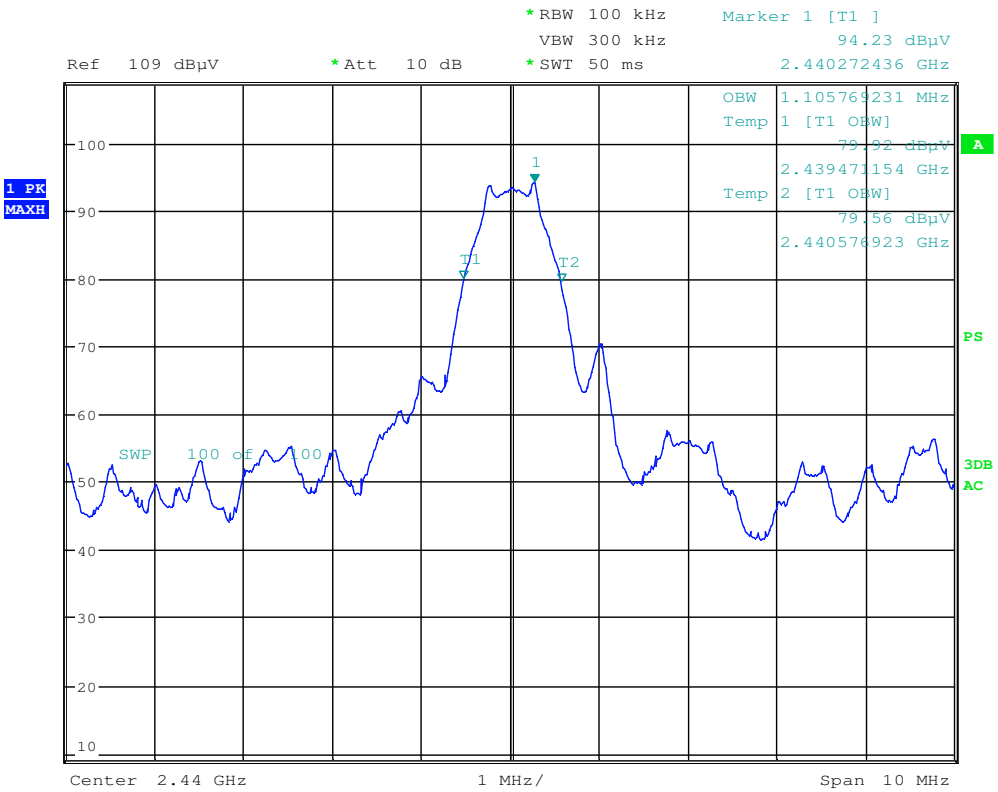

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Bluetooth LE Mid Channel

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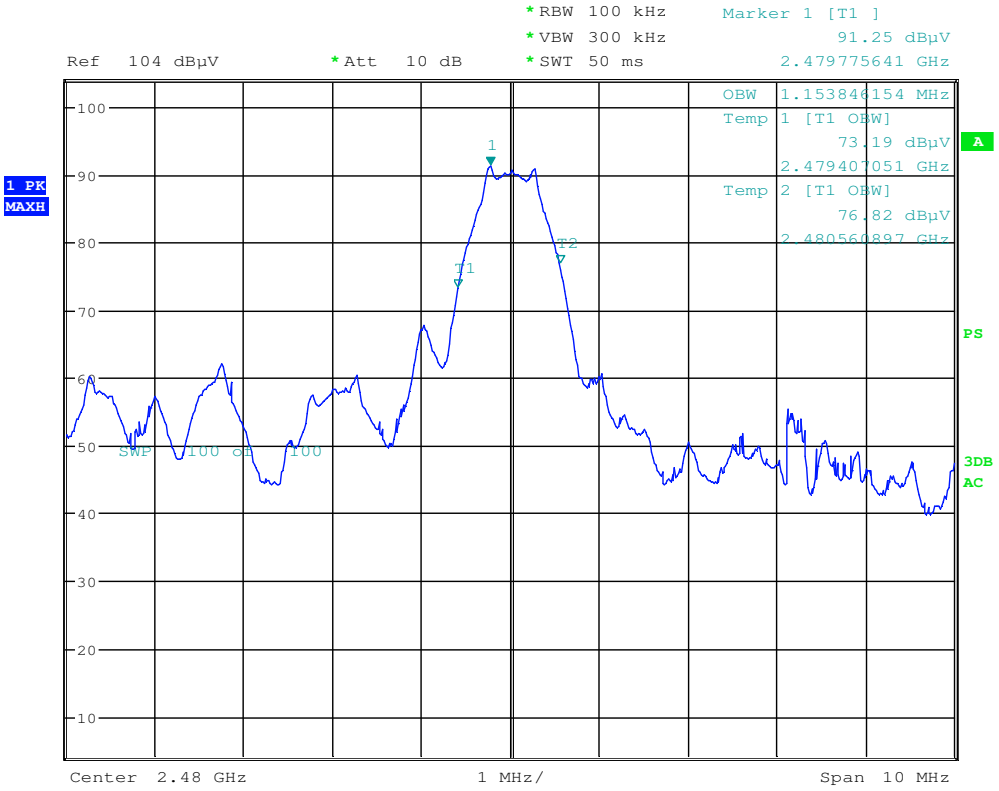
America



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Bluetooth LE High Channel

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2.4 MINIMUM 6 dB RF BANDWIDTH

2.4.1 Specification Reference

Part 15 Subpart C §15.247(a)(2)

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: 142500148 / Default Test Configuration

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

July 22, 2014/KAM

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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.5°C
Relative Humidity	52.7%
ATM Pressure	99.2 kPa

2.4.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is set to 100 kHz.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The “n” dB down marker function of the spectrum analyzer was used for this test.
- For signal modulation where “n” dB down marker function is not practical, a peak measurement is performed while the trace is in max hold.

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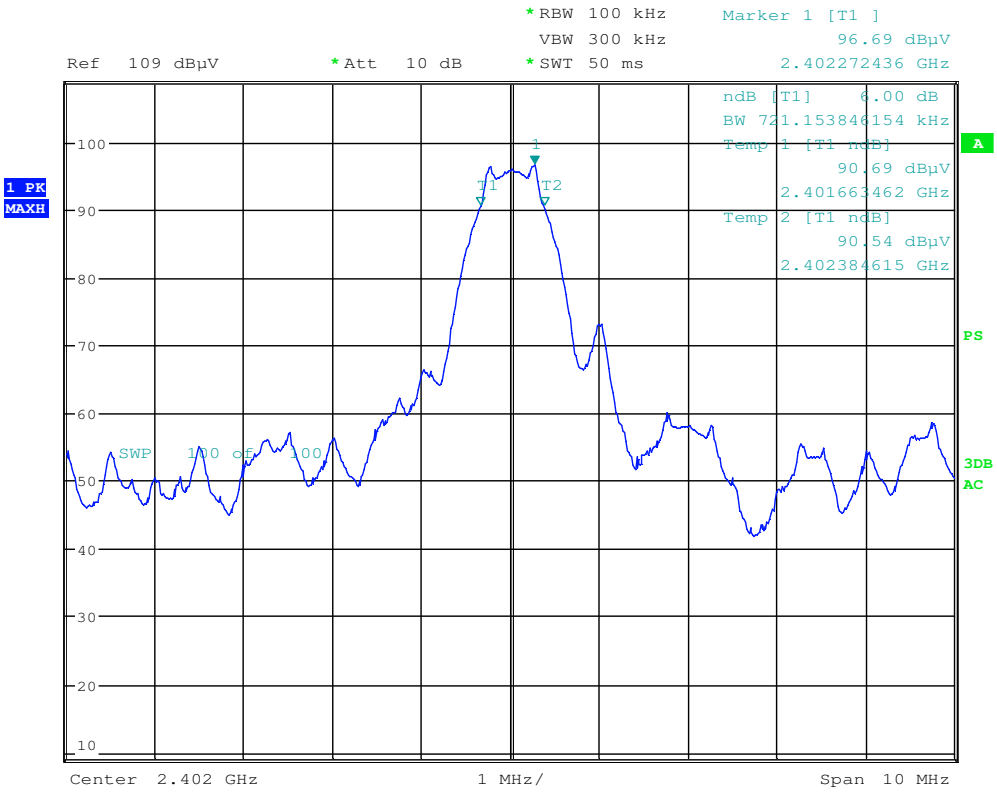
2.4.8 Test Results

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
Bluetooth LE	37 (2402 MHz)	0.721	0.500	Complies
	17 (2440 MHz)	0.721	0.500	Complies
	39 (2480 MHz)	0.721	0.500	Complies

2.4.9 Test Results Plots



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Bluetooth LE Low Channel

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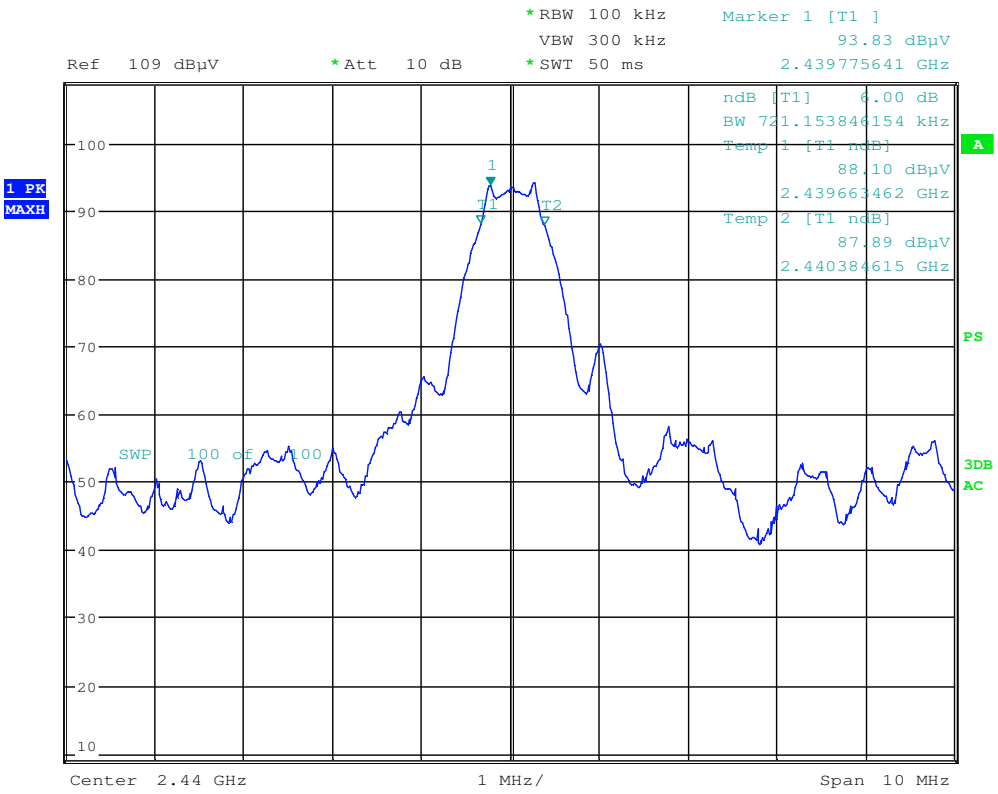

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Bluetooth LE Mid Channel

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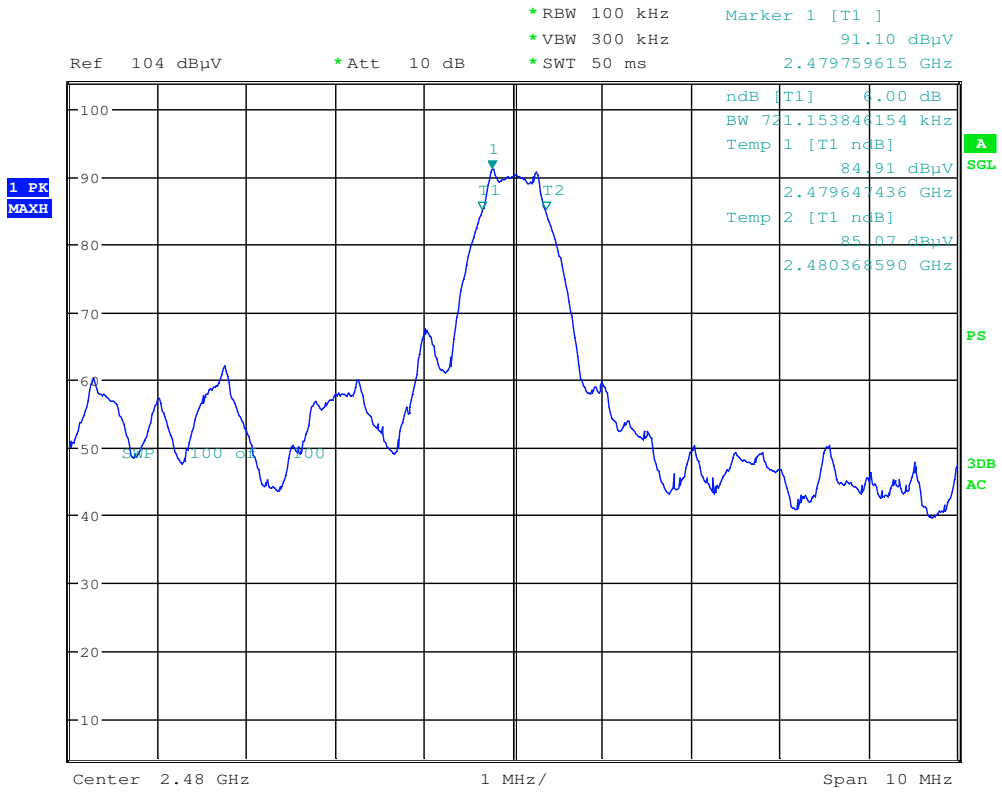

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Bluetooth LE High Channel

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2.5 OUT-OF-BAND EMISSIONS - CONDUCTED

2.5.1 Specification Reference

Part 15 Subpart C §15.247(d)

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

Not performed. Since the EUT does not have a conducted port, the test results from section 2.7 apply

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2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 Standard Applicable

See previous test.

2.6.3 Equipment Under Test and Modification State

Not performed. All band edge measurements were performed using radiated measurements. Test results are presented in Section 2.8 of this test report

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2.7 SPURIOUS RADIATED EMISSIONS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

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: 142500148 / Default Test Configuration

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

July 14, 2014/KAM

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	25.0°C
Relative Humidity	48.8%
ATM Pressure	99.1 kPa

2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- 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 presented for radiated emissions below 1GHz. There are no significant differences in emissions between all modes below 1GHz.

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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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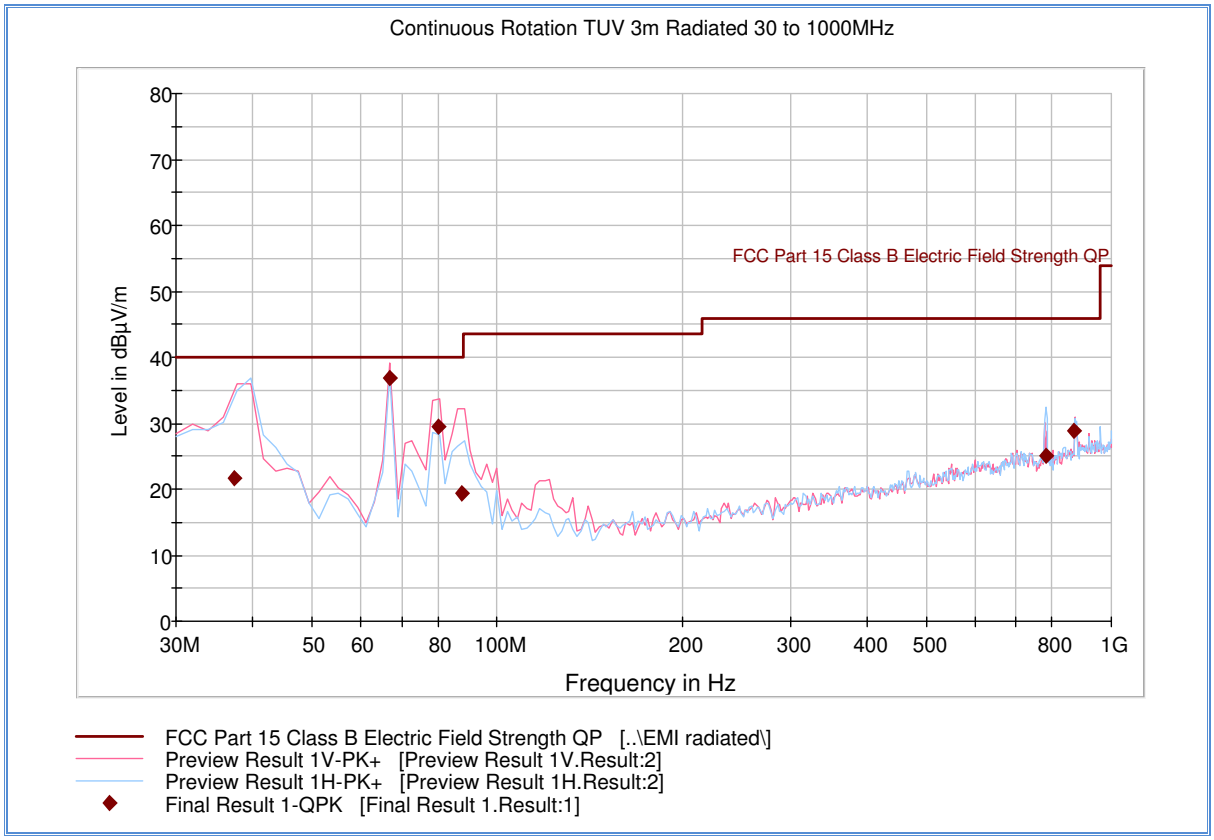
2.7.10 Test Results Below 1GHz (Receive Mode)



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)
37.239439	21.8	1000.0	120.000	250.0	H	11.0	-14.3	18.2	40.0
66.773868	36.9	1000.0	120.000	100.0	V	318.0	-21.4	3.1	40.0
80.021082	29.4	1000.0	120.000	170.0	V	73.0	-21.0	10.6	40.0
87.452745	19.3	1000.0	120.000	300.0	V	-4.0	-20.4	20.7	40.0
782.684569	25.0	1000.0	120.000	100.0	H	112.0	-0.2	21.0	46.0
870.863407	28.8	1000.0	120.000	250.0	H	38.0	0.8	17.2	46.0

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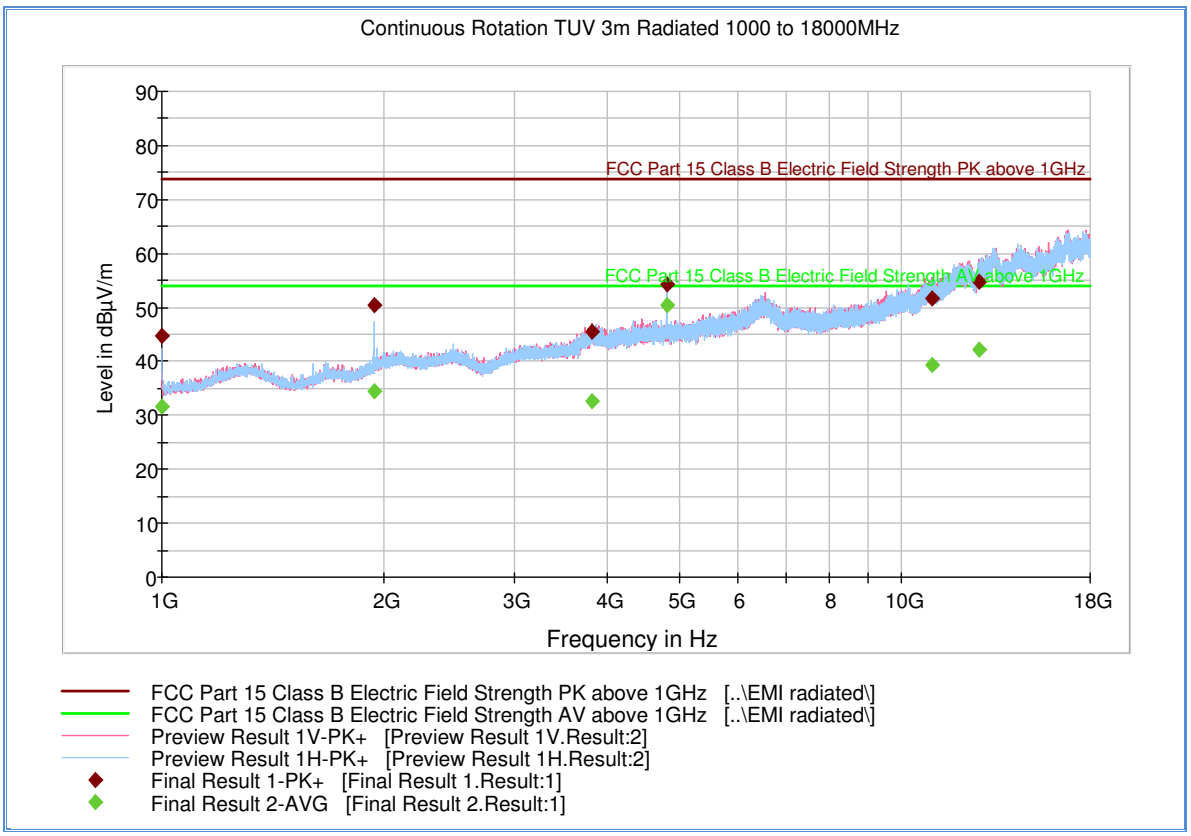
2.7.11 Test Results Above 1GHz (Receive Mode)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	44.7	1000.0	1000.000	100.0	H	320.0	-7.0	29.2	73.9
1937.500000	50.3	1000.0	1000.000	410.0	H	264.0	-1.4	23.6	73.9
3823.133333	45.5	1000.0	1000.000	102.0	V	204.0	6.0	28.4	73.9
4809.900000	54.2	1000.0	1000.000	100.1	H	148.0	6.8	19.7	73.9
11007.53333	51.6	1000.0	1000.000	406.9	V	339.0	17.0	22.3	73.9
12746.96666	54.8	1000.0	1000.000	400.0	V	204.0	19.9	19.1	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)
1000.000000	31.7	1000.0	1000.000	100.0	H	320.0	-7.0	22.2	53.9
1937.500000	34.4	1000.0	1000.000	410.0	H	264.0	-1.4	19.5	53.9
3823.133333	32.8	1000.0	1000.000	102.0	V	204.0	6.0	21.1	53.9
4809.900000	50.5	1000.0	1000.000	100.1	H	148.0	6.8	3.4	53.9
11007.53333	39.3	1000.0	1000.000	406.9	V	339.0	17.0	14.6	53.9
12746.96666	42.2	1000.0	1000.000	400.0	V	204.0	19.9	11.7	53.9

Test Notes: No significant emissions observed above 18GHz.

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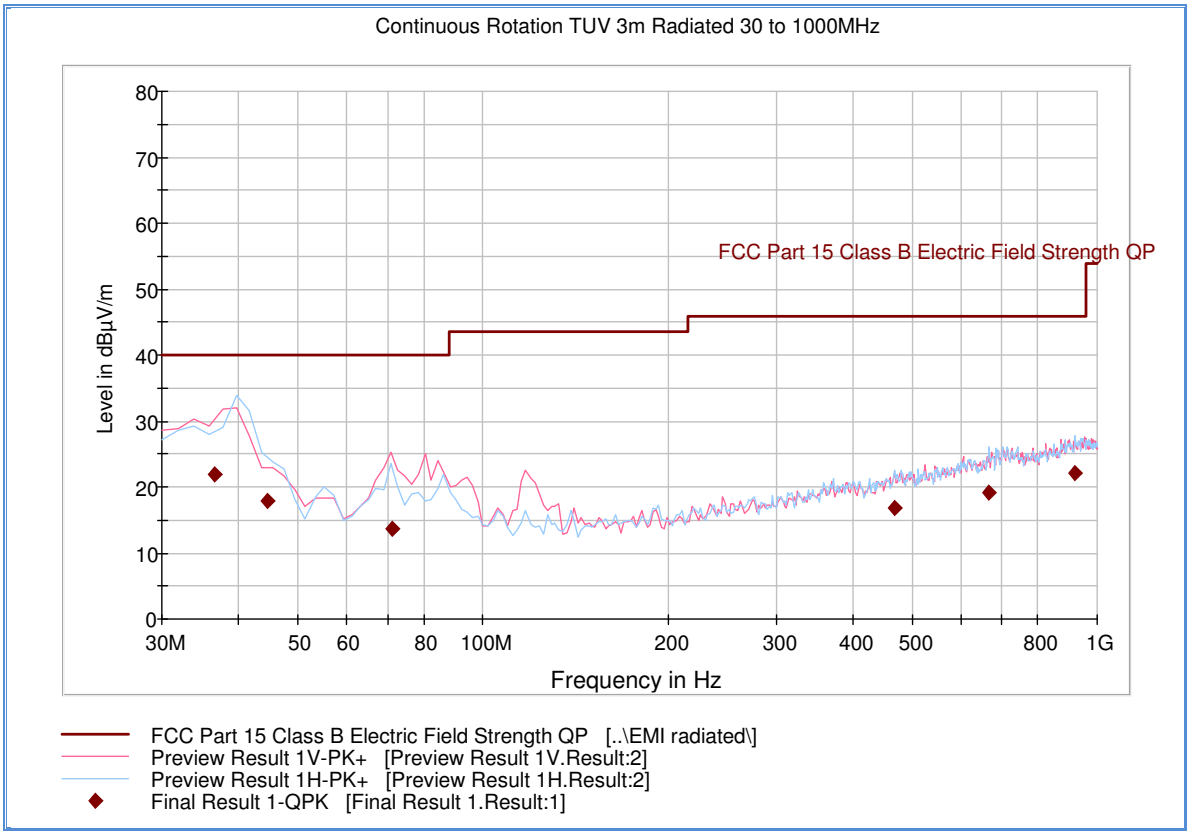
2.7.12 Test Results Below 1GHz (Bluetooth LE)



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)
36.479439	21.9	1000.0	120.000	366.0	H	3.0	-14.0	18.1	40.0
44.647214	18.0	1000.0	120.000	238.0	H	15.0	-17.3	22.0	40.0
71.301643	13.6	1000.0	120.000	100.0	V	18.0	-21.4	26.4	40.0
467.334749	16.8	1000.0	120.000	122.0	H	10.0	-6.6	29.2	46.0
667.755190	19.1	1000.0	120.000	360.0	H	183.0	-1.9	26.9	46.0
920.964489	22.2	1000.0	120.000	400.0	H	201.0	2.2	23.8	46.0

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

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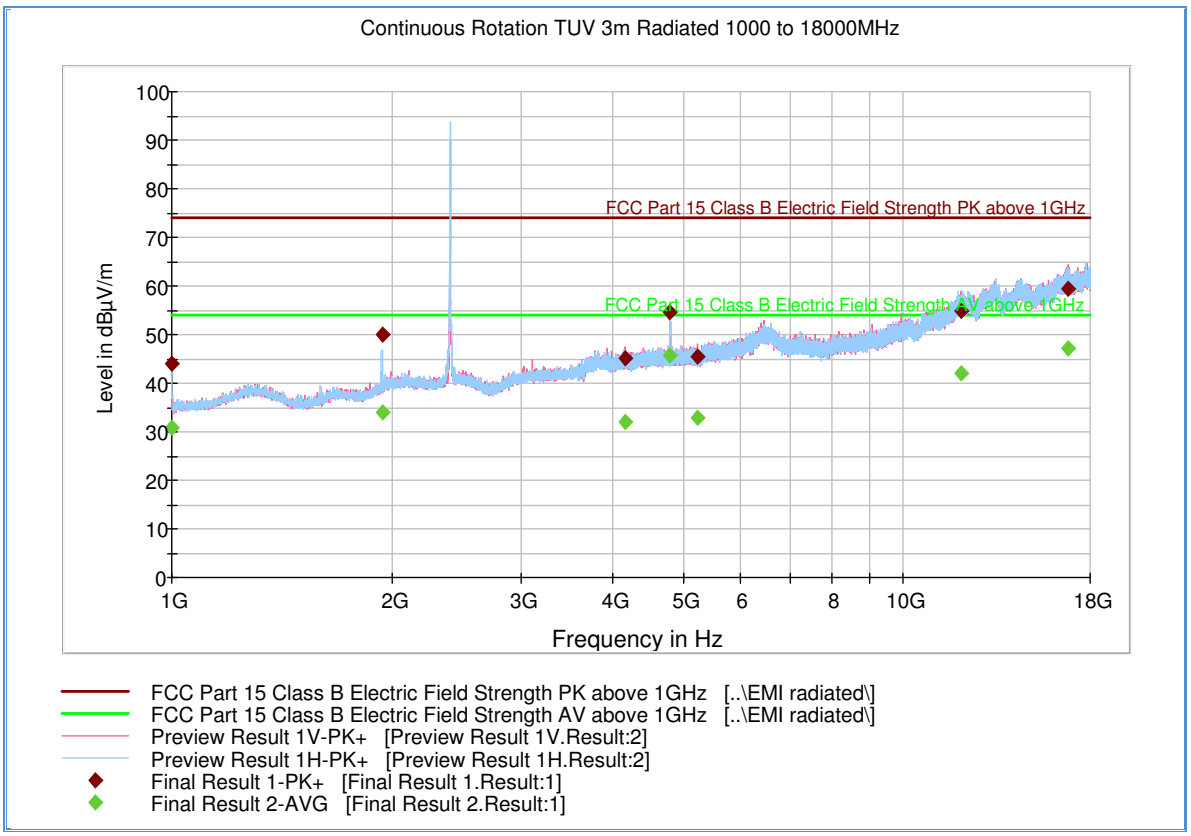
2.7.13 Test Results Above 1GHz (Bluetooth LE Low Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	43.9	1000.0	1000.000	124.0	H	40.0	-7.0	30.0	73.9
1937.633333	49.9	1000.0	1000.000	400.0	H	147.0	-1.4	24.0	73.9
4167.066667	45.3	1000.0	1000.000	100.0	V	102.0	6.2	28.6	73.9
4804.633333	54.6	1000.0	1000.000	333.0	H	204.0	6.8	19.3	73.9
5229.266667	45.4	1000.0	1000.000	300.0	V	267.0	7.9	28.5	73.9
12012.066667	54.8	1000.0	1000.000	230.0	V	220.0	20.4	19.1	73.9
16785.466667	59.5	1000.0	1000.000	344.0	V	49.0	25.9	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)
1000.000000	30.9	1000.0	1000.000	124.0	H	40.0	-7.0	23.0	53.9
1937.633333	33.9	1000.0	1000.000	400.0	H	147.0	-1.4	20.0	53.9
4167.066667	32.1	1000.0	1000.000	100.0	V	102.0	6.2	21.8	53.9
4804.633333	45.8	1000.0	1000.000	333.0	H	204.0	6.8	8.1	53.9
5229.266667	32.9	1000.0	1000.000	300.0	V	267.0	7.9	21.0	53.9
12012.066667	42.0	1000.0	1000.000	230.0	V	220.0	20.4	11.9	53.9
16785.466667	47.1	1000.0	1000.000	344.0	V	49.0	25.9	6.8	53.9

Test Notes: No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

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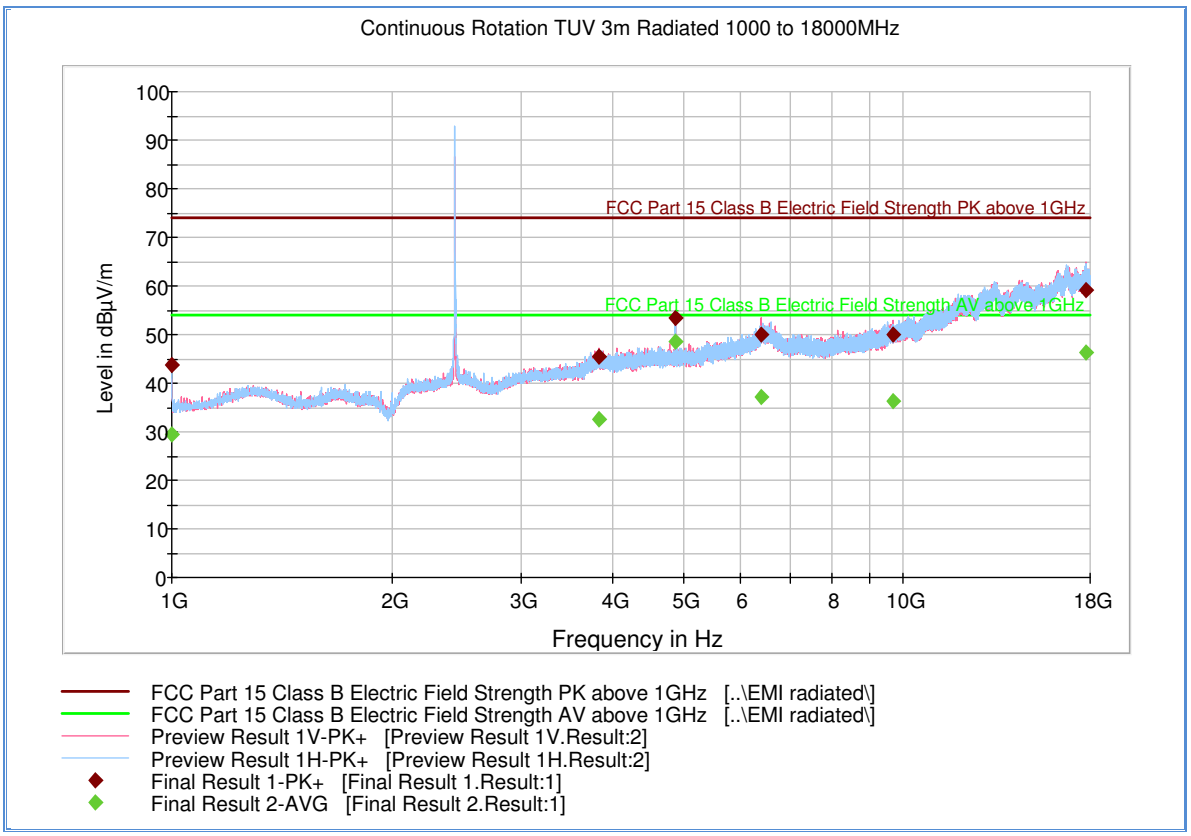
2.7.14 Test Results Above 1GHz (Bluetooth LE Mid Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.400000	43.7	1000.0	1000.000	99.7	H	184.0	-7.0	30.2	73.9
3835.966667	45.5	1000.0	1000.000	344.1	V	25.0	6.1	28.4	73.9
4881.866667	53.4	1000.0	1000.000	190.5	V	76.0	7.1	20.5	73.9
6394.466667	49.9	1000.0	1000.000	103.7	V	39.0	12.7	24.0	73.9
9671.133333	50.1	1000.0	1000.000	302.2	V	130.0	13.6	23.8	73.9
17730.266667	59.2	1000.0	1000.000	302.2	V	321.0	25.7	14.7	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)
1000.400000	29.5	1000.0	1000.000	99.7	H	184.0	-7.0	24.4	53.9
3835.966667	32.6	1000.0	1000.000	344.1	V	25.0	6.1	21.3	53.9
4881.866667	48.7	1000.0	1000.000	190.5	V	76.0	7.1	5.2	53.9
6394.466667	37.0	1000.0	1000.000	103.7	V	39.0	12.7	16.9	53.9
9671.133333	36.3	1000.0	1000.000	302.2	V	130.0	13.6	17.6	53.9
17730.266667	46.3	1000.0	1000.000	302.2	V	321.0	25.7	7.6	53.9

Test Notes: No significant emissions observed above 8GHz. Measurements above 8GHz are noise floor figures.

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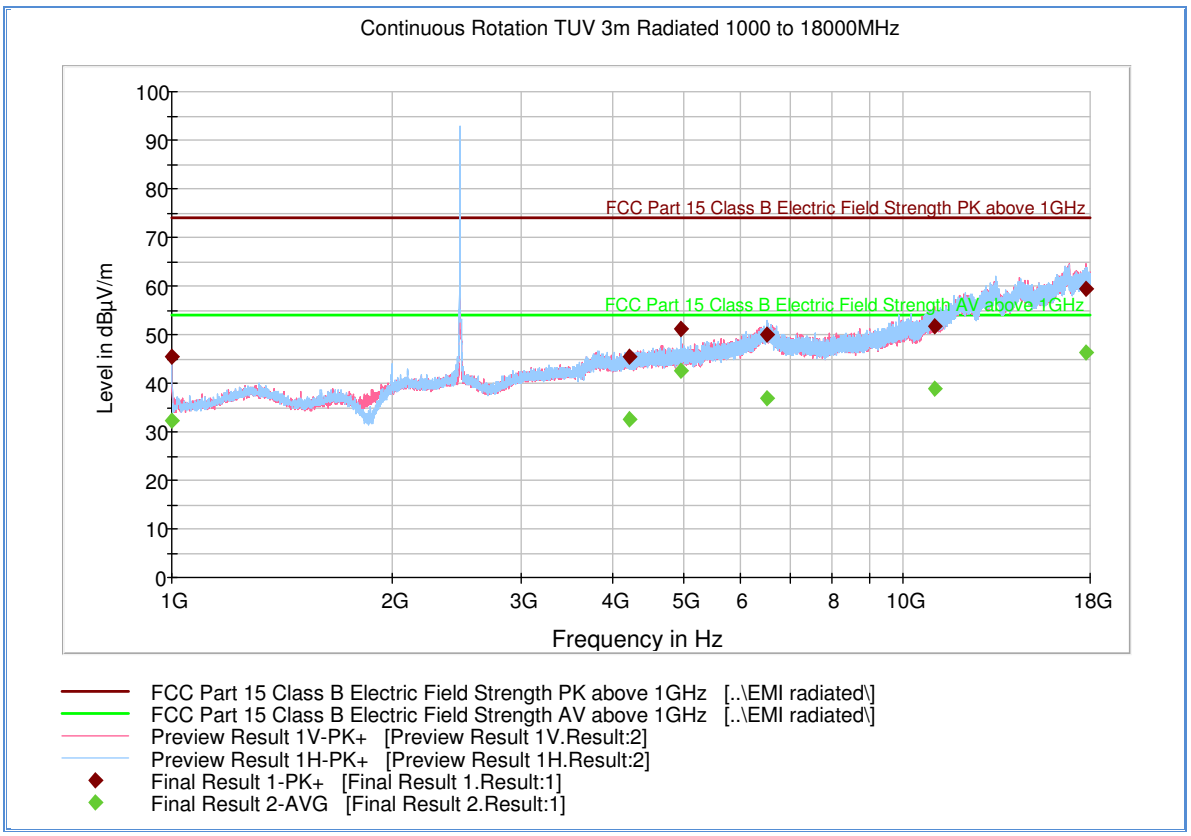
2.7.15 Test Results Above 1GHz (Bluetooth LE High Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	45.4	1000.0	1000.000	120.7	H	254.0	-7.0	28.5	73.9
4229.433333	45.5	1000.0	1000.000	302.2	H	198.0	6.2	28.4	73.9
4958.600000	51.2	1000.0	1000.000	103.7	V	67.0	7.4	22.7	73.9
6499.366667	49.9	1000.0	1000.000	159.6	H	283.0	12.7	24.0	73.9
11038.333333	51.8	1000.0	1000.000	405.7	V	55.0	16.9	22.1	73.9
17777.266667	59.4	1000.0	1000.000	279.3	V	249.0	25.8	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)
1000.000000	32.2	1000.0	1000.000	120.7	H	254.0	-7.0	21.7	53.9
4229.433333	32.6	1000.0	1000.000	302.2	H	198.0	6.2	21.3	53.9
4958.600000	42.5	1000.0	1000.000	103.7	V	67.0	7.4	11.4	53.9
6499.366667	36.9	1000.0	1000.000	159.6	H	283.0	12.7	17.0	53.9
11038.333333	38.9	1000.0	1000.000	405.7	V	55.0	16.9	15.0	53.9
17777.266667	46.3	1000.0	1000.000	279.3	V	249.0	25.8	7.6	53.9

Test Notes: No significant emissions observed above 6GHz. Measurements above 6GHz are noise floor figures.

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2.8 RADIATED BAND EDGE MEASUREMENTS AND IMMEDIATE RESTRICTED BANDS

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)).

2.8.3 Equipment Under Test and Modification State

Serial No: 142200170 / Default Test Configuration

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

July 22, 2014/KAM

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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.1°C
Relative Humidity	48.5%
ATM Pressure	99.1 kPa

2.8.7 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.

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- 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 2.8.8 for sample computation.

2.8.8 Sample Computation (Radiated Emission)

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

2.8.9 Test Results

See attached plots.

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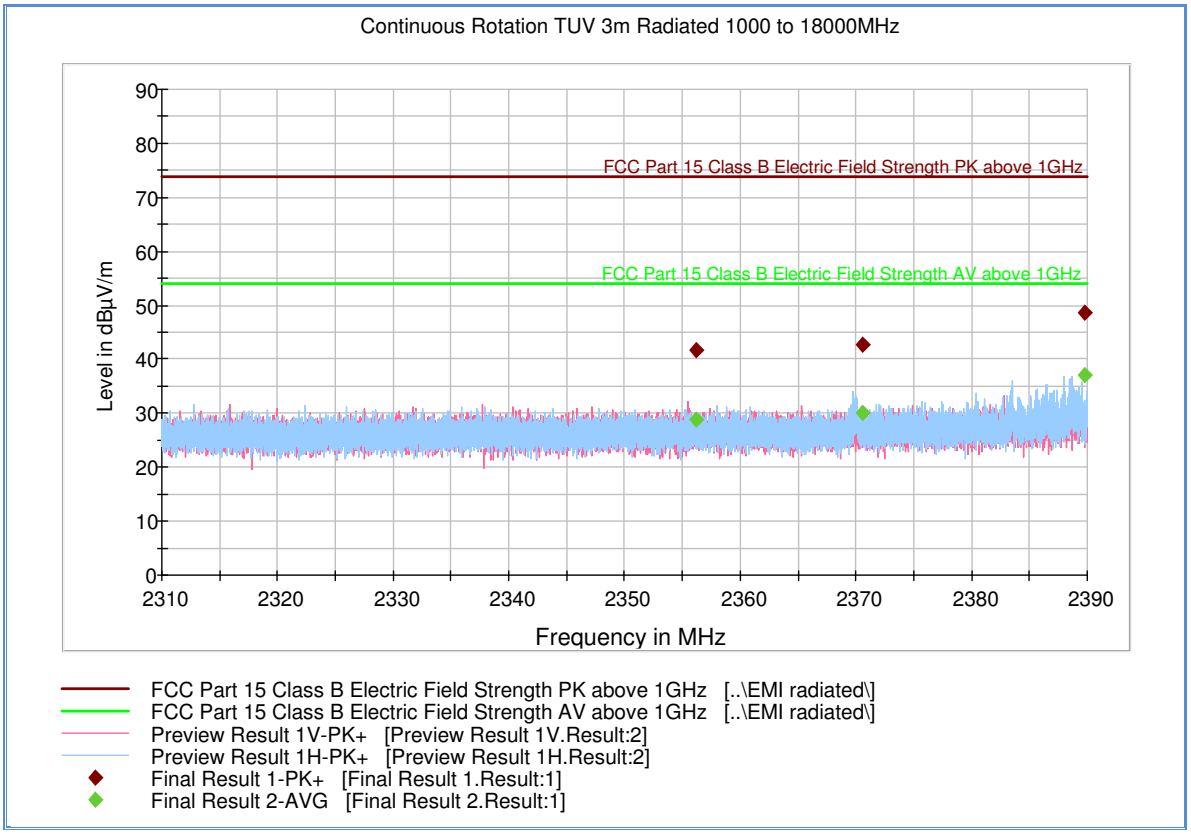
2.8.10 Test Results Restricted Band 2310MHz to 2490MHz (Bluetooth LE Low Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2356.221333	41.6	1000.0	1000.000	405.7	V	20.0	-0.4	32.3	73.9
2370.584000	42.8	1000.0	1000.000	124.7	H	4.0	-0.3	31.1	73.9
2389.701333	48.7	1000.0	1000.000	115.7	H	351.0	-0.2	25.2	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)
2356.221333	28.9	1000.0	1000.000	405.7	V	20.0	-0.4	25.0	53.9
2370.584000	30.0	1000.0	1000.000	124.7	H	4.0	-0.3	23.9	53.9
2389.701333	37.0	1000.0	1000.000	115.7	H	351.0	-0.2	16.9	53.9

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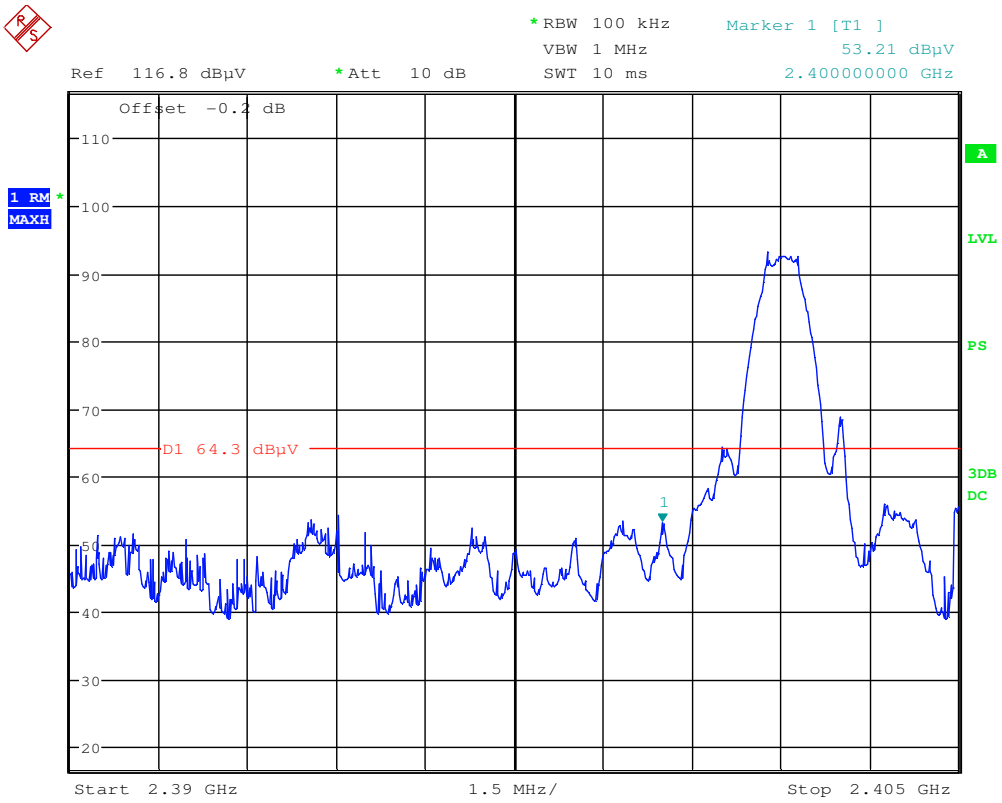
2.8.11 Test Results Band Edge 2400MHz using 100kHz RBW (Bluetooth LE Low Channel)



Date: 30.JUL.2014 16:32:09

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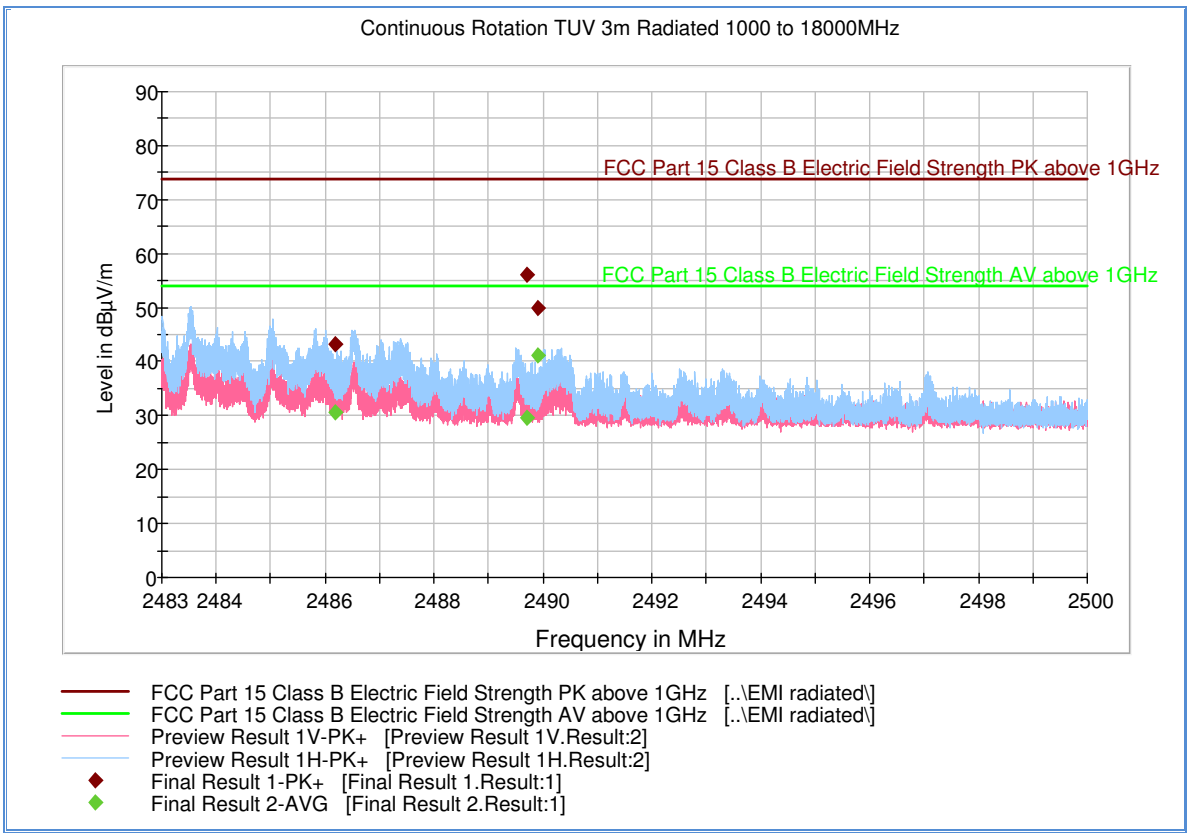
2.8.12 Test Results Restricted Band 2483.5MHz to 2500MHz (Bluetooth LE High Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2486.198233	43.3	1000.0	1000.000	114.7	H	237.0	0.2	30.6	73.9
2489.697400	56.0	1000.0	1000.000	200.5	H	232.0	0.2	17.9	73.9
2489.897400	49.9	1000.0	1000.000	101.7	H	226.0	0.2	24.0	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)
2486.198233	30.5	1000.0	1000.000	114.7	H	237.0	0.2	23.4	53.9
2489.697400	29.5	1000.0	1000.000	200.5	H	232.0	0.2	24.4	53.9
2489.897400	41.1	1000.0	1000.000	101.7	H	226.0	0.2	12.8	53.9

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2.9 POWER SPECTRAL DENSITY

2.9.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.9.2 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.

2.9.3 Equipment Under Test and Modification State

Serial No: 142500148 / Default Test Configuration

2.9.4 Date of Test/Initial of test personnel who performed the test

Not Performed. EUT complies with the requirement since the measured total power (peak conducted output power or maximum conducted output power) complies with the PSD limit, therefore the actual measurement of PSD is not required (per Section 10.1 of KDB 558074 D01 DTS Meas Guidance v03r02,(June 5,2014) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

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SECTION 3

TEST EQUIPMENT USED

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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						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	01/30/14	01/30/16
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
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	02/28/14	02/28/16
8760	Pre-amplifier	ZKL-2	1001	Mini-Circuits	09/03/13	09/03/14
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	09/03/13	09/03/14
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	07/31/13	07/31/14
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/14	03/17/15
1016	Pre-amplifier	PAM-0202	187	PAM	10/08/13	10/08/14
Miscellaneous						
6452	Multimeter	3478A	2911A52177	Hewlett Packard	08/02/13	08/02/14
7560	Barometer/Temperature /Humidity Transmitter	iBTHX-W	1240476	Omega	01/30/14	01/30/15
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

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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

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SECTION 4

DIAGRAM OF TEST SETUP

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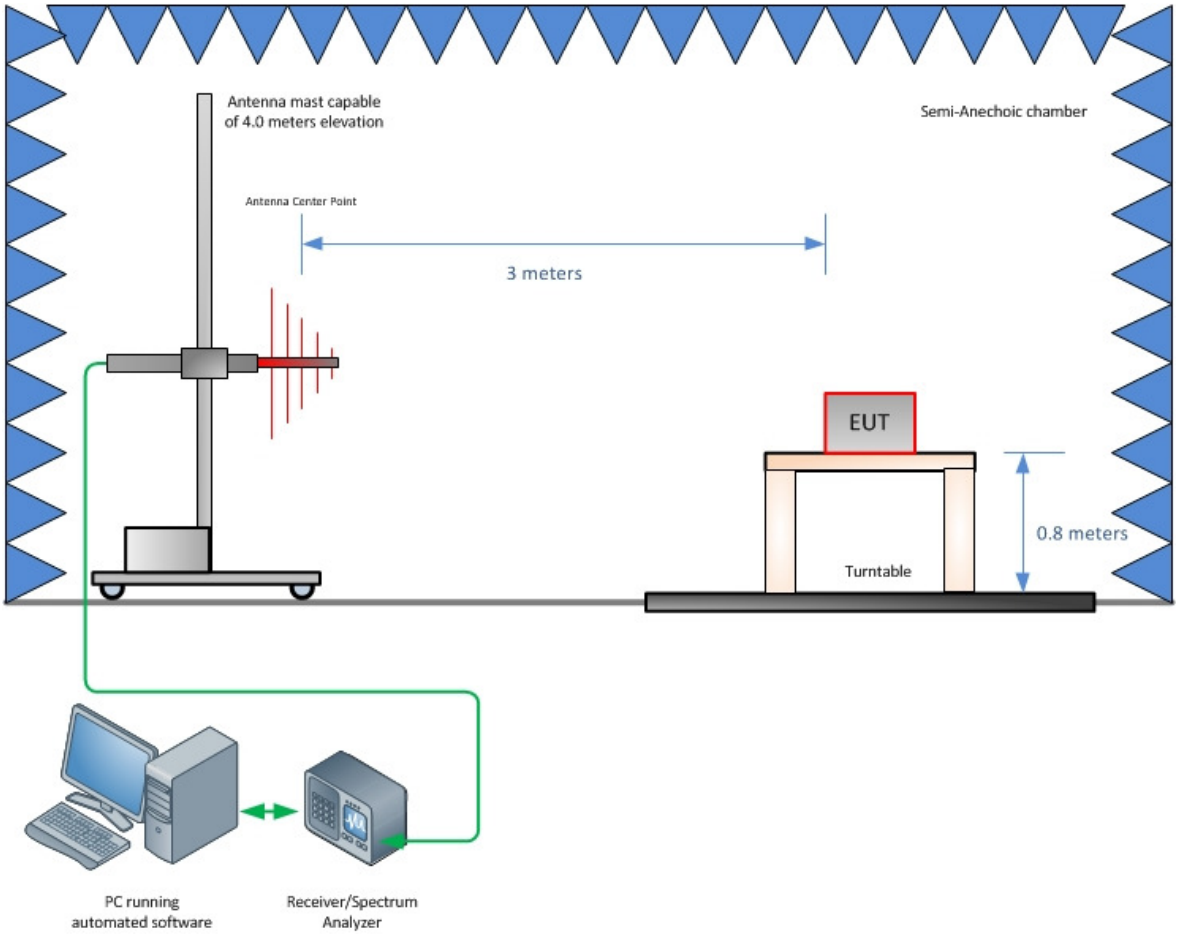
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)

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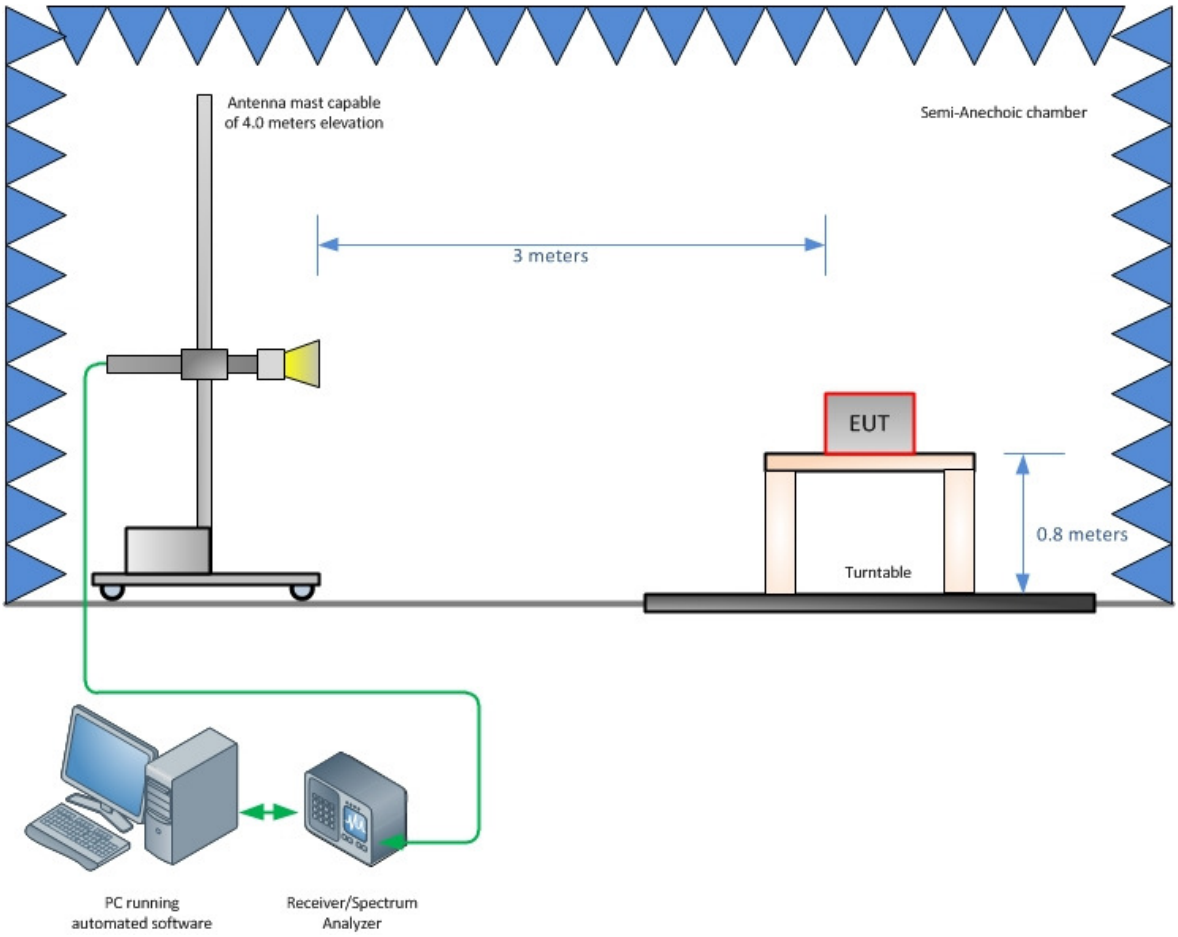

Radiated Emission Test Setup (Above 1GHz)

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SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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