



America

**Choose certainty.
Add value.**

Report On

Application for Grant of Equipment Authorization of the
Piper Networks, Inc.

Piper Sensor Model SG1001

FCC Part 15 Subpart C §15.247 (DTS)

Report No. SD72120112-0916A

February 2017



REPORT ON	Radio Testing of the Piper Networks, Inc. Piper Sensor
TEST REPORT NUMBER	SD72120112-0916A
PREPARED FOR	Piper Networks, Inc. 3655 Nobel Drive, Suite 120 San Diego, CA 92122
CONTACT PERSON	Robert Hanczor Carrier & Product Certification Manager 619-248-2002 robert@pipernetworks.com
PREPARED BY	 _____ Name Nikolay Shtin Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	 _____ Name Ferdinand S. Custodio Authorized Signatory Title: EMC/Senior Wireless Test Engineer
DATED	_____ February 22, 2017



Revision History

SD72120112-0916A Piper Networks, Inc. Piper Sensor					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
02/22/2017	Initial Release				Ferdinand Custodio

CONTENTS

Section	Page No
1	REPORT SUMMARY 5
1.1	Introduction 6
1.2	Brief Summary of Results..... 7
1.3	Product Information 8
1.4	EUT Test configuration..... 10
1.5	Deviations from the Standard..... 12
1.6	Modification Record 12
1.7	Test Methodology 12
1.8	Test Facility Location..... 12
1.9	Test Facility Registration 12
2	TEST DETAILS 14
2.1	Peak Output Power..... 15
2.2	Conducted Emissions 18
2.3	Minimum 6 dB RF Bandwidth 19
2.4	Out-of-band Emissions - Conducted 20
2.5	Band-edge and Restricted Bands Compliance of RF Conducted Emissions 23
2.6	Spurious Radiated Emissions 26
2.7	Power Spectral Density 30
3	TEST EQUIPMENT USED 33
3.1	Test Equipment Used 34
3.2	Measurement Uncertainty 35
4	DIAGRAM OF TEST SETUP 36
4.1	Test Setup Diagram..... 37
5	ACCREDITATION, DISCLAIMERS AND COPYRIGHT 39
5.1	Accreditation, Disclaimers and Copyright..... 40



SECTION 1

REPORT SUMMARY

Radio Testing of the
Piper Networks, Inc.
Piper Sensor SG1001



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Piper Networks, Inc. Piper Sensor to the requirements of FCC Part 15 Subpart C §15.247.

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	Piper Networks, Inc.
Model Number(s)	SG1001
FCC ID Number	2AIK7-SG1001
Serial Number(s)	90004024
Number of Samples Tested	1
Test Specification/Issue/Date	<ul style="list-style-type: none">• FCC Part 15 Subpart C §15.247 (October 1, 2016).• 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	January 18, 2017
Finish of Test	January 19, 2017
Name of Engineer(s)	Nikolay Shtin
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 is shown below.

Section	FCC Part 15 Spec Clause	Test Description	Result	Comments/ Base Standard
2.1	§15.247(b)(3)	Peak Output Power	Compliant	
2.2	§15.207(a)	Conducted Emissions	N/A ¹	
2.3	§15.247(a)(2)	Minimum 6 dB RF Bandwidth	N/A ²	
2.4	§15.247(d)	Out-of-Band Emissions - Conducted	Compliant	
2.5	§15.247(d)	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.6	§15.247(d)	Spurious Radiated Emissions	Compliant	
2.7	§15.247(e)	Power Spectral Density for Digitally Modulated Device	Compliant	

N/A¹ Not performed. EUT is a PoE powered device having no direct connection to the AC mains.

N/A² Not performed. Minimum 6 dB RF Bandwidth test results are from Test Report: TRA-029073-45-01B FCC 47CFR 15.247 & IC RSS-247 Test Report for Raspberry Pi (Trading) Ltd. Raspberry Pi 3 issued on 02-18-2016 by Element Materials Technology Warwick Ltd.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was an Piper Networks, Inc. Piper Sensor Model SG1001 as shown in the photographs below.



Equipment Under Test



1.3.2 EUT General Description

EUT Description	Piper Sensor
Model Name	Piper Sensor
Model Number(s)	SG1001
Rated Voltage	48VDC from PoE Ethernet Switch
Mode Verified	Bluetooth Low Energy (BT LE)
Capability	WLAN 802.11 b/g/n and Bluetooth Low Energy (BT LE)
Primary Unit (EUT)	<input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> Engineering
Antenna Type	Ceiling Mount Directional Antenna
Antenna Manufacturer	N/A
Antenna Model Number	N/A
Antenna Dimensions	N/A
Antenna Gain	12 dBi (Peak)

1.3.3 Maximum Peak Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
Bluetooth LE	2402-2480	6.56	4.53

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
A	Antenna Conducted Port Test Setup. EUT transmitting continuously with Duty Cycle greater than 98 % with antenna port connected directly to the Spectrum Analyzer through 20 dB external attenuator. TX power is set to maximum by default and can't be modified.
B	Radiated emissions test configuration. The EUT connected to PoE Ethernet switch transmitting at full power to a Dummy load.

1.4.2 EUT Exercise Software

EUT was loaded with FW version 1.0.149. Before each test, the operating channel was configured. Power level is set to maximum by default and can't be modified.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Apple	Support Laptop	Mac Book Pro Model: A1398
Trendnet	Ethernet Switch	Model TPE-S44 S/N: C21546P400047
I. T.E	Power Supply (Input: 100-240V 50/60 Hz 1.0A Output: 48V 0.8A)	Model NU38-1480080-12
	Ethernet (EUT to Support PC)	CAT6 Ethernet Cable 2m

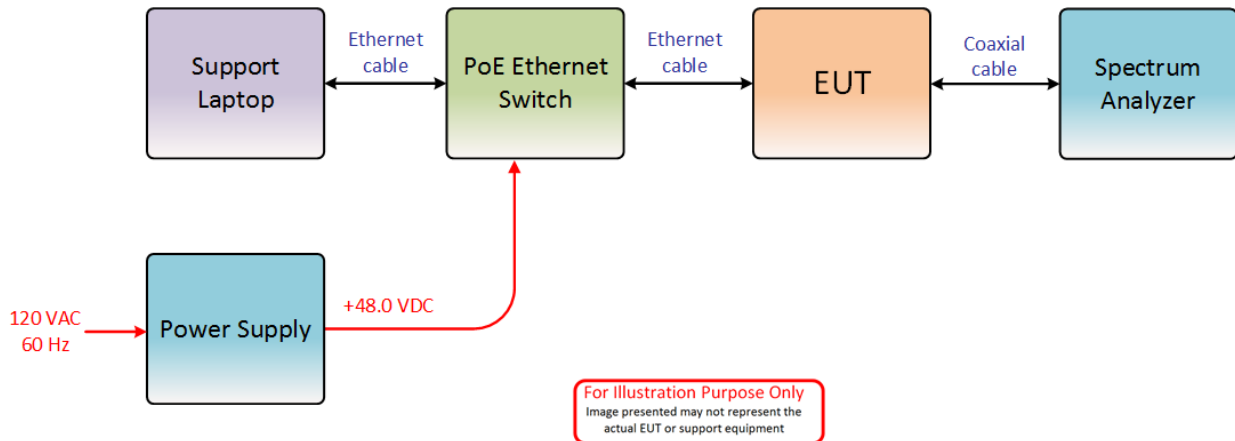
1.4.4 Worst Case Configuration

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

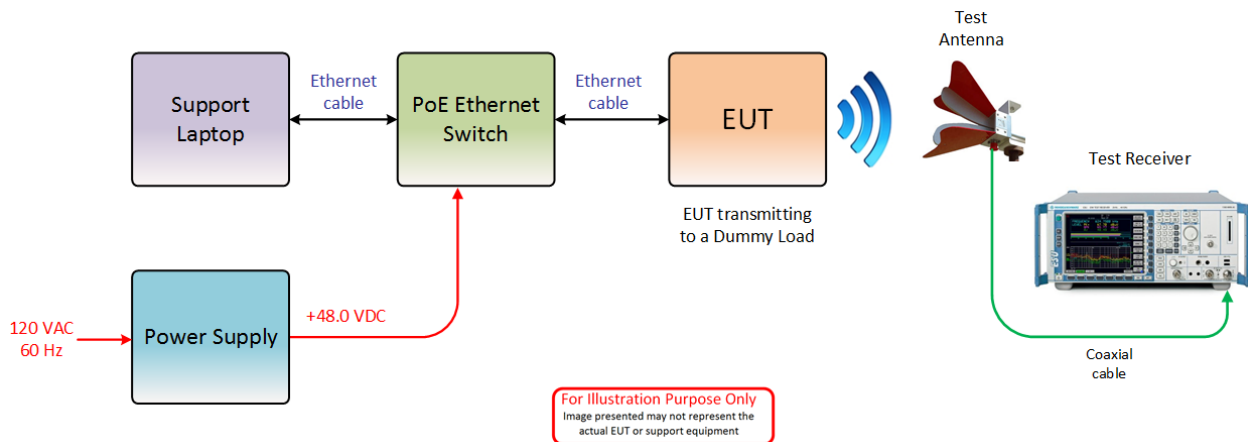
Mode	Channel	Data Rate
Bluetooth LE	39 (High Channel)	1Mbps

1.4.5 Simplified Test Configuration Diagram

Antenna Conducted Port Measurements



Radiated Emissions Test Configuration





1.5 DEVIATIONS FROM THE STANDARD

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

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: N/A		
N/A	-	-

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

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.4-2014. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

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

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

16936 Via Del Campo, 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 Innovation, Science and Economic Development Canada 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 for radio equipment testing with Registration No. 3067A.



SECTION 2

TEST DETAILS

Radio Testing of the
Piper Networks, Inc.
Piper Sensor SG1001



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.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2.1.3 Equipment Under Test and Modification State

Serial No: 90004024 / Test Configuration A

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

January 19, 2017/NS

2.1.5 Test Equipment Used

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

2.1.6 Environmental Conditions


Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.1.7 Additional Observations

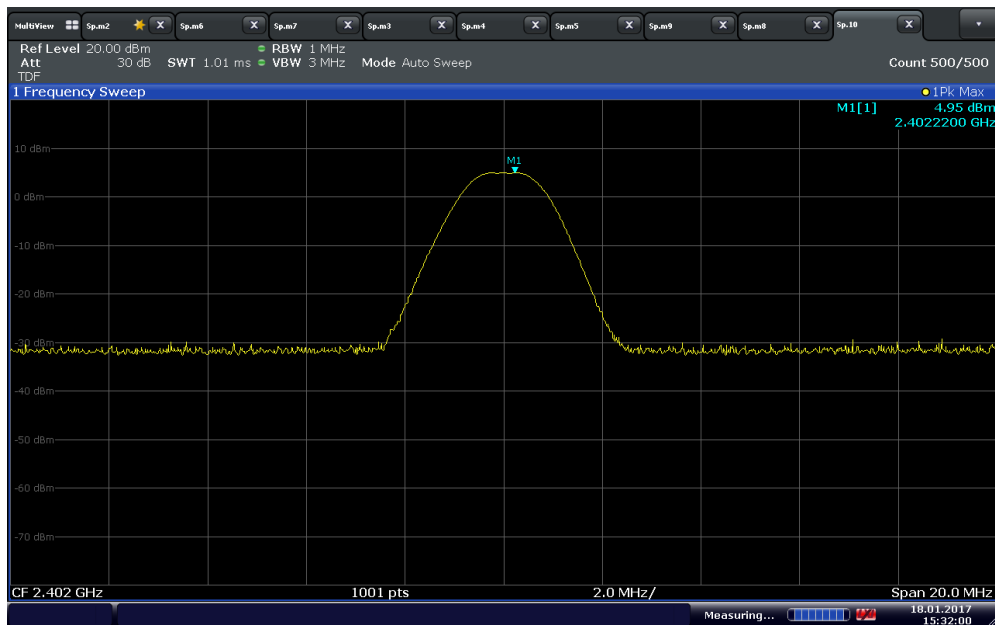
- This is a conducted test (Maximum peak conducted output power) using direct connection to a spectrum analyzer.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- Test methodology is per Clause 9.1.1 of KDB 558074 D01 DTS Meas Guidance v03r05,(April 08, 2016) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

2.1.8 Test Results

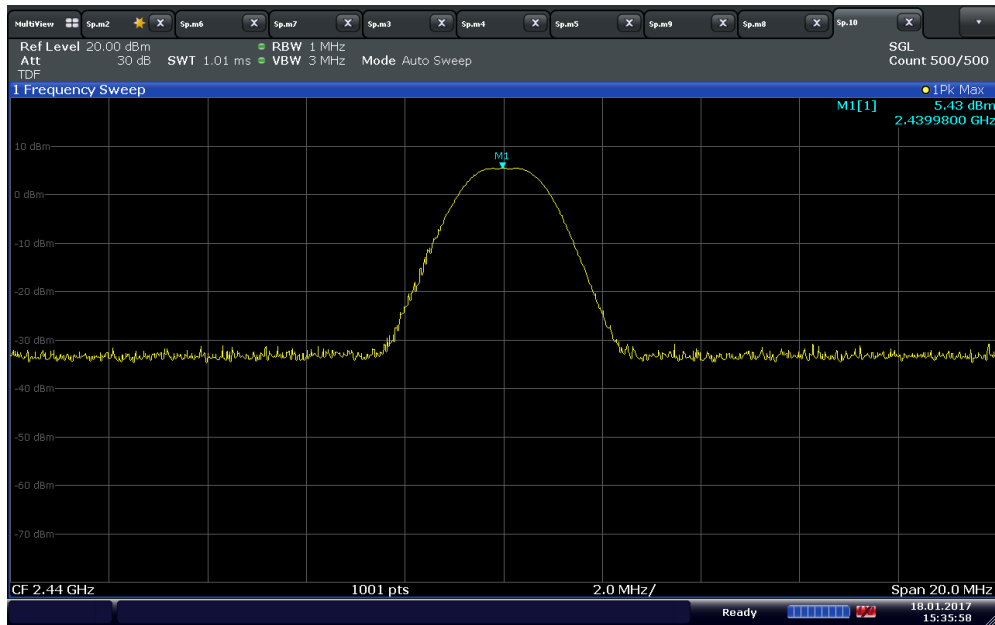
Bluetooth Low Energy (LE)	Channel	Modulation	Measured Peak Power (dBm)
	37 (2402 MHz)	GFSK	4.95
	17 (2440 MHz)		5.43
	39 (2480 MHz)		6.56
Limit (0.2512W/24.0 dBm)*		Complies	

* Output power limit was reduced by 6 dB (from 1 W to 0.2512 W) since the antenna gain is 12dBi.

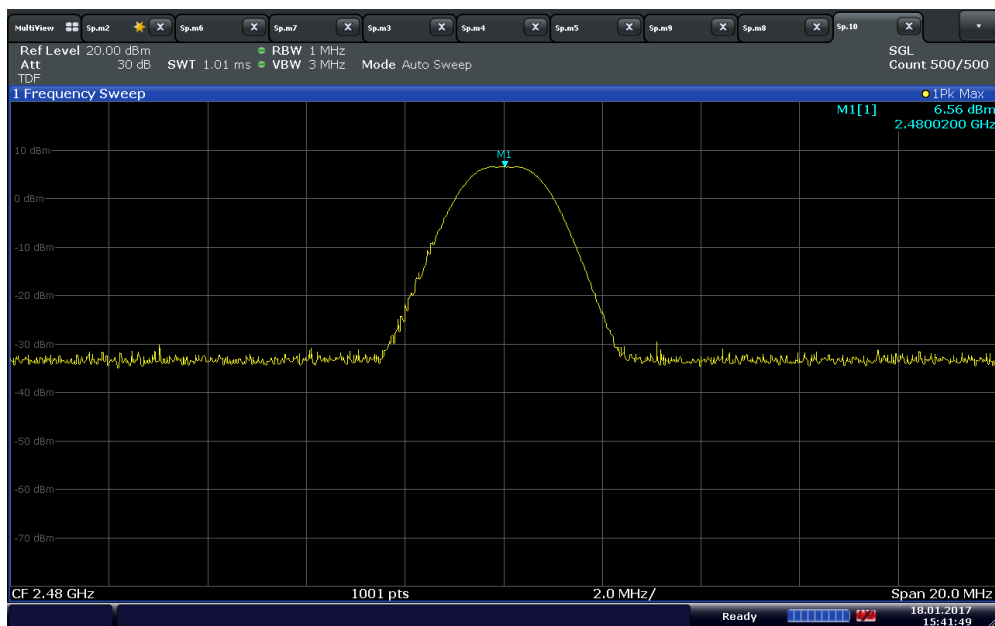
2.1.9 Test Plots



Low Channel BT LE



Mid Channel BT LE



High Channel BT LE



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 μ H/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	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 PoE powered device having no direct connection to the AC mains.



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

Not performed. Conducted antenna port test results from Report Number: TRA-029073-45-01B FCC 47CFR 15.247 & IC RSS-247 Test Report for Raspberry Pi (Trading) Ltd. Raspberry Pi 3 issued on 02-18-2016 by Element Materials Technology Warwick Ltd.



2.4 OUT-OF-BAND EMISSIONS - CONDUCTED

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: 90004024 / Test Configuration A

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

January 18, 2017/NS

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions/ Test Location

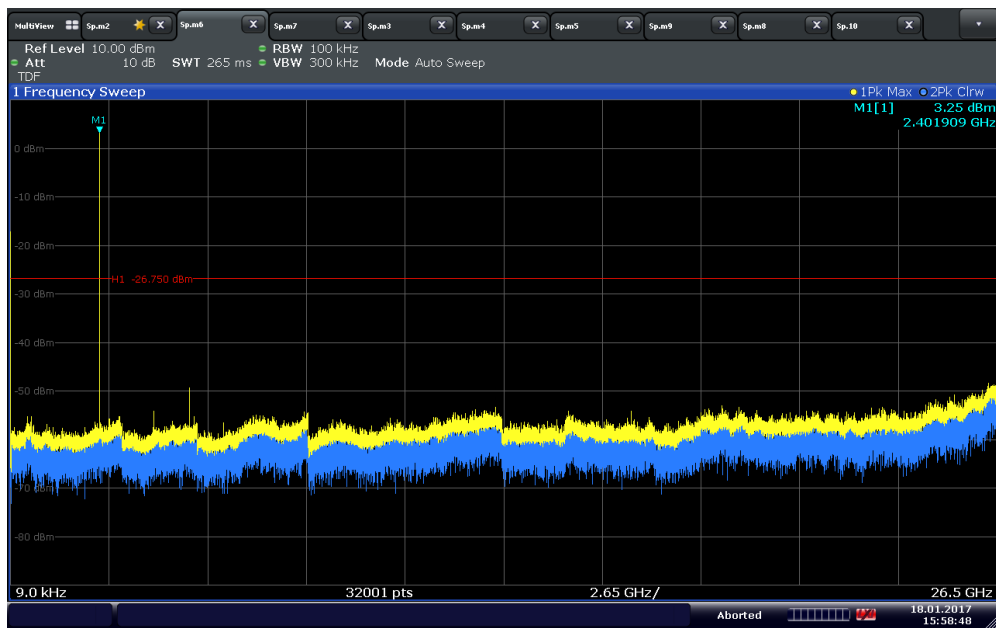
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

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

2.4.7 Additional Observations

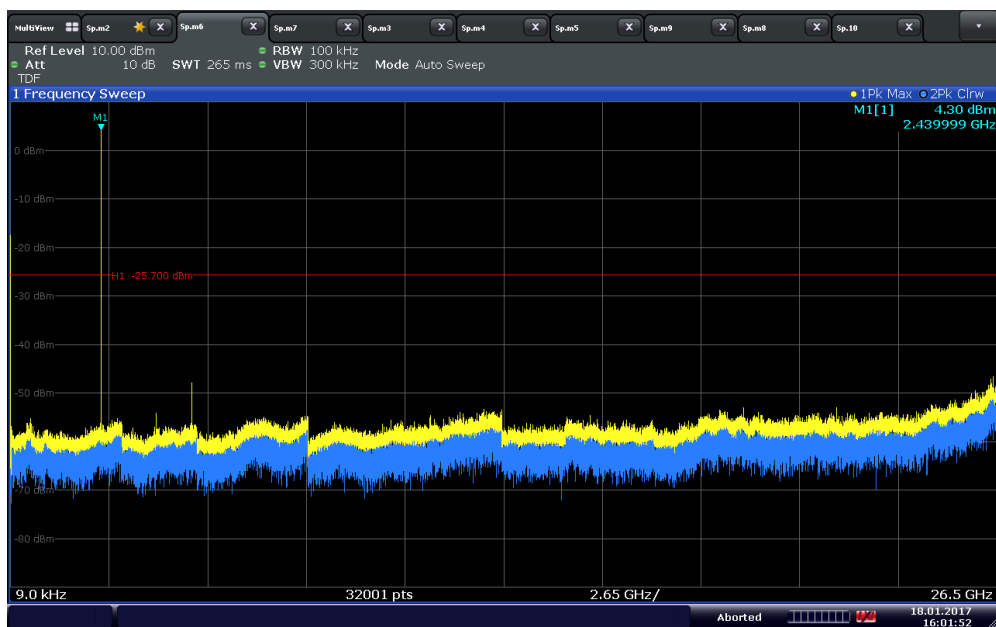
- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- RBW is 100kHz.VBW is 3X RBW.
- Sweep is auto. Detector is peak. Trace is max hold.
- Initial scan was performed to determine the highest level of the desired power within the band.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

2.4.8 Test Results Plots



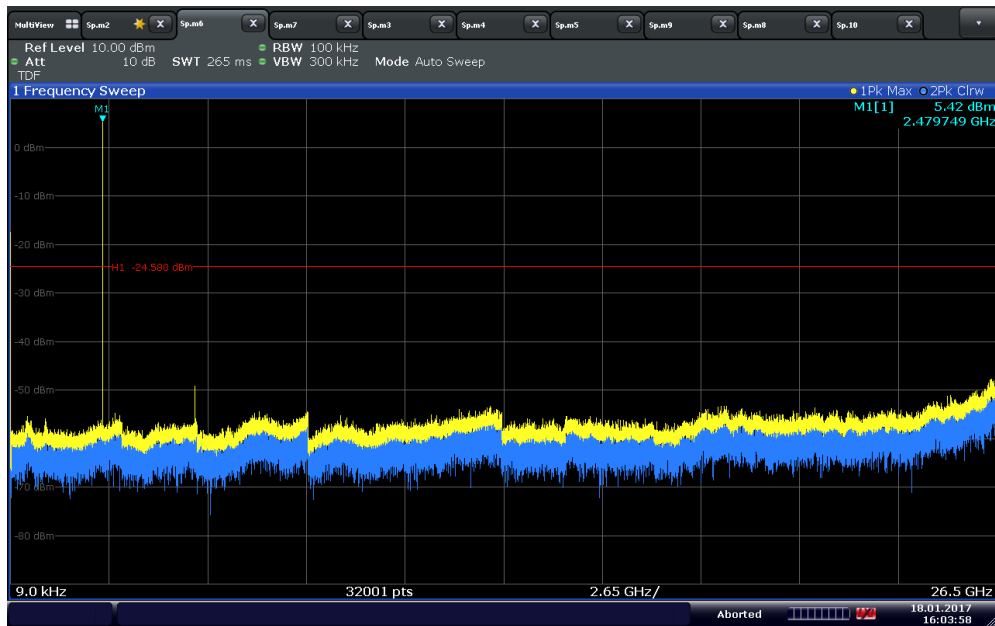
15:58:48 18.01.2017

Bluetooth LE Low Channel



16:01:52 18.01.2017

Bluetooth LE Mid Channel



16:03:59 18.01.2017

Bluetooth LE High Channel



2.5 BAND-EDGE AND RESTRICTED BANDS COMPLIANCE OF RF CONDUCTED EMISSIONS

2.5.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.5.2 Standard Applicable

See previous test.

2.5.3 Equipment Under Test and Modification State

Serial No: 90004024 / Test Configuration A

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

January 19, 2017/NS

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

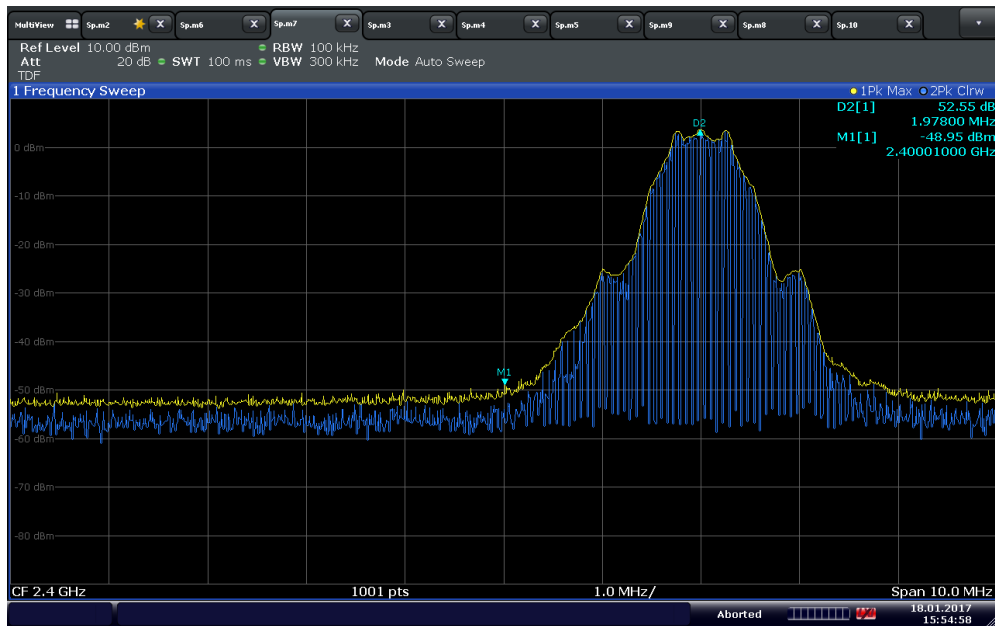
Ambient Temperature	24.6 °C
Relative Humidity	43.8.%
ATM Pressure	99.3 kPa

2.5.7 Additional Observations

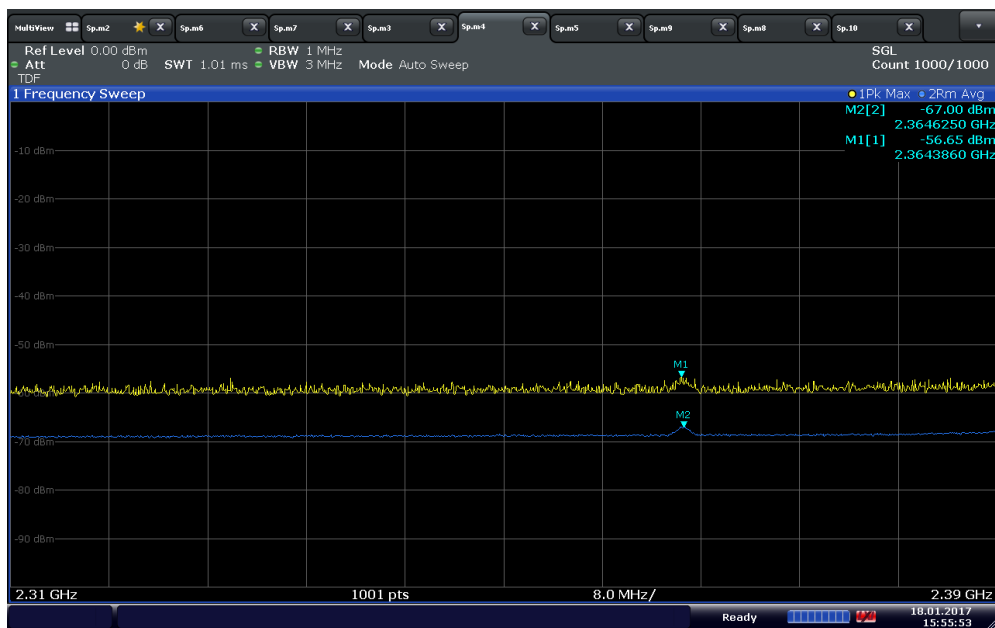
- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- Procedure is per Clause 12.2.4, 12.2.5.1, 12.2.5.2 and 13.3.2 of KDB558074.

2.5.8 Test Results

Complies. See attached plots.



Bluetooth LE Low Channel (2402 MHz)



Lower Restricted Band Verification

Measured Peak = -56.65 dBm, since antenna gain is 12 dBi then EIRP is -44.65 dBm. Electric field strength in dBμV/m is then calculated using the formula:

$$E = \text{EIRP} - 20\log D + 104.8$$

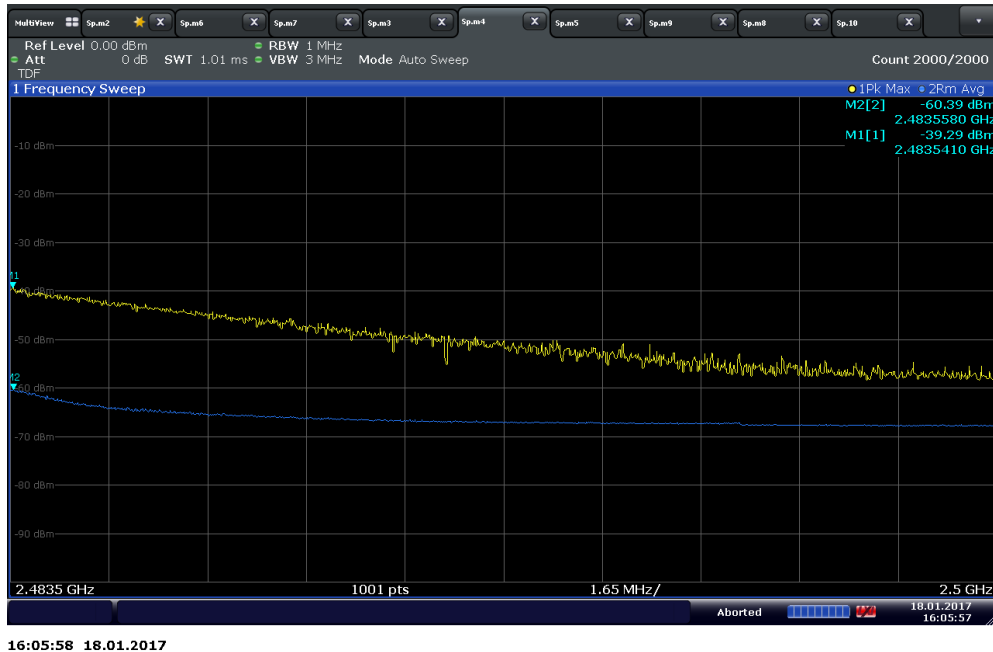
Where: E = electric field strength in dBμV/m
EIRP = equivalent isotropic radiated power in dBm

D = specific measurement distance in meters

E is therefore = $-44.65 \text{ dBm} - (20 \log 3 \text{ meters}) + 104.8$
= $50.61 \text{ dB}\mu\text{V/m}$ @ 3 meters

Since the peak field strength ($50.61 \text{ dB}\mu\text{V/m}$) complies with the average limit ($54 \text{ dB}\mu\text{V/m}$), then it's not necessary to perform a separate average measurement. **EUT complies 2.31-2.39 GHz restricted band.**

2.5.9 Emissions Verification in the Restricted Bands (Conducted Method)



Upper Band Edge (in Restricted Band)

Measured Peak = -39.29 dBm , since antenna gain is 12 dBi then EIRP is -27.29 dBm . Electric field strength in $\text{dB}\mu\text{V/m}$ is then calculated using the formula:

$$E = \text{EIRP} - 20 \log D + 104.8$$

Where: E = electric field strength in $\text{dB}\mu\text{V/m}$
EIRP = equivalent isotropic radiated power in dBm
D = specific measurement distance in meters

E is therefore = $-27.29 \text{ dBm} - (20 \log 3 \text{ meters}) + 104.8$
= $67.97 \text{ dB}\mu\text{V/m}$ @ 3 meters (**complies with 74 dBμV/m Peak limits**)

Upper Band Edge (in Restricted Band) measurement using Trace averaging with continuous EUT transmission at full power as per Clause 12.2.5.1 of KDB558074

E is therefore = $(-60.39 + 12.0 \text{ dBi}) \text{ dBm} - (20 \log 3 \text{ meters}) + 104.8$
= $46.87 \text{ dB}\mu\text{V/m}$ @ 3 meters (**complies with 54 dBμV/m Average limits**)



2.6 SPURIOUS RADIATED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 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)).

2.6.3 Equipment Under Test and Modification State

Serial No: 90004024 / Test Configuration B

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

January 18, 2017/NS

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	22.8 °C
Relative Humidity	37.7 %
ATM Pressure	99.0 kPa

2.6.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic.
- Test Methodology is per Clause 12.2.7 of KDB558074 D01 DTS Meas Guidance v03r04.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the worst case channel presented. EUT has an integrated antenna and can't be terminated for this test (cabinet spurious emissions).



- Only noise floor measurements observed above 18GHz.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.6.8 for sample computation.

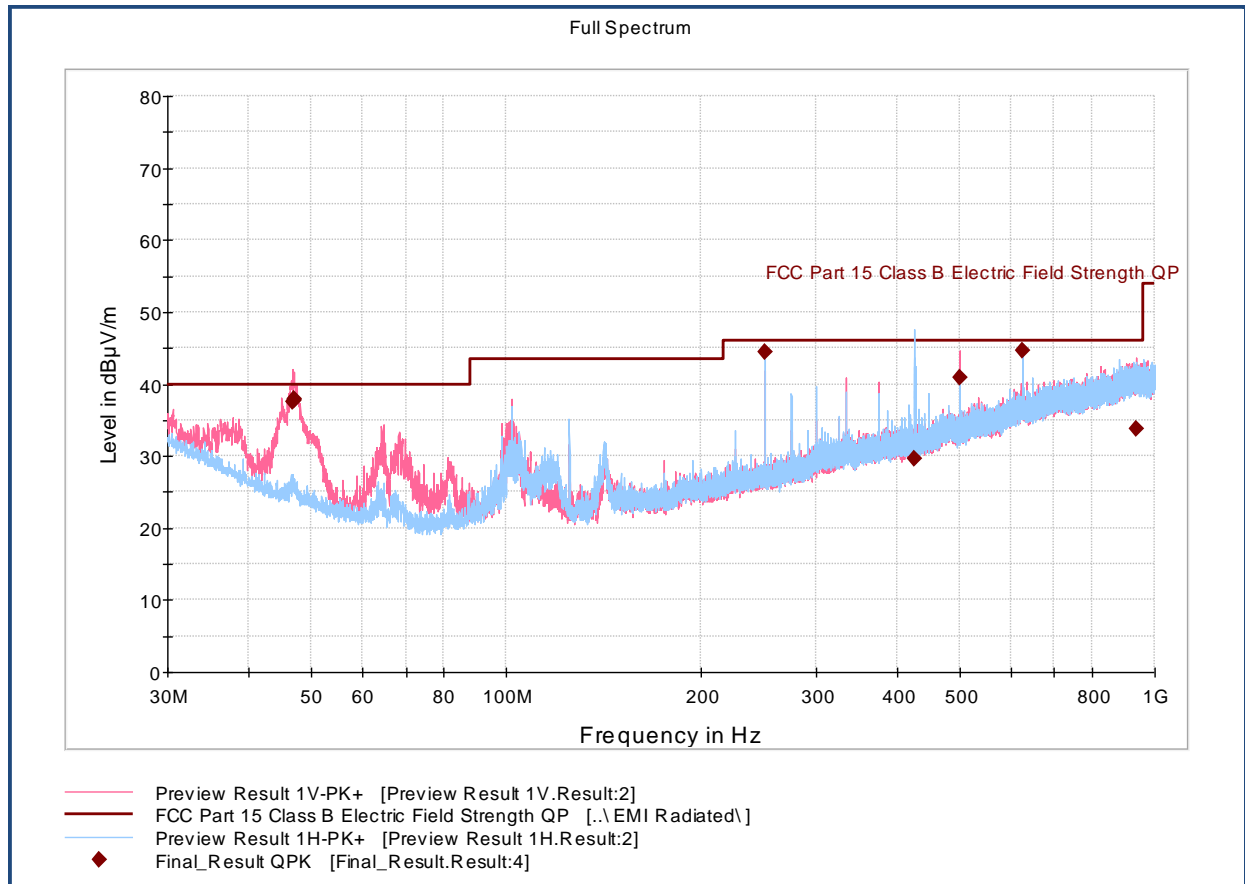
2.6.8 Sample Computation (Radiated Emission)

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 QuasiPeak Final Measurement (db μ V/m) @ 30MHz			11.8

2.6.9 Test Results

See attached plots.

2.6.10 Test Results Below 1GHz (Worst Case Channel – High Channel)

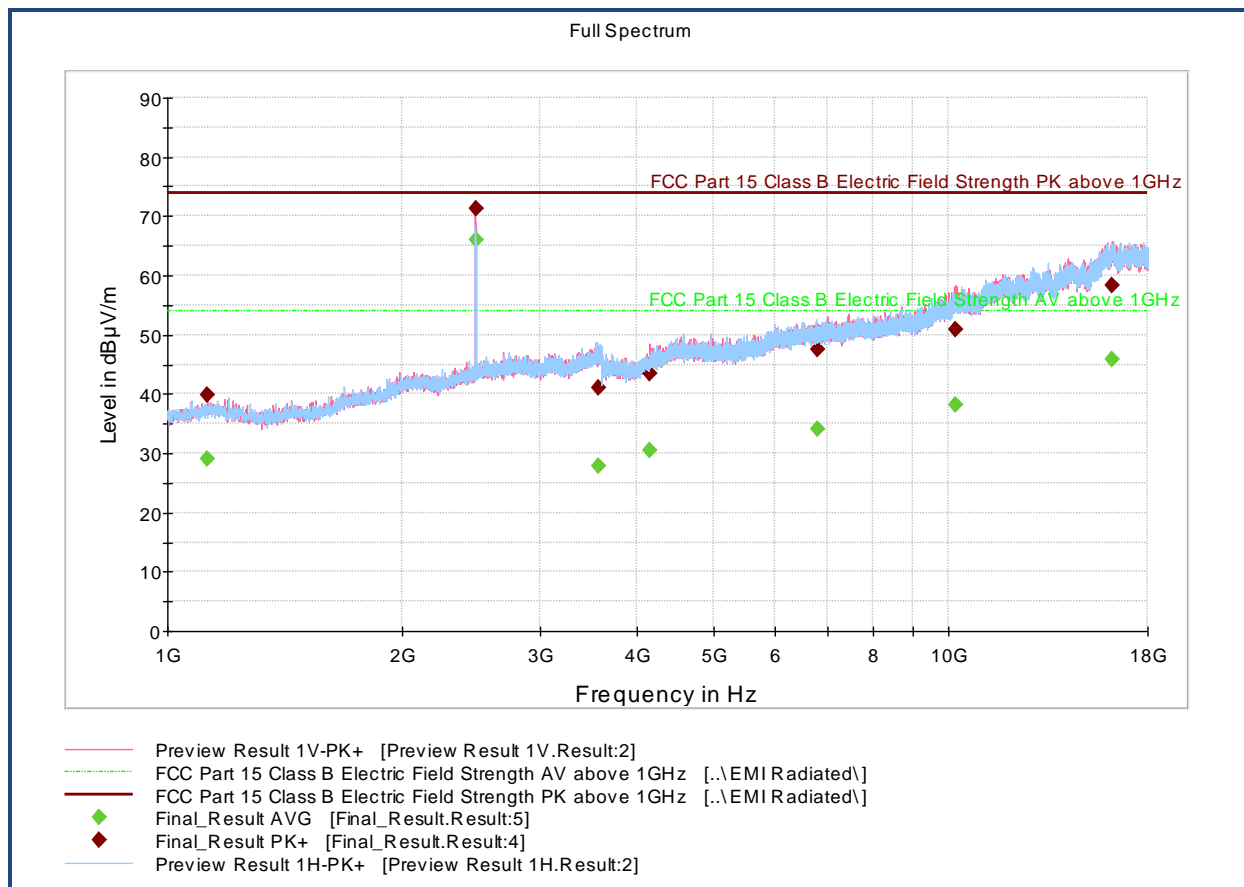


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
46.896333	37.56	40.00	2.44	1000.0	120.000	99.8	V	73.0	17.1
46.995000	37.91	40.00	2.09	1000.0	120.000	103.3	V	-5.0	17.1
47.058000	37.63	40.00	2.37	1000.0	120.000	105.8	V	156.0	17.0
250.016000	44.41	46.00	1.59	1000.0	120.000	127.3	H	110.0	20.3
426.468333	29.64	46.00	16.36	1000.0	120.000	233.8	H	136.0	25.0
500.049667	40.89	46.00	5.11	1000.0	120.000	125.1	V	121.0	27.1
625.018000	44.71	46.00	1.29	1000.0	120.000	122.6	H	215.0	29.9
937.430333	33.83	46.00	12.17	1000.0	120.000	308.1	V	212.0	33.8

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

2.6.11 Test Results Above 1GHz (Worst Case Channel – High Channel)



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1125.009091	39.87	73.90	34.03	1000.0	1000.000	99.7	V	260.0	-1.0
2479.972727	71.20	Fundamental		1000.0	1000.000	350.2	V	248.0	4.8
3559.954545	41.01	73.90	32.89	1000.0	1000.000	250.0	H	326.0	7.0
4140.027273	43.34	73.90	30.56	1000.0	1000.000	120.5	V	72.0	9.1
6798.436364	47.46	73.90	26.44	1000.0	1000.000	151.5	H	9.0	15.2
10223.472727	50.84	73.90	23.06	1000.0	1000.000	367.7	V	215.0	19.6
16193.327273	58.38	73.90	15.52	1000.0	1000.000	366.3	V	276.0	27.1

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1125.009091	29.12	53.90	24.78	1000.0	1000.000	99.7	V	260.0	-1.0
2479.972727	65.98	Fundamental		1000.0	1000.000	350.2	V	248.0	4.8
3559.954545	27.96	53.90	25.94	1000.0	1000.000	250.0	H	326.0	7.0
4140.027273	30.40	53.90	23.50	1000.0	1000.000	120.5	V	72.0	9.1
6798.436364	34.16	53.90	19.74	1000.0	1000.000	151.5	H	9.0	15.2
10223.472727	38.16	53.90	15.74	1000.0	1000.000	367.7	V	215.0	19.6
16193.327273	45.75	53.90	8.15	1000.0	1000.000	366.3	V	276.0	27.1

Test Notes: No significant emissions observed above 18GHz.

Measurements above 10GHz were noise floor figures that was verified using lower RBW settings. Noise floor was more than 6 dB below the applicable limits.



2.7 POWER SPECTRAL DENSITY

2.7.1 Specification Reference

Part 15 Subpart C §15.247(e)

2.7.2 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.

2.7.3 Equipment Under Test and Modification State

Serial No: 90004024 / Test Configuration A

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

January 19, 2017/NS

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	24.6 °C
Relative Humidity	43.8.%
ATM Pressure	99.3 kPa

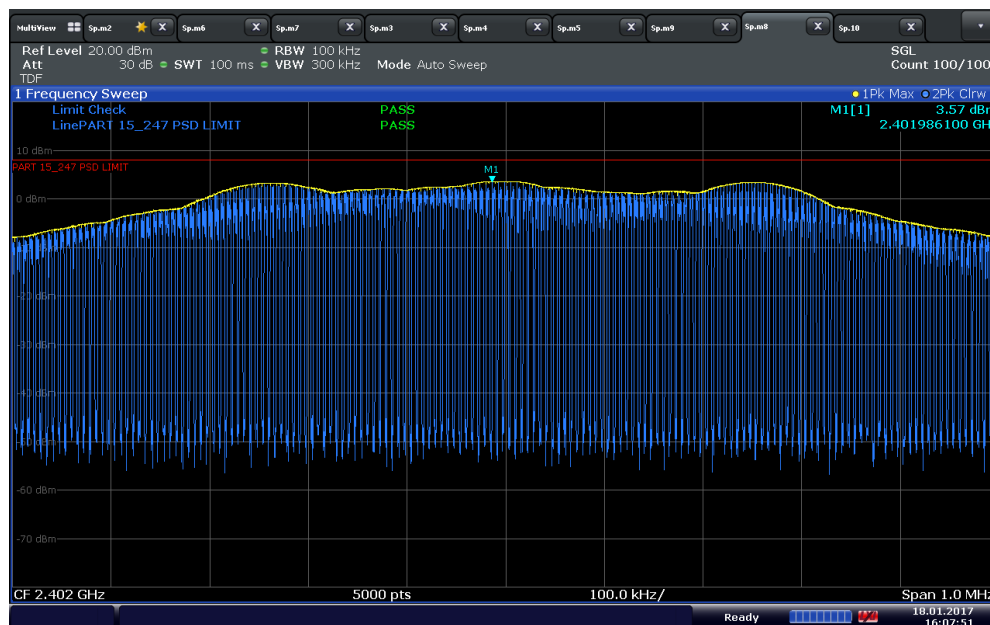
2.7.7 Additional Observations

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

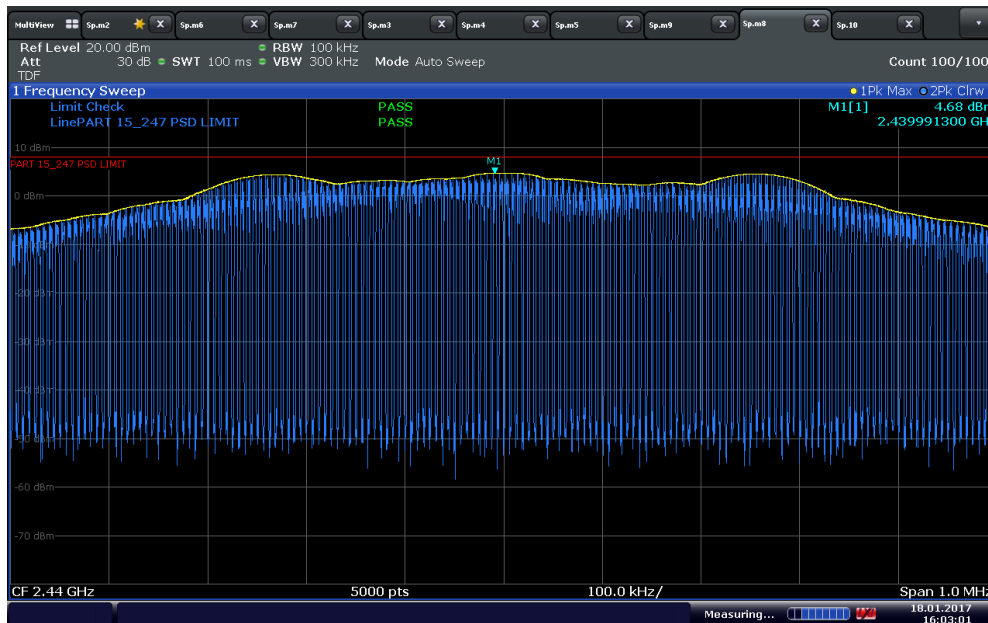
2.7.8 Test Results Summary

Mode	Channel	Marker Reading using 100 kHz RBW (dBm)	PSD Limit (dBm)	Margin (dB)	Compliance
Bluetooth LE	37 (2402 MHz)	3.57	8	4.43	Complies
	17 (2440 MHz)	4.68	8	3.32	Complies
	39 (2480 MHz)	5.64	8	2.36	Complies

2.7.9 Test Results Plots

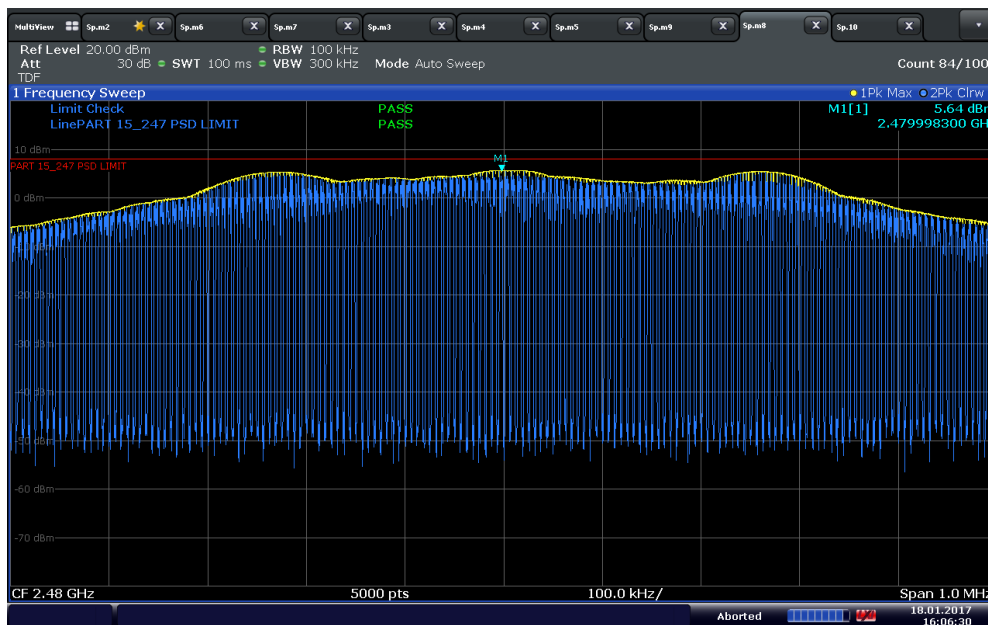


Bluetooth LE LowChannel



16:03:01 18.01.2017

Bluetooth LE Mid Channel



16:06:31 18.01.2017

Bluetooth LE High Channel



SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Antenna Conducted Port Setup						
7611	Signal/Spectrum Analyzer	FSW26	102017	Rhode & Schwarz	02/01/16	02/01/17
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	05/16/16	05/16/17
8832	20dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 1003 and 7611	
Radiated Test Setup						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/06/15	11/06/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
8891	Pre-amplifier (1-18 GHz)	PE15A3262	1012	Pasternack	04/29/16	04/29/17
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	07/05/16	07/05/17
8878	High-frequency cable	R90-088-240	N/A	Teledyne/Storm Microwave	03/16/16	03/16/17
8879	High-frequency cable	084-0505-100	N/A	Teledyne/Storm Microwave	03/16/16	03/16/17
Miscellaneous						
11312	Mini Environmental Quality Meter	850027	CF099-56010-340	Sper Scientific	08/22/16	08/22/17
	Test Software	EMC32	V9.26.0	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Radiated Measurements (Below 1GHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					1.78
Coverage Factor (k):					2
Expanded Uncertainty:					3.57

3.2.2 Radiated Emission Measurements (Above 1GHz)

Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	2.70	1.56	2.43
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					1.78
Coverage Factor (k):					2
Expanded Uncertainty:					3.56

3.2.3 Conducted Antenna Port Measurement

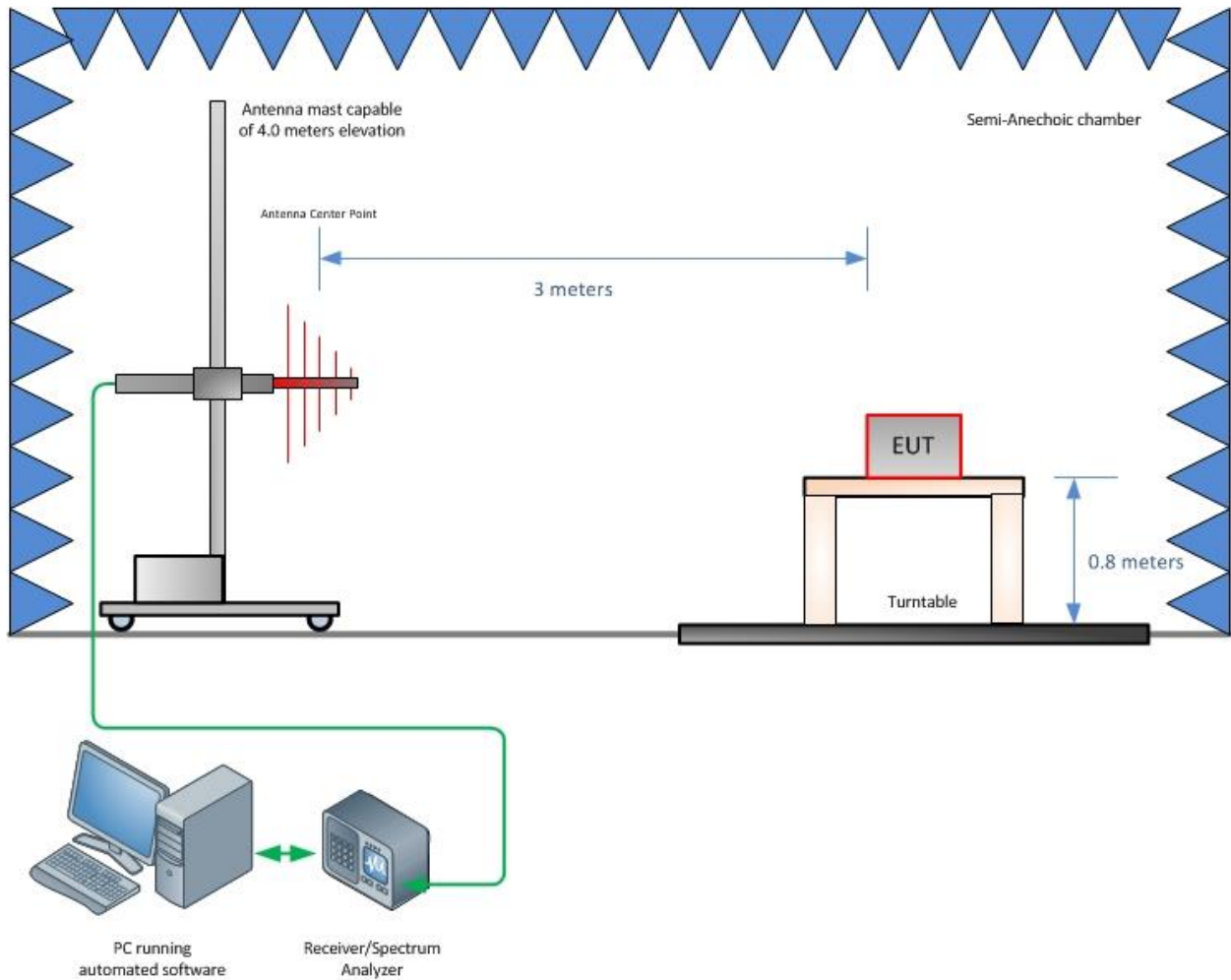
Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.50	0.29	0.08
3	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					0.72
Coverage Factor (k):					2
Expanded Uncertainty:					1.45



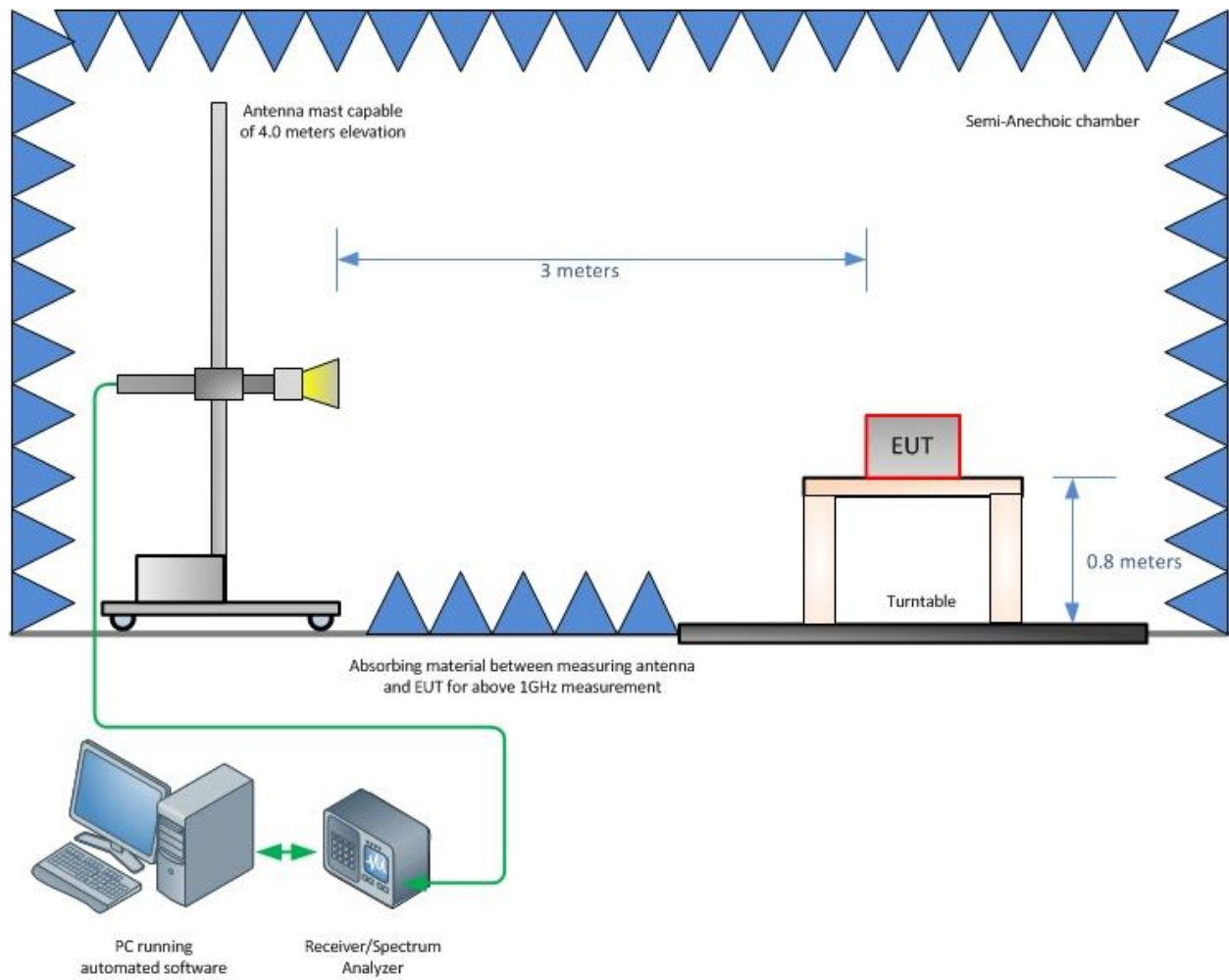
SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



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.



A2LA Cert. No. 2955.13

