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Report On

Application for Grant of Equipment Authorization of the GreatCall
Lively Wearable BLE Wearable Device

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

Report No. SD72114801-0316A **March 2016**

REPORT ON	Radio Testing of the GreatCall BLE Wearable Device
TEST REPORT NUMBER	SD72114801-0316A
PREPARED FOR	GreatCall 10935 Vista Sorrento Pkwy, Suite 200 San Diego, CA 92121
CONTACT PERSON	Chris Gutierrez Director, Product Innovation (858) 859-7337 chris.gutierrez@greatcall.com
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC/Senior Wireless Test Engineer
APPROVED BY	Chip R. Fleury **Name** Authorized Signatory Title: West Coast EMC Manager
DATED	March 23, 2016

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

Revision History

SD72114801-0316A GreatCall Lively Wearable BLE Wearable Device					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
03/23/2016	Initial Release				Chip R. Fleury

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SECTION 1

REPORT SUMMARY

Radio Testing of the
GreatCall
BLE Wearable Device

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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the GreatCall Lively Wearable BLE Wearable Device 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	GreatCall
Model Number(s)	VM01
FCC ID Number	2AHQE-VM01
IC Number	N/A
Serial Number(s)	N/A
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2015). • RSS-247 Issue 1 May 2015 - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 4, November 2014). • 558074 D01 DTS Meas Guidance v03r04, (January 07, 2016) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247. • ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Start of Test	March 21, 2016
Finish of Test	March 23, 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 - Radiated	Compliant	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance and Immediate Restricted Band	Compliant	
2.7	§15.247(d)	RSS-Gen 8.9 and 8.10	Spurious Radiated Emissions	N/A[1]	Clause 12.2.7 of KDB558074 D01 DTS Meas Guidance v03r04
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 battery powered device
N/A[1] Not performed. Test results from "Out-of-Band Emissions – Radiated" covers this requirement

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1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a GreatCall Lively Wearable BLE Wearable Device as shown in the photograph below. The EUT is a device that monitors the acceleration of a wearer and sends this information to a mobile phone. The device is powered with a CR2450 coin cell battery. The EUT communicates with a mobile phone over a Bluetooth Low Energy (BLE) connection. The mobile phone runs an application to communicate with the EUT, reading acceleration data.

Equipment Under Test

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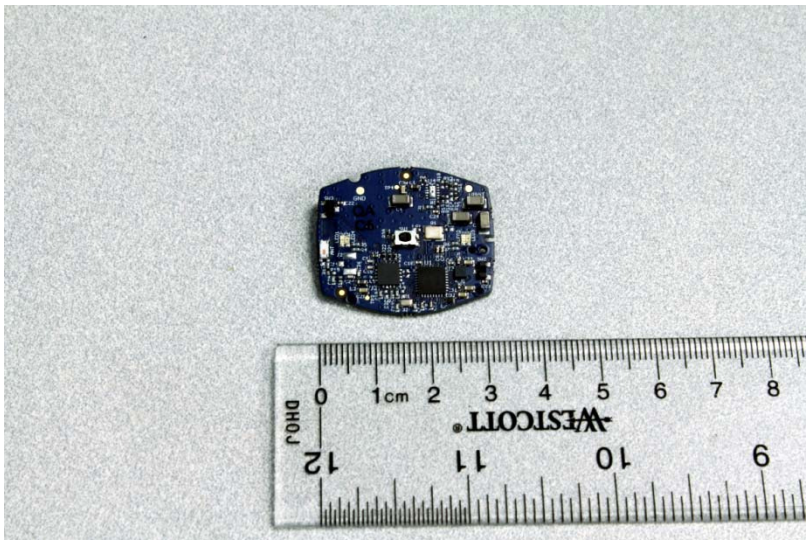

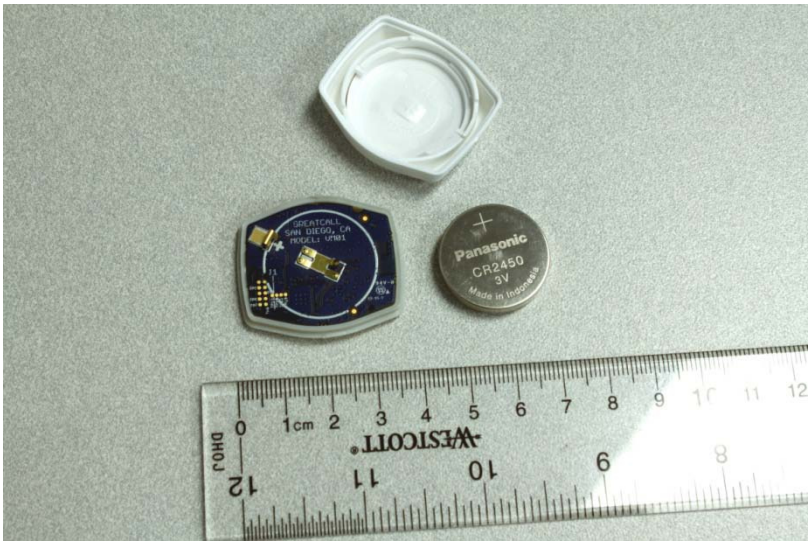

Equipment Under Test (without wrist band)

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1.3.2 EUT General Description

EUT Description	BLE Wearable Device
Model Name	Lively Wearable
Model Number(s)	VM01
Rated Voltage	3V Coin Cell Battery (CR2450)
Mode Verified	Bluetooth Low Energy (BT LE)
Capability	Bluetooth Low Energy (BT LE) only
Primary Unit (EUT)	☐ Production
	☐ Pre-Production
	☒ Engineering
Antenna Type	RF Ceramic Chip antenna
Antenna Manufacturer	Johanson Technology
Antenna Model Number	2.45 GHz SMD Antenna, EIA 1210, Detuning resilient, Edge Mount Design P/N 2450AT18D0100
Antenna Dimensions	3.20mm x 1.60mm x 1.20mm
Antenna Gain	1.5 dBi (Peak)

1.3.3 Maximum Peak Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
Bluetooth LE	2402-2480	10.64	11.56

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1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	Test firmware loaded which allows the EUT to transmit at 100% duty cycle. The main button of the EUT was pressed between modes (Low Channel TX, Mid Channel TX and High Channel TX).

1.4.2 EUT Exercise Software

None. No special test software was used to exercise the EUT during verification. Firmware however was updated to allow test modes.

1.4.3 Support Equipment and I/O cables

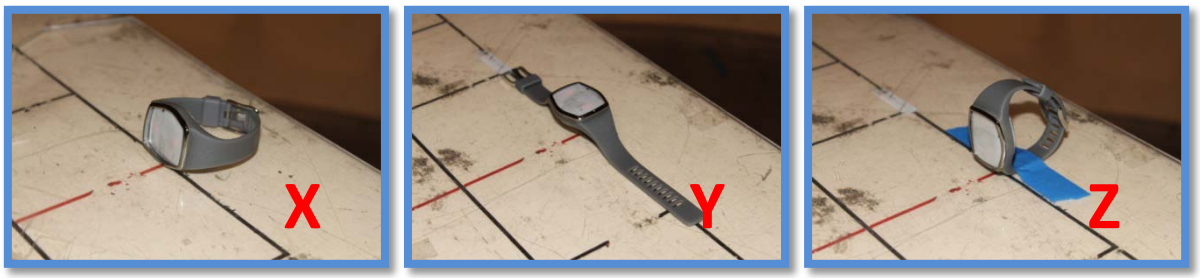
Manufacturer	Equipment/Cable	Description
-	-	-

1.4.4 Worst Case Configuration

Worst-case configuration used in this test report as per fundamental field strength measurements:

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

EUT is a portable device. For radiated measurements, all three axes were verified to determine worst case axis to be used during testing. “X” axis was verified to be the worst axis for radiated emissions.



Please see verification plot on the following page.

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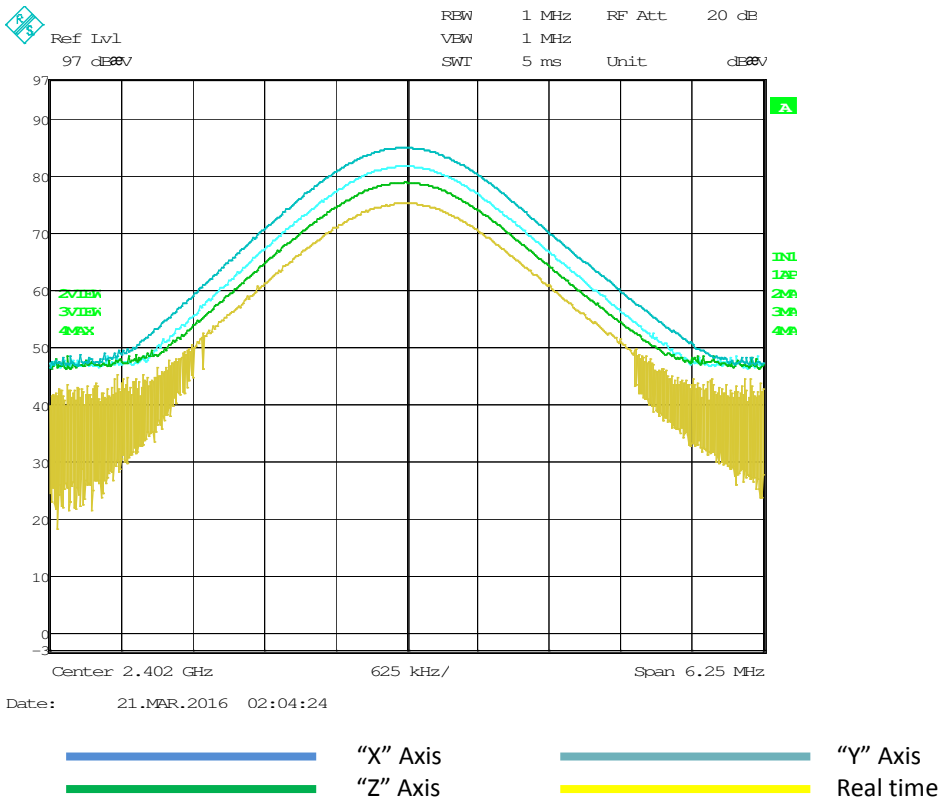
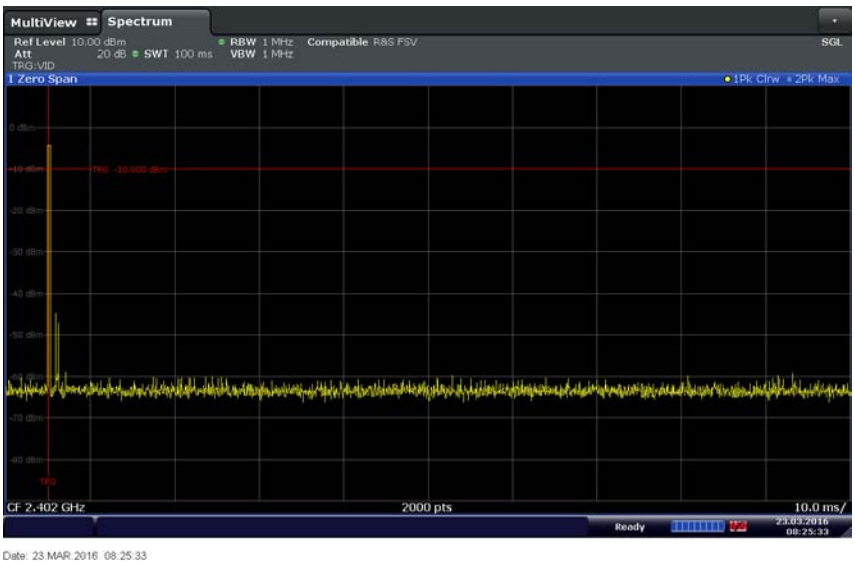


1.4.5 Duty Cycle Correction Factor

The EUT has an integral antenna and does not have provision for temporary antenna connector. All measurements performed were done via radiated method. Radiated emissions were normally performed at 100% duty cycle using Quasi Peak detector below 1GHz and Peak/Average detector above 1GHz. As an alternative for determining average value as per Clause 7.5 of ANSI C63.10-2013, average field strength could be calculated by applying DCCF to the peak pulse amplitude. All requirements stated in this Clause should be followed.



EUT transmission in 100ms pulse train

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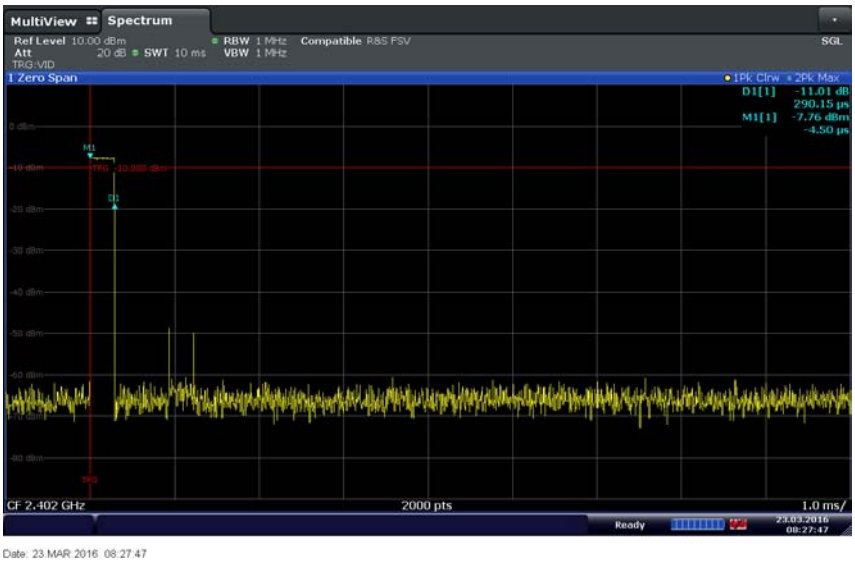

Total maximum pulse "ON time" (290.15µs)

Duty Cycle Correction Factor (DCCF) calculation:

DCCF = 20log (0.29015/100)
= -50.7dB (maximum correction limited to -20dB, 20dB peak to average ratio applies)

1.4.6 Simplified Test Configuration Diagram

Not required. EUT was verified on a stand-alone test configuration.

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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 Innovation, Science and Economic Development 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 Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A.

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SECTION 2

TEST DETAILS

Radio Testing of the
GreatCall
BLE Wearable Device

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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 21, 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 radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- Test Methodology is per Clause 3.0 of KDB558074 D01 DTS Meas Guidance v03r04.
- Calculate the EIRP from the radiated field strength in the far field using Equation (22) of ANSI C63.10-2013:

$$\text{EIRP} = E_{\text{Meas}} + 20\log(d_{\text{Meas}}) - 104.7$$

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Where

EIRP is the equivalent isotropically radiated power, in dBm
E_{Meas} is the field strength of the emission at the measurement distance, in dBµV/m
d_{Meas} is the measurement distance, in m

- Calculate the conducted power from the EIRP using Equation (23) of ANSI C63.10-2013:

$$P_{Cond} = EIRP - G_{EUT}$$

Where

P_{Cond} is the measured power at feedpoint of the EUT antenna, in dBm
EIRP is the equivalent isotropically radiated power, in dBm
G_{EUT} is the gain of the EUT radiating element (antenna), in dBi

- 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 2.1.8 for sample computation.

2.1.8 Sample Computation (Radiated Emission)

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

2.1.9 Test Results

See attached plots.

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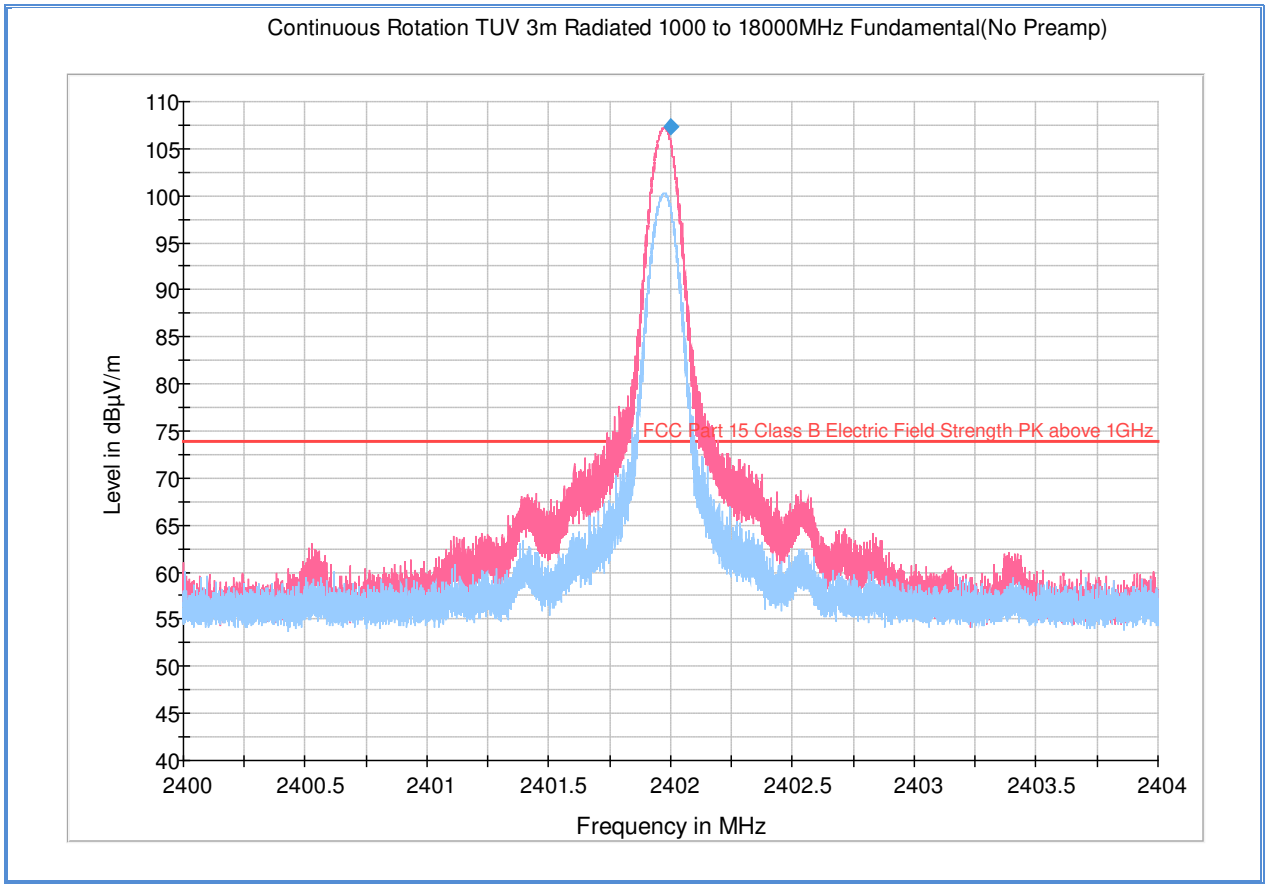
2.1.10 Low Channel Fundamental Field Strength Measurement



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2402.00	107.3	1000.0	1000.000	101.7	V	271.0	35.1

Therefore EIRP = 107.3 + 20log(3) -104.7
= 12.14 dBm

P_{Cond} = EIRP - G_{EUT}
= 12.14 dBm – 1.5 dBi
= 10.64 dBm. Complies with 30dBm limit.

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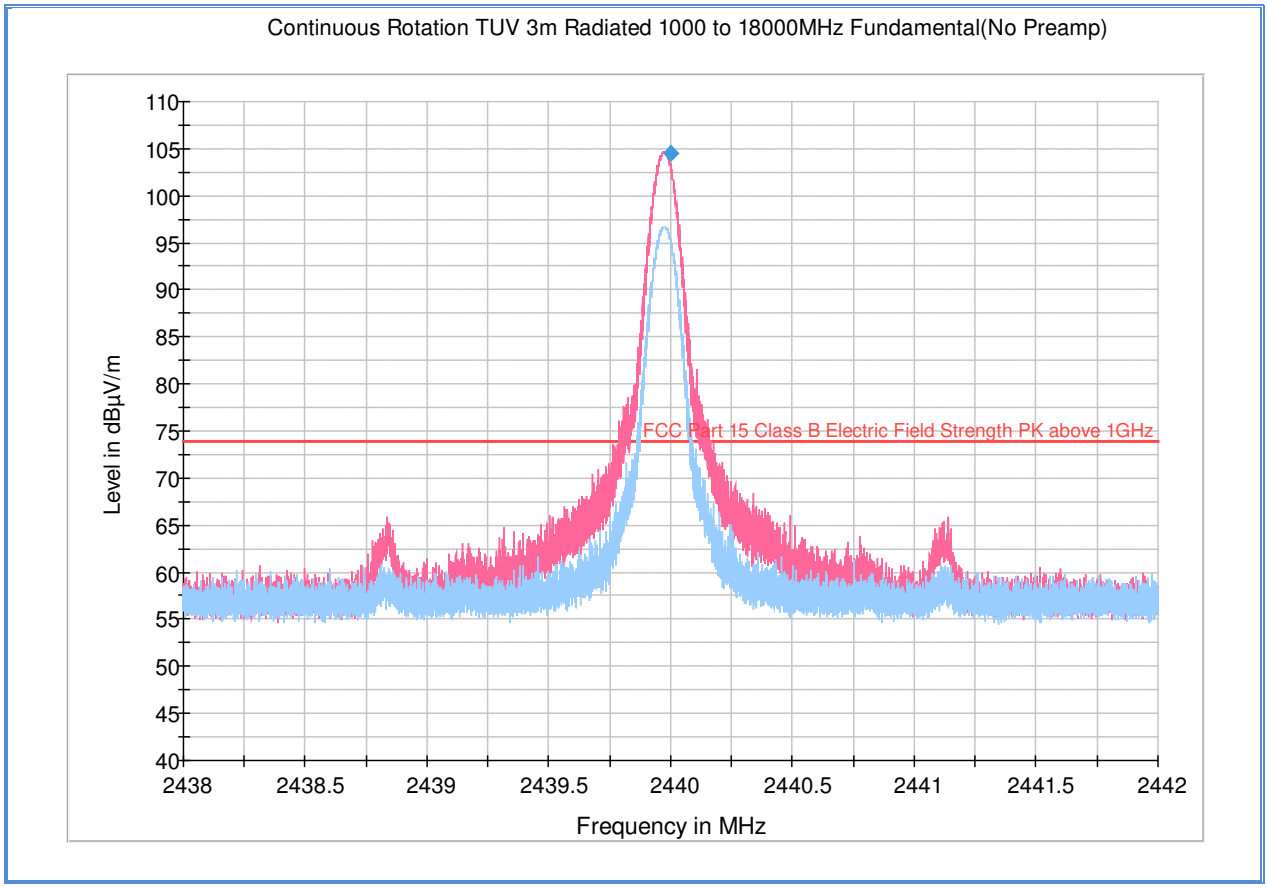
2.1.11 Mid Channel Fundamental Field Strength Measurement



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2440.00	104.5	1000.0	1000.000	101.7	V	312.0	35.3

Therefore EIRP = 104.5 + 20log(3) -104.7
= 9.34 dBm

P_{Cond} = EIRP - G_{EUT}
= 9.34 dBm – 1.5 dBi
= 7.84 dBm. Complies with 30dBm limit.

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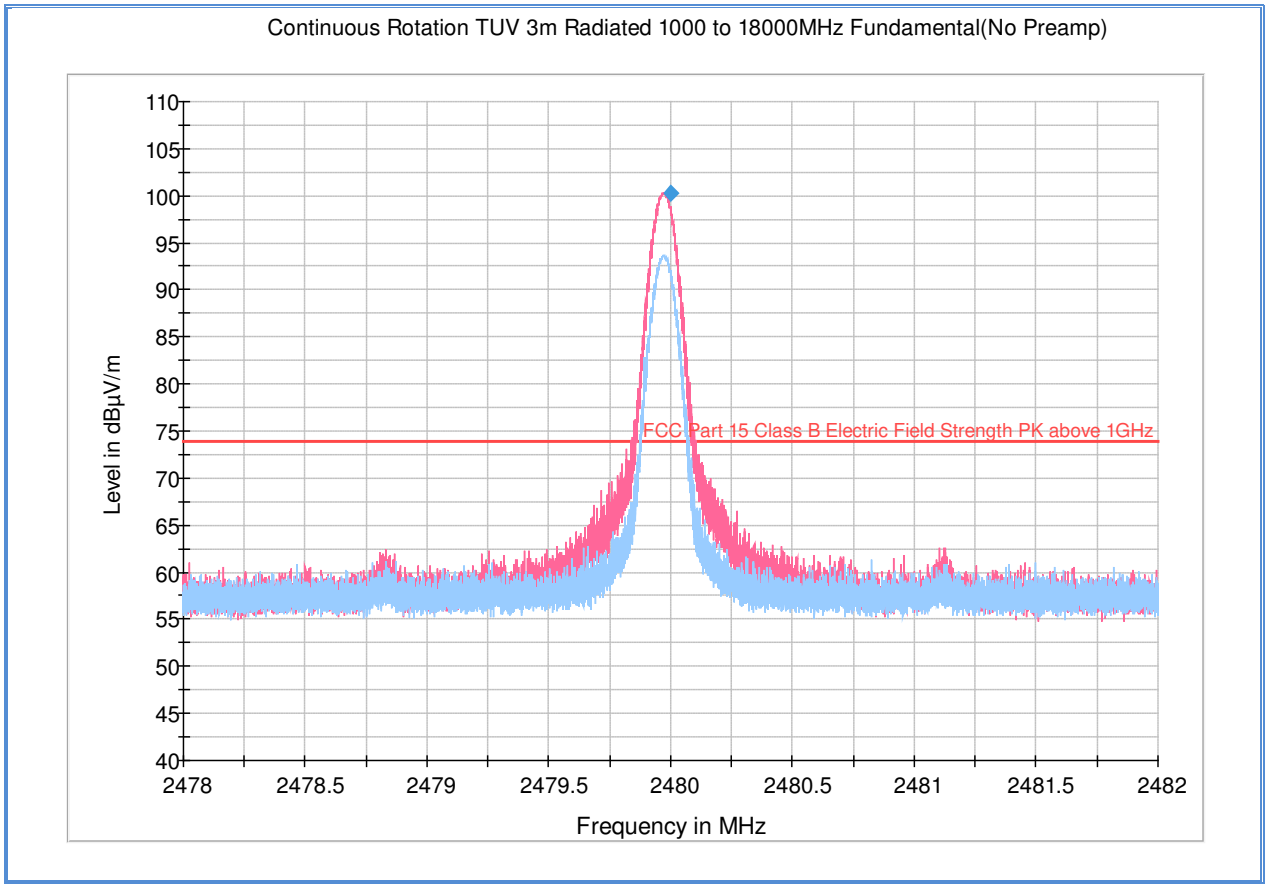
2.1.12 High Channel Fundamental Field Strength Measurement



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)
2480.00	100.3	1000.0	1000.000	101.7	V	312.0	35.4

Therefore EIRP = 100.3 + 20log(3) -104.7
= 5.14 dBm

P_{Cond} = EIRP - G_{EUT}
= 5.14 dBm – 1.5 dBi
= 3.64 dBm. Complies with 30dBm limit.

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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 battery powered device.

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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 23, 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.

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2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.3 °C
Relative Humidity	34.0.%
ATM Pressure	99.6 kPa

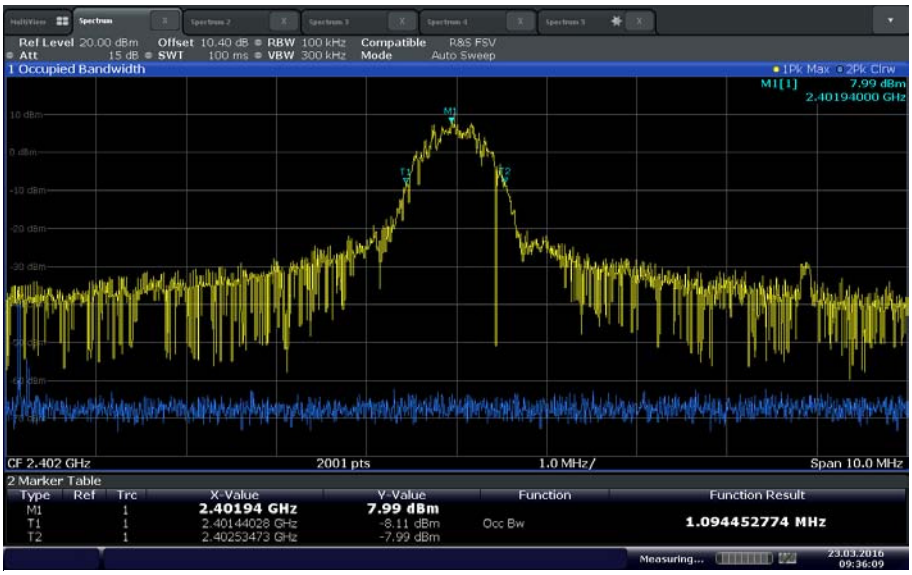
2.3.7 Additional Observations

- 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.
- 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)	1.094
	17 (2440 MHz)	1.099
	39 (2480 MHz)	1.089

2.3.9 Test Results Plots



Date: 23 MAR 2016 09:36:08

Bluetooth LE Low Channel

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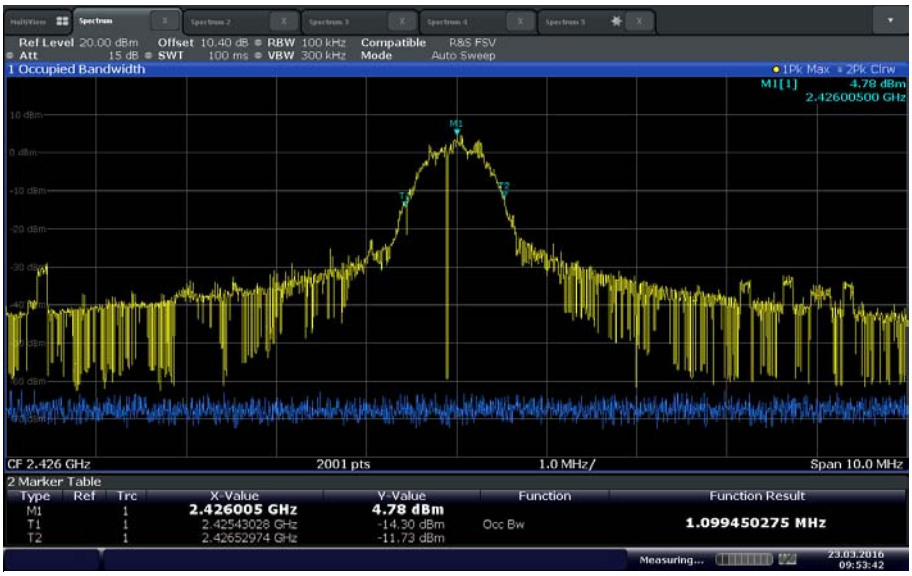

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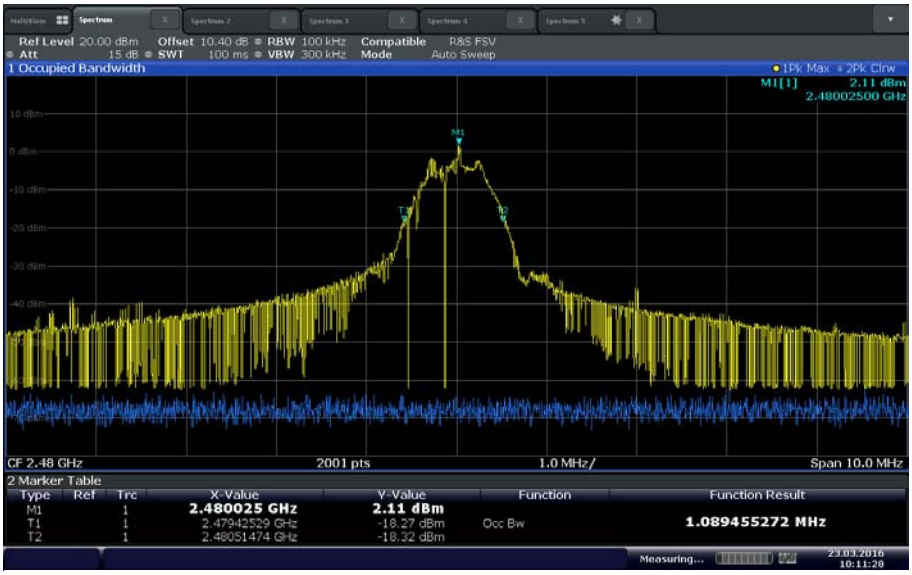
Bluetooth LE Mid Channel



Date: 23 MAR 2016 10:11:28

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) 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 23, 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	25.3 °C
Relative Humidity	34.0.%
ATM Pressure	99.6 kPa

2.4.7 Additional Observations

- This is a radiated test.
- 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)	0.622	0.500	Complies
	38 (2426 MHz)	0.626	0.500	Complies
	39 (2480 MHz)	0.674	0.500	Complies

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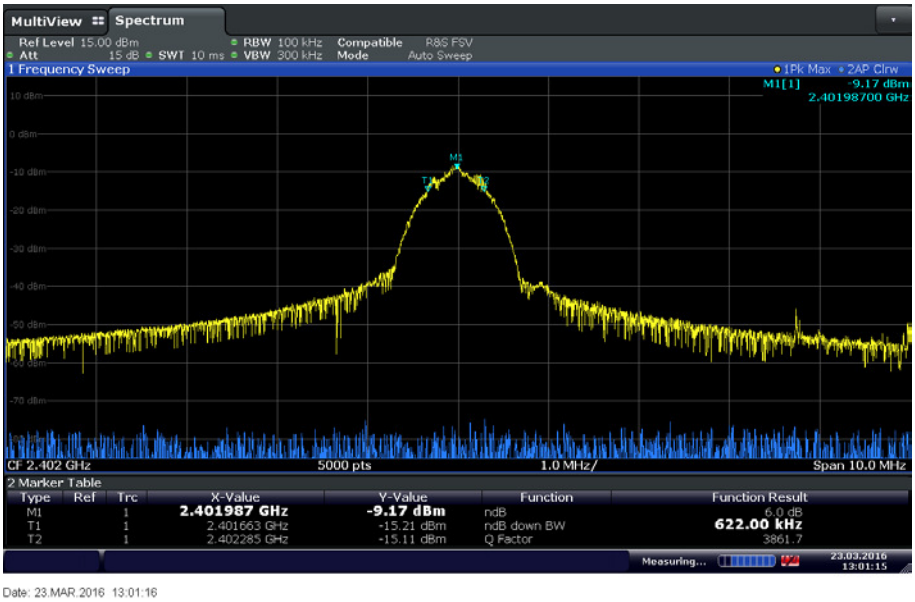
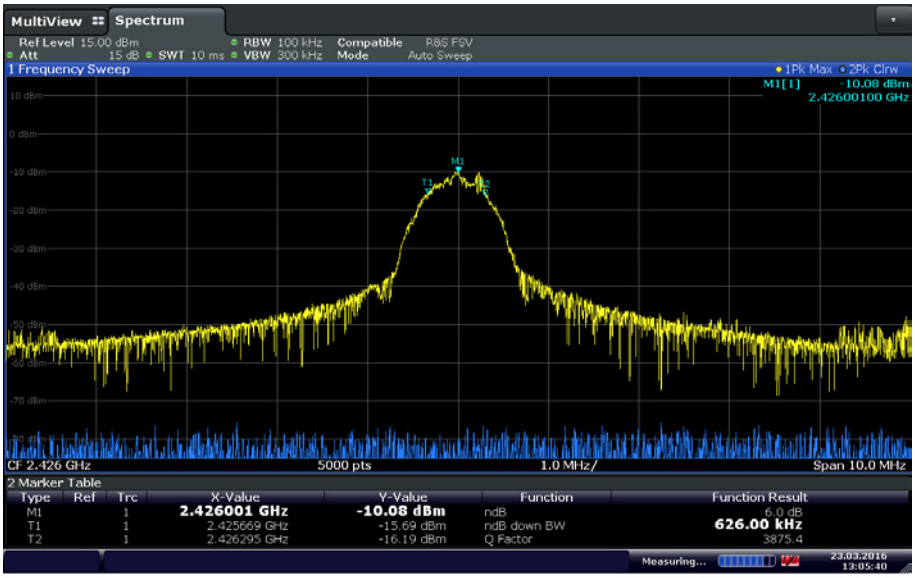
2.4.9 Test Results Plots



Date: 23.MAR.2016 13:01:16

Bluetooth LE Low Channel



Date: 23.MAR.2016 13:05:40

Bluetooth LE Mid Channel

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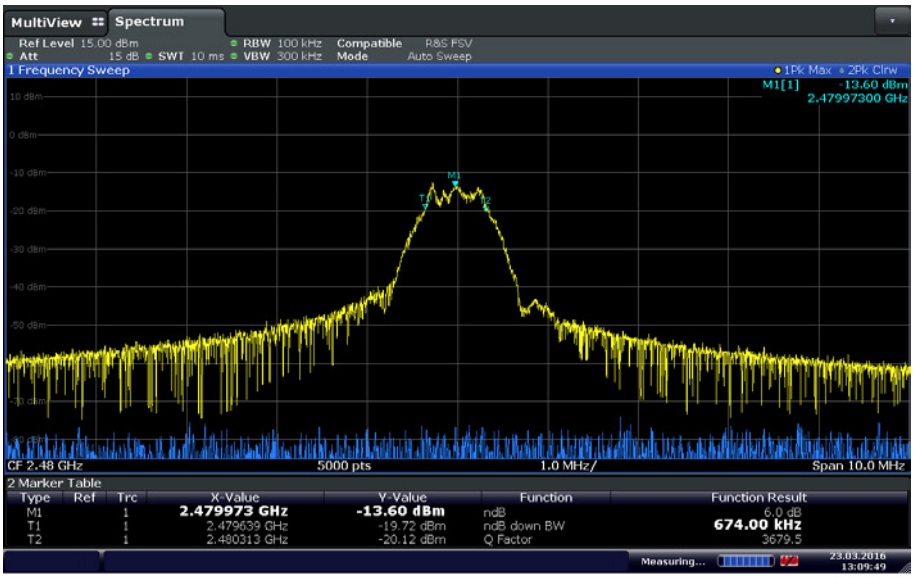

Bluetooth LE High Channel

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2.5 OUT-OF-BAND EMISSIONS - RADIATED

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 21, 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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.5.7 Additional Observations

- This is a radiated test.
- Data presented is per§15.209(a) and §15.205(c). Test results are considered worst case compared to the 20dBc limit.
- It was verified however that all emissions measured complies with the 20dBc limit.
- 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 2.5.8 for sample computation.

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2.5.8 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**

2.5.9 Test Results

See attached plots.

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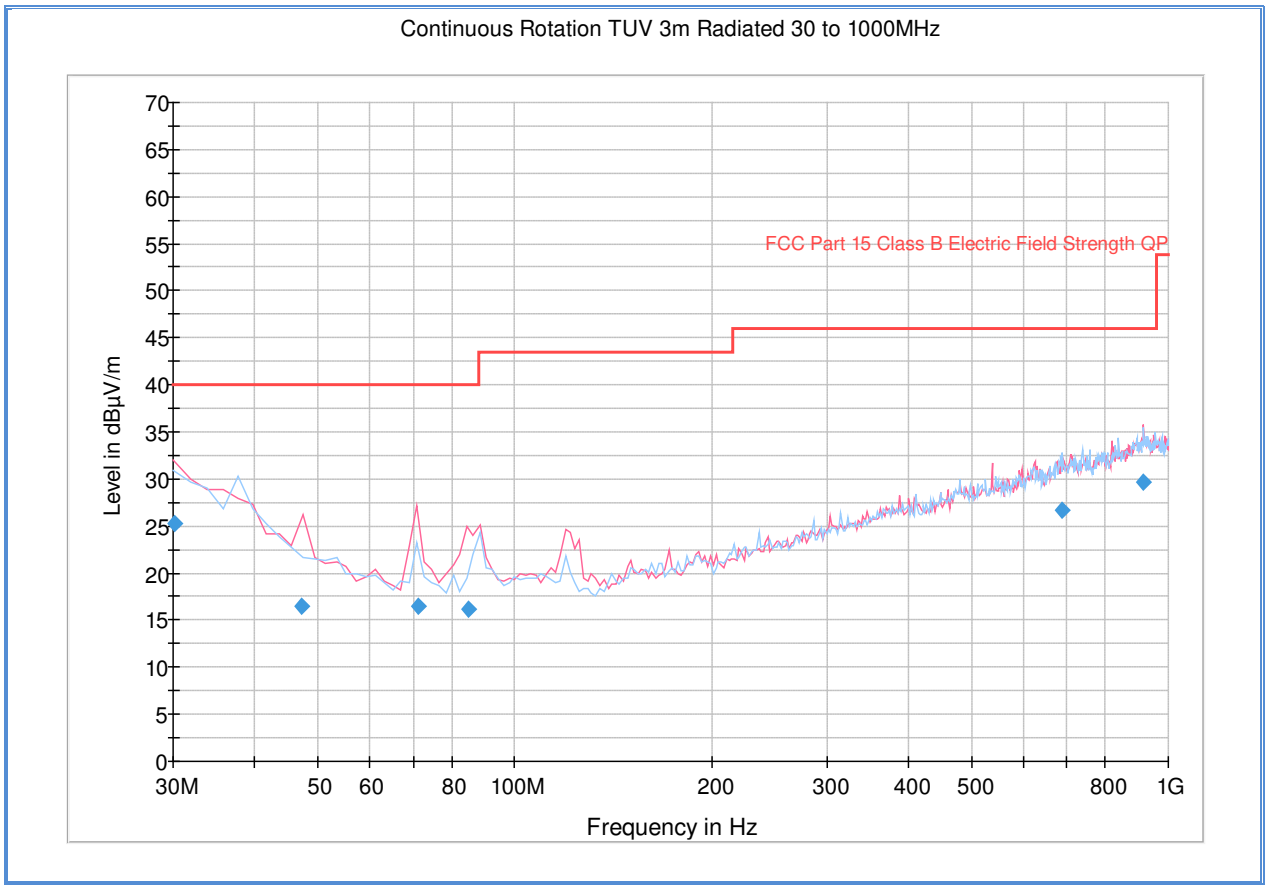
2.5.10 Test Results Below 1GHz (Worst Case Channel – Low Channel)



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)
30.160000	25.3	1000.0	120.000	211.0	V	1.0	-5.8	14.7	40.0
47.054990	16.4	1000.0	120.000	100.0	V	207.0	-13.6	23.6	40.0
71.061643	16.4	1000.0	120.000	109.0	V	168.0	-16.8	23.6	40.0
85.092745	16.1	1000.0	120.000	100.0	V	283.0	-16.1	23.9	40.0
689.017956	26.7	1000.0	120.000	150.0	H	0.0	2.6	19.3	46.0
915.212826	29.6	1000.0	120.000	350.0	V	274.0	6.4	16.4	46.0

Test Notes: Since the measured fundamental frequency level is 107.3dBµV/m (from Section 2.1 of this test report). Therefore the limit as per Part 15 Subpart C §15.247(d) will be 87.3 dBµV/m. Test results from §15.209(a) and §15.205(c) presented (worst case). EUT complies.

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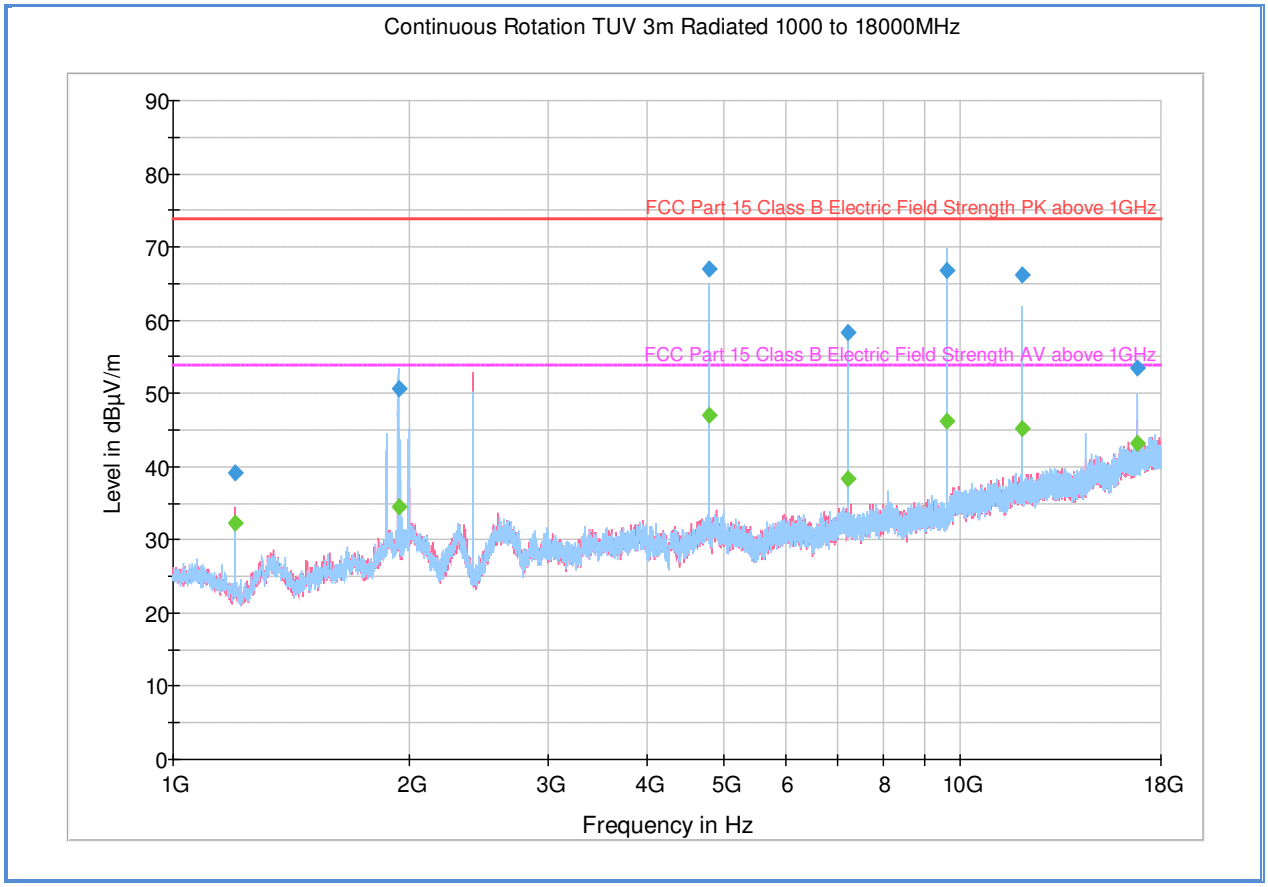
2.5.11 Test Results Above 1GHz (Low Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1199.866667	39.1	1000.0	1000.000	181.6	V	-3.0	-6.4	34.8	73.9
1932.933333	50.6	1000.0	1000.000	103.7	H	120.0	-1.1	23.3	73.9
4803.833333	67.1	1000.0	1000.000	266.3	H	15.0	3.4	6.8	73.9
7205.933333	58.3	1000.0	1000.000	322.2	H	2.0	7.2	15.6	73.9
9607.866667	66.8	1000.0	1000.000	180.6	H	34.0	10.1	7.1	73.9
12009.966667	66.3	1000.0	1000.000	171.6	H	20.0	13.3	7.6	73.9
16813.766667	53.5	1000.0	1000.000	162.6	H	57.0	19.3	20.4	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)
1199.866667	32.3	1000.0	1000.000	181.6	V	-3.0	-6.4	21.6	53.9
1932.933333	34.5	1000.0	1000.000	103.7	H	120.0	-1.1	19.4	53.9
4803.833333	47.1	1000.0	1000.000	266.3	H	15.0	3.4	6.8	53.9
7205.933333	38.3	1000.0	1000.000	322.2	H	2.0	7.2	15.6	53.9
9607.866667	46.2	1000.0	1000.000	180.6	H	34.0	10.1	7.1	53.9
12009.966667	45.1	1000.0	1000.000	171.6	H	20.0	13.3	7.6	53.9
16813.766667	43.1	1000.0	1000.000	162.6	H	57.0	19.3	10.8	53.9

Test Notes: No significant emissions observed above 18GHz. Measurements above 18GHz were noise floor figures. DCCF applied to harmonics of the fundamental. See Section 1.4.5 of this test report for details.

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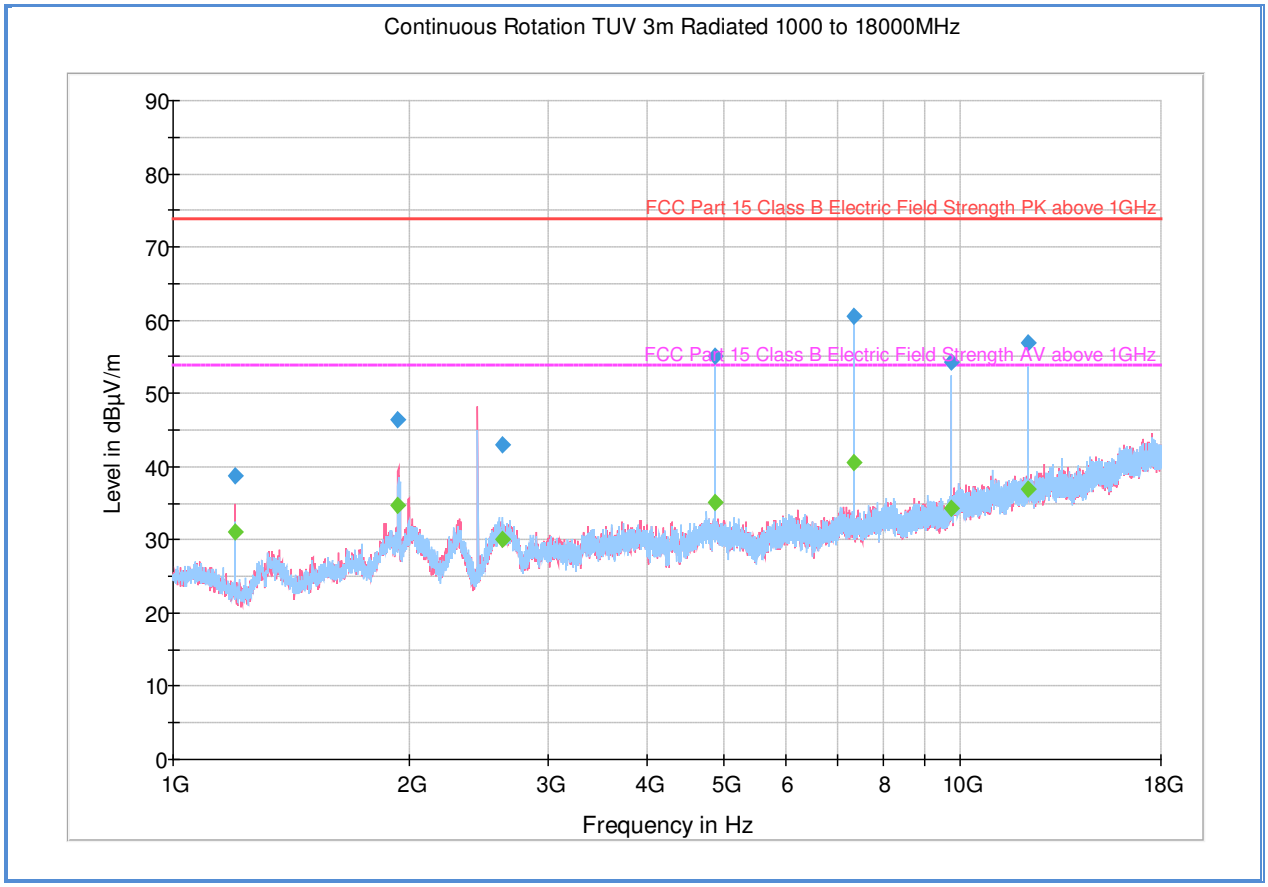
2.5.12 Test Results Above 1GHz (Mid Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1199.866667	38.8	1000.0	1000.000	155.6	V	141.0	-6.4	35.1	73.9
1932.533333	46.5	1000.0	1000.000	401.7	V	38.0	-1.1	27.4	73.9
2621.633333	43.0	1000.0	1000.000	138.7	H	0.0	-0.9	30.9	73.9
4879.766667	55.1	1000.0	1000.000	238.3	H	318.0	3.5	18.8	73.9
7319.833333	60.5	1000.0	1000.000	209.4	H	-10.0	7.4	13.4	73.9
9759.900000	54.3	1000.0	1000.000	300.6	H	20.0	10.4	19.6	73.9
12199.966667	56.9	1000.0	1000.000	163.6	H	20.0	14.2	17.0	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)
1199.866667	31.0	1000.0	1000.000	155.6	V	141.0	-6.4	22.9	53.9
1932.533333	34.7	1000.0	1000.000	401.7	V	38.0	-1.1	19.2	53.9
2621.633333	30.0	1000.0	1000.000	138.7	H	0.0	-0.9	23.9	53.9
4879.766667	35.1	1000.0	1000.000	238.3	H	318.0	3.5	18.8	53.9
7319.833333	40.5	1000.0	1000.000	209.4	H	-10.0	7.4	13.4	53.9
9759.900000	34.3	1000.0	1000.000	300.6	H	20.0	10.4	19.6	53.9
12199.966667	36.9	1000.0	1000.000	163.6	H	20.0	14.2	17.0	53.9

Test Notes: No significant emissions observed above 18GHz. Measurements above 18GHz were noise floor figures. DCCF applied to harmonics of the fundamental. See Section 1.4.5 of this test report for details.

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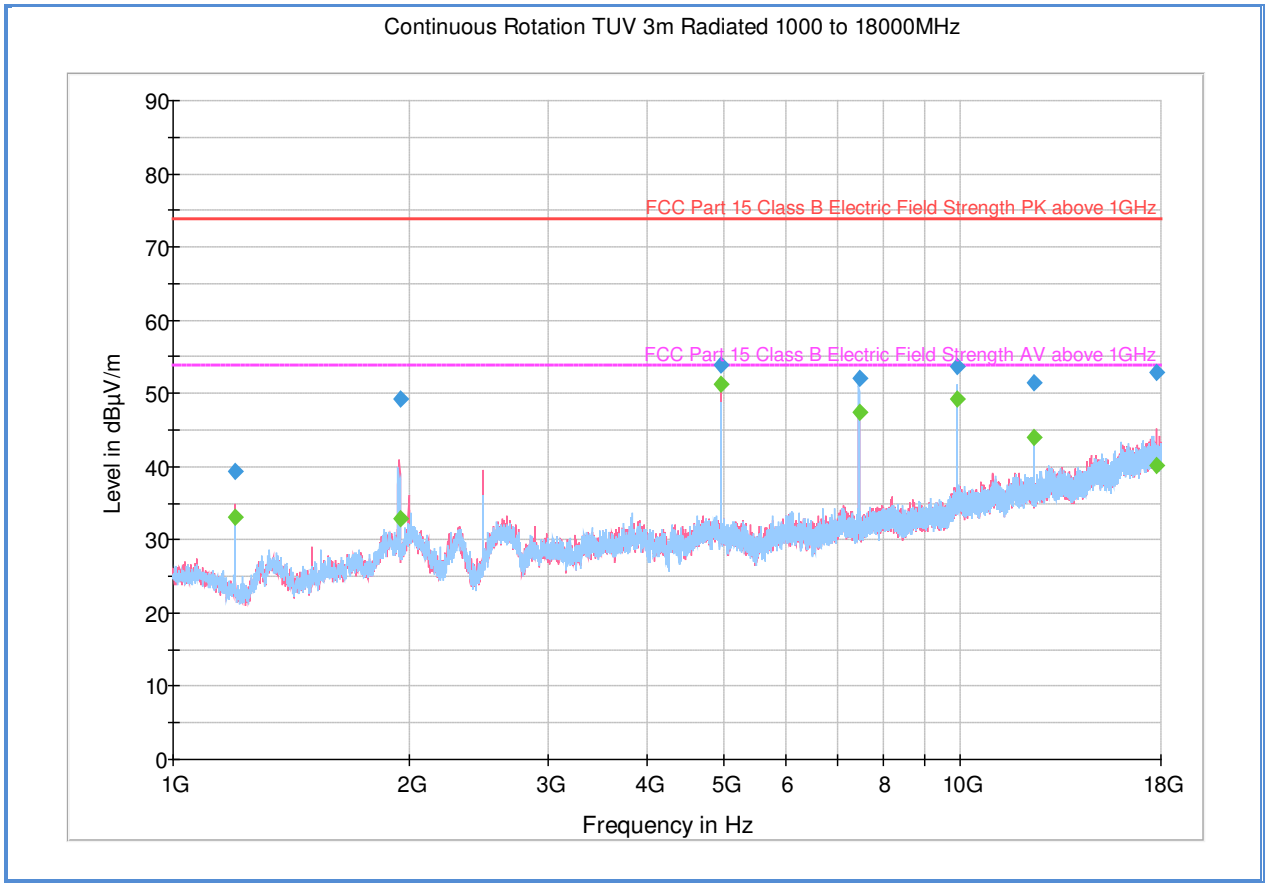
2.5.13 Test Results Above 1GHz (High Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1199.866667	39.3	1000.0	1000.000	191.5	V	226.0	-6.4	34.6	73.9
1941.066667	49.2	1000.0	1000.000	302.2	V	-9.0	-1.1	24.7	73.9
4960.066667	53.9	1000.0	1000.000	139.7	V	288.0	3.6	20.0	73.9
7440.200000	52.0	1000.0	1000.000	257.3	H	57.0	7.4	21.9	73.9
9919.700000	53.7	1000.0	1000.000	180.6	H	38.0	10.7	20.2	73.9
12400.000000	51.4	1000.0	1000.000	164.6	H	1.0	13.9	22.5	73.9
17795.400000	52.9	1000.0	1000.000	257.3	V	2.0	20.3	21.0	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)
1199.866667	33.1	1000.0	1000.000	191.5	V	226.0	-6.4	20.8	53.9
1941.066667	32.8	1000.0	1000.000	302.2	V	-9.0	-1.1	21.1	53.9
4960.066667	51.2	1000.0	1000.000	139.7	V	288.0	3.6	2.7	53.9
7440.200000	47.4	1000.0	1000.000	257.3	H	57.0	7.4	6.5	53.9
9919.700000	49.1	1000.0	1000.000	180.6	H	38.0	10.7	4.8	53.9
12400.000000	43.9	1000.0	1000.000	164.6	H	1.0	13.9	10.0	53.9
17795.400000	40.2	1000.0	1000.000	257.3	V	2.0	20.3	13.7	53.9

Test Notes: No significant emissions observed above 18GHz. Measurements above 18GHz were noise floor figures. DCCF not applied to harmonics of the fundamental. Average detector used with 100% duty cycle.

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2.6 BAND-EDGE COMPLIANCE AND IMMEDIATE RESTRICTED BAND

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 21, 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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.6.7 Additional Observations

- This is a radiated test.
- Verification performed to show compliance with immediate restricted band adjacent to 2.4GHz band.
- Lower and Upper band edges were also verified in this test since spurious emissions verification performed under Section 2.5 of this test report were done using a 2.4GHz notch filter.
- All measurement performed using Peak and Average detector at 100% duty cycle. DCCF was not applied for Average since the EUT complied using this test configuration (worst case).
- Lower band edge, even not in restricted band was verified using §15.205(c) test methodology. The results however was also assessed againts the 20dBc limit as required by §15.247(d).

2.6.8 Test Results

Complies. See attached plots.

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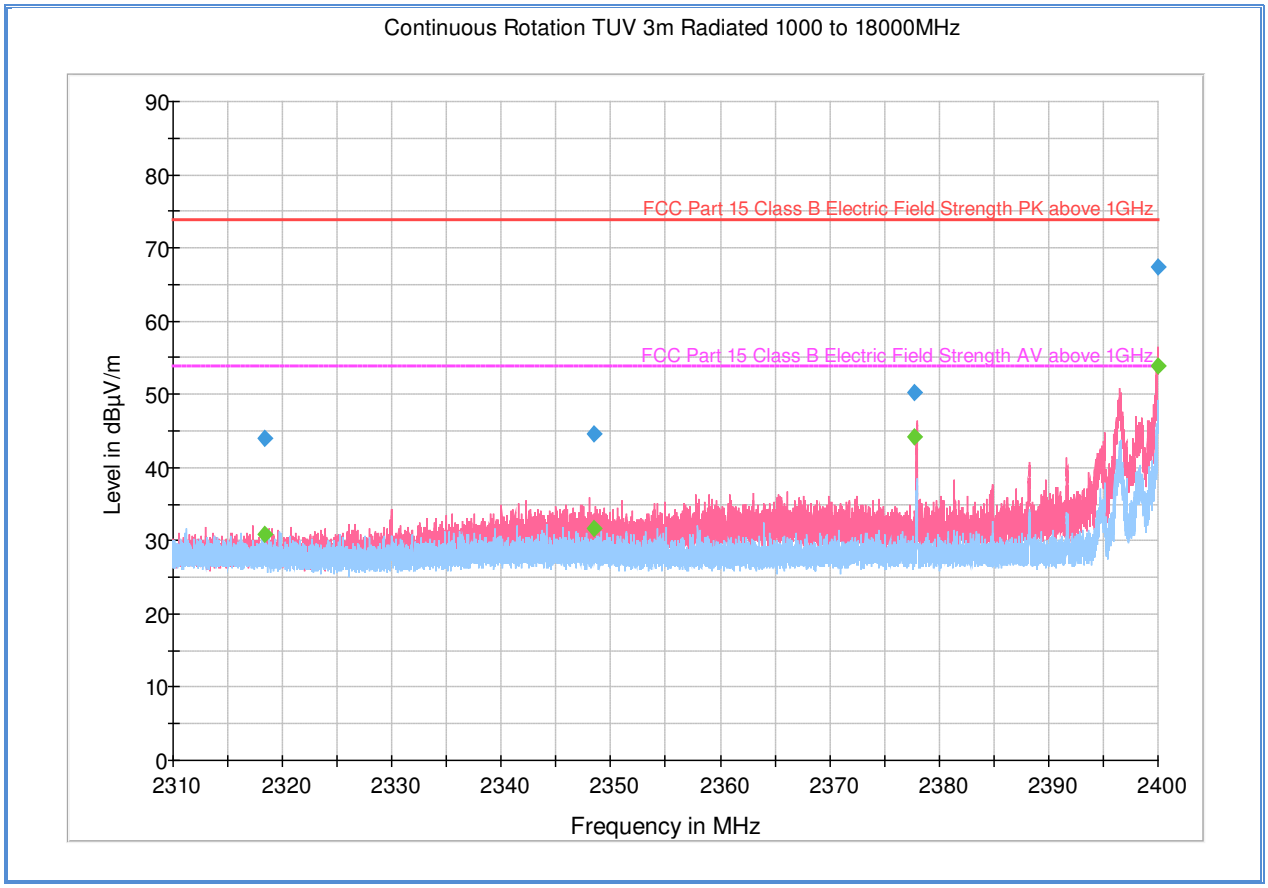
2.6.9 Test Results (Lower Immediate Restricted Band (2310MHz to 2390MHz) + Band Edge)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2318.338000	43.9	1000.0	1000.000	106.7	V	299.0	-1.1	30.0	73.9
2348.464000	44.6	1000.0	1000.000	112.7	V	300.0	-1.2	29.3	73.9
2377.786000	50.2	1000.0	1000.000	107.7	V	314.0	-1.1	23.7	73.9
2400.000000	67.4	1000.0	1000.000	208.4	V	273.0	-1.1	6.5	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)
2318.338000	30.8	1000.0	1000.000	106.7	V	299.0	-1.1	23.1	53.9
2348.464000	31.7	1000.0	1000.000	112.7	V	300.0	-1.2	22.2	53.9
2377.786000	44.1	1000.0	1000.000	107.7	V	314.0	-1.1	9.8	53.9
2400.000000	53.8	1000.0	1000.000	208.4	V	273.0	-1.1	0.2	53.9

Test Notes: Lower band edge measurement performed using §15.205(c) requirement. Since the EUT complies with §15.205(c) limits, therefore it also complies with 20dBc requirement since the fundamental was measured at 107.3dBµV/m. RBW setting is not relevant since both the fundamental and the band edge measurement uses the same setting (1MHz).

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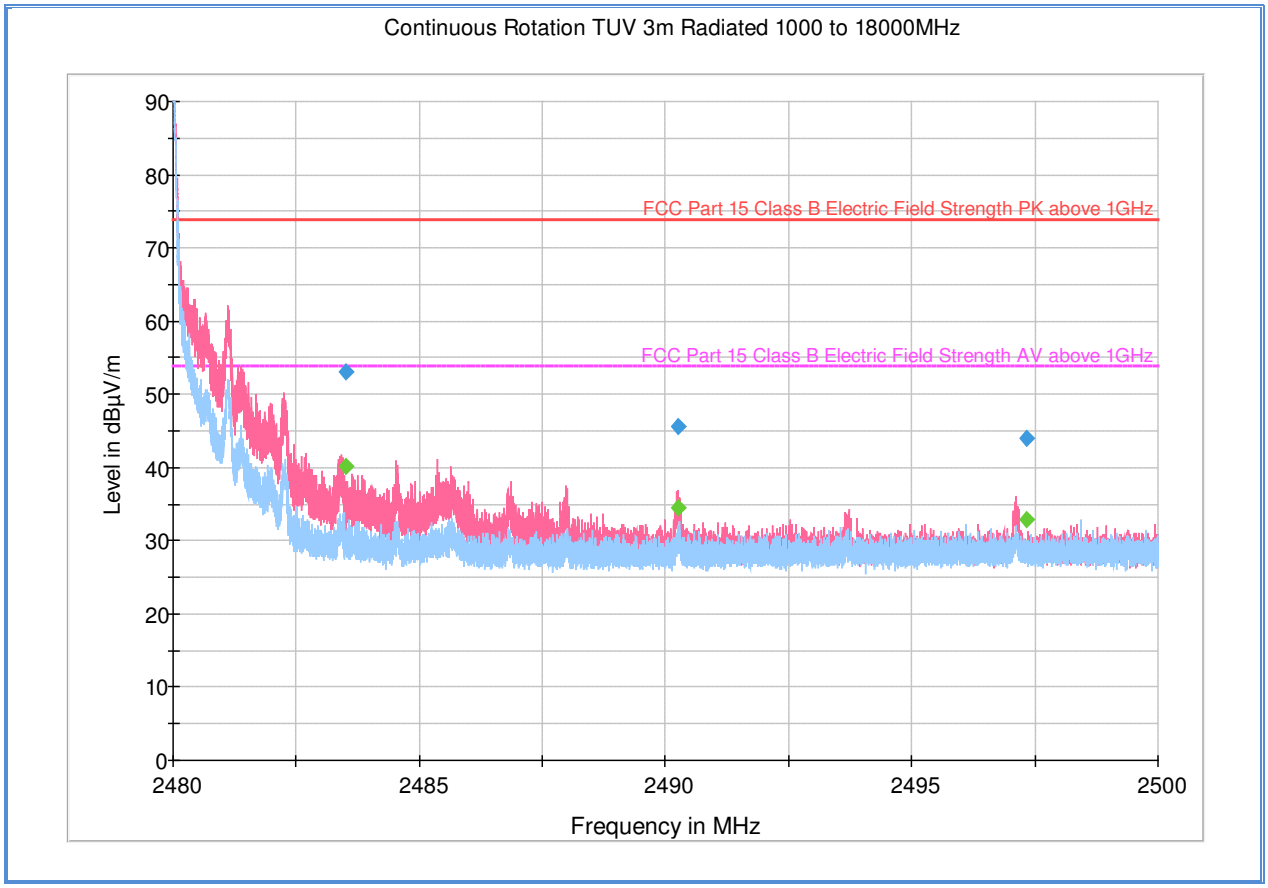
2.6.10 Test Results (Upper Immediate Restricted Band (2483.5MHz to 2500MHz) + Band Edge)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.500000	53.2	1000.0	1000.000	101.7	V	311.0	-0.7	20.7	73.9
2490.242000	45.7	1000.0	1000.000	102.7	V	311.0	-0.7	28.2	73.9
2497.331333	44.0	1000.0	1000.000	103.7	V	311.0	-0.6	29.9	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)
2483.500000	40.2	1000.0	1000.000	101.7	V	311.0	-0.7	13.7	53.9
2490.242000	34.5	1000.0	1000.000	102.7	V	311.0	-0.7	19.4	53.9
2497.331333	32.9	1000.0	1000.000	103.7	V	311.0	-0.6	21.0	53.9

Test Notes: Upper band edge complies with §15.205(c) requirement.

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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

Not performed. The EUT is deemed to comply with this requirement (Clause 12.2.7 of KDB558074 D01 DTS Meas Guidance v03r04) by virtue of Section 2.5 test results.

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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 21, 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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.8.7 Additional Observations

- This is a radiated test. Test performed at the same time fundamental field strength were measured (Section 2.1 of this test report).
- Test Methodology is per Clause 3.0 and 10.2 of KDB558074 D01 DTS Meas Guidance v03r04.
- The 8dBm PSD limit was first converted to field strength utilizing the same formula used in Section 2.1 of this test report.

E_{Limit} = EIRP - 20log(d_{Meas}) + 104.7
= 8 dBm – 20log(3 meters) + 104.7
= 103.16 dBµV/m @ 3 meters.

- Since the 8dBm PSD limit is not an EIRP limit, the antenna gain of the EUT will be deducted from the measurement plots and will be verified against the 103.16 dBµV/m calculated limit.

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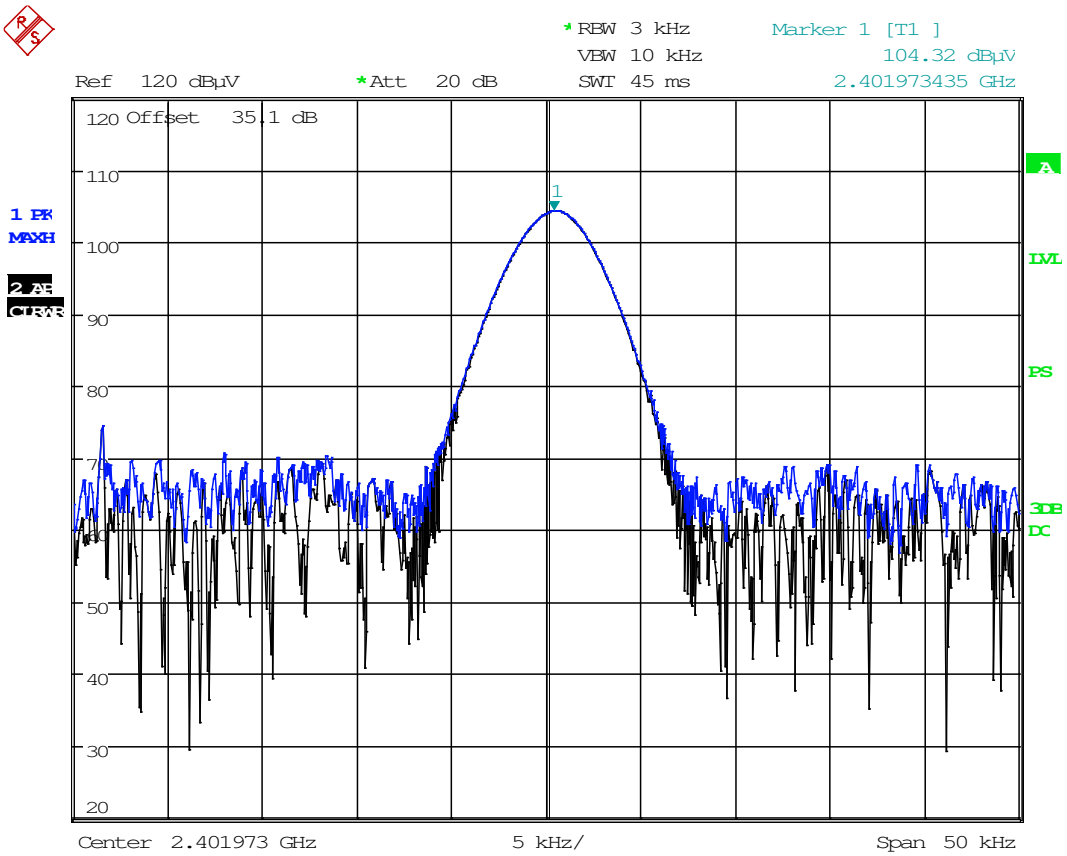
2.8.8 Test Results Summary

Channel	Marker Reading using 3 kHz RBW (dBµV/m)	Calculated PSD: Marker Reading – Antenna Gain (dBµV/m)	Calculated PSD Limit (dBµV/m)	Margin (dB)	Compliance
37 (2402 MHz)	104.32	102.82	103.16	0.34	Complies
17 (2440 MHz)	102.54	101.04		2.12	Complies
39 (2480 MHz)	98.94	97.44		5.72	Complies

2.8.9 Test Results Plots



Date: 3.MAR.2016 08:53:33

Bluetooth LE Low Channel

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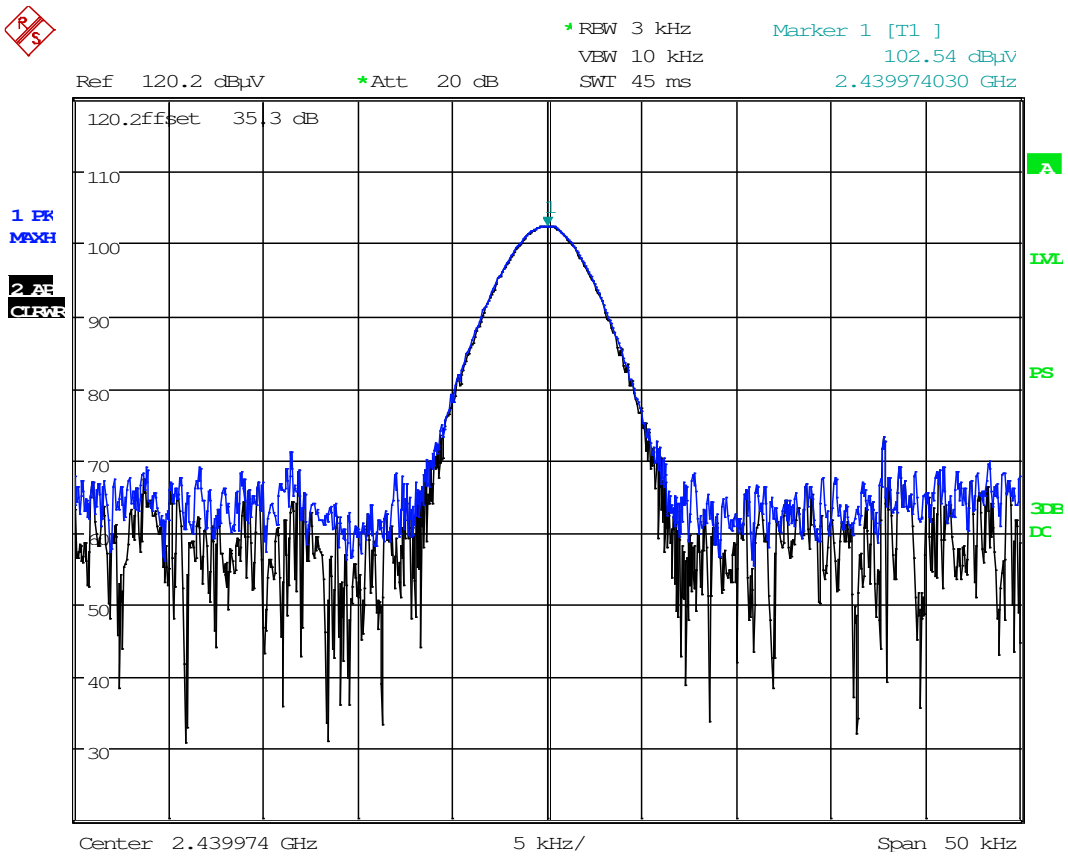

Date: 3.MAR.2016 08:48:45

Bluetooth LE Mid Channel

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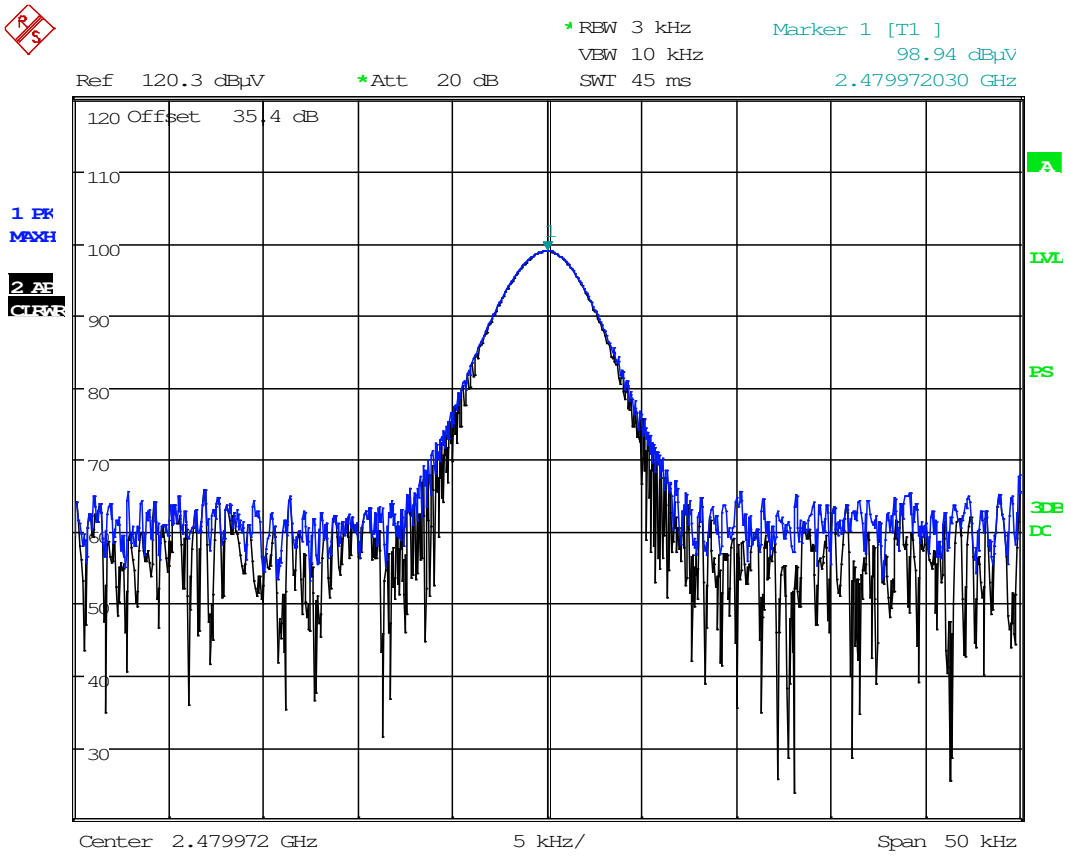

Date: 3.MAR.2016 08:51:57

Bluetooth LE High Channel

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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						
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
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	09/29/15	09/29/16
1016	Pre-amplifier	PAM-0202	187	PAM	12/15/15	12/15/16
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	

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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

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SECTION 4

DIAGRAM OF TEST SETUP

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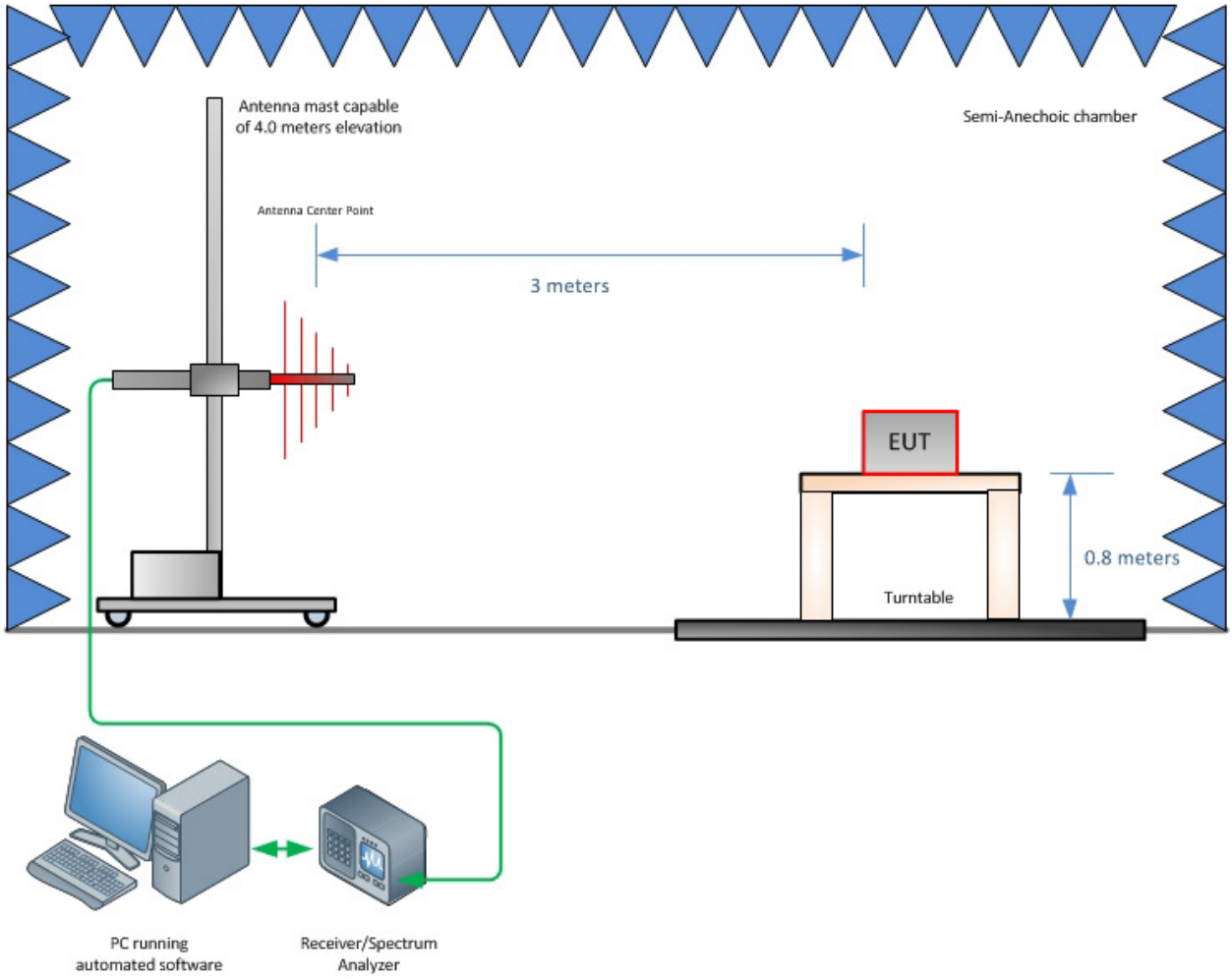
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)

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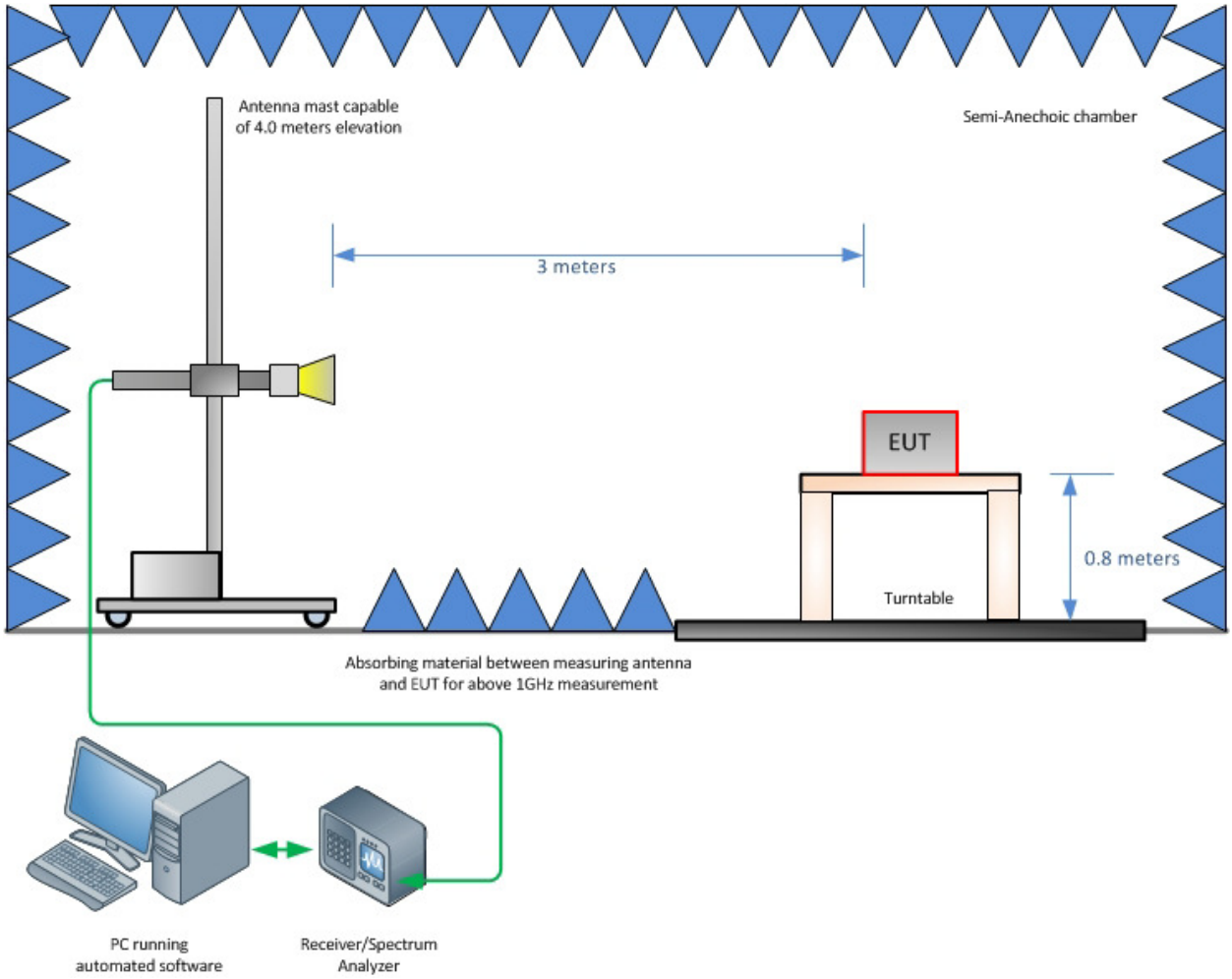

Radiated Emission Test Setup (Above 1GHz)

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SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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