



America

**Choose certainty.
Add value.**

Report On

Application for Grant of Equipment Authorization of the
NantHealth
GlowCap BLE

FCC Part 15 Subpart C §15.247
IC RSS-247 Issue 1 May 2015

Report No. SD72117576-0616C

August 2016



REPORT ON Radio Testing of the
NantHealth
GlowCap

TEST REPORT NUMBER SD72117576-0616C

REPORT DATE August 2016

PREPARED FOR NantHealth
430 West 5th Street, Suite 800
Panama City, FL 32401
USA

CONTACT PERSON Charles Glisan
VP, Product Development
(850) 296-9525
cglisan@nanthealth.com

PREPARED BY


Alex Chang
Name
Authorized Signatory
Title: EMC/Wireless Test Engineer

APPROVED BY


Juan Manuel Gonzalez
Name
Authorized Signatory
Title: Western Region EMC Service Line Manager

DATED

August 17, 2016



Revision History

SD72117576-0616C NantHealth GlowCap BLE					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
08/17/2016	Initial Release				Juan M. Gonzalez



CONTENTS

Section	Page No
1	REPORT SUMMARY5
1.1	Introduction.....6
1.2	Brief Summary Of Results 7
1.3	Product Information8
1.4	EUT Test Configuration9
1.5	Deviations From The Standard..... 11
1.6	Modification Record 11
1.7	Test Methodology 11
1.8	Test Facility Location 11
1.9	Test Facility Registration..... 11
2	TEST DETAILS.....13
2.1	Peak Output Power.....14
2.2	99% Emission Bandwidth 20
2.3	Minimum 6 dB RF Bandwidth 25
2.4	Spurious Radiated Emissions 29
2.5	Radiated Band Edge Measurements And Immediate Restricted Bands.....37
2.6	Power Spectral Density 41
3	TEST EQUIPMENT USED45
3.1	Test Equipment Used.....46
3.2	Measurement Uncertainty 47
4	DIAGRAM OF TEST SETUP48
4.1	Test Setup Diagram 49
5	ACCREDITATION, DISCLAIMERS AND COPYRIGHT51
5.1	Accreditation, Disclaimers And Copyright..... 52



SECTION 1

REPORT SUMMARY

Radio Testing of the
NantHealth
GlowCap BLE



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the NantHealth GlowCap to the requirements of FCC Part 15 Subpart C §15.247 and IC 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	NantHealth
Model Name	GlowCap BLE
Model Number(s)	100-GCO-PDL 100-GCB-PDL
FCC ID Number	2AH33373100
IC Number	N/A
Serial Number(s)	CA124797
Number of Samples Tested	1 (model 100-GCO-PDL as represented sample)
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 v03r05 (April 08, 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	June 30, 2016
Finish of Test	July 08, 2016
Name of Engineer(s)	Alex Chang
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-247 5.4(4)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.3		RSS-Gen 6.6	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-247 5.2(1)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	N/A	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	N/A	
2.7	§15.247(d)	RSS-Gen 8.9 and 8.10	Spurious Radiated Emissions	Compliant	
2.7		RSS-Gen 7.1	Receiver Spurious Emissions	Compliant	
2.8	§15.247(d)	RSS-Gen 8.9 and 8.10	Radiated Band Edge Measurements	Compliant	
2.9	§15.247(e)	RSS-247 5.2(2)	Power Spectral Density for Digitally Modulated Device	Compliant	



1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) is a NantHealth GlowCap. The EUT reminds users to adhere to their medication schedule through the use of audio/visual indicators and reports adherence information. The two models of 100-GCO-PDL and 100-GCB-PDL are only color differences and which model 100-GCO-PDL presented for evaluation. The EUT BLE function was verified and evaluated in this test report.

1.3.2 EUT General Description

EUT Description	GlowCap
Model Name	GlowCap BLE
Model Number(s)	100-GCO-PDL 100-GCB-PDL
Rated Voltage	3VDC (Lithium-Coin Cell Battery CR2477)
Mode Verified	Bluetooth LE
Capability	Bluetooth LE
Primary Unit (EUT)	☒ Production ☐ Pre-Production ☐ Engineering
Antenna Type	RF Ceramic Chip Antenna
Antenna Manufacture	Johanson Technology
Antenna Part Number	2450AT18D0100
Antenna Gain	1.5 dBi (Peak)

1.3.3 Maximum Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
Bluetooth LE	2402-2480	4.24	2.65

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	Emission configuration. Measurement was performed with EUT configured at 100% modulated transmit signal.

1.4.2 EUT Exercise Software

None. No special software used to exercise the EUT. A firmware version 1.0 was loaded to the EUT prior to the EMC investigation.

1.4.3 Support Equipment and I/O cables

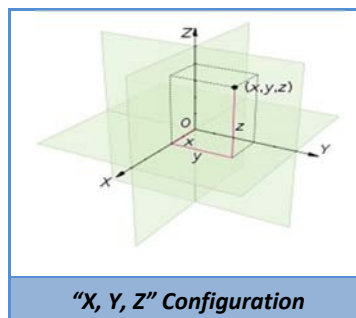
Manufacturer	Equipment/Cable	Description
—	—	—

1.4.4 Worst Case Configuration

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

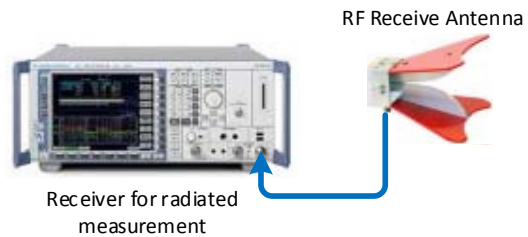
Mode	Channel	Data Rate
Bluetooth LE	2402MHz (Low Channel)	1Mbps

For radiated measurements X, Y and Z orientations were verified. The X orientation was rotated 90° from Y position. Identical result obtained between X and Y orientations. The worst case orientation “X” was verified and performed throughout this test report.



1.4.5 Simplified Test Configuration Diagram

Emission Test Configuration



Not To Scale – Illustration Purpose Only
Objects may not represent actual image of
original equipment/s or set-up.





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		
None	—	—

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 C63.4-2014, 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 C63.10-2013. 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)

16936 Via Del Campo, 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 (ISED) Registration No.: 3067A

The 10m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada (ISED) for radio equipment testing with Registration No. 3067A.



SECTION 2

TEST DETAILS

Radio Testing of the
NantHealth
GlowCap BLE



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: CA124797 / Default Test Configuration

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

June 30, 2016 / AC

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	28.0 °C
Relative Humidity	48.1 %
ATM Pressure	99.0 kPa

2.1.7 Additional Observations

- This is a radiated test.
- Test Methodology is per Clause 3.0 of KDB558074 D01 Meas Guidance v03or05.
- Calculate the EIRP from the radiated field strength in the far field using Equation of ANSI C63.10-2013 Section 9.5.

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



Where

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

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

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

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 (dB μ V) @ 2400 MHz			53.9
Correction Factor (dB)	Asset# 1153 (cable)	3.4	-0.4
	Asset# 8628(preamplifier)	-36.5	
	Asset#7575 (antenna)	32.7	
Reported Max Peak Final Measurement (dB μ V/m) @ 2400 MHz			53.5

2.1.9 Test Results

See attached plots.

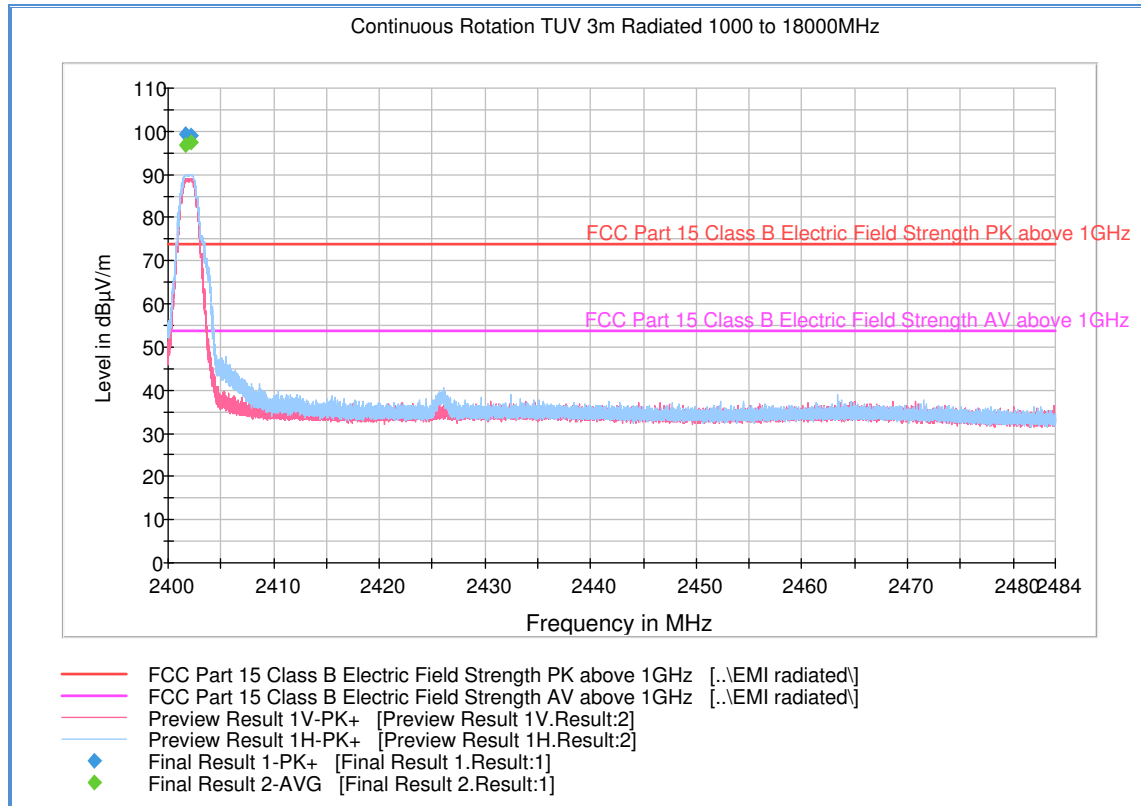
2.1.10 Test Results

Bluetooth Low Energy (LE)	Channel (MHz)	Modulation	Measured Radiated Peak Power (dBμV/m)	Measured Radiated Average Power (dBμV/m)	Calculated Peak Power (dBm)
	2402	GFSK @ 1Mbps	99.4	97.4	4.24
	2440		98.0	95.7	2.84
	2480		96.3	94.1	1.14

2.1.11 Test results

Compliant. See attached plots and tables.

2.1.12 Fundamental Low Channel 2402MHz



Peak Data

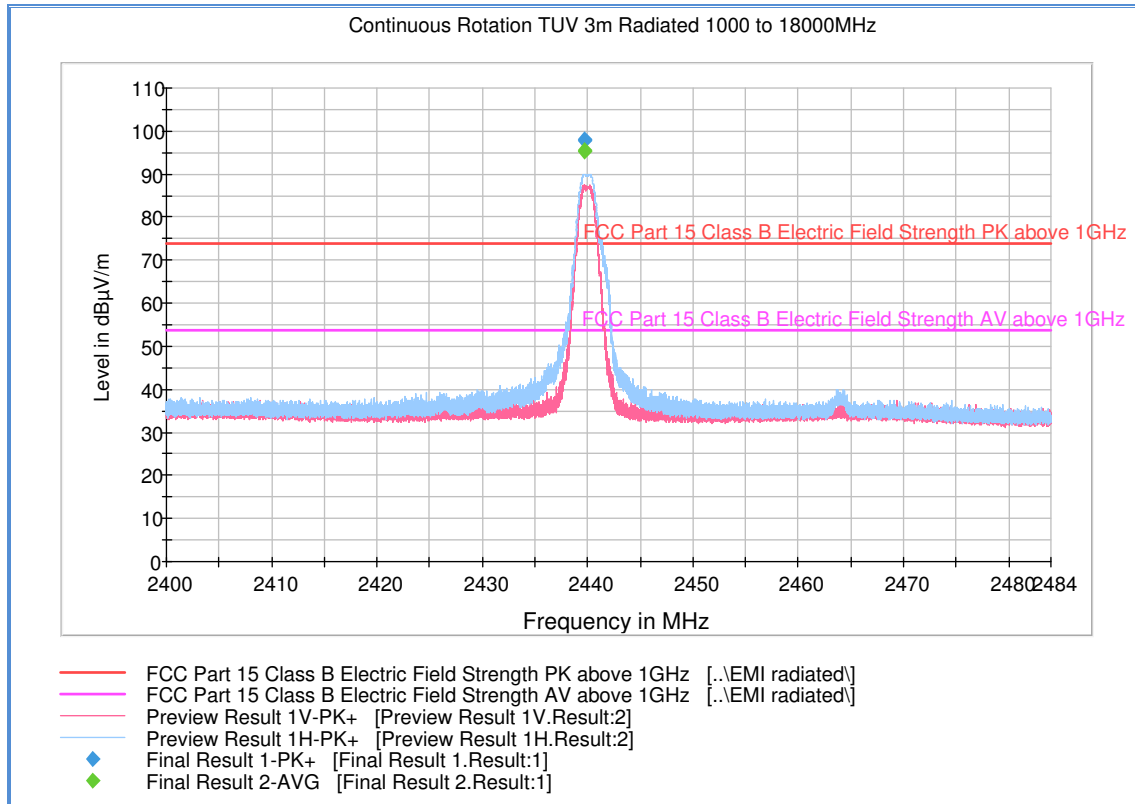
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2401.676667	99.4	1000.0	1000.000	302.2	H	16.0	-5.1	Note	
2402.163333	99.1	1000.0	1000.000	307.2	H	20.0	-5.1		

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2401.676667	96.8	1000.0	1000.000	302.2	H	16.0	-5.1	Note	
2402.163333	97.4	1000.0	1000.000	307.2	H	20.0	-5.1		

Note: This is fundamental frequency evaluation, limit lines do not apply and can be ignored or for information purposes only.

2.1.13 Fundamental Mid Channel 2440MHz



Peak Data

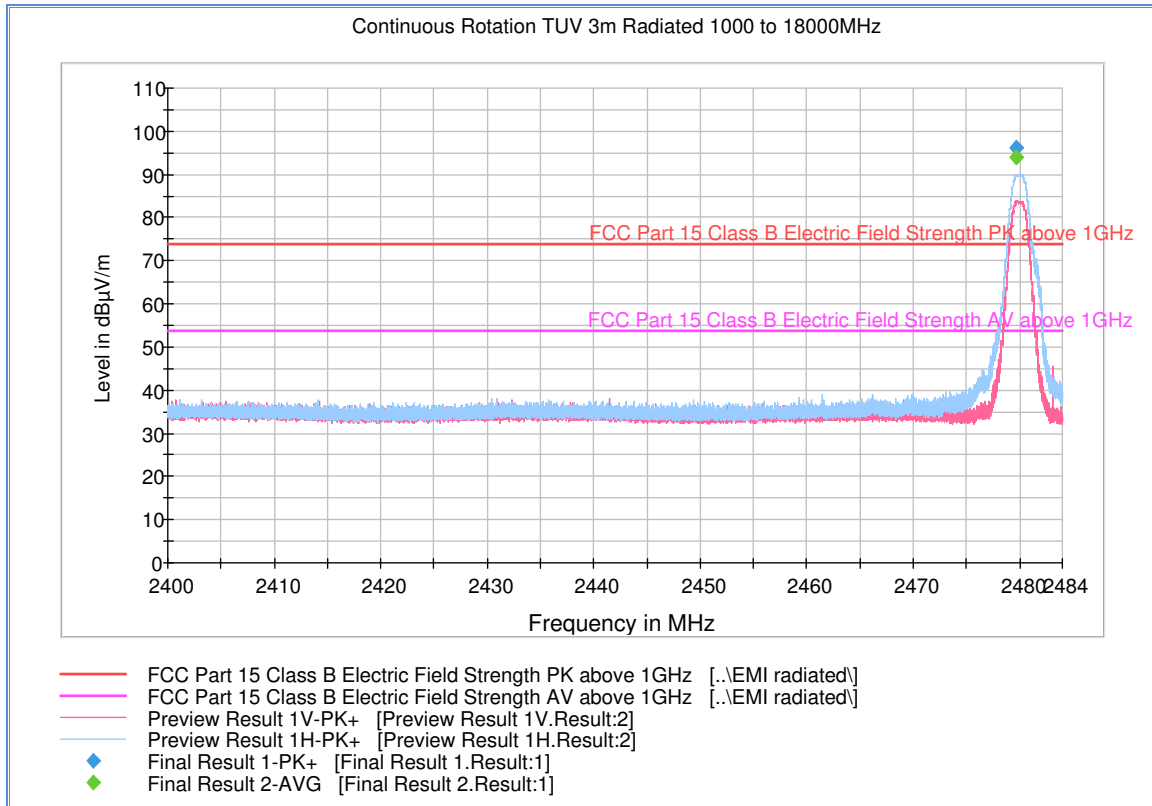
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2439.678000	97.9	1000.0	1000.000	293.2	H	16.0	-5.1	Note	
2439.704000	98.0	1000.0	1000.000	293.2	H	16.0	-5.1		

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2439.678000	95.3	1000.0	1000.000	293.2	H	16.0	-5.1	Note	
2439.704000	95.7	1000.0	1000.000	293.2	H	16.0	-5.1		

Note: This is fundamental frequency evaluation, limit lines do not apply and can be ignored or for information purposes only.

2.1.14 Fundamental High Channel 2480MHz



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2479.707600	96.3	1000.0	1000.000	177.6	H	199.0	-5.0	Note	
2479.712400	96.3	1000.0	1000.000	175.6	H	199.0	-5.0		

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2479.707600	94.1	1000.0	1000.000	177.6	H	199.0	-5.0	Note	
2479.712400	94.1	1000.0	1000.000	175.6	H	199.0	-5.0		

Note: This is fundamental frequency evaluation, limit lines do not apply and can be ignored or for information purposes only.



2.2 99% EMISSION BANDWIDTH

2.2.1 Specification Reference

RSS-Gen Clause 6.6

2.2.2 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.

2.2.3 Equipment Under Test and Modification State

Serial No: CA124797 / Default Test Configuration

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

June 30, 2016 / AC

2.2.5 Test Equipment Used

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



2.2.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 24.6 °C
Relative Humidity 48.2.%
ATM Pressure 98.9 kPa

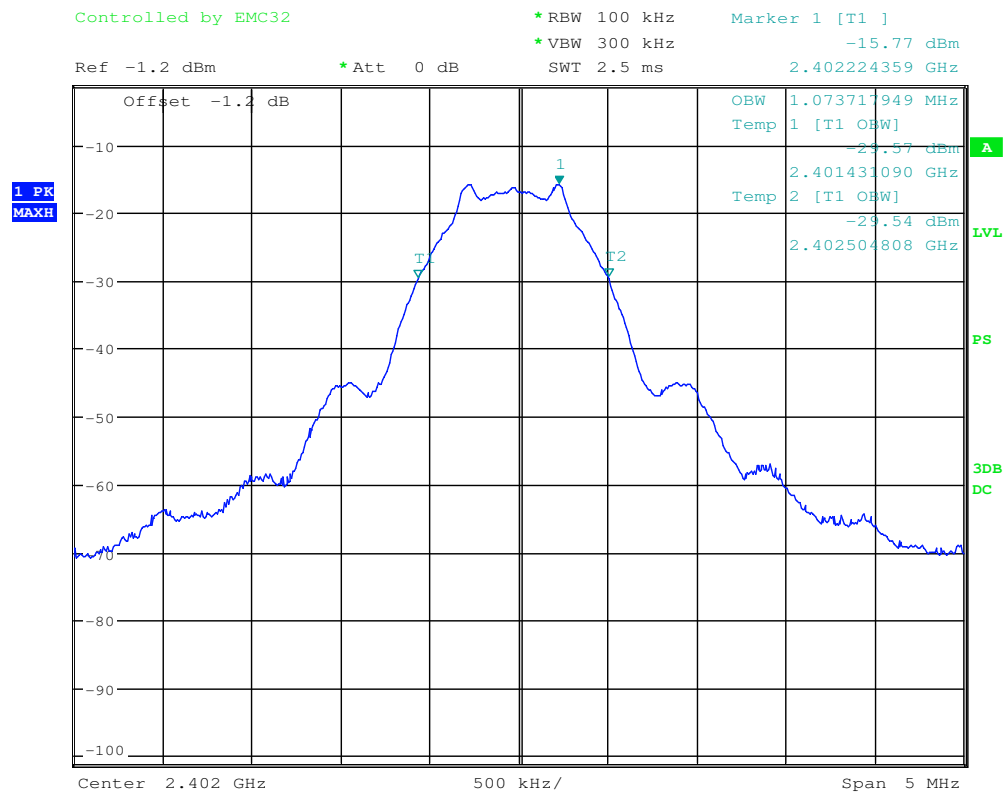
2.2.7 Additional Observations

- 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.

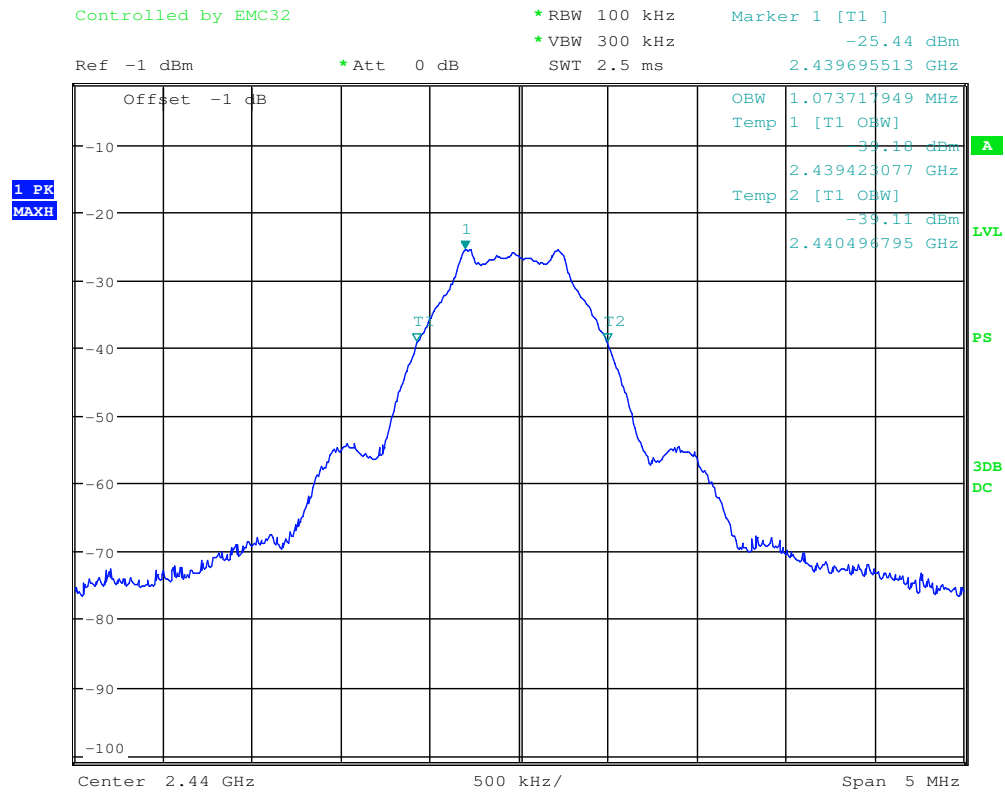
2.2.8 Test Results (For reporting purposes only)

Mode	Channel (MHz)	Measured 99% Bandwidth (MHz)
Bluetooth LE	2402	1.074
	2440	1.074
	2480	1.082

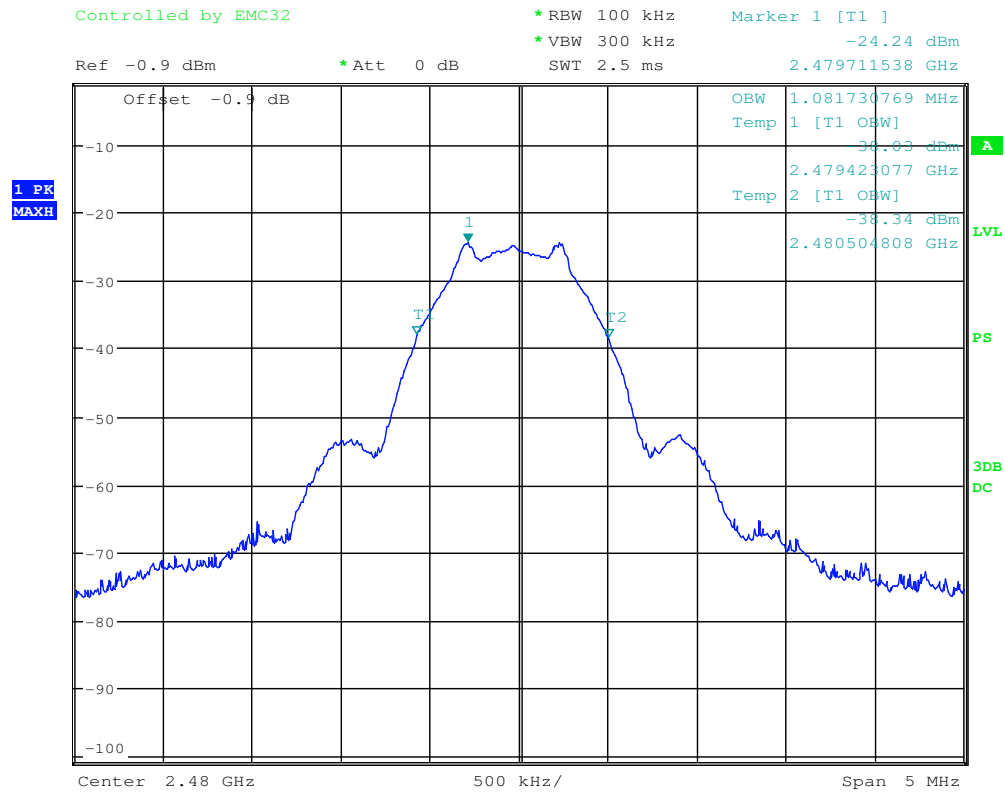
2.2.9 Test Results Plots



Bluetooth LE Low Channel (2402MHz)



Bluetooth LE Mid Channel (2440MHz)



Bluetooth LE High Channel (2480MHz)



2.3 MINIMUM 6 dB RF BANDWIDTH

2.3.1 Specification Reference

Part 15 Subpart C §15.247(a)(2)

2.3.2 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.

2.3.3 Equipment Under Test and Modification State

Serial No: CA124797 / Default Test Configuration

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

June 30, 2016 / AC

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.6 °C
Relative Humidity	48.2. %
ATM Pressure	98.9 kPa

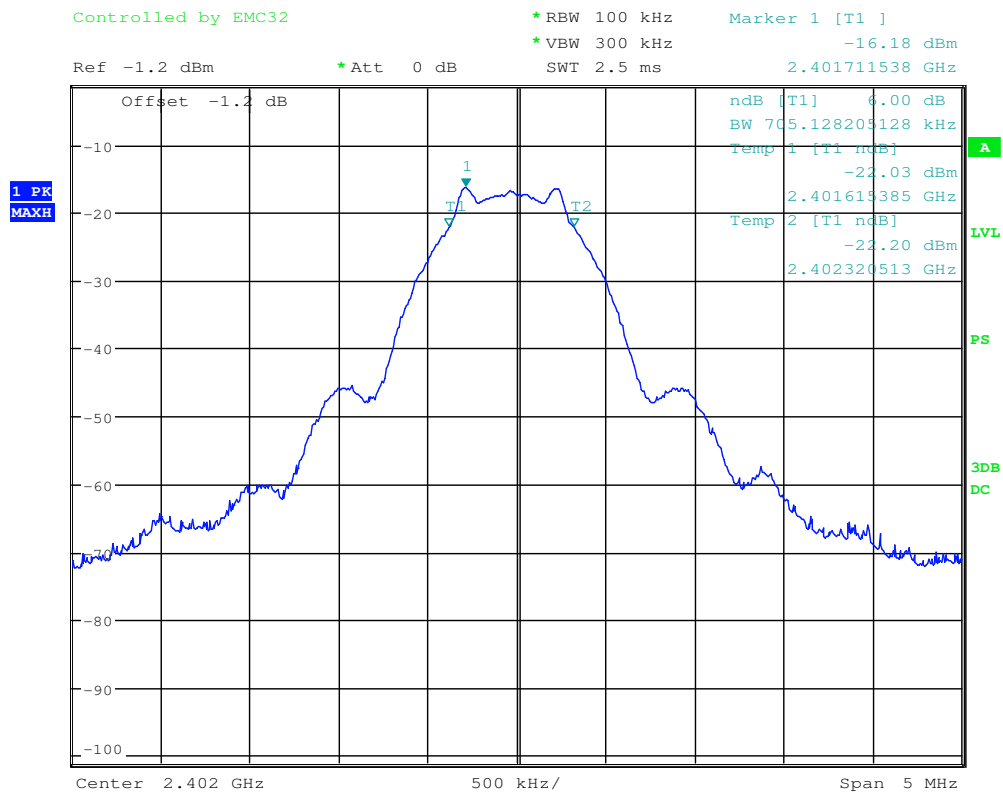
2.3.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is set to 1% of the span.
- VBW is $\geq 3X$ RBW.
- Sweep is auto.
- Detector is peak.
- The “n” dB down marker function of the spectrum analyzer was used for this test.

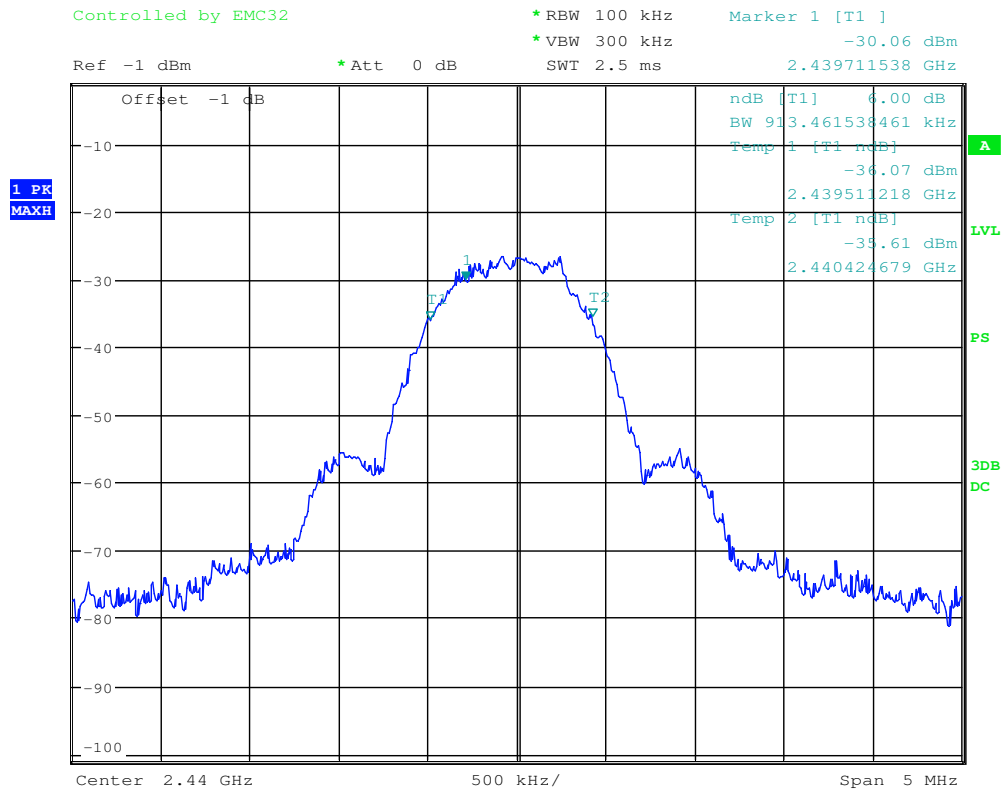
2.3.8 Test Results

Mode	Channel (MHz)	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
Bluetooth LE	2402	0.705	0.500	Complies
	2440	0.913	0.500	Complies
	2480	0.737	0.500	Complies

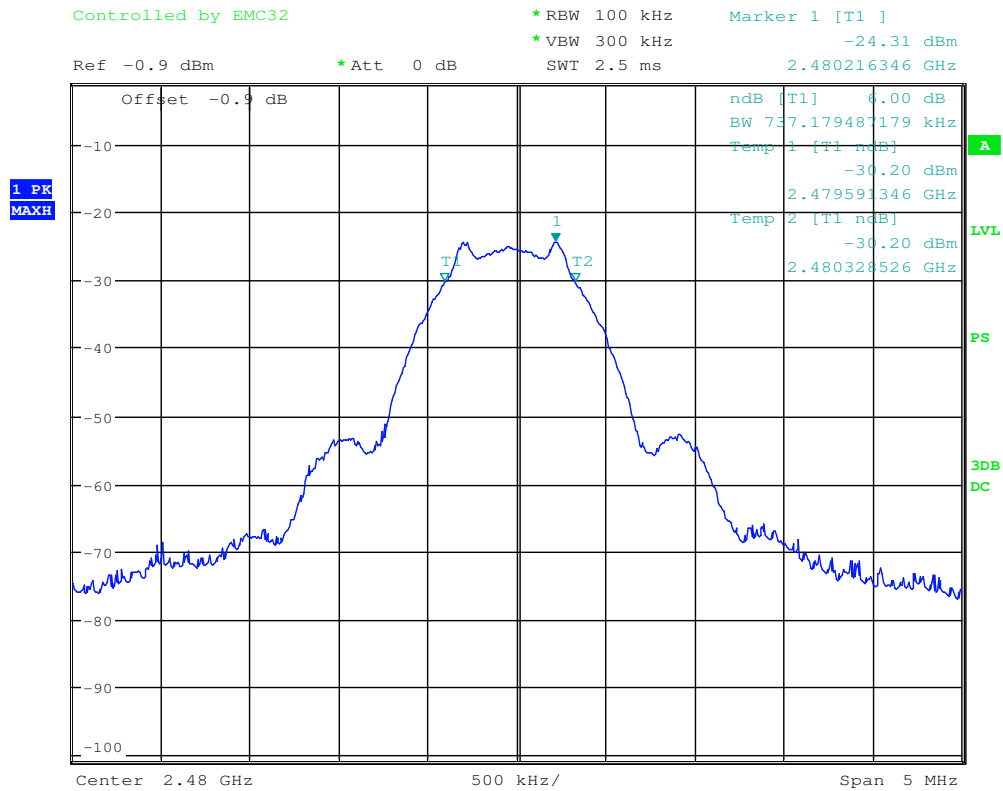
2.3.9 Test Results Plots



Bluetooth LE Low Channel (2402MHz)



Bluetooth LE Mid Channel (2440MHz)



Bluetooth LE High Channel (2480MHz)



2.4 SPURIOUS RADIATED EMISSIONS

2.4.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.4.2 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)).

2.4.3 Equipment Under Test and Modification State

Serial No: CA124797 / Default Test Configuration

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

June 30 and July 08, 2016 / AC

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	28.2 °C
Relative Humidity	28.5 %
ATM Pressure	98.6 kPa

2.4.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic. There are no significant emissions observed beyond 18GHz.
- 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).
- 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 2.4.8 for sample computation.



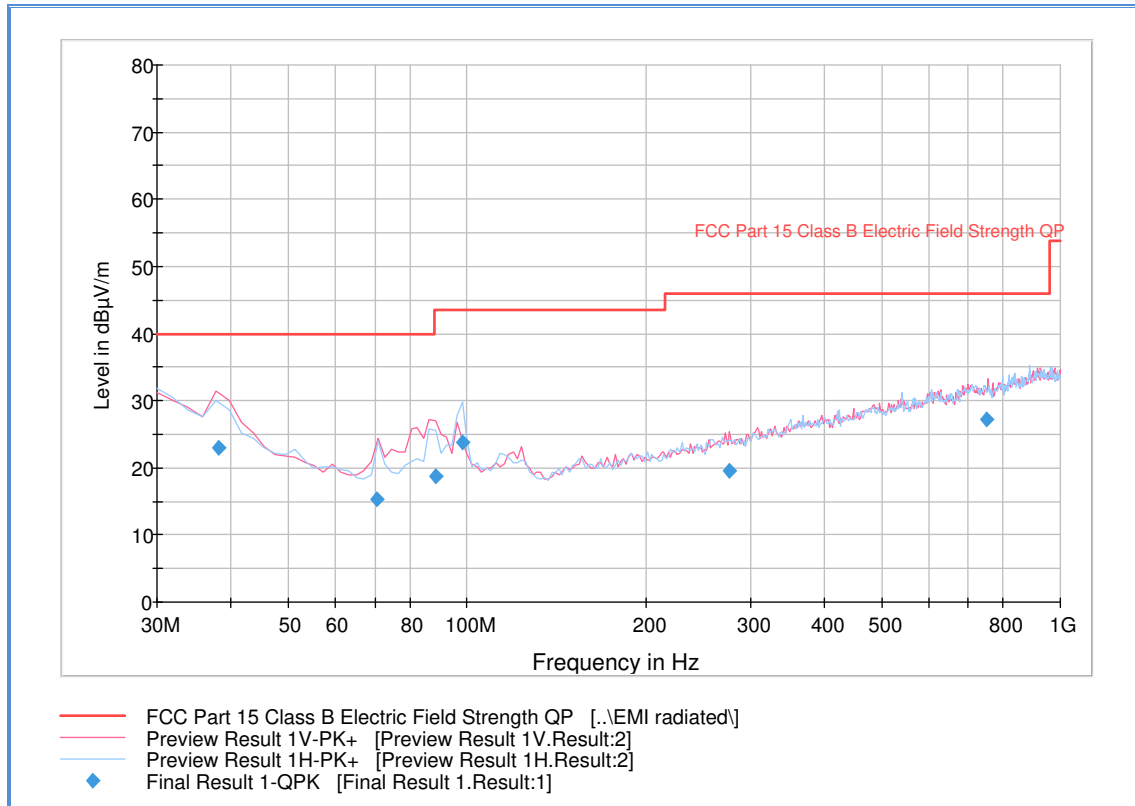
2.4.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dB μ V) @ 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 Quasi Peak Final Measurement (dB μ V/m) @ 30MHz			11.8

2.4.9 Test Results

See attached plots.

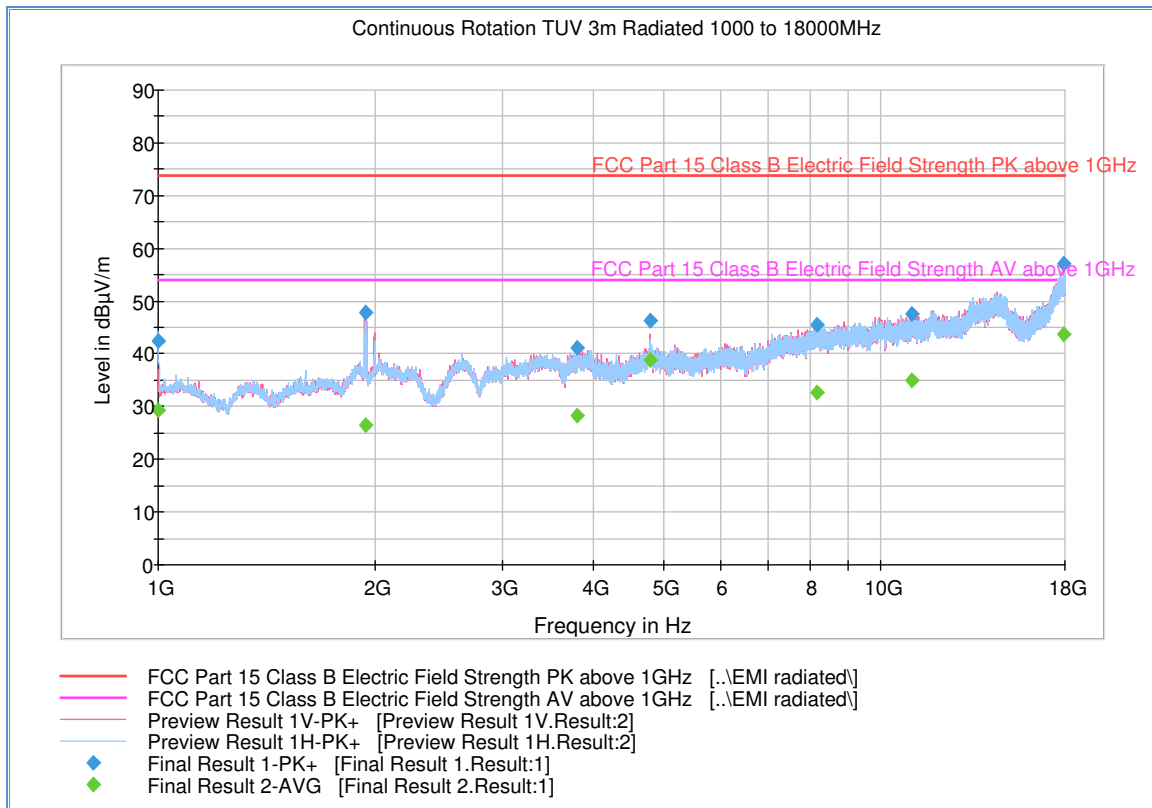
2.4.10 Test Results Below 1GHz (Receive Mode)



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
38.055551	23.0	1000.0	120.000	115.0	V	14.0	-10.1	17.0	40.0
70.541643	15.3	1000.0	120.000	300.0	V	52.0	-16.8	24.7	40.0
88.332745	18.7	1000.0	120.000	100.0	V	8.0	-15.7	24.8	43.5
98.276072	23.9	1000.0	120.000	188.0	H	0.0	-14.4	19.6	43.5
276.873747	19.5	1000.0	120.000	194.0	V	110.0	-7.8	26.5	46.0
751.870140	27.2	1000.0	120.000	383.0	V	328.0	3.3	18.8	46.0

2.4.11 Test Results Above 1GHz (Receive Mode)



Peak Data

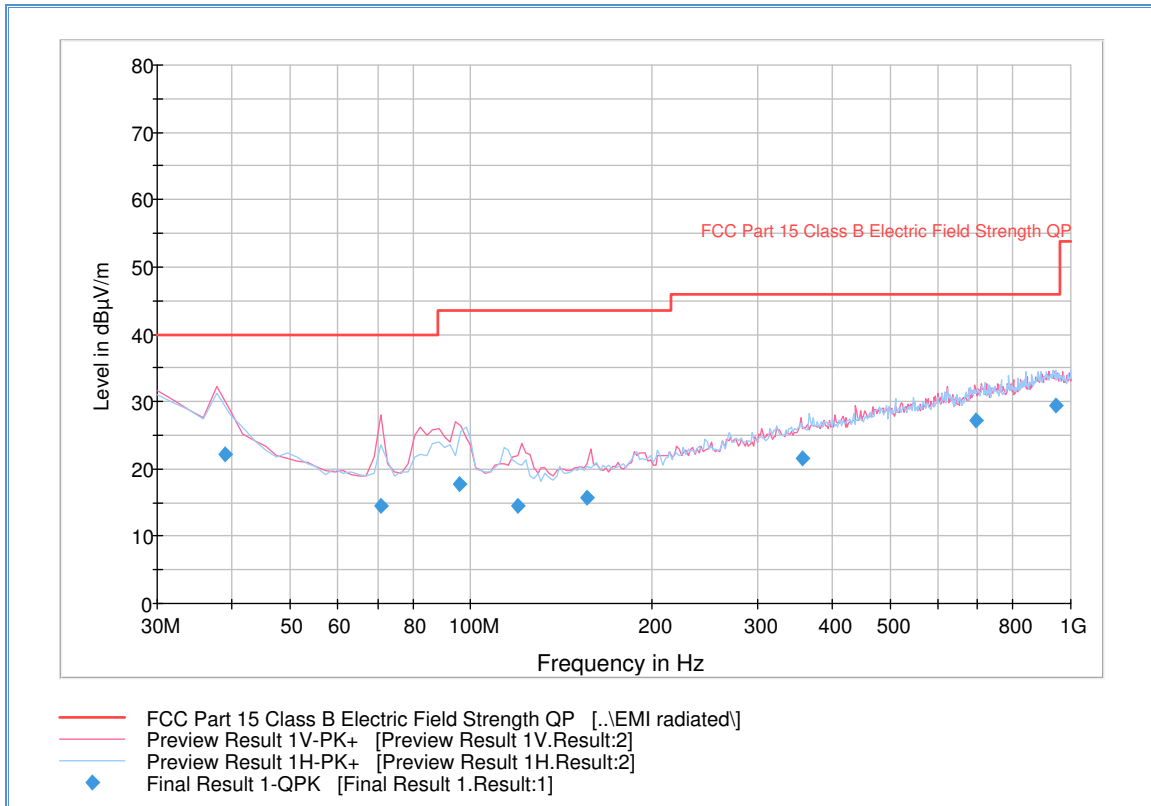
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	42.4	1000.0	1000.000	185.5	H	173.0	-11.2	31.5	73.9
1935.200000	47.7	1000.0	1000.000	302.2	H	-1.0	-4.6	26.2	73.9
3798.166667	41.1	1000.0	1000.000	403.3	H	79.0	0.8	32.8	73.9
4801.966667	46.2	1000.0	1000.000	317.1	V	6.0	2.0	27.7	73.9
8150.966667	45.4	1000.0	1000.000	192.5	V	296.0	8.7	28.5	73.9
11063.066666	47.6	1000.0	1000.000	112.7	H	324.0	13.2	26.3	73.9
17949.233333	57.1	1000.0	1000.000	338.1	V	134.0	24.2	16.8	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)
1000.000000	29.4	1000.0	1000.000	185.5	H	173.0	-11.2	24.5	53.9
1935.200000	26.5	1000.0	1000.000	302.2	H	-1.0	-4.6	27.4	53.9
3798.166667	28.4	1000.0	1000.000	403.3	H	79.0	0.8	25.5	53.9
4801.966667	38.9	1000.0	1000.000	317.1	V	6.0	2.0	15.0	53.9
8150.966667	32.7	1000.0	1000.000	192.5	V	296.0	8.7	21.2	53.9
11063.066666	34.9	1000.0	1000.000	112.7	H	324.0	13.2	19.0	53.9
17949.233333	43.6	1000.0	1000.000	338.1	V	134.0	24.2	10.3	53.9

Test Notes: No significant emissions observed above 5GHz.

2.4.12 Test Results Below 1GHz (Worst Case Tx Mid Channel)

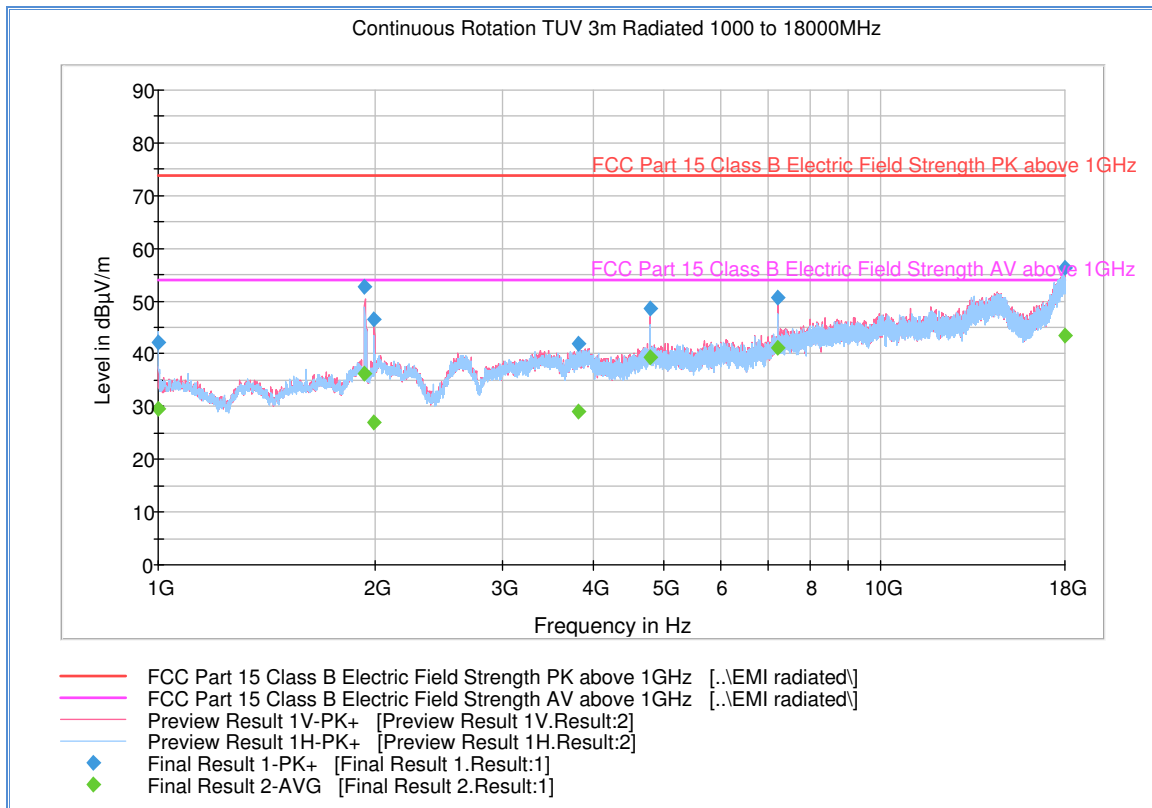


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
38.855551	22.2	1000.0	120.000	150.0	V	269.0	-10.6	17.8	40.0
70.621643	14.4	1000.0	120.000	100.0	V	198.0	-16.8	25.6	40.0
95.468297	17.8	1000.0	120.000	109.0	V	19.0	-14.5	25.7	43.5
119.482725	14.6	1000.0	120.000	200.0	V	1.0	-15.2	28.9	43.5
156.376593	15.6	1000.0	120.000	150.0	V	111.0	-12.9	27.9	43.5
356.669259	21.5	1000.0	120.000	350.0	V	229.0	-5.2	24.5	46.0
693.225731	27.2	1000.0	120.000	105.0	V	126.0	2.7	18.8	46.0
942.347255	29.3	1000.0	120.000	321.0	H	83.0	6.1	16.7	46.0

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

2.4.13 Test Results Above 1GHz (Bluetooth LE Low Channel – 2402MHz)



Peak Data

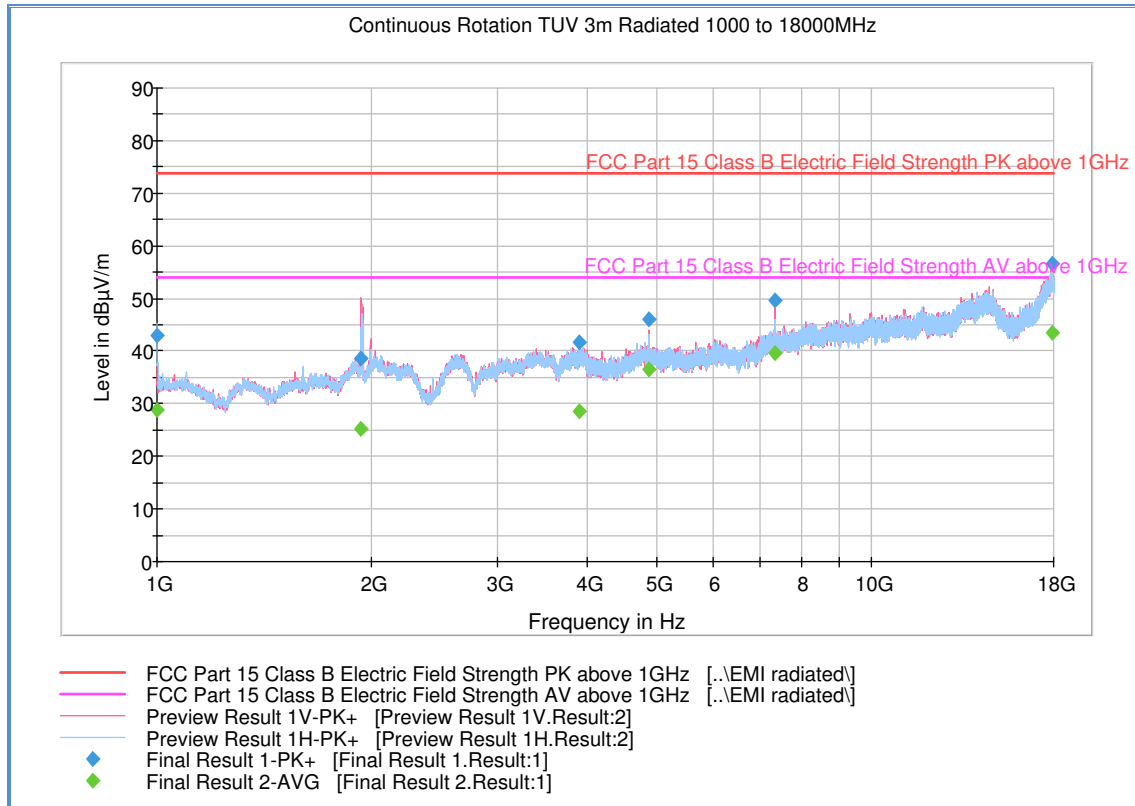
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	42.1	1000.0	1000.000	195.5	H	-1.0	-11.2	31.8	73.9
1932.533333	52.7	1000.0	1000.000	326.2	V	251.0	-4.6	21.2	73.9
1991.900000	46.6	1000.0	1000.000	403.3	V	309.0	-4.4	27.3	73.9
3818.566667	42.0	1000.0	1000.000	387.1	V	48.0	0.9	31.9	73.9
4803.433333	48.7	1000.0	1000.000	302.2	V	179.0	2.0	25.2	73.9
7206.500000	50.7	1000.0	1000.000	303.5	V	268.0	7.4	23.2	73.9
17980.700000	56.4	1000.0	1000.000	143.7	V	127.0	24.3	17.5	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	29.5	1000.0	1000.000	195.5	H	-1.0	-11.2	24.4	53.9
1932.533333	36.2	1000.0	1000.000	326.2	V	251.0	-4.6	17.7	53.9
1991.900000	26.9	1000.0	1000.000	403.3	V	309.0	-4.4	27.0	53.9
3818.566667	29.1	1000.0	1000.000	387.1	V	48.0	0.9	24.8	53.9
4803.433333	39.4	1000.0	1000.000	302.2	V	179.0	2.0	14.5	53.9
7206.500000	41.1	1000.0	1000.000	303.5	V	268.0	7.4	12.8	53.9
17980.700000	43.4	1000.0	1000.000	143.7	V	127.0	24.3	10.5	53.9

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

2.4.14 Test Results Above 1GHz (Bluetooth LE Mid Channel – 2440MHz)



Peak Data

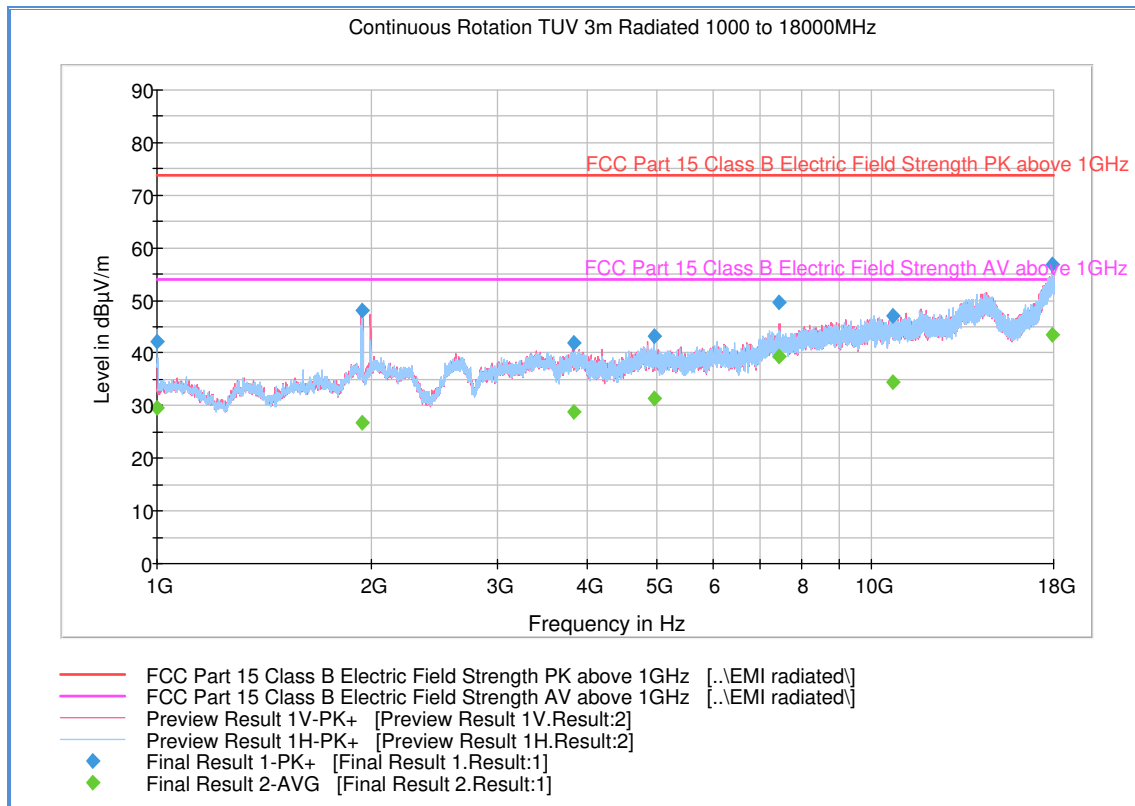
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.400000	42.9	1000.0	1000.000	187.5	H	121.0	-11.2	31.0	73.9
1932.366667	38.6	1000.0	1000.000	197.5	V	241.0	-4.6	35.3	73.9
3906.433333	41.7	1000.0	1000.000	157.6	H	71.0	1.1	32.2	73.9
4880.333333	46.1	1000.0	1000.000	272.3	V	11.0	2.3	27.8	73.9
7320.566667	49.7	1000.0	1000.000	161.6	V	202.0	8.0	24.2	73.9
17925.966667	56.6	1000.0	1000.000	102.7	H	8.0	24.1	17.3	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)
1000.400000	28.7	1000.0	1000.000	187.5	H	121.0	-11.2	25.2	53.9
1932.366667	25.3	1000.0	1000.000	197.5	V	241.0	-4.6	28.6	53.9
3906.433333	28.7	1000.0	1000.000	157.6	H	71.0	1.1	25.2	53.9
4880.333333	36.5	1000.0	1000.000	272.3	V	11.0	2.3	17.4	53.9
7320.566667	39.6	1000.0	1000.000	161.6	V	202.0	8.0	14.3	53.9
17925.966667	43.4	1000.0	1000.000	102.7	H	8.0	24.1	10.5	53.9

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

2.4.15 Test Results Above 1GHz (Bluetooth LE High Channel – 2480MHz)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	42.1	1000.0	1000.000	186.5	H	162.0	-11.2	31.8	73.9
1938.200000	48.0	1000.0	1000.000	292.2	V	215.0	-4.6	25.9	73.9
3825.633333	42.0	1000.0	1000.000	353.1	V	182.0	0.9	31.9	73.9
4959.900000	43.1	1000.0	1000.000	246.3	H	232.0	2.3	30.8	73.9
7439.433333	49.6	1000.0	1000.000	153.7	V	269.0	8.1	24.3	73.9
10730.033333	47.1	1000.0	1000.000	403.3	V	269.0	12.6	26.8	73.9
17912.166667	56.8	1000.0	1000.000	302.2	V	186.0	24.1	17.1	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	29.5	1000.0	1000.000	186.5	H	162.0	-11.2	24.4	53.9
1938.200000	26.8	1000.0	1000.000	292.2	V	215.0	-4.6	27.1	53.9
3825.633333	28.9	1000.0	1000.000	353.1	V	182.0	0.9	25.0	53.9
4959.900000	31.3	1000.0	1000.000	246.3	H	232.0	2.3	22.6	53.9
7439.433333	39.3	1000.0	1000.000	153.7	V	269.0	8.1	14.6	53.9
10730.033333	34.4	1000.0	1000.000	403.3	V	269.0	12.6	19.5	53.9
17912.166667	43.5	1000.0	1000.000	302.2	V	186.0	24.1	10.4	53.9

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



2.5 RADIATED BAND EDGE MEASUREMENTS AND IMMEDIATE RESTRICTED BANDS

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

Serial No: CA124797 / Default Test Configuration

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

July 08, 2016 / AC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.6 °C
Relative Humidity	48.2. %
ATM Pressure	98.9 kPa

2.5.7 Additional Observations

- This is a radiated test. The spectrum was searched from 2310MHz to 2390MHz for lower immediate restricted band and 2483.5MHz to 2500MHz for the upper immediate restricted band.
- There are no emissions found that do not comply with the restricted bands defined in FCC Part 15 Subpart C, 15.205.



- 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.

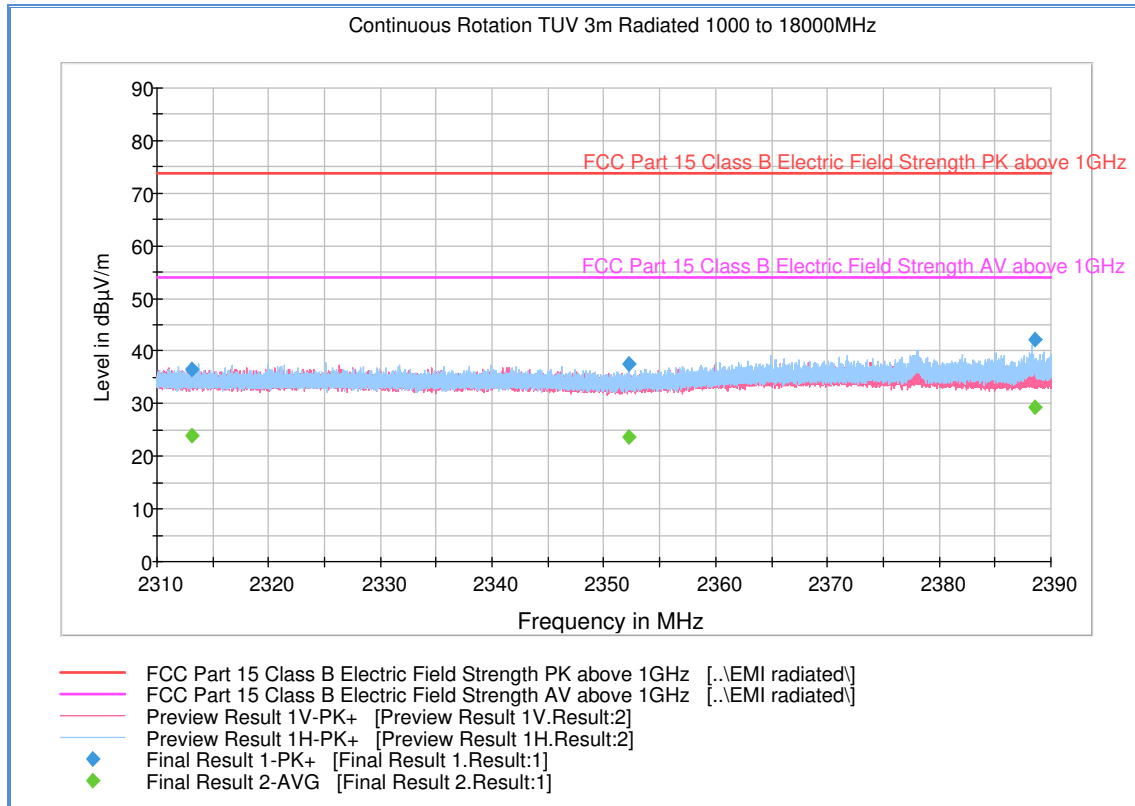
2.5.8 Sample Computation (Radiated Emission)

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

2.5.9 Test Results

See attached plots.

2.5.10 Test Results Restricted Band 2310MHz to 2390MHz (Bluetooth LE Low Channel – 2402MHz)



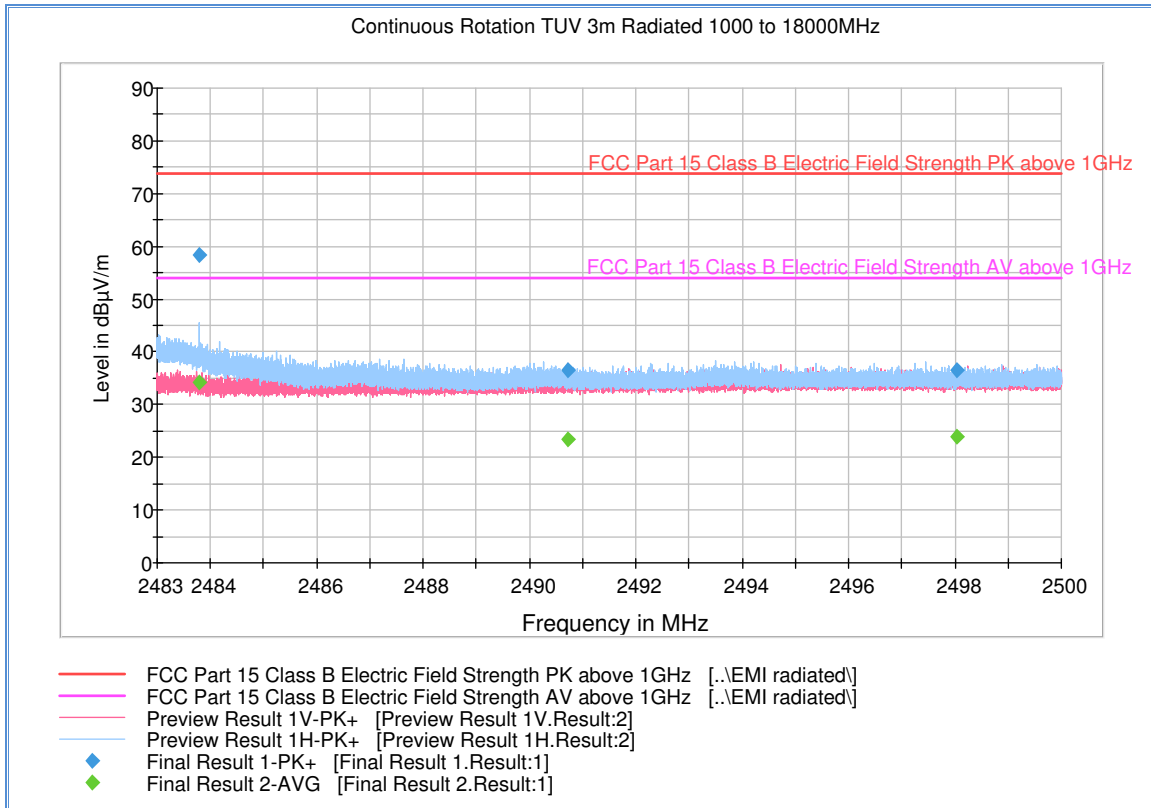
Peak Data

Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2313.122667	36.5	1000.0	1000.000	270.3	V	119.0	-5.4	37.4	73.9
2352.226667	37.4	1000.0	1000.000	302.2	H	20.0	-5.3	36.5	73.9
2388.565333	42.2	1000.0	1000.000	305.2	H	17.0	-5.1	31.7	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2313.122667	23.8	1000.0	1000.000	270.3	V	119.0	-5.4	30.1	53.9
2352.226667	23.8	1000.0	1000.000	302.2	H	20.0	-5.3	30.1	53.9
2388.565333	29.3	1000.0	1000.000	305.2	H	17.0	-5.1	24.6	53.9

2.5.11 Test Results Restricted Band 2483.5MHz to 2500MHz (Bluetooth LE High Channel – 2480MHz)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2483.793333	58.5	1000.0	1000.000	179.5	H	172.0	-5.0	15.4	73.9
2490.718000	36.4	1000.0	1000.000	403.7	V	63.0	-5.0	37.5	73.9
2498.034267	36.6	1000.0	1000.000	261.3	V	336.0	-5.0	37.3	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)
2483.793333	34.1	1000.0	1000.000	179.5	H	172.0	-5.0	19.8	53.9
2490.718000	23.3	1000.0	1000.000	403.7	V	63.0	-5.0	30.6	53.9
2498.034267	23.8	1000.0	1000.000	261.3	V	336.0	-5.0	30.1	53.9



2.6 POWER SPECTRAL DENSITY

2.6.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.6.2 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.

2.6.3 Equipment Under Test and Modification State

Serial No: CA124797 / Default Test Configuration

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

July 08, 2016 / AC

2.6.5 Test Equipment Used

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

2.6.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.6 °C
Relative Humidity	48.2. %
ATM Pressure	98.9 kPa

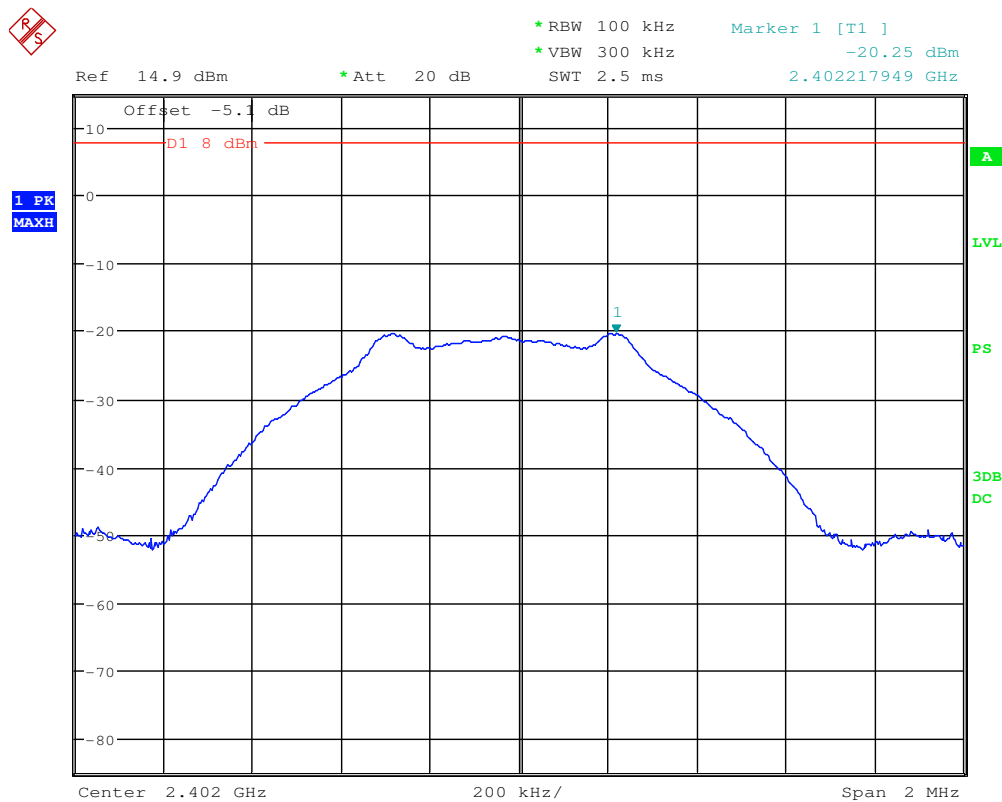
2.6.7 Additional Observations

- This is a radiated test.
- Span is wide enough to capture the channel transmission.
- RBW is set to 1% of the span.
- VBW is $\geq 3X$ RBW.
- Sweep time is Auto Couple.
- Detector is peak
- EUT complies with 100 kHz RBW.

2.6.8 Test Results Summary

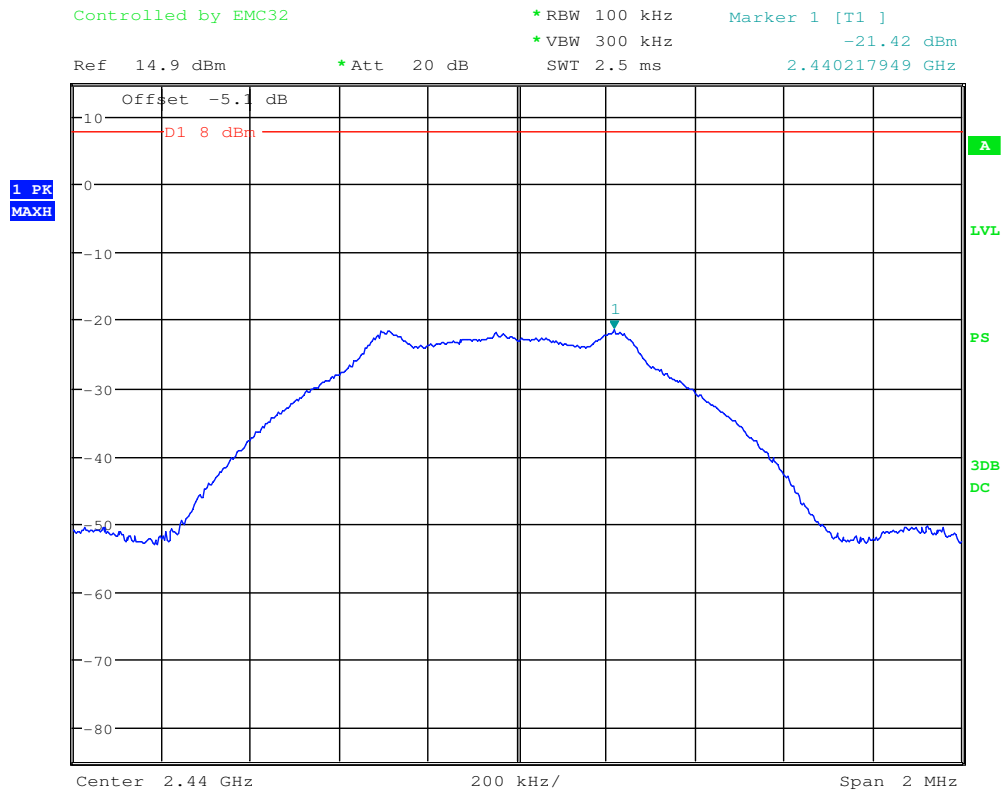
Mode	Channel (MHz)	Marker Reading using 100 kHz RBW (dBm)	PSD Limit (dBm)	Margin (dB)	Compliance
Bluetooth LE	2402	-20.25	8	28.25	Complies
	2440	-21.42	8	29.42	Complies
	2480	-20.60	8	28.60	Complies

2.6.9 Test Results Plots



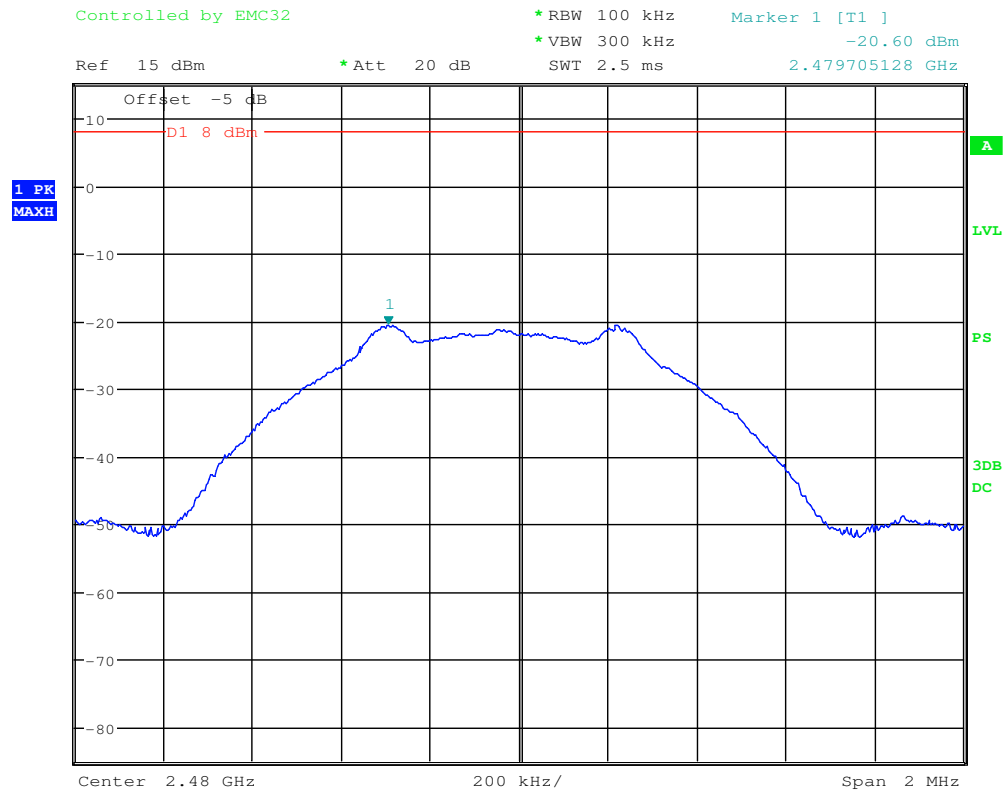
Date: 8.JUL.2016 15:00:18

Bluetooth LE Worst Case Channel (2402MHz)



Date: 8.JUL.2016 11:41:29

Bluetooth LE Worst Case Channel (2440MHz)



Date: 8.JUL.2016 11:43:26

Bluetooth LE Worst Case Channel (2480MHz)



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						
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	03/21/16	03/21/17
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
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	05/12/16	05/12/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	01/11/16	01/11/17
6815	2.4GHz Band Notch Filter	BRM50702	008	Micro-Tronics	Verified by 1049	
Miscellaneous						
7560	Barometer/Temperature/Hu midity Transmitter	iBTHX-W	1240476	Omega	10/19/15	10/19/16
	Test Software	EMC32	V8.53.0	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	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)

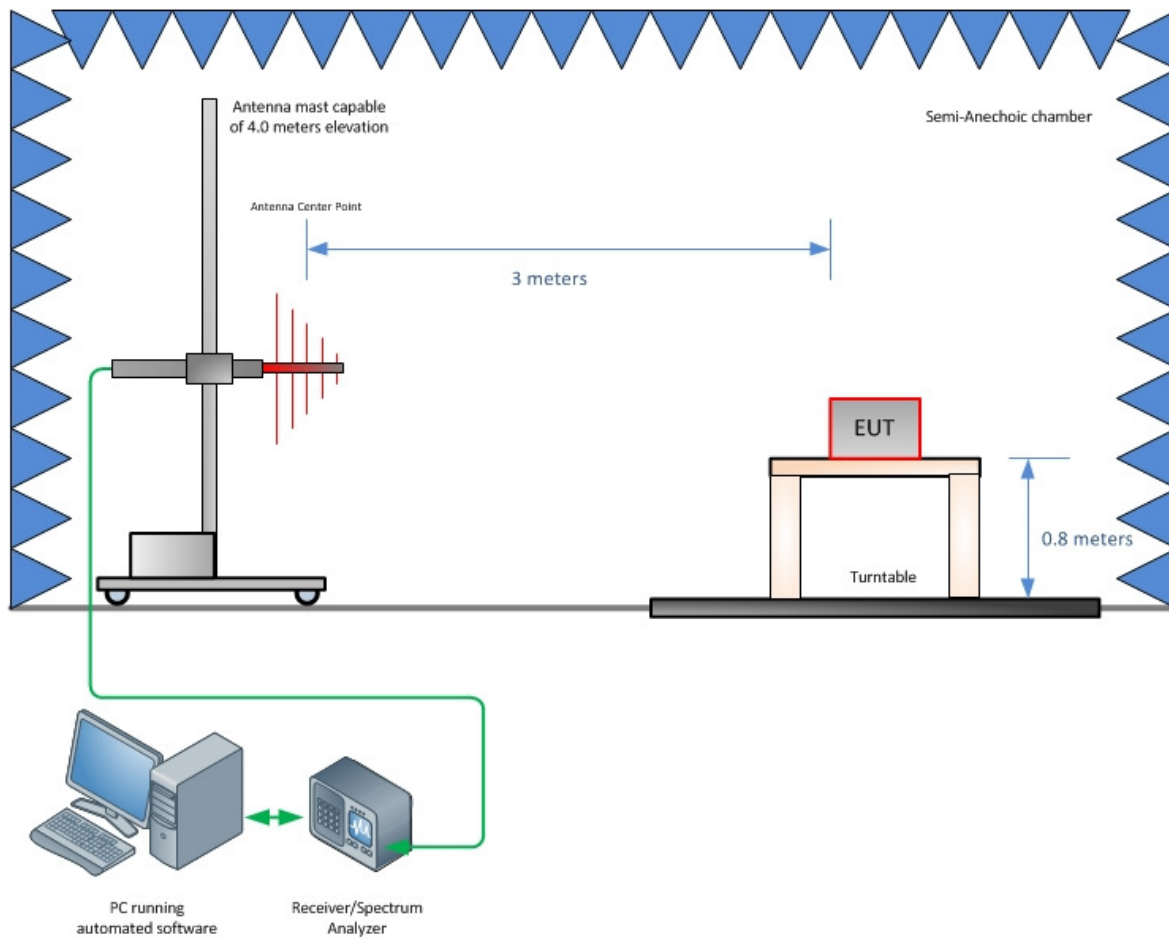
Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	2.70	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



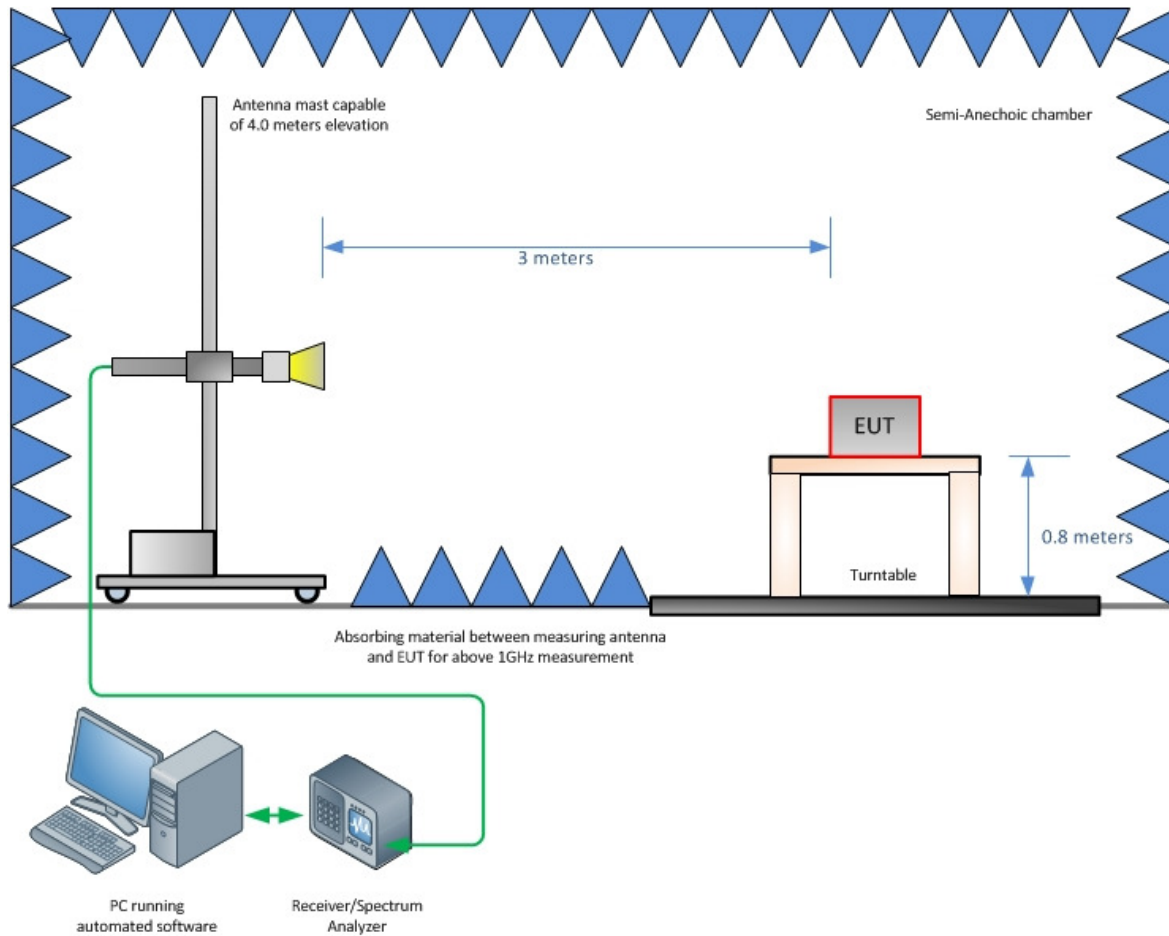
SECTION 4

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

TÜV SÜD America Inc.'s reports apply only to the specific sample tested under stated test conditions. It is the manufacturer's responsibility to assure the continued compliance of production units of this model. TÜV SÜD America, Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America, Inc.'s issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and TÜV SÜD America, Inc., extracts from the test report shall not be reproduced, except in full without TÜV SÜD America, Inc.'s written approval.

This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the federal government.

TÜV SÜD America, Inc. and its professional staff hold government and professional organization certifications for AAMI, ACIL, AEA, ANSI, IEEE, A2LA, NIST and VCCI.

