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Report On

Application for Grant of Equipment Authorization of the
CalAmp Wireless Networks Corp.
LMU-3030 GPS Tracking Unit with OBD-II Interface

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

Report No. SC1409996B October 2014

REPORT ON	Radio Testing of the CalAmp Wireless Networks Corp. GPS Tracking Unit with OBD-II Interface
TEST REPORT NUMBER	SC1409996B
PREPARED FOR	CalAmp Wireless Networks Corp. 1401 N Rice Ave. Oxnard, CA 93030
CONTACT PERSON	Imad Rizk Certification Manager (805) 987-9000 IRizk@CalAmp.com
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Chip R. Fleury **Name** Authorized Signatory
DATED	October 14, 2014

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

Revision History

SC1409996B CalAmp Wireless Networks Corp. LMU-3030 GPS Tracking Unit with OBD-II Interface					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
10/14/2014	Initial Release				Chip R. Fleury

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SECTION 1

REPORT SUMMARY

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

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

1.1 INTRODUCTION

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

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	CalAmp Wireless Networks Corp.
Model Number(s)	LMU30H30BT3
FCC ID Number	APV-3030HBT
IC Number	5843C-3030HBT
Serial Number(s)	4532000604 and 4632081643
Number of Samples Tested	2
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2013). • 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 v03r01,(April 09,2013) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.
Start of Test	July 03, 2014
Finish of Test	October 02, 2014
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.

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[1]	
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]	
2.6	§15.247(d)	RSS-210 A8.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	§15.247(d)	RSS-210 A8.5	Spurious Radiated Emissions	Compliant	
2.8	§15.247(d)	RSS-210 A8.5	Radiated Immediate Restricted bands	Compliant	
2.9	§15.247(e)	RSS-210 A8.2(b)	Power Spectral Density for Digitally Modulated Device	Compliant	
2.10		RSS-Gen 4.10	Receiver Spurious Emissions	Compliant	

N/A[1] Not applicable. EUT is battery operated only and designed for vehicular use.
N/A[2] Not applicable. EUT has an integral antenna. Spurios Emissions is covered under Section 2.10 of this test report.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

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

Equipment Under Test

1.3.2 EUT General Description

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

1.3.3 Maximum Peak Output Power (EIRP)

Modulation	Frequency Range (MHz)	Field Strength (Peak - dBµV/m @ 3 meters)	Peak Output Power EIRP (dBm)	Peak Output Power EIRP (mW)
GFSK	2402-2480	86.6	-8.2970	0.148

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

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

1.4.2 EUT Exercise Software

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

1.4.3 Support Equipment and I/O cables

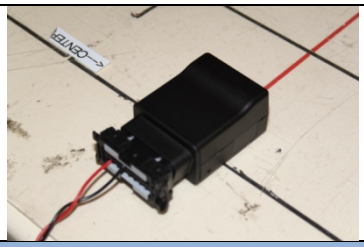
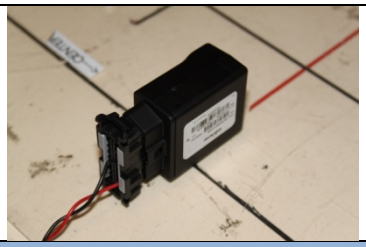
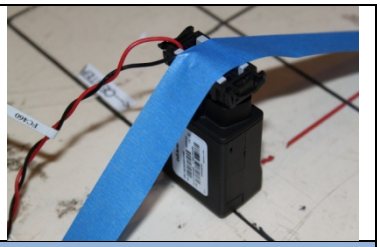
Manufacturer	Equipment/Cable	Description
Protek	Laboratory DC Power Supply	M/N 35010M S/N D102007S
GM	Wiring Harness Connector	OBD2 OBDII ALDL (4.5m power cable only)
Duralast	Marine Battery	12VDC P/N 24MD-DL, 685 MCA, 550 CCA, 85Ah
Rhode & Schwarz	Wideband Radio Communication Tester	M/N CMW 500 S/N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

1.4.4 Worst Case Configuration

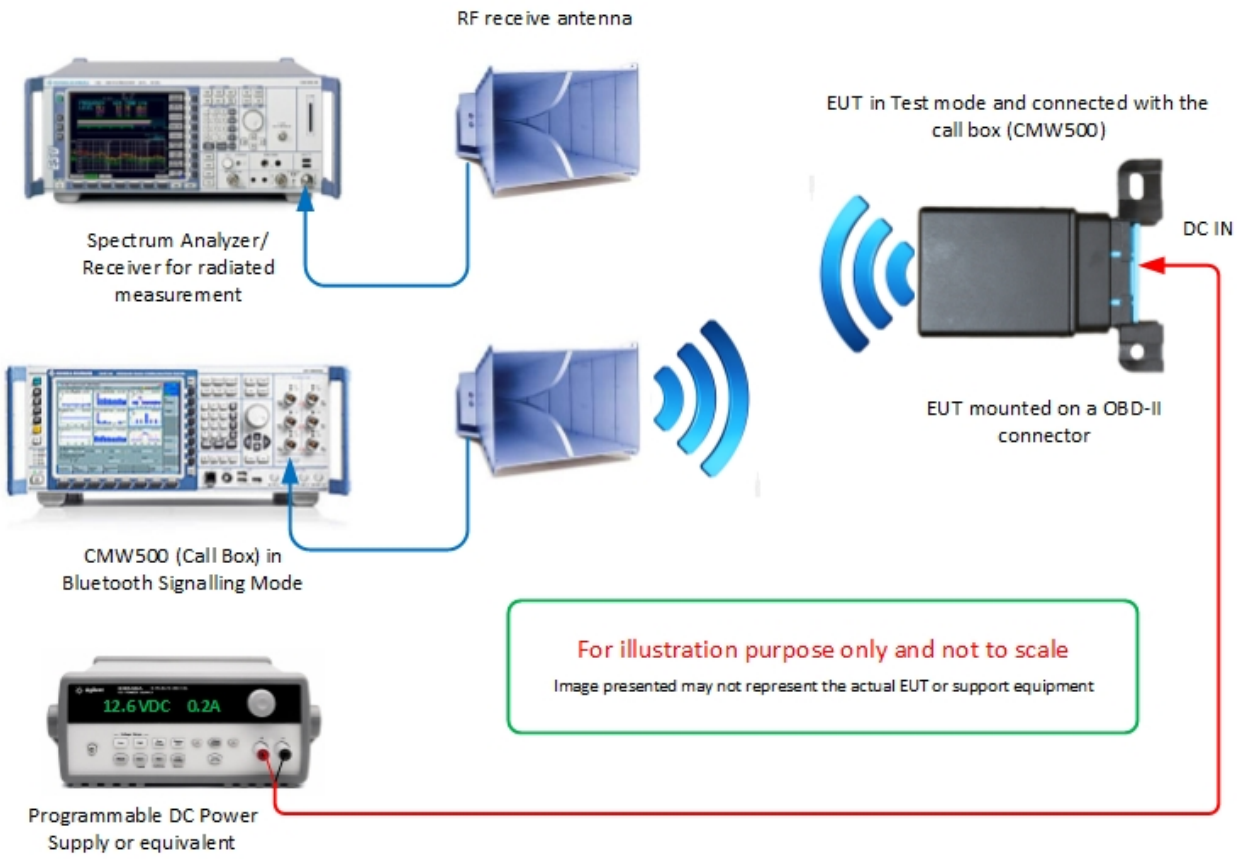
Worst-case configuration used in this test report as per maximum conducted output power measurements:

Mode	Channel	Data Rate
Bluetooth LE	39 (High Channel)	1Mbps

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

		
“X” Configuration	***“Y” Configuration***	***“Z” Configuration***

1.4.5 Simplified Test Configuration Diagram



1.5 DEVIATIONS FROM THE STANDARD

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

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number 4532000604 and 4632081643		
N/A		

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

1.7 TEST METHODOLOGY

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

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

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

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

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

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

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

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

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

SECTION 2

TEST DETAILS

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

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: 4532000604 and 4632081643/ Default Test Configuration

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

August 06, 2014/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	24.8°C
Relative Humidity	50.8%
ATM Pressure	99.2 kPa

2.1.7 Additional Observations

- This is a radiated test. The spectrum was searched from 2390MHz to 2500MHz to cover immediate restricted bands (masked by the notch filter during Radiated Spurious Emissions test), upper band edges and the fundamental frequency.
- All packet types' verified, only worst case presented.
- Fundamental measurements will be proven by Substitution Method.
- Verifications were performed on two samples, only the worst results presented.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.1.8 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 (EIRP Limit)

Bluetooth LE Modulation	Channel	Frequency (MHz)	Measured Field Strength (dBµV/m @ 3 meters)	Substitution Peak Output Power (dBm)	Substitution Peak Output Power (mW)	Limit (mW)
GFSK	0	2402	86.7	-8.1970	0.151	1000.0
	38	2440	81.6	-13.197	0.048	1000.0
	78	2480	86.6	-8.2970	0.148	1000.0

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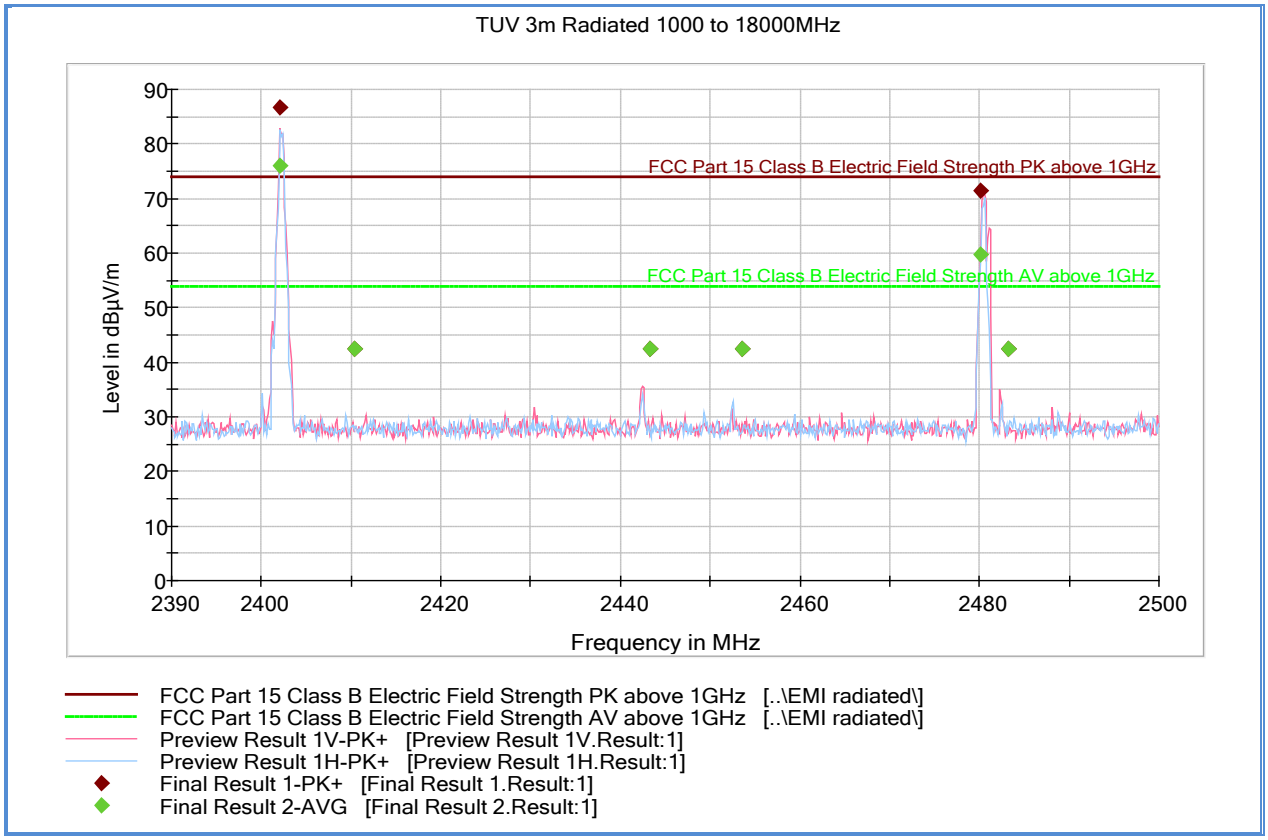
2.1.10 Test Results GFSK Low Channel



Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2402.077778	86.7	1000.0	1000.000	100.0	V	193.0	7.1	Fundamental	
2410.333333	42.4	1000.0	1000.000	103.0	H	176.0	7.1	31.5	73.9
2443.333333	42.5	1000.0	1000.000	100.0	V	286.0	7.2	31.4	73.9
2453.477778	42.5	1000.0	1000.000	103.0	H	153.0	7.2	31.4	73.9
2483.177778	42.5	1000.0	1000.000	100.0	V	154.0	7.2	31.4	73.9

Average Data

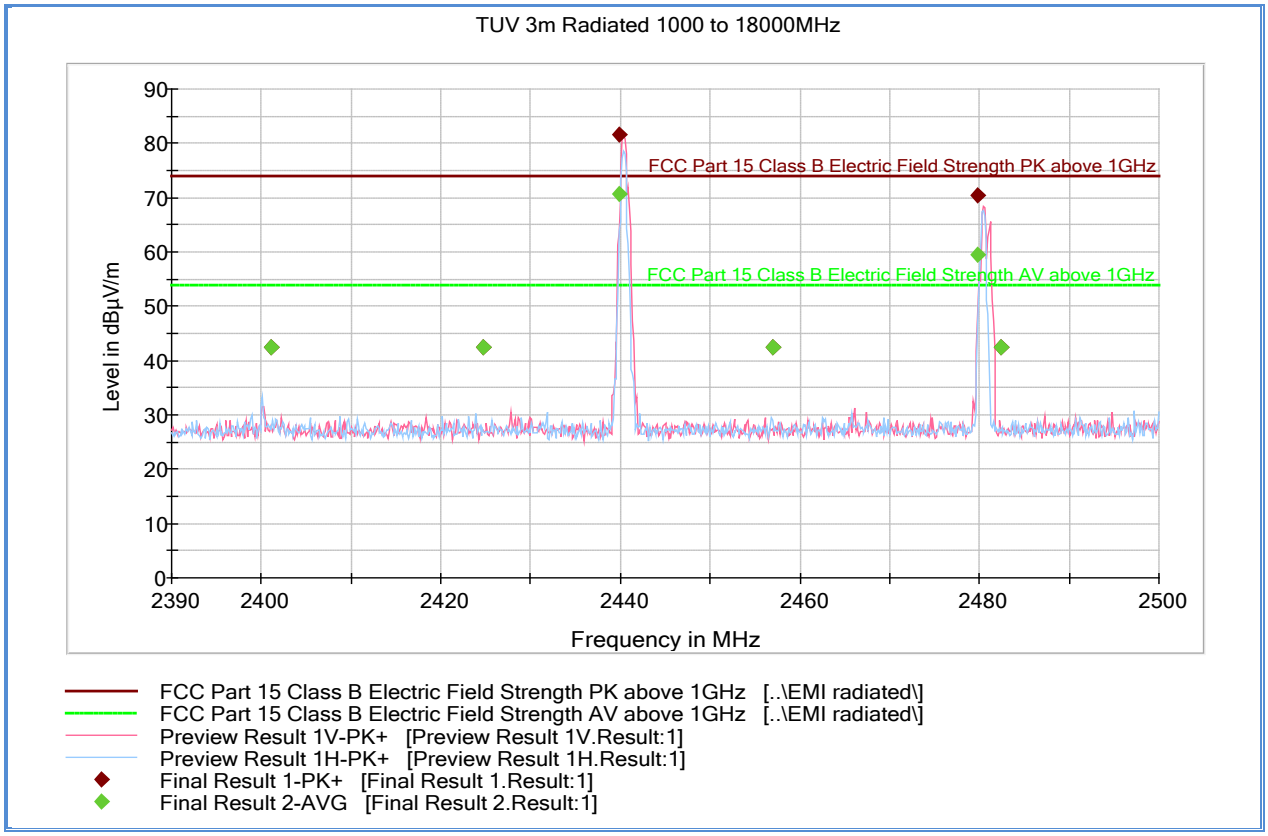
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2402.077778	76.0	1000.0	1000.000	100.0	V	193.0	7.1	Fundamental	
2410.333333	42.4	1000.0	1000.000	103.0	H	176.0	7.1	11.5	53.9
2443.333333	42.5	1000.0	1000.000	100.0	V	286.0	7.2	11.4	53.9
2453.477778	42.5	1000.0	1000.000	103.0	H	153.0	7.2	11.4	53.9
2483.177778	42.5	1000.0	1000.000	100.0	V	154.0	7.2	11.4	53.9

Substitution Data

Frequency (MHz)	Max Peak (dBµV/m)	Substitution Antenna Gain (dBi)	Cable Loss (dB)	Signal Generator Level (dBm)	Substitution Level (dBm)	Limit (dBm)	Margin (dB)
2402.000000	86.7	9.503	-3.7	-14.0	-8.197	30	38.197

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

2.1.11 Test Results GFSK Mid Channel



Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2401.044445	42.4	1000.0	1000.000	103.0	H	198.0	7.1	31.5	73.9
2424.755556	42.4	1000.0	1000.000	103.0	H	210.0	7.1	31.5	73.9
2440.000000	81.6	1000.0	1000.000	100.0	V	345.0	7.2	Fundamental	
2457.022222	42.5	1000.0	1000.000	100.0	V	242.0	7.2	31.4	73.9
2482.322222	42.5	1000.0	1000.000	100.0	V	-1.0	7.2	31.4	73.9

Average Data

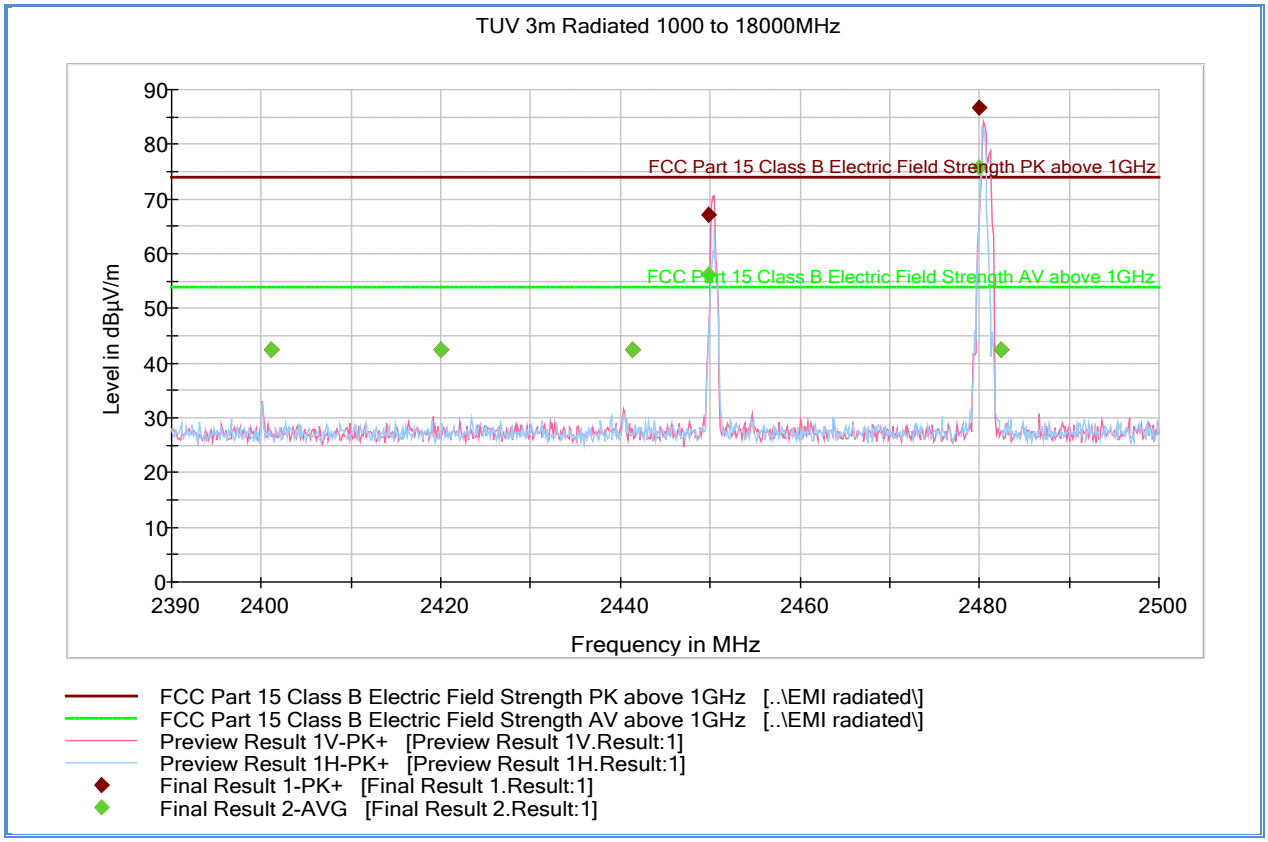
Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2401.044445	42.4	1000.0	1000.000	103.0	H	198.0	7.1	11.5	53.9
2424.755556	42.4	1000.0	1000.000	103.0	H	210.0	7.1	11.5	53.9
2440.000000	70.6	1000.0	1000.000	100.0	V	345.0	7.2	Fundamental	
2457.022222	42.5	1000.0	1000.000	100.0	V	242.0	7.2	11.4	53.9
2482.322222	42.5	1000.0	1000.000	100.0	V	-1.0	7.2	11.4	53.9

Substitution Data

Frequency (MHz)	Max Peak (dBµV/m)	Substitution Antenna Gain (dBi)	Cable Loss (dB)	Signal Generator Level (dBm)	Substitution Level (dBm)	Limit (dBm)	Margin (dB)
2440.000000	81.6	9.503	-3.7	-19.0	-13.197	30	43.197

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

2.1.12 Test Results GFSK High Channel



Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2401.044445	42.4	1000.0	1000.000	100.0	V	154.0	7.1	31.5	73.9
2419.988889	42.4	1000.0	1000.000	100.0	V	210.0	7.1	31.5	73.9
2441.255556	42.5	1000.0	1000.000	100.0	V	264.0	7.2	31.4	73.9
2480.00000	87.6	1000.0	1000.000	100.0	V	145.0	7.2	Fundamental	
2482.322222	42.5	1000.0	1000.000	100.0	V	-1.0	7.2	31.4	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)
2401.044445	42.4	1000.0	1000.000	100.0	V	154.0	7.1	11.5	53.9
2419.988889	42.4	1000.0	1000.000	100.0	V	210.0	7.1	11.5	53.9
2441.255556	42.5	1000.0	1000.000	100.0	V	264.0	7.2	11.4	53.9
2480.00000	75.8	1000.0	1000.000	100.0	V	145.0	7.2	Fundamental	
2482.322222	42.5	1000.0	1000.000	100.0	V	-1.0	7.2	11.4	53.9

Substitution Data

Frequency (MHz)	Max Peak (dBµV/m)	Substitution Antenna Gain (dBi)	Cable Loss (dB)	Signal Generator Level (dBm)	Substitution Level (dBm)	Limit (dBm)	Margin (dB)
2480.00000	87.6	9.503	-3.8	-13.0	-7.297	30	37.297

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

2.2 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

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

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: 4532000604 and 4632081643/ Default Test Configuration

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

August 08, 2014/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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.3.7 Additional Observations

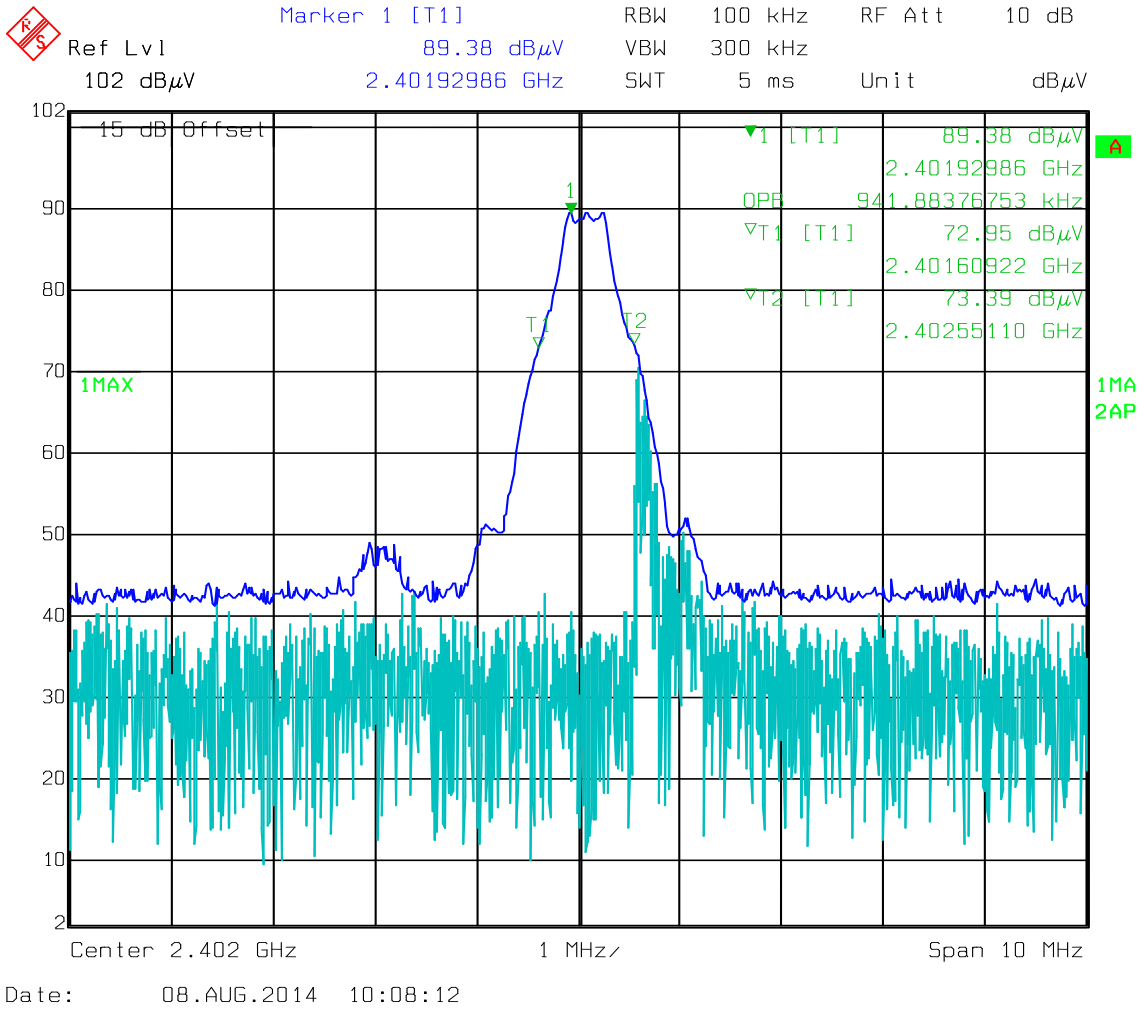
- This is a radiated test.
- An offset was added to compensate for the receiving antenna factor, preamp gain and cable loss.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.

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

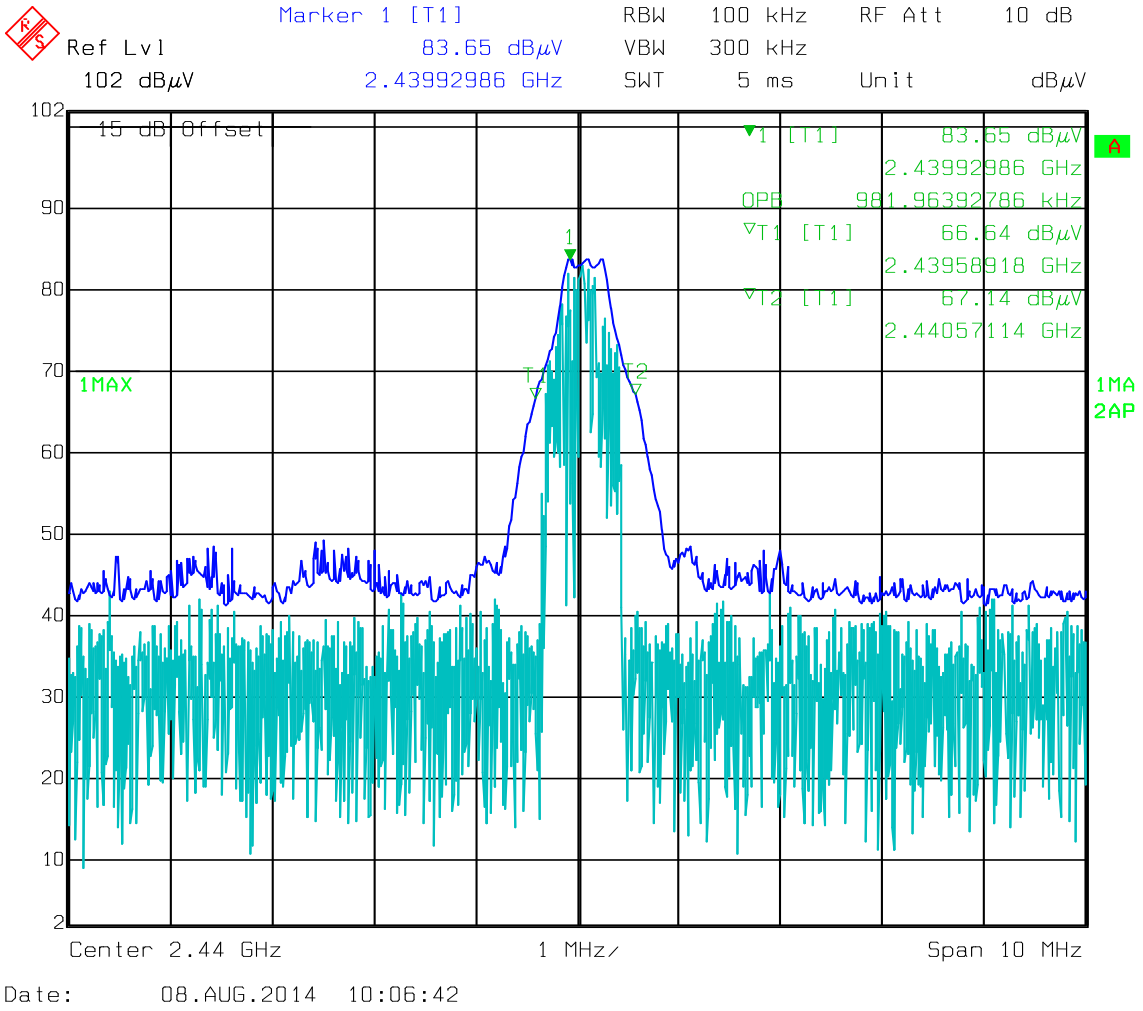
2.3.8 Test Results (For reporting purposes only)

Modulation	Channel	Frequency (MHz)	Measured 99% OBW (MHz)
GFSK	0	2402	0.942
	38	2440	0.982
	78	2480	0.962

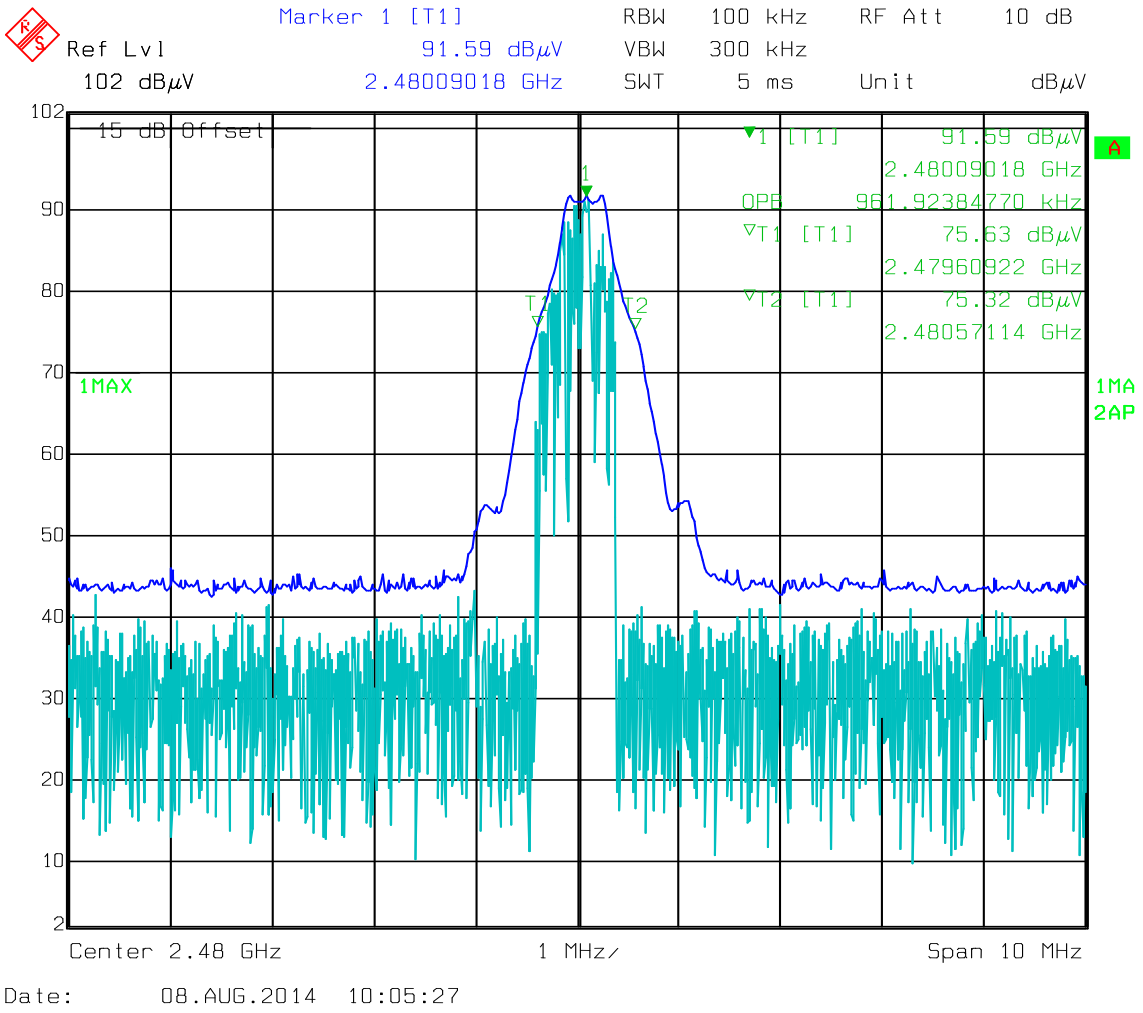
2.3.9 Test Results Plots



Bluetooth LE Low Channel



Bluetooth LE Mid Channel



Bluetooth LE High Channel

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: 4532000604 and 4632081643/ Default Test Configuration

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

August 18, 2014/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	25.7 °C
Relative Humidity	46.7.%
ATM Pressure	98.6 kPa

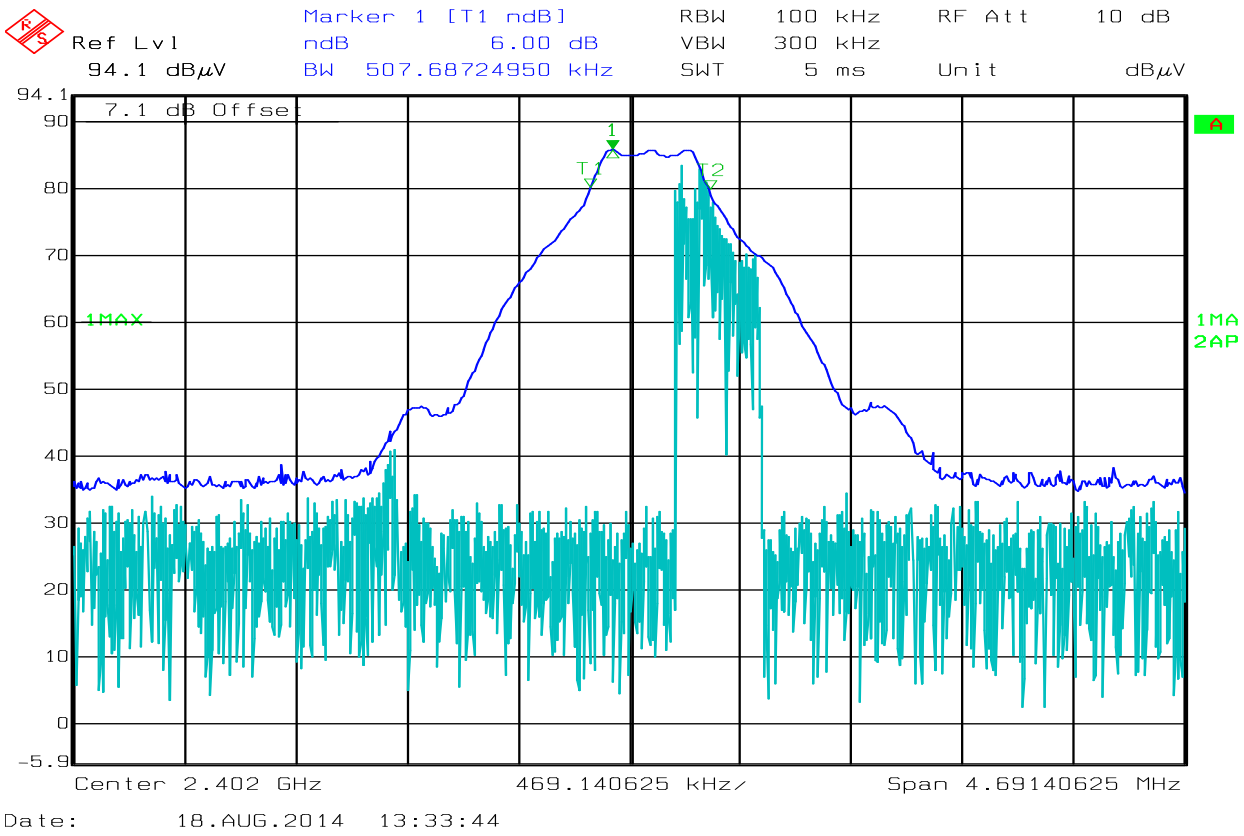
2.4.7 Additional Observations

- This is a radiated test.
- The 7.1dB reference offset is for the antenna factor, cable loss and preamp gain used.
- Span is wide enough to capture the channel transmission.
- RBW is set to either 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.

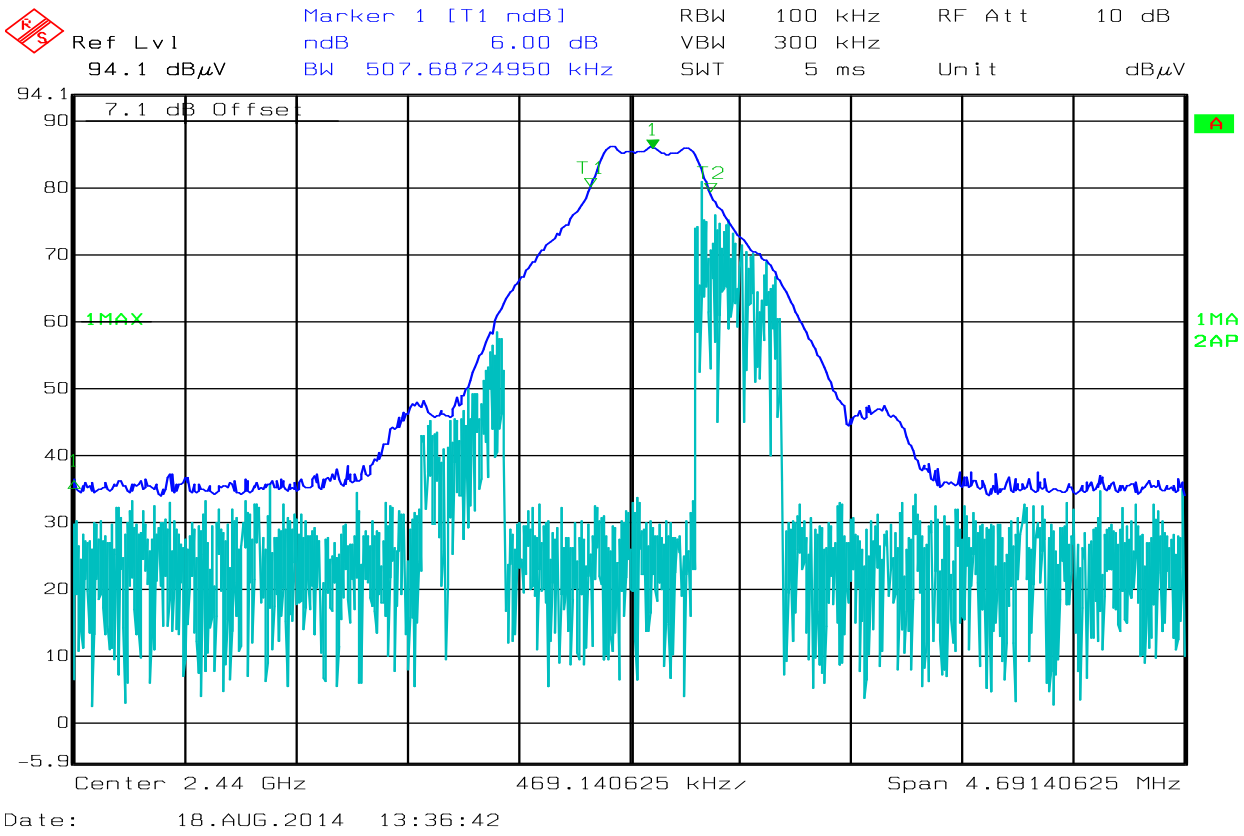
2.4.8 Test Results

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
Bluetooth LE	37 (2402 MHz)	0.508	0.500	Complies
	17 (2440 MHz)	0. 508	0.500	Complies
	39 (2480 MHz)	0.508	0.500	Complies

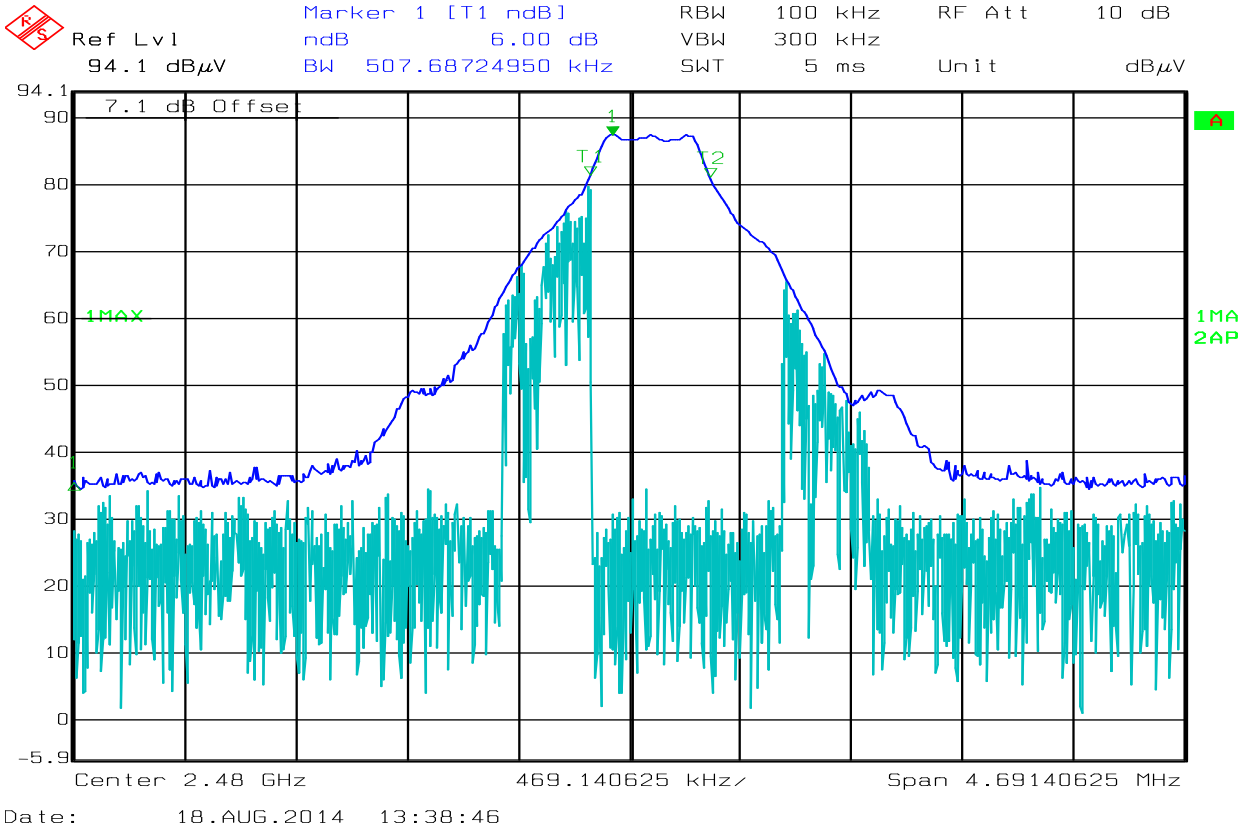
2.4.9 Test Results Plots



Bluetooth LE Low Channel



Bluetooth LE Mid Channel



Bluetooth LE High Channel

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. EUT has an integral antenna. Spurios Emissions is covered under Section 2.7 of this test report.

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

Serial No: 4532000604 and 4632081643/ Default Test Configuration

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

August 18, 2014/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

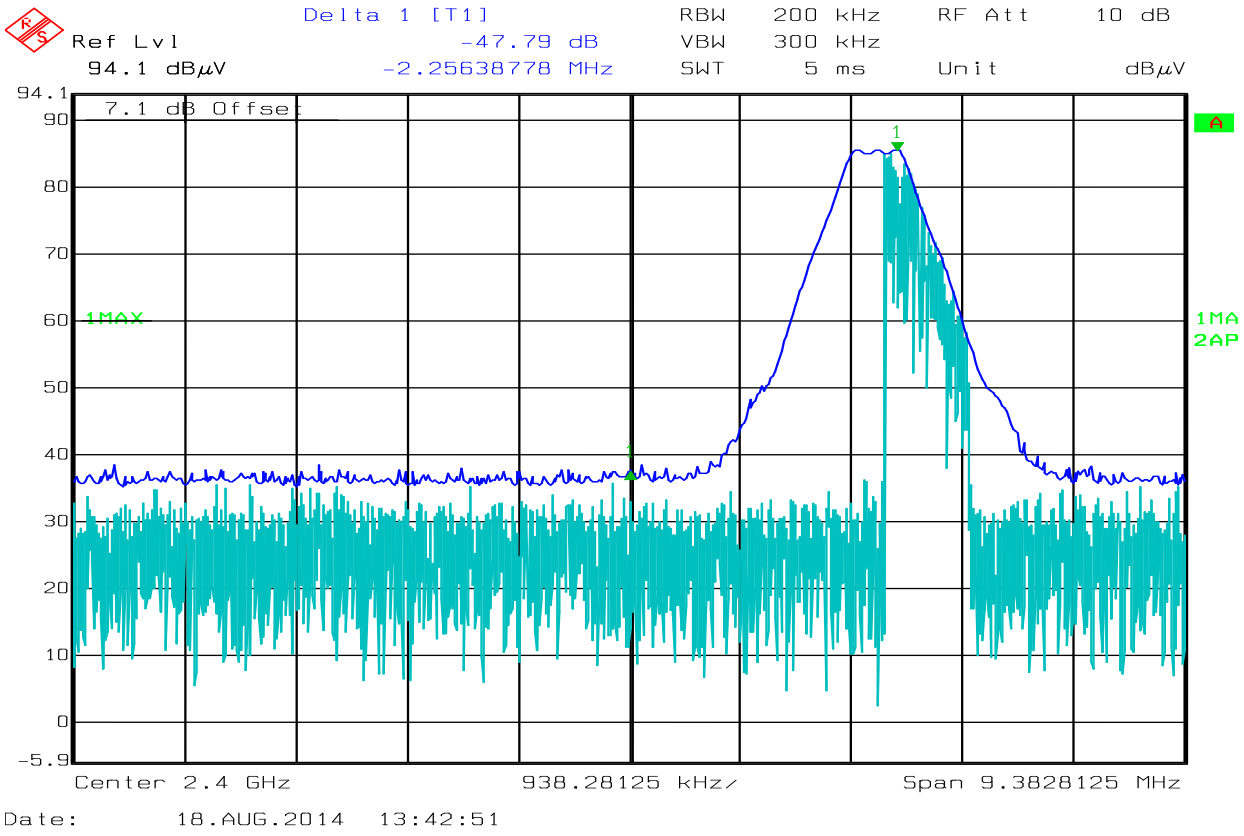
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.7 °C
Relative Humidity	46.7.%
ATM Pressure	98.6 kPa

2.6.7 Additional Observations

- This is a radiated test.
- The 7.1dB reference offset is for the antenna factor, cable loss and preamp gain used.
- Span is wide enough to capture the peak level of the emission operating on the channel closest to the band edge.
- RBW is 100kHz, VBW is 3X RBW.
- Sweep is auto, detector is peak, trace is max hold.
- Trace allowed to stabilize. Marker-delta function used to verify compliance.
- Limit is 20dBc.
- Only Lower Bandedges presented, Upper Bandedge test results are covered under Section 2.1 and 2.8 of this test report since it falls under the restricted bands (15.205).

2.6.8 Test Results



Lower Bandedge (Bluetooth LE Low Channel)

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: 4532000604 and 4632081643/ Default Test Configuration

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

July 03, 09 and October 02, 2014/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 Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.7.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic (25GHz).
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the considered worst case channel presented for radiated emissions below 1GHz. There are no significant differences in radiated emissions below 1GHz between Low, Mid and High channels.

- Verifications were performed on two samples, only the worst results presented. For Receive Mode, only M/N LMU30H30BT3 was verified.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

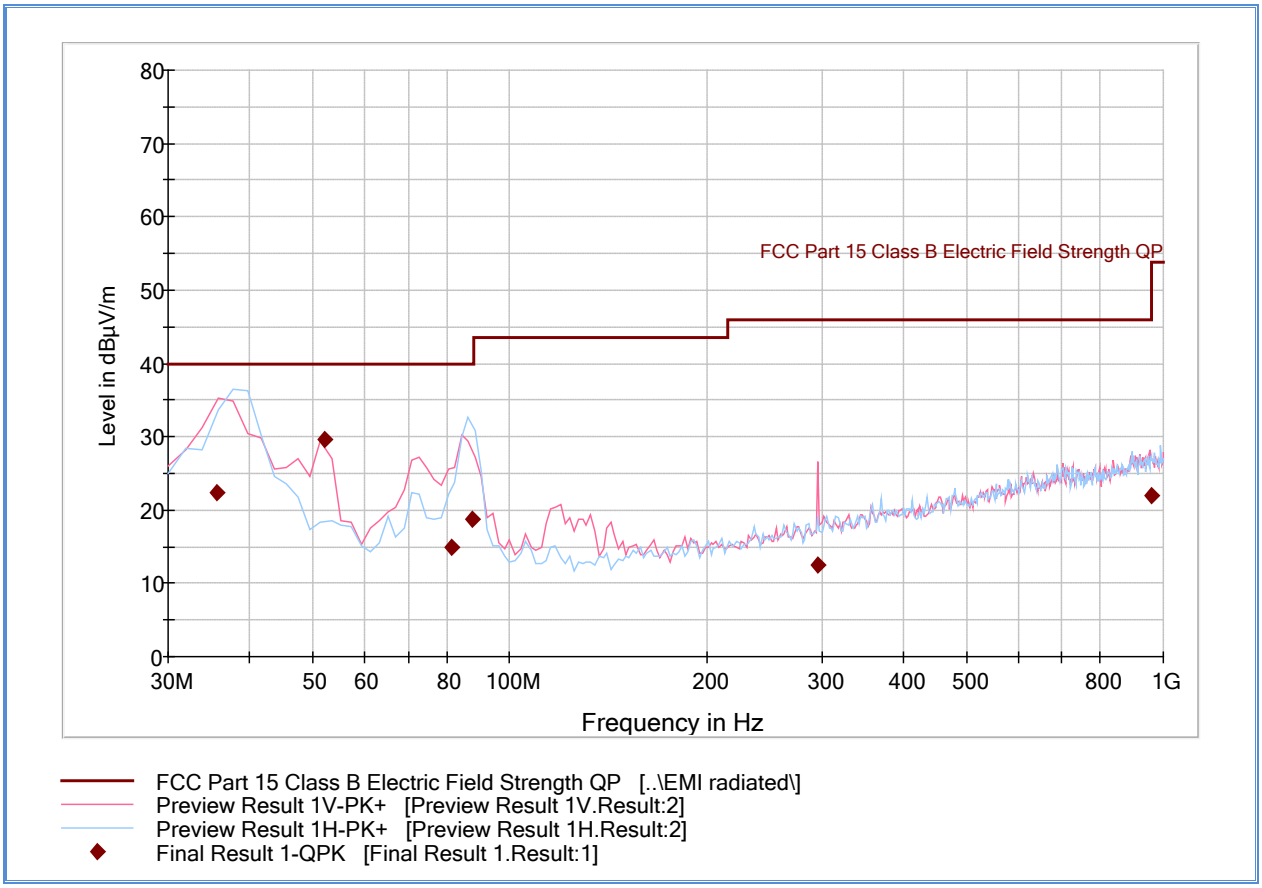
2.7.8 Sample Computation (Radiated Emission)

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.

2.7.10 Test Results Below 1GHz (Receive Mode)

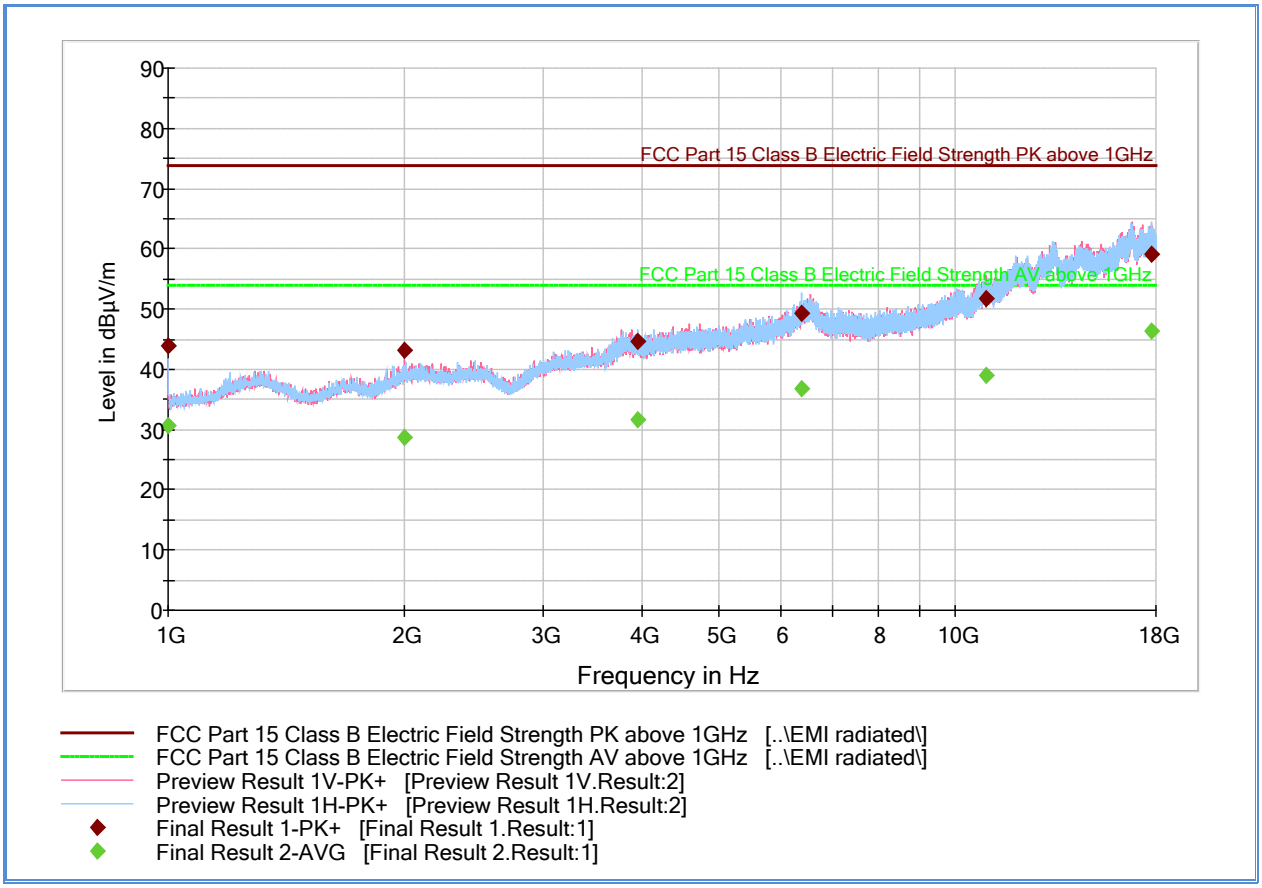


Quasi Peak Data

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

Test Notes:

2.7.11 Test Results Above 1GHz (Receive Mode)



Peak Data

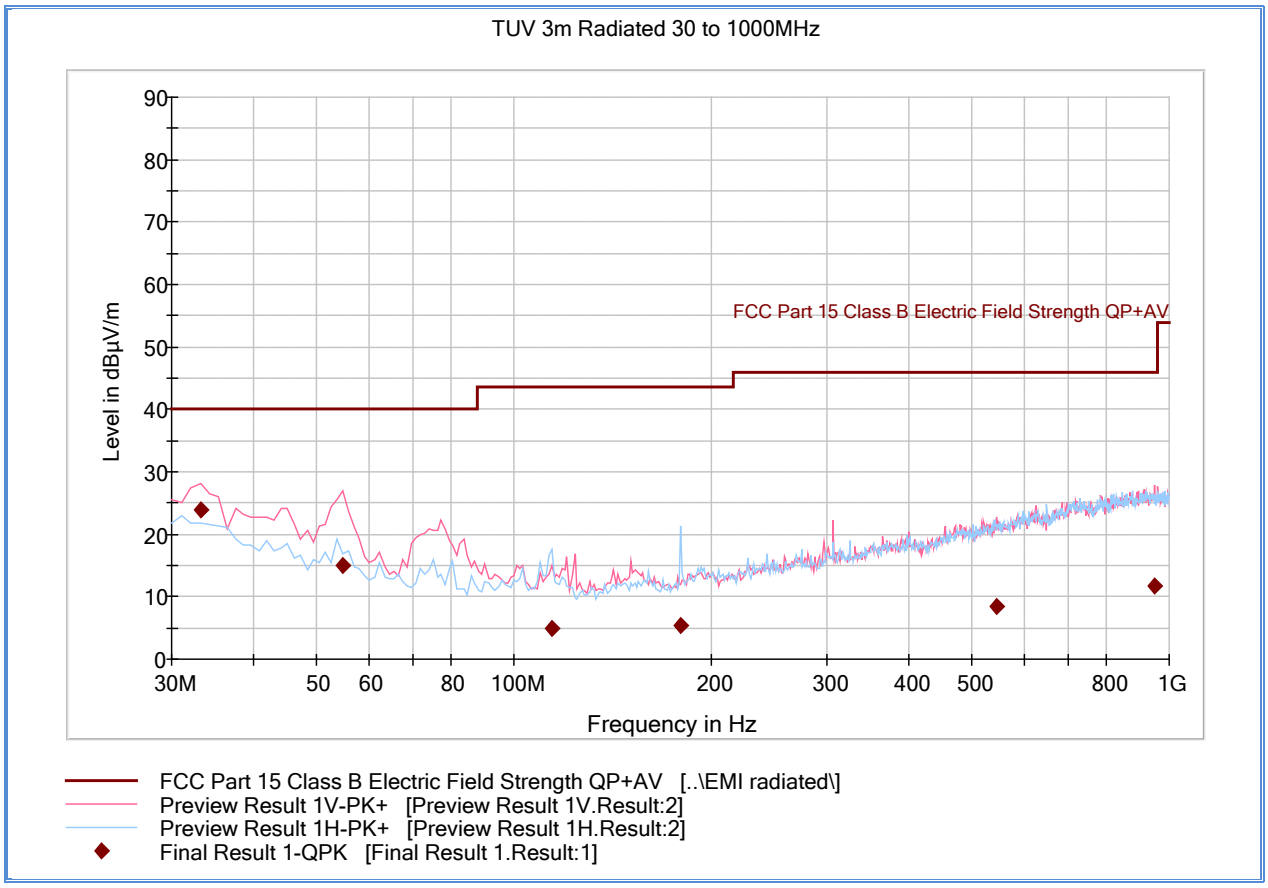
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.00000	43.8	1000.0	1000.000	115.7	H	15.0	-7.0	30.1	73.9
1999.56666	43.2	1000.0	1000.000	406.7	V	16.0	-1.0	30.7	73.9
3955.93333	44.7	1000.0	1000.000	410.2	H	0.0	6.0	29.2	73.9
6388.83333	49.2	1000.0	1000.000	250.3	H	276.0	12.7	24.7	73.9
10973.5666	51.8	1000.0	1000.000	116.7	V	240.0	17.0	22.1	73.9
17752.7666	59.1	1000.0	1000.000	313.2	H	256.0	25.8	14.8	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.00000	30.7	1000.0	1000.000	115.7	H	15.0	-7.0	23.2	53.9
1999.56666	28.6	1000.0	1000.000	406.7	V	16.0	-1.0	25.3	53.9
3955.93333	31.7	1000.0	1000.000	410.2	H	0.0	6.0	22.2	53.9
6388.83333	36.7	1000.0	1000.000	250.3	H	276.0	12.7	17.2	53.9
10973.5666	38.9	1000.0	1000.000	116.7	V	240.0	17.0	15.0	53.9
17752.7666	46.4	1000.0	1000.000	313.2	H	256.0	25.8	7.5	53.9

Test Notes:

2.7.12 Test Results Below 1GHz (Bluetooth TX Worst Case Channel)

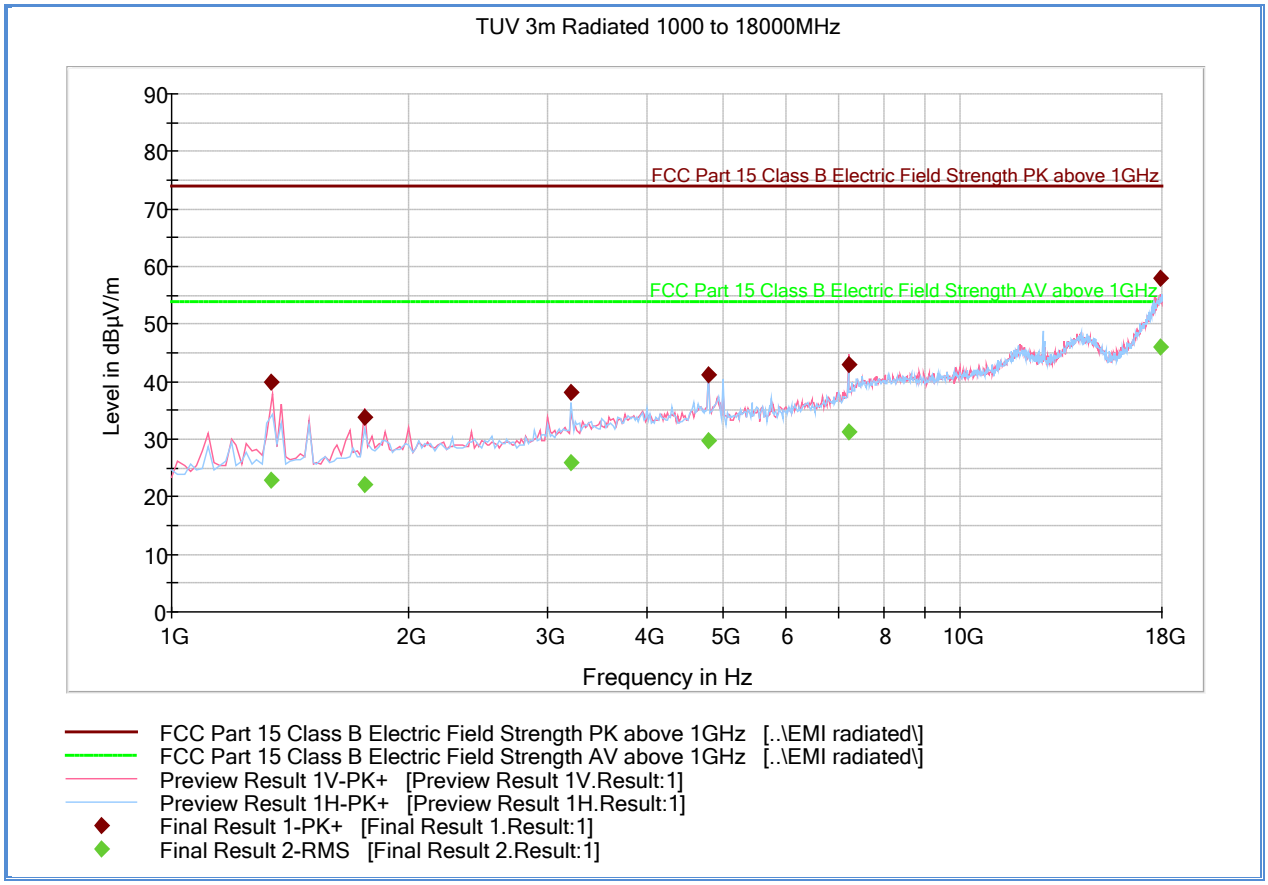


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
33.193333	24.0	1000.0	120.000	100.0	V	5.0	-16.1	16.0	40.0
54.828889	15.1	1000.0	120.000	100.0	V	146.0	-24.3	24.9	40.0
114.186667	4.9	1000.0	120.000	103.0	H	22.0	-24.8	38.6	43.5
179.691111	5.3	1000.0	120.000	103.0	H	266.0	-23.6	38.2	43.5
545.217778	8.4	1000.0	120.000	100.0	V	13.0	-14.7	37.6	46.0
950.342222	11.6	1000.0	120.000	100.0	V	250.0	-10.2	34.4	46.0

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

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



Peak Data

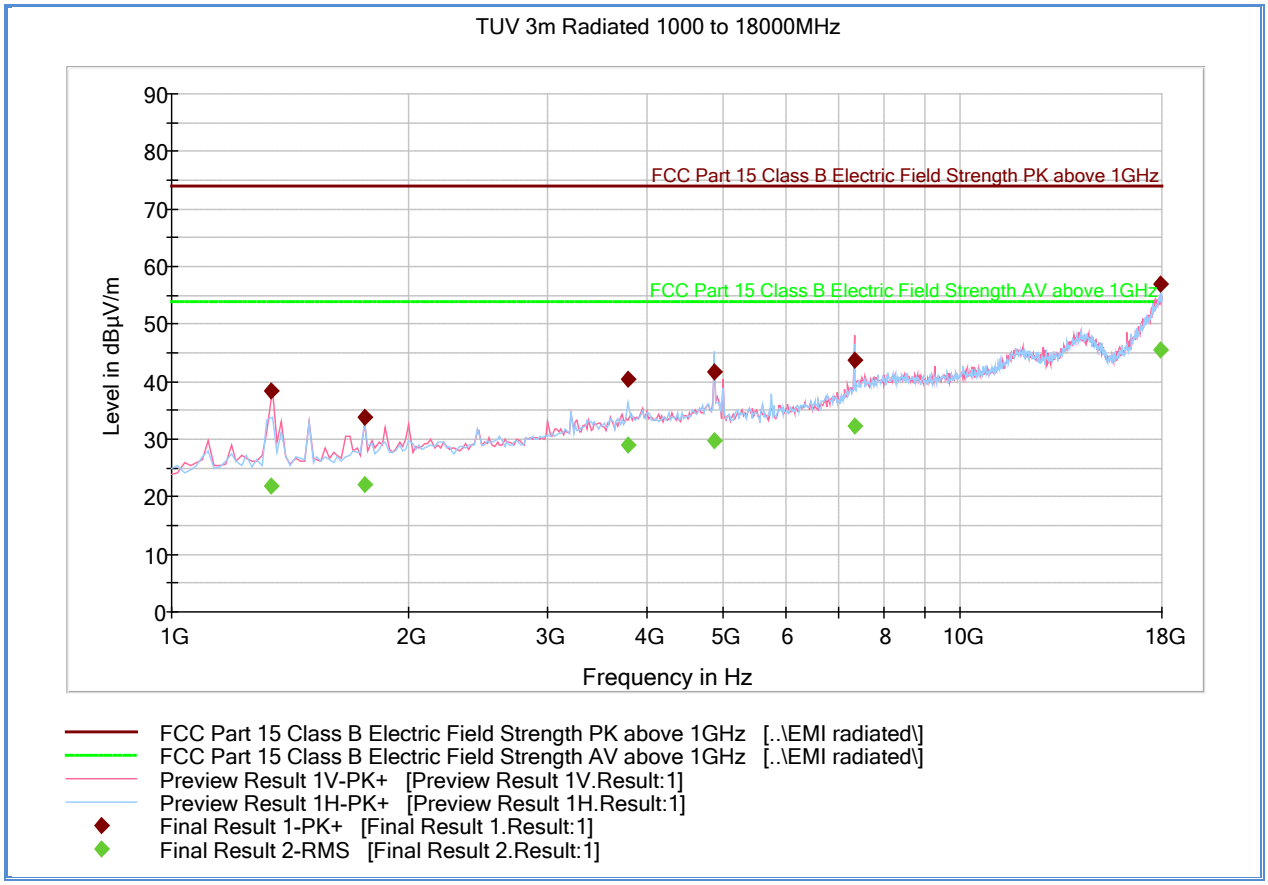
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1339.100000	39.9	1000.0	1000.000	100.0	V	65.0	3.8	34.0	73.9
1756.455556	33.7	1000.0	1000.000	100.0	V	115.0	5.1	40.2	73.9
3210.900000	38.1	1000.0	1000.000	103.0	H	65.0	9.2	35.8	73.9
4797.566667	41.1	1000.0	1000.000	103.0	H	-1.0	11.7	32.8	73.9
7215.344444	43.0	1000.0	1000.000	100.0	V	88.0	16.6	30.9	73.9
17906.455556	58.0	1000.0	1000.000	100.0	V	299.0	33.6	15.9	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)
1339.100000	22.8	1000.0	1000.000	100.0	V	65.0	3.8	31.1	53.9
1756.455556	22.2	1000.0	1000.000	100.0	V	115.0	5.1	31.7	53.9
3210.900000	25.8	1000.0	1000.000	103.0	H	65.0	9.2	28.1	53.9
4797.566667	29.8	1000.0	1000.000	103.0	H	-1.0	11.7	24.1	53.9
7215.344444	31.4	1000.0	1000.000	100.0	V	88.0	16.6	22.5	53.9
17906.455556	45.9	1000.0	1000.000	100.0	V	299.0	33.6	8.0	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 18GHz. Measurements above 18GHz are noise floor figures.

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



Peak Data

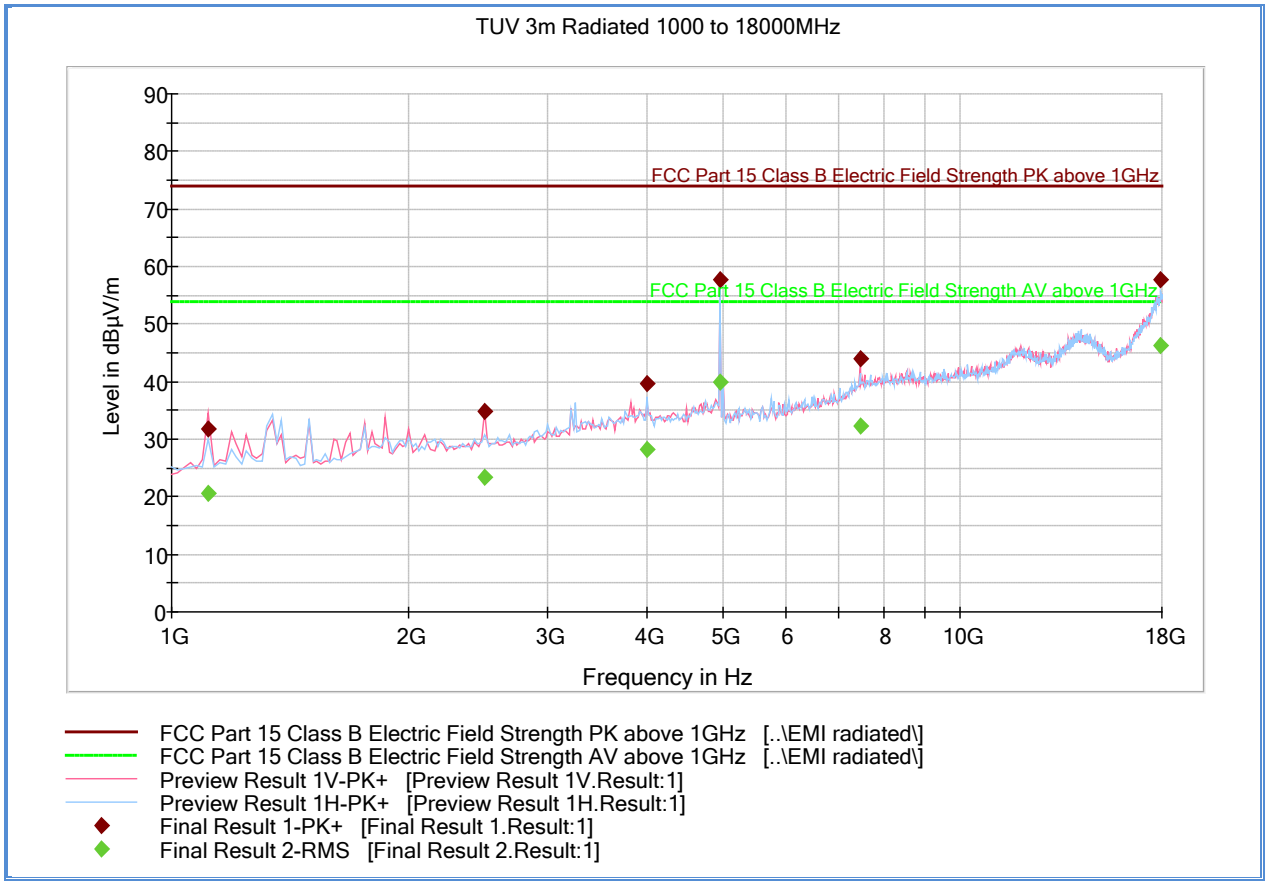
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1339.100000	38.3	1000.0	1000.000	100.0	V	101.0	3.8	35.6	73.9
1756.455556	33.9	1000.0	1000.000	100.0	V	199.0	5.1	40.0	73.9
3796.455556	40.5	1000.0	1000.000	103.0	H	12.0	10.8	33.4	73.9
4873.122222	41.7	1000.0	1000.000	103.0	H	-1.0	11.8	32.2	73.9
7328.677778	43.7	1000.0	1000.000	100.0	V	89.0	17.5	30.2	73.9
17887.566667	57.0	1000.0	1000.000	103.0	H	-1.0	33.5	16.9	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)
1339.100000	22.0	1000.0	1000.000	100.0	V	101.0	3.8	31.9	53.9
1756.455556	22.0	1000.0	1000.000	100.0	V	199.0	5.1	31.9	53.9
3796.455556	28.9	1000.0	1000.000	103.0	H	12.0	10.8	25.0	53.9
4873.122222	29.7	1000.0	1000.000	103.0	H	-1.0	11.8	24.2	53.9
7328.677778	32.3	1000.0	1000.000	100.0	V	89.0	17.5	21.6	53.9
17887.566667	45.6	1000.0	1000.000	103.0	H	-1.0	33.5	8.3	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 10GHz. Measurements above 10GHz are noise floor figures.

2.7.15 Test Results Above 1GHz High Channel (Bluetooth TX 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)
1114.233333	31.7	1000.0	1000.000	100.0	V	286.0	3.0	42.2	73.9
2493.122222	34.9	1000.0	1000.000	100.0	V	132.0	7.3	39.0	73.9
4002.433333	39.6	1000.0	1000.000	103.0	H	187.0	10.6	34.3	73.9
4948.677778	57.8	1000.0	1000.000	103.0	H	320.0	12.0	16.1	73.9
7460.900000	44.0	1000.0	1000.000	100.0	V	108.0	18.2	29.9	73.9
17944.233333	57.6	1000.0	1000.000	103.0	H	3.0	33.7	16.3	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1114.233333	20.6	1000.0	1000.000	100.0	V	286.0	3.0	33.3	53.9
2493.122222	23.5	1000.0	1000.000	100.0	V	132.0	7.3	30.4	53.9
4002.433333	28.2	1000.0	1000.000	103.0	H	187.0	10.6	25.7	53.9
4948.677778	39.9	1000.0	1000.000	103.0	H	320.0	12.0	14.0	53.9
7460.900000	32.2	1000.0	1000.000	100.0	V	108.0	18.2	21.7	53.9
17944.233333	46.2	1000.0	1000.000	103.0	H	3.0	33.7	7.7	53.9

Test Notes: Measurement was performed with a 2.4GHz notch filter. No significant emissions observed above 10GHz. Measurements above 10GHz are noise floor figures.

2.8 RADIATED 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

Test results from Section 2.1.10, 2.1.11 and 2.1.12 of this test report applies. The scan performed under Section 2.1 of this report covers the upper immediate restricted band. Section 2.7 on the other hand covers the lower immediate restricted band (2310 MHz to 2390 MHz).

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: 4532000604 and 4632081643/ Default Test Configuration

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

August 18, 2014/FSC

2.9.5 Test Equipment Used

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

2.9.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.7 °C
Relative Humidity	46.7.%
ATM Pressure	98.6 kPa

2.9.7 Additional Observations

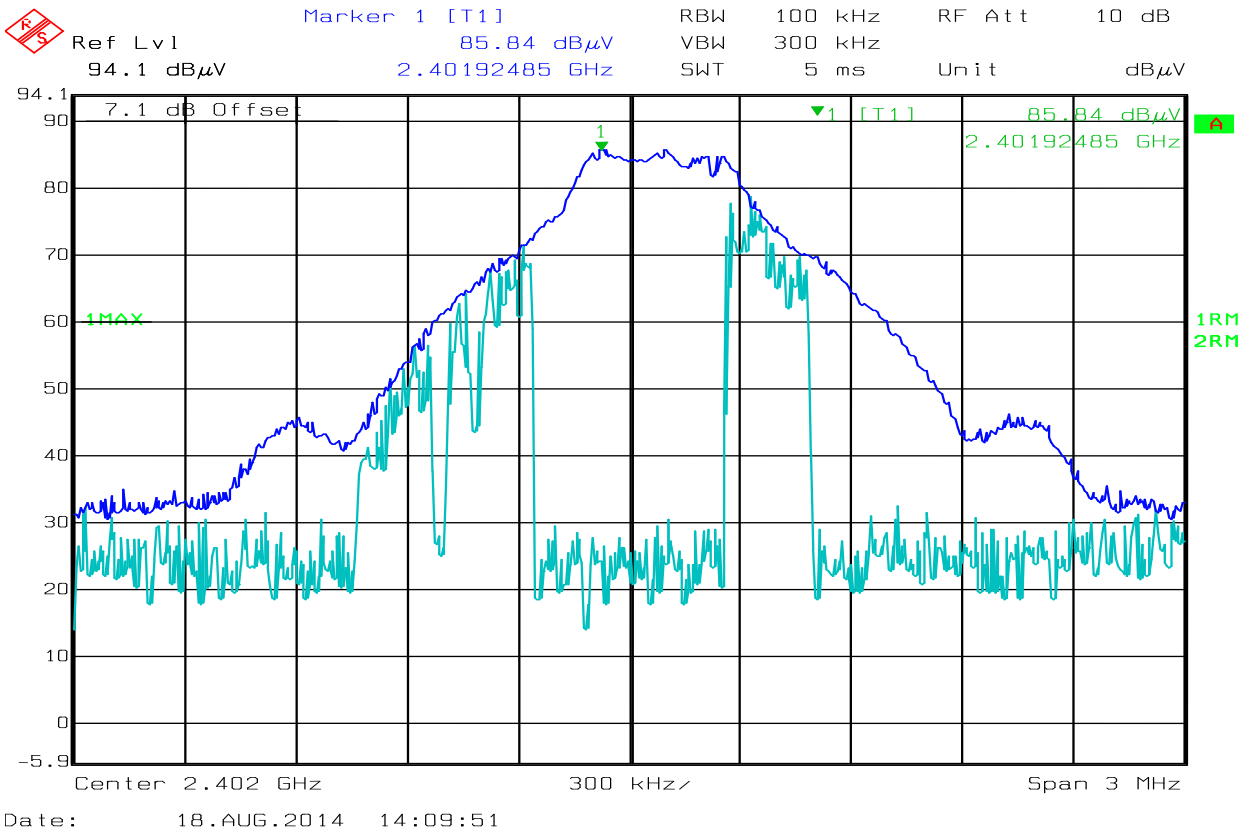
- This is a radiated test.
- The 7.1dB reference offset is for the antenna factor, cable loss and preamp gain used.
- Span is wide enough to capture the channel transmission and should be ≥ 1.5x the DTS bandwidth.
- RBW initially set to 100kHz while VBW is set to 300kHz.
- Detector is Peak.
- Sweep time is Auto Couple.
- Trace mode is max hold.
- EUT complies with 100 kHz RBW.

2.9.8 Test Results Summary

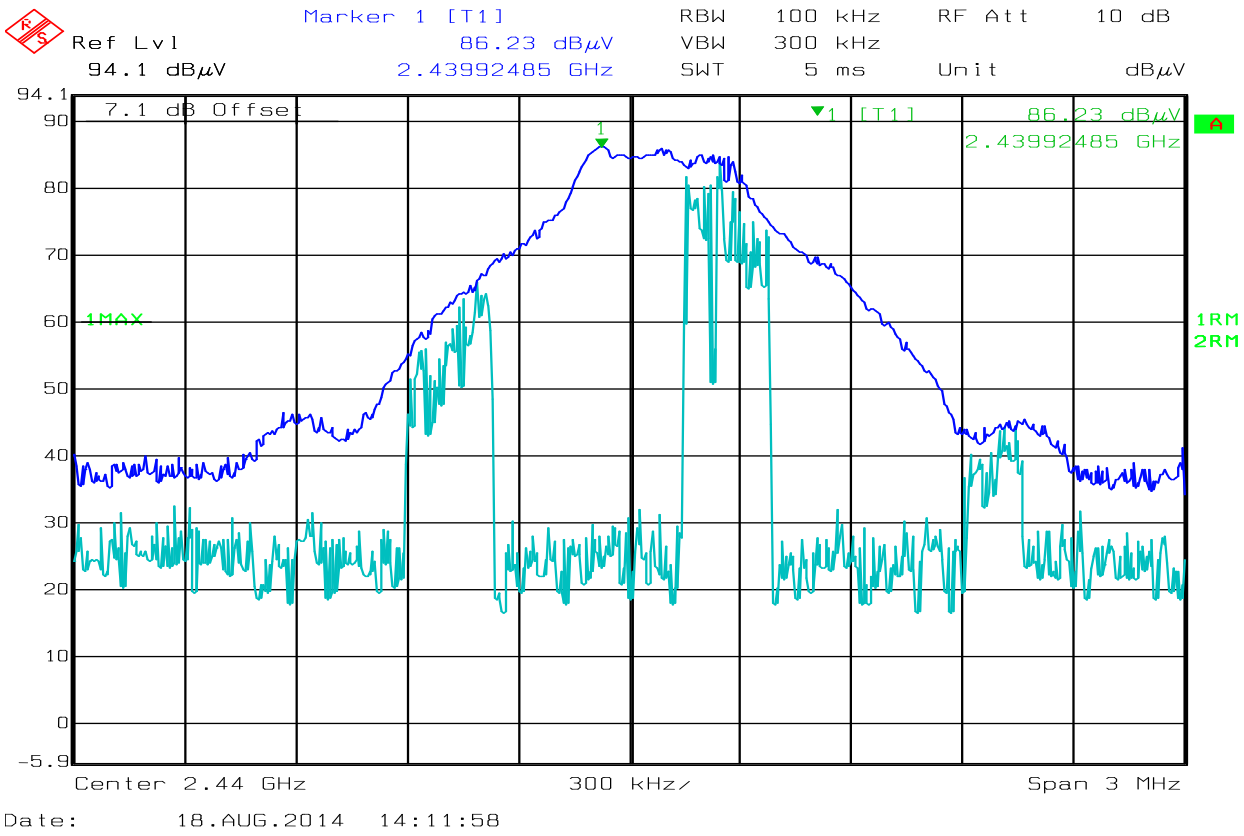
Mode	Channel	Marker Reading using 100 kHz RBW (dBµV/m @ 3 meters)	PSD Limit (dBm)	Margin (dB)	Compliance
Bluetooth LE	37 (2402 MHz)	85.84	8	>15	Complies
	17 (2440 MHz)	86.23	8	>15	Complies
	39 (2480 MHz)	87.56	8	>15	Complies

Note:Since the detector used is Peak and the test methodology is identical to Section 2.1 (Peak Output Power), almost identical results were obtained between the two test. Therefore proving the results with Substitution Method again is not required since worst case Substitution Method performed under Section 2.1 resulted in -7.397 dBm result. This is based from 87.6 dBµV/m @ 3 meters (High Channel).

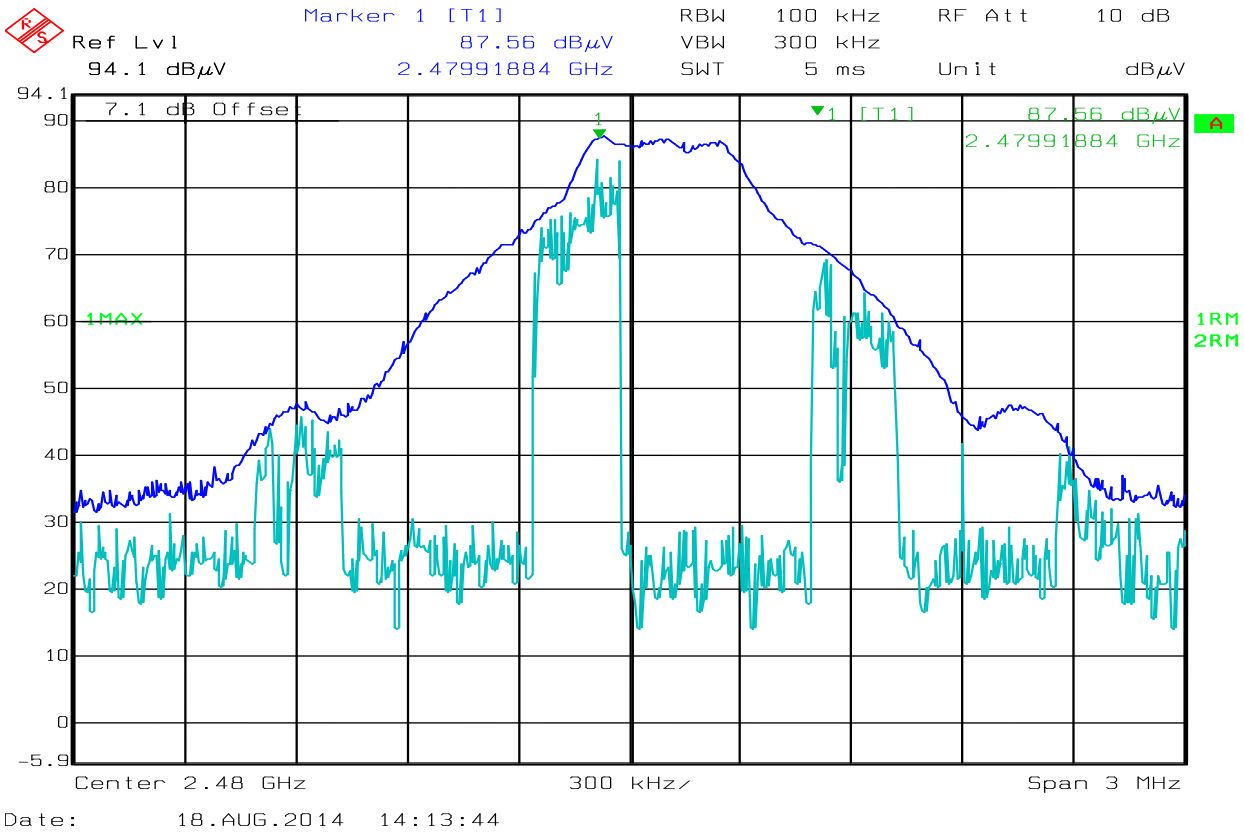
2.9.9 Test Results Plots



Bluetooth LE Low Channel



Bluetooth LE Mid Channel



Bluetooth LE High Channel

2.10 RECEIVER SPURIOUS EMISSIONS

2.10.1 Specification Reference

RSS-Gen 6.0

2.10.2 Standard Applicable

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

Table 2: Radiated Limits of Receiver Spurious Emissions

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

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

2.10.3 Equipment Under Test and Modification State

Serial No: 4532000604 / Default Test Configuration

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

July 03 and 09, 2014/FSC

2.10.5 Test Equipment Used

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

2.10.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.10.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 3rd harmonic (up to 10th performed).
- Result identical to Section 2.7.10 and 2.7.11 of this test report.
- EUT in RX (Receive) mode configuration.

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SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Radiated Test Setup						
1184	Spectrum Analyzer	FSEM	849718/025	Rhode & Schwarz	06/27/14	06/27/15
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	04/08/14	04/08/15
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	04/03/14	04/03/15
1150	Horn antenna	3160-09	012054-004	ETS	04/26/13	04/26/15
1151	Pre-amplifier	TS-PR26	100026	Rhode & Schwarz	05/02/13	05/02/15
8760	Pre-amplifier	ZKL-2	1001	Mini-Circuits	09/04/14	09/04/15
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	04/03/14	04/03/15
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	09/04/14	09/04/15
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	08/29/14	08/29/15
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/14	03/17/15
6815	2.4GHz Band Notch Filter	BRM50702	008	Micro-Tronics	Verified by 1188 and 1049	
1016	Pre-amplifier	PAM-0202	187	PAM	10/08/13	10/08/14
1188	Signal Generator	2024	112282/488	Marconi	09/05/13	09/05/14
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	01/20/14	01/20/15
Miscellaneous						
6452	Multimeter	3478A	2911A52177	Hewlett Packard	08/02/13	09/02/14
7554	Barometer/Temperature /Humidity Transmitter	iBTHX-W	0400706	Omega	01/30/14	01/30/15
1123	DC Power Supply	E3631A	N/A	Hewlett Packard	Verified by 6452	
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Radiated Emission Measurements (Below 1GHz)

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

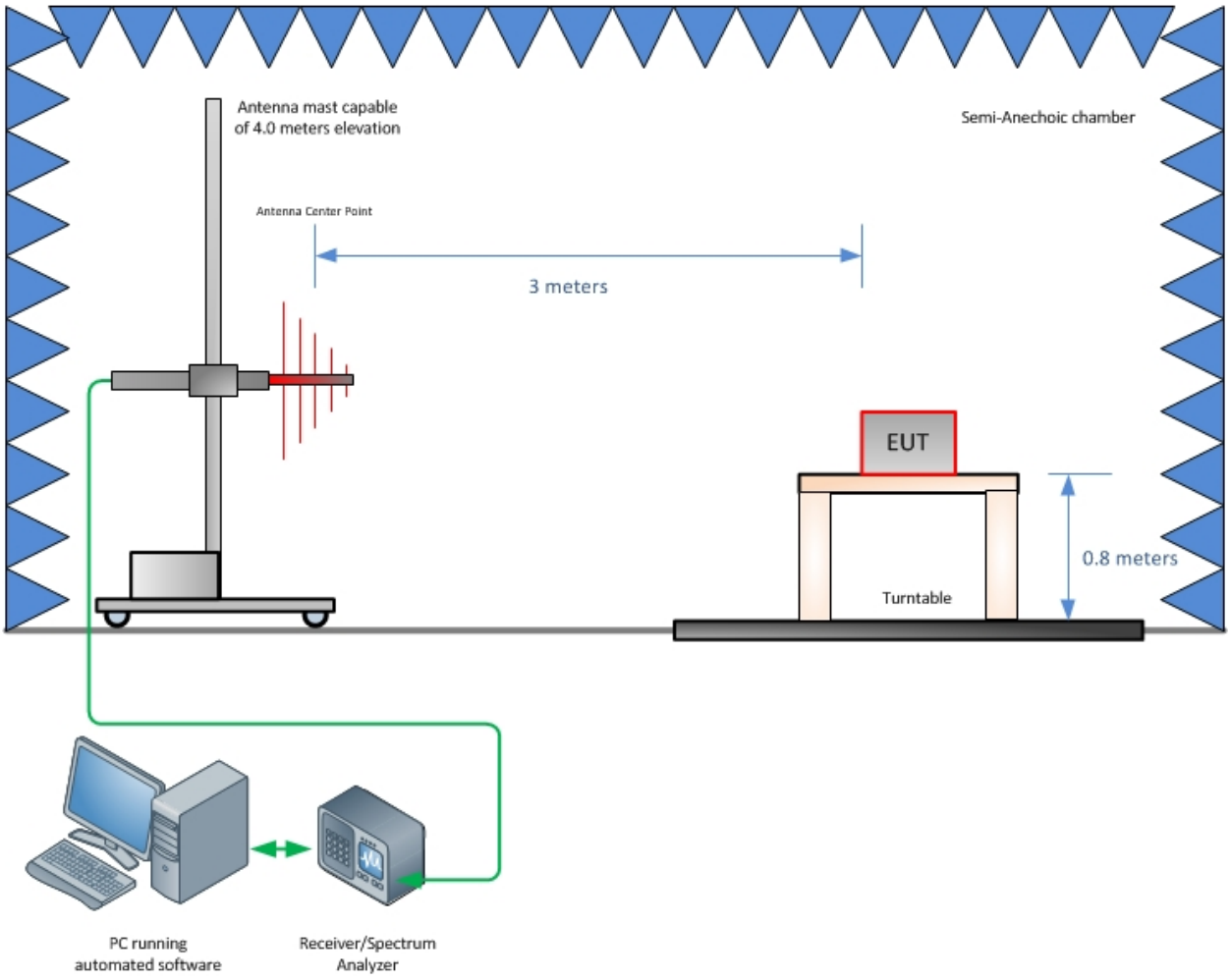
3.2.2 Radiated Emission Measurements (Above 1GHz)

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

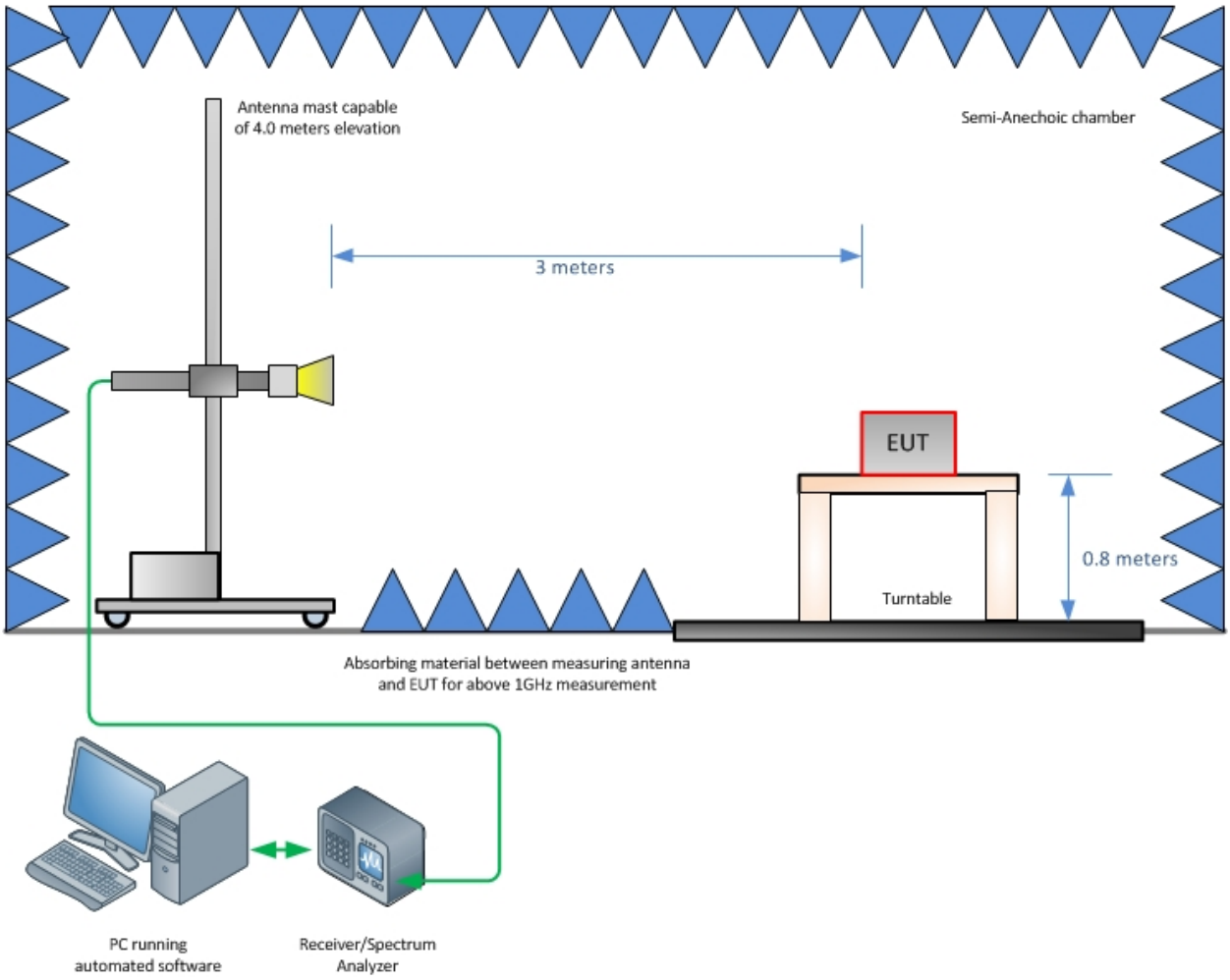
SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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