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Report On

Application for Grant of Equipment Authorization of the
Piper Networks, Inc.
SG1001 Piper Sensor

FCC Part 15 Subpart C §15.247 (DTS)

Report No. SD72120112-0916B **February 2017**

REPORT ON	Radio Testing of the Piper Networks, Inc. SG1001 Piper Sensor
TEST REPORT NUMBER	SD72120112-0916B
PREPARED FOR	Piper Networks, Inc. 3655 Nobel Drive, Suite 120 San Diego, CA 92122
CONTACT PERSON	Robert Hanczor Senior Regulatory Engineer 619-248-2002 robert@pipernetworks.com
PREPARED BY	Nikolay Shtin **Name** Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	Ferdinand S. Custodio Name Authorized Signatory Title: EMC/Senior Wireless Test Engineer
DATED	February 22, 2017

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

Revision History

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

CONTENTS

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

SECTION 1

REPORT SUMMARY

Radio Testing of the

Piper Networks, Inc.
SG1001 Piper Sensor

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.
Product Marketing Name	Piper Sensor
Model Number(s)	SG1001
FCC ID Number	2AIK7-SG1001
Serial Number(s)	90004024
Number of Samples Tested	1
Test Specification/Issue/Date	• 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)	Test Report: TRA-029073-45-00B 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. 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	

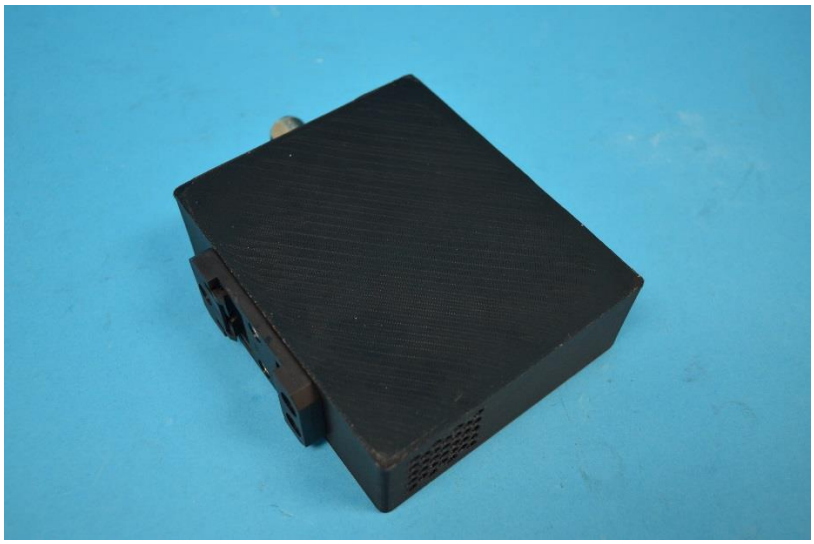
N/A[1] Not performed. EUT is a PoE powered device having no direct connection to the AC mains.

N/A[2] Not performed. Minimum 6 dB RF Bandwidth test results are from Test Report: TRA-029073-45-00B 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
Product Marketing Name	Piper Sensor
Model Number(s)	SG1001
Rated Voltage	48VDC from PoE Ethernet Switch
Mode Verified	802.11b, 802.11g and 802.11n in 2.4GHz band
Capability	WLAN 802.11 b/g/n and Bluetooth Low Energy (BT LE)
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
Antenna Type	Omnidirectional Monopole Antenna
Antenna Manufacturer	N/A
Antenna Model Number	N/A
Antenna Gain	0 dBi

1.3.3 Maximum Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (W)
802.11g*	2412-2462	24.38	0.274

*Worst case mode based on the data from Test Report: TRA-029073-45-00B 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.

EUT TEST CONFIGURATION

1.3.4 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.

1.3.5 EUT Exercise Software

EUT was loaded with FW version 1.0.149. Before each test, the operating channel was configured using wlan_radio.sh script. TX power setting used was adjusted to 16dBm.

1.3.6 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

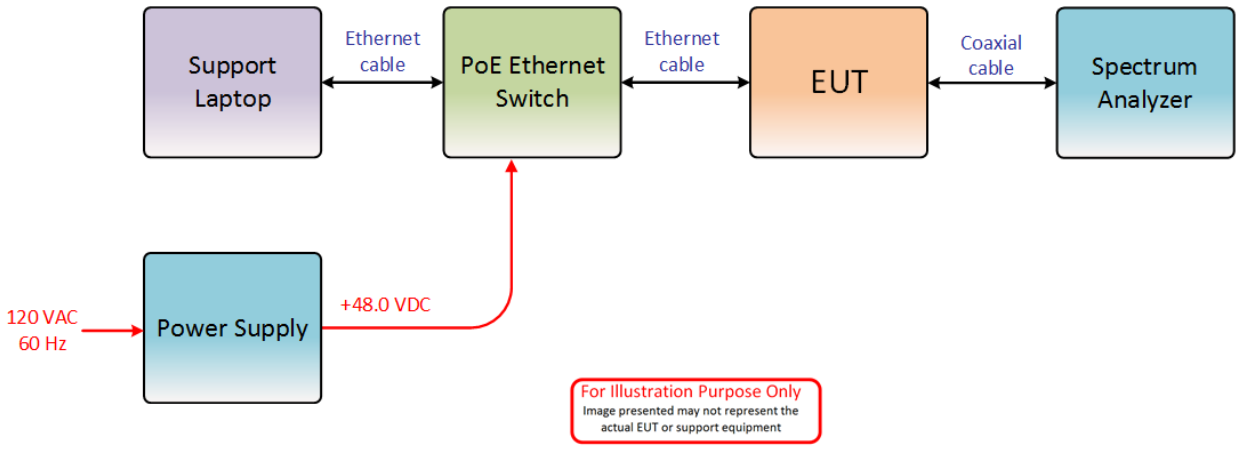
1.3.7 Worst Case Configuration

Worst-case configuration used in this test report as per maximum conducted output power measurements from Report Number: TRA-029073-45-00B 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.

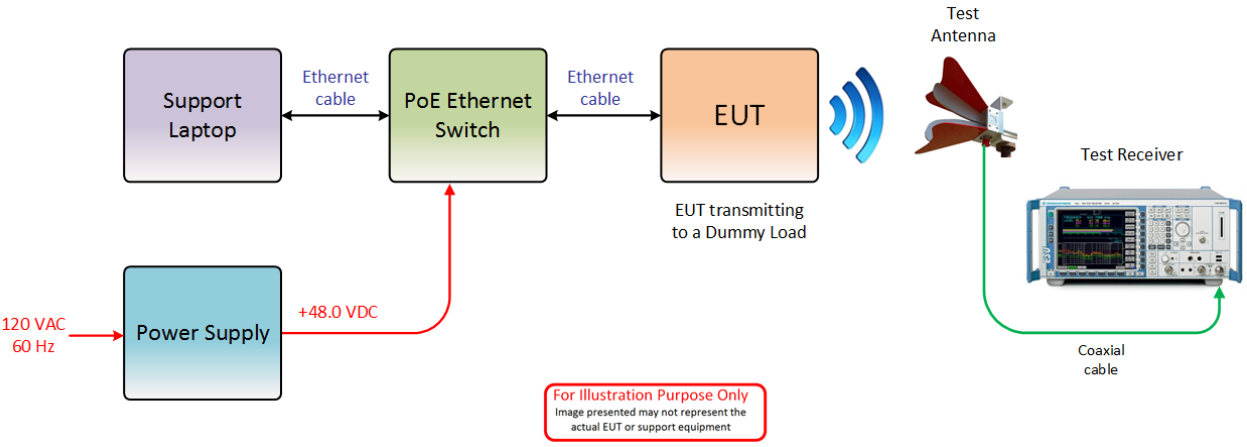
Mode	Channel	Data Rate
802.11g	11 (High Channel)	6Mbps

1.3.8 Simplified Test Configuration Diagram

Antenna Conducted Port Measurements



Radiated Emissions Test Configuration



1.4 DEVIATIONS FROM THE STANDARD

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

1.5 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.

1.6 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.

1.7 TEST FACILITY LOCATION

1.7.1 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

1.7.2 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.

1.8 TEST FACILITY REGISTRATION

1.8.1 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.

1.8.2 Innovation, Science and Economic Development Canada Registration No.: 3067A

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

SECTION 2

TEST DETAILS

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

2.1 MAXIMUM CONDUCTED 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: 90004024 / Test Configuration A

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

December 18, 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	25.4 °C
Relative Humidity	47.4 %
ATM Pressure	99.2 kPa

2.1.7 Additional Observations

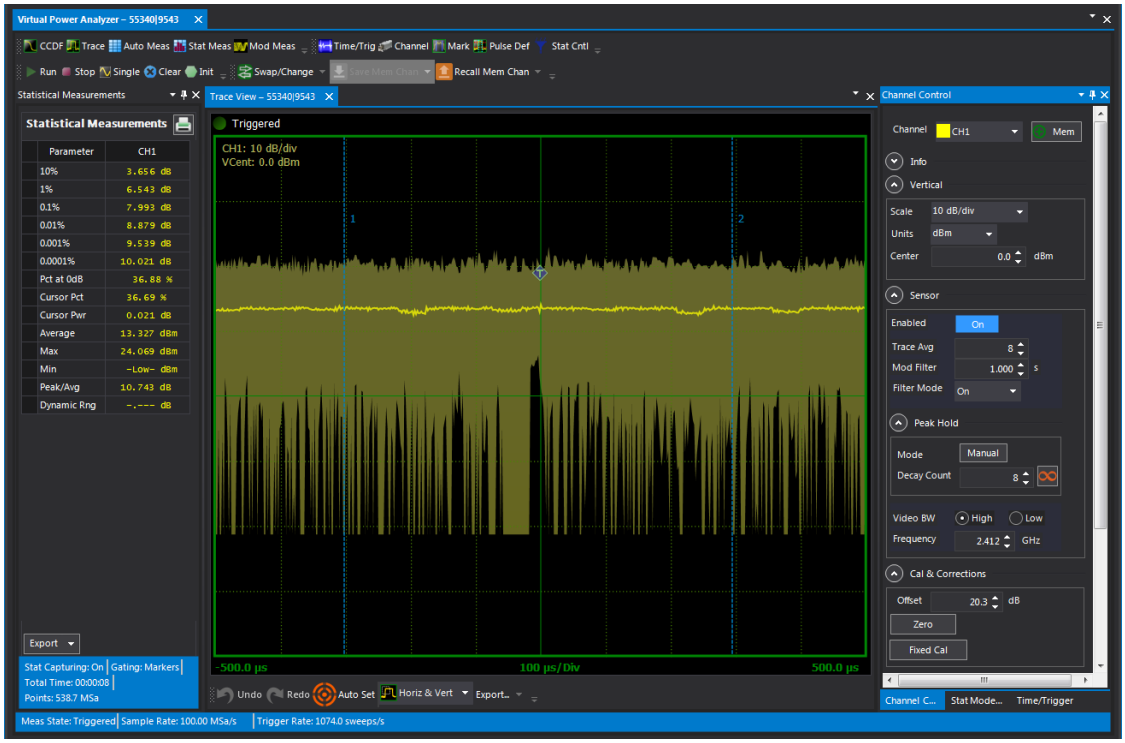
- This is a conducted test (Maximum conducted output power) using direct connection to a power meter.
- An offset of 20.3dB was added to compensate for the external attenuator and cable used from the antenna port to the power sensor.
- Test methodology is per Clause 9.1.2 of KDB 558074 D01 (DTS Meas Guidance v03r05, April 08, 2016). All conditions under this Clause are satisfied.
- EUT complies with the 30 dBm limit.

2.1.8 Test Results

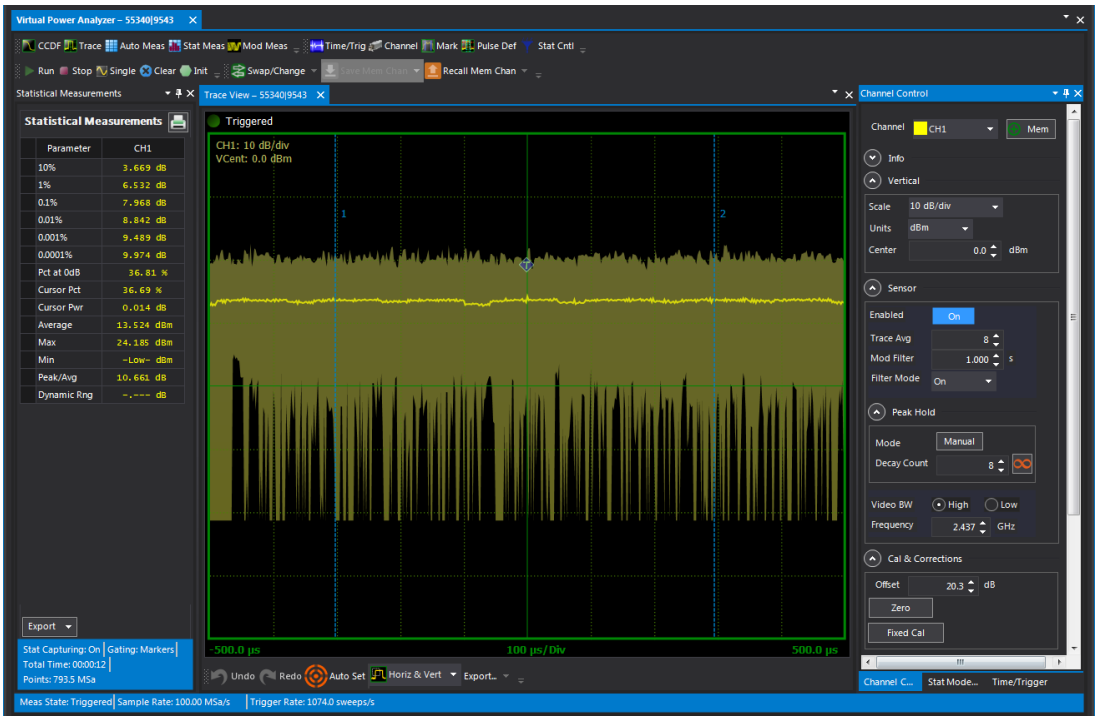
WLAN Mode	Channel	Data Rates (Mbps)	Maximum Peak Conducted Output Power (dBm)
802.11g	1 (2412 MHz)	6	24.069
	6 (2437 MHz)		24.185
	11 (2462 MHz)		24.380
Limit (1W/30 dBm)	**EUT Complies**		

* Only worst case mode and data rate (802.11g, 6Mbps) are presented. Worst case configuration is based on the data from Test Report: TRA-029073-45-00B 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.

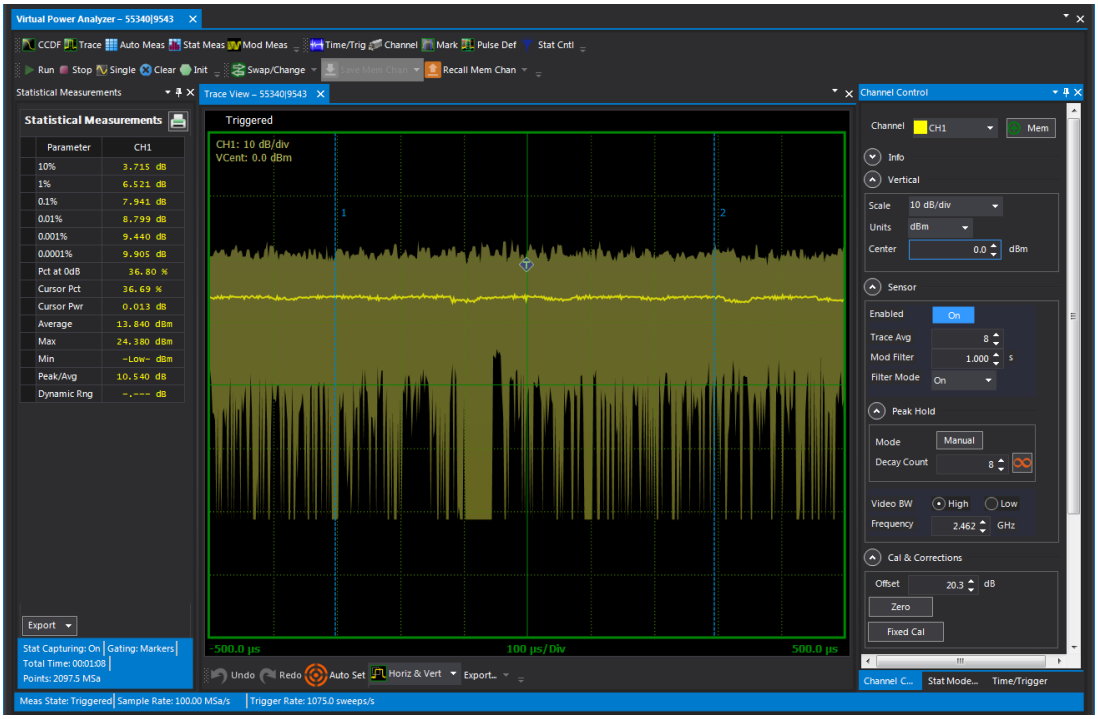
2.1.9 Sample Test Plots



Low Channel 802.11g 6Mbps



Mid Channel 802.11g 6Mbps



High Channel 802.11g 6Mbps

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 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-029073-45-00B 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

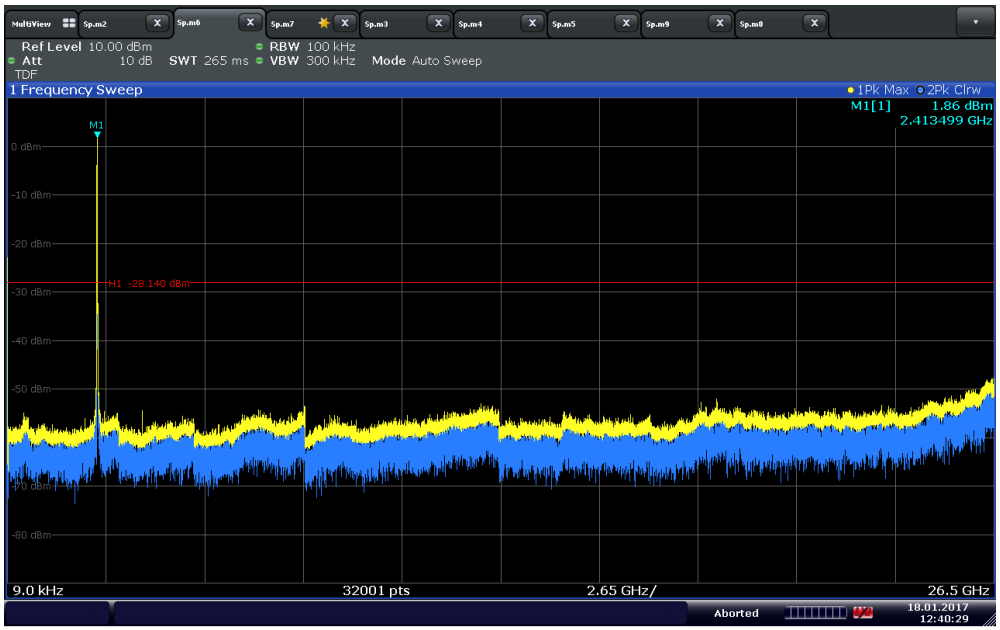
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.4 °C
Relative Humidity	47.4 %
ATM Pressure	99.2 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.
- Only worst case mode (802.11g 6Mbps) is presented.

2.4.8 Test Results Plots



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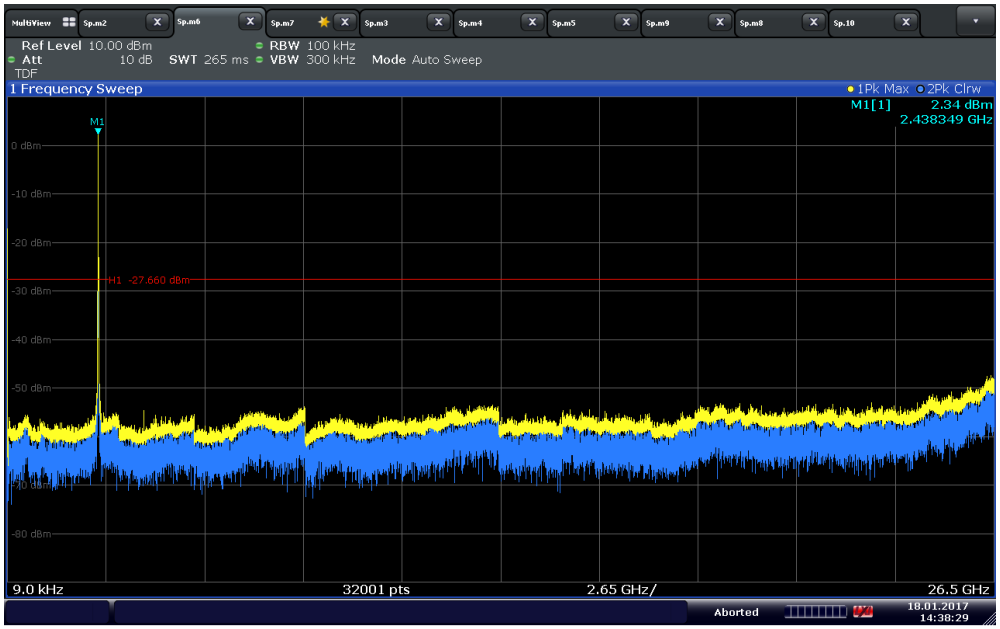
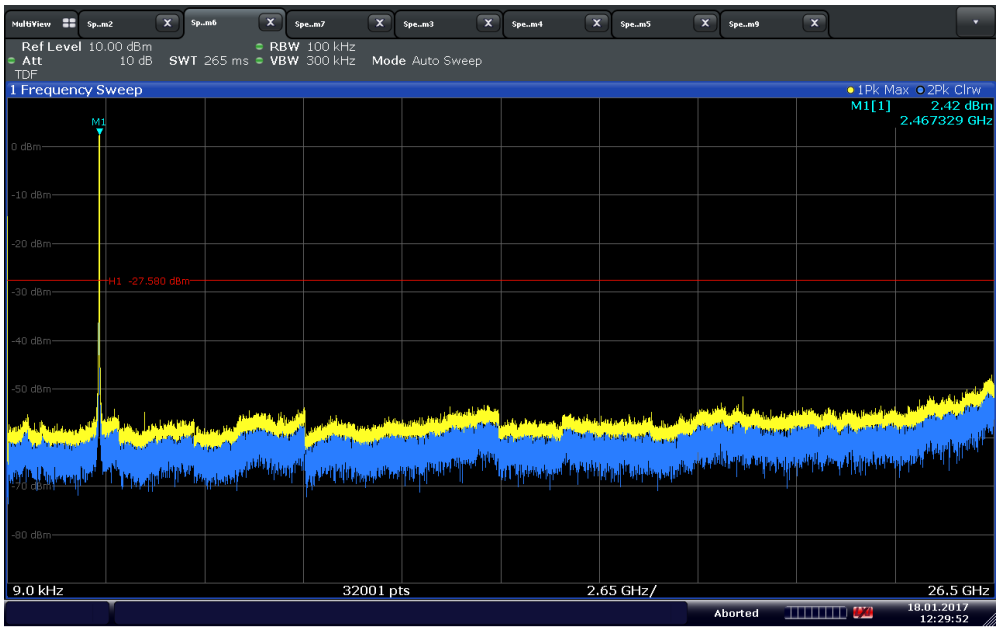
802.11g Low Channel



14:38:30 18.01.2017

802.11g Mid Channel



12:29:52 18.01.2017

802.11g High Channel

2.5 BAND-EDGE 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 18, 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

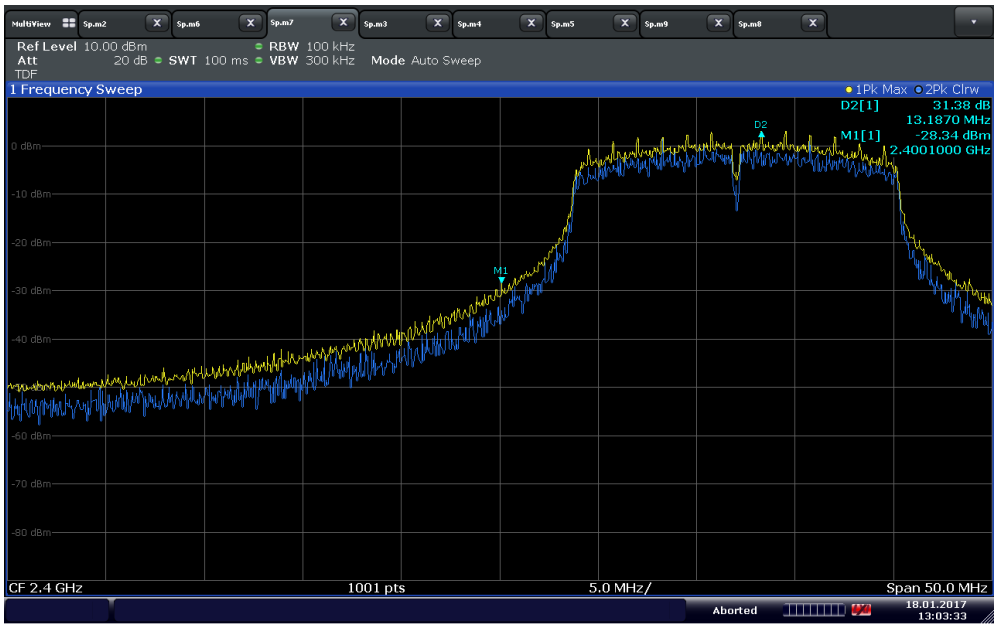
Ambient Temperature	25.4 °C
Relative Humidity	47.4 %
ATM Pressure	99.2 kPa

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 13.3.1 of KDB558074.
- Only worst case modes (802.11g 6Mbps and 802.11n MCS0) are presented.

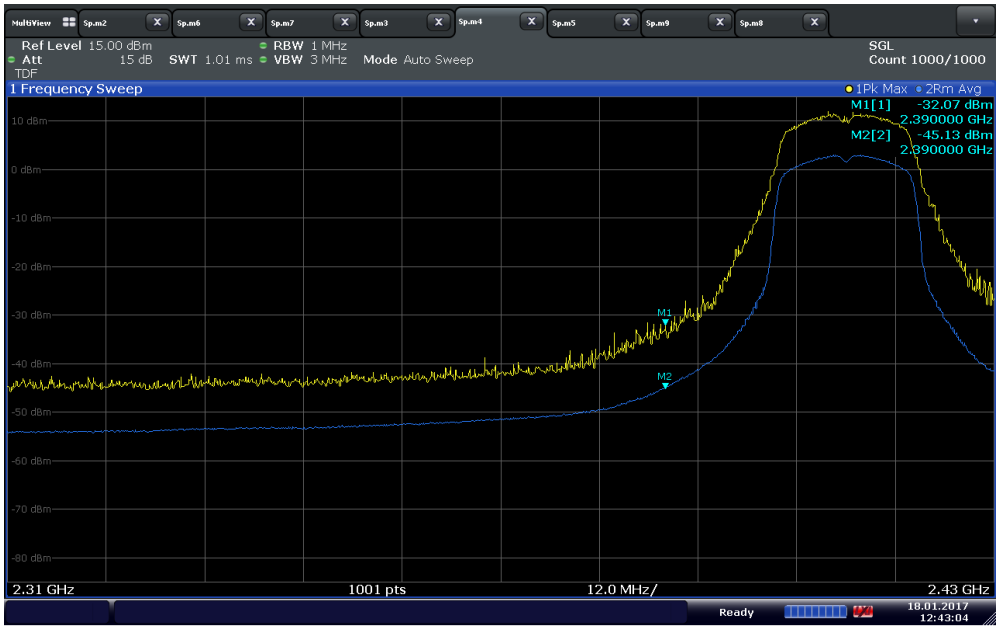
2.5.8 Test Results

Complies. See attached plots.



13:03:33 18.01.2017

802.11g Low Channel (2412 MHz)



12:43:04 18.01.2017

802.11g Low Channel (2412 MHz Peak)

Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074

Measured Peak = -32.07 dBm, since antenna gain is 0 dBi then EIRP is -32.07 dBm. Electric field strength in dBµV/m is then calculated using the formula:

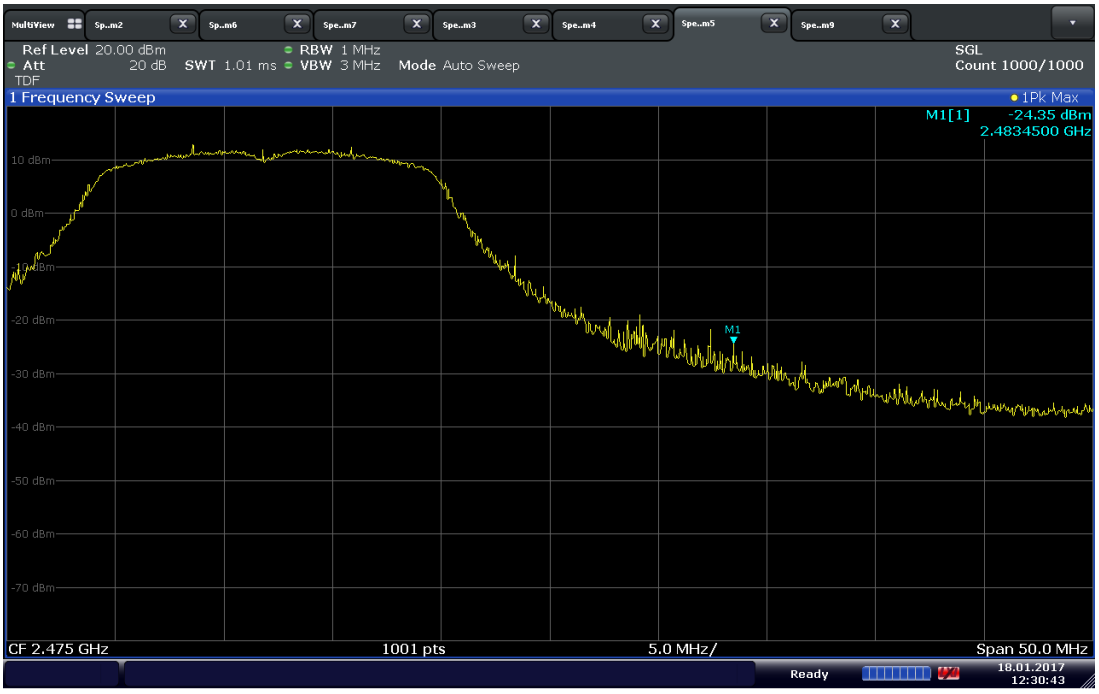
$$E = EIRP - 20\log D + 104.8$$

Where: E = electric field strength in dBµV/m
EIRP = equivalent isotropic radiated power in dBm
D = specific measurement distance in meters

E is therefore =(-32.07 + 0 dbi) dBm – (20log 3 meters) + 104.8
= 63.19 dBµV/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 =(-45.13 + 0 dbi) dBm – (20log 3 meters) + 104.8
= 50.13 dBµV/m @ 3 meters (complies with 54 dBµV/m Average limits)



12:30:43 18.01.2017

802.11g High Channel (2462 MHz Peak)

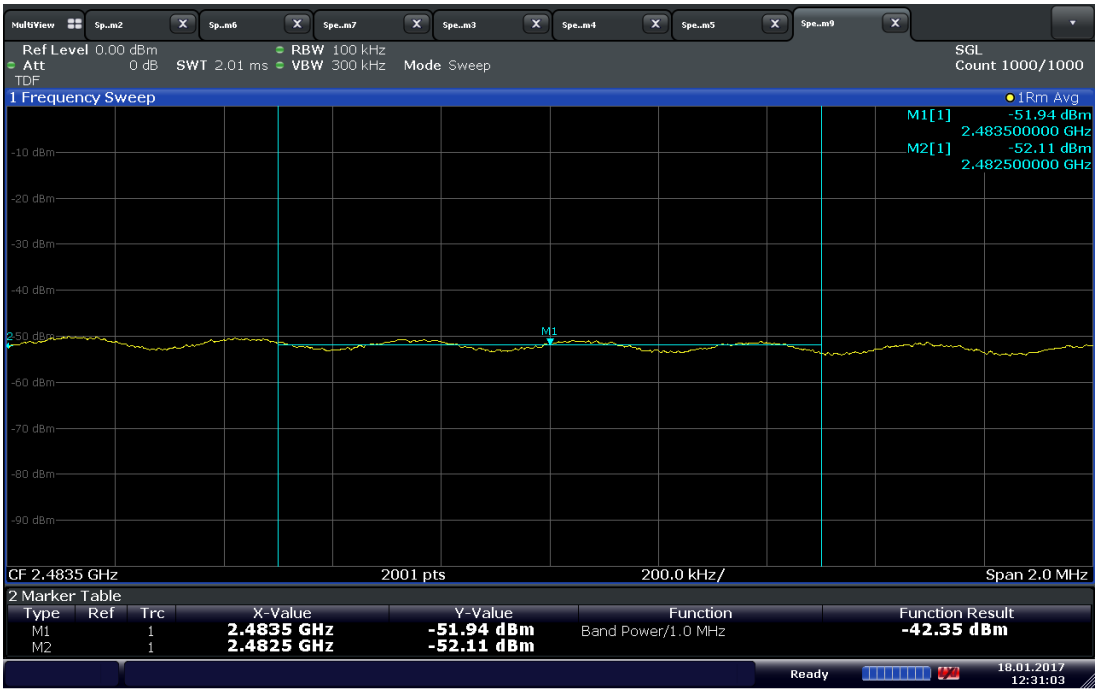
Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074

Measured Peak = -24.35 dBm, since antenna gain is 0 dBi then EIRP is -24.35 dBm. Electric field strength in dBµV/m is then calculated using the formula:

E = EIRP -20logD + 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 =(-24.35 + 0 dbi) dBm – (20log 3 meters) + 104.8
= 70.91 dBµV/m @ 3 meters (complies with 74 dBµV/m Peak limits)

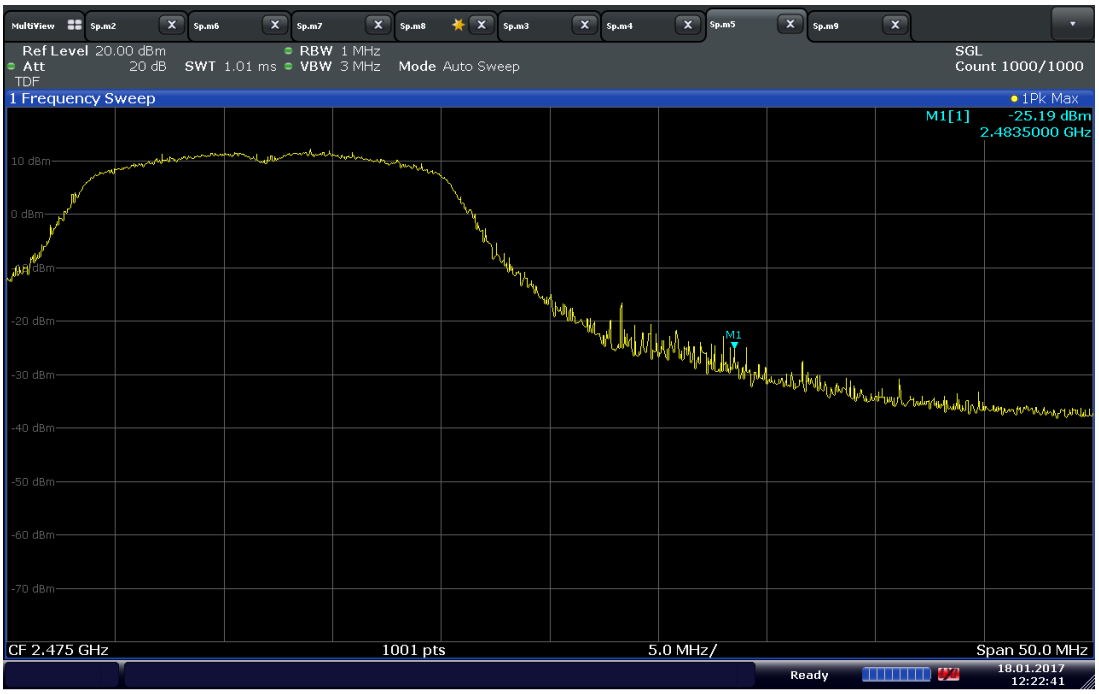


12:31:03 18.01.2017

802.11g High Channel (2462 MHz Average)

Upper Band Edge (in Restricted Band) measurement using Trace averaging with continuous EUT transmission at full power as per Clause 13.3.1 of KDB558074

E is therefore =(-42.35 + 0 dbi) dBm – (20log 3 meters) + 104.8
= 52.91 dBµV/m @ 3 meters (complies with 54 dBµV/m Average limits)



12:22:41 18.01.2017

802.11n High Channel (2462 MHz Peak)

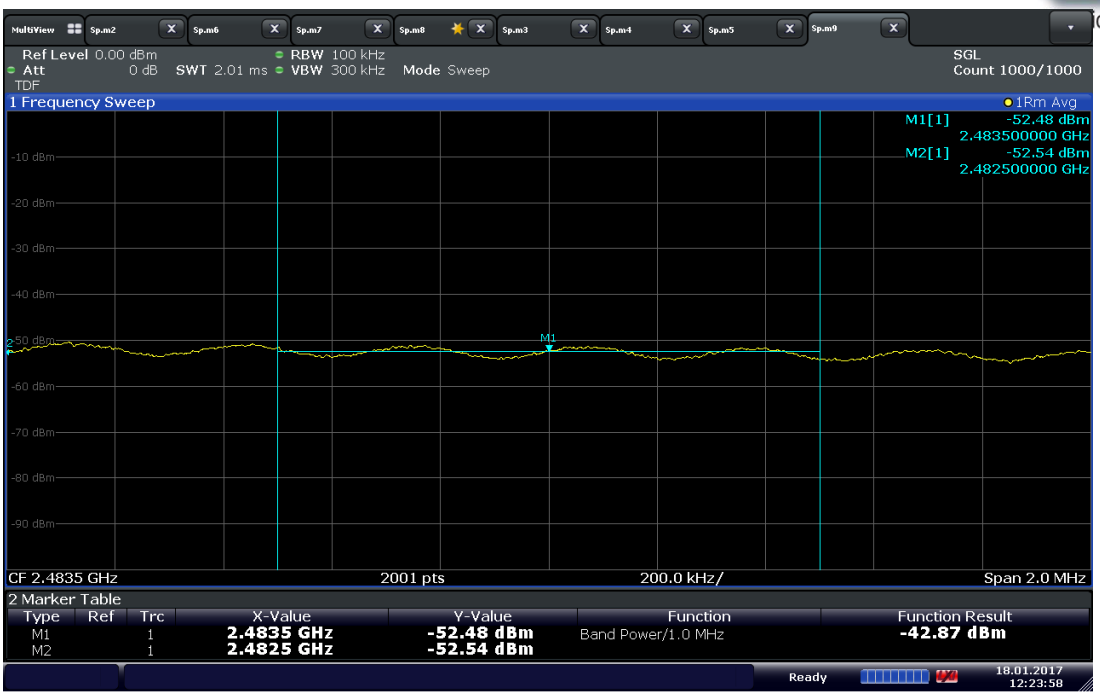
Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074

Measured Peak = -25.19 dBm, since antenna gain is 0 dBi then EIRP is -25.19 dBm. Electric field strength in dBµV/m is then calculated using the formula:

$$E = EIRP - 20\log D + 104.8$$

Where:	E	= electric field strength in dBµV/m
	EIRP	= equivalent isotropic radiated power in dBm
	D	= specific measurement distance in meters

E is therefore =(-25.19 + 0 dbi) dBm – (20log 3 meters) + 104.8
= 70.07 dBµV/m @ 3 meters (complies with 74 dBµV/m Peak limits)



12:23:59 18.01.2017

802.11n High Channel (2462 MHz Average)

Upper Band Edge (in Restricted Band) measurement using Trace averaging with continuous EUT transmission at full power as per Clause 13.3.1 of KDB558074

E is therefore =(-42.87 + 0 dbi) dBm – (20log 3 meters) + 104.8
= 52.38 dBµV/m @ 3 meters (complies with 54 dBµV/m Average limits)

2.6 SPURIOUS RADIATED EMISSIONS

2.6.1 Specification Reference

KDB558074 D01 DTS Meas Guidance v03r05 Clause 12.2.7

2.6.2 Standard Applicable

An additional consideration when performing conducted measurements of restricted band emissions is that unwanted emissions radiating from the EUT cabinet, control circuits, power leads, or intermediate circuit elements will likely go undetected in a conducted measurement configuration. To address this concern, a radiated test shall be performed to ensure that emissions emanating from the EUT cabinet (rather than the antenna port) also comply with the applicable limits.

For these cabinet radiated spurious emission measurements the EUT transmit antenna may be replaced with a termination matching the nominal impedance of the antenna. Procedures for performing radiated measurements are specified in ANSI C63.10. All detected emissions shall comply with the applicable limits.

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	25.4 °C
Relative Humidity	47.4 %
ATM Pressure	99.2 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 v03r05.
- 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 and data rate/MCS presented.
- Only noise floor measurements observed above 18GHz.

- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

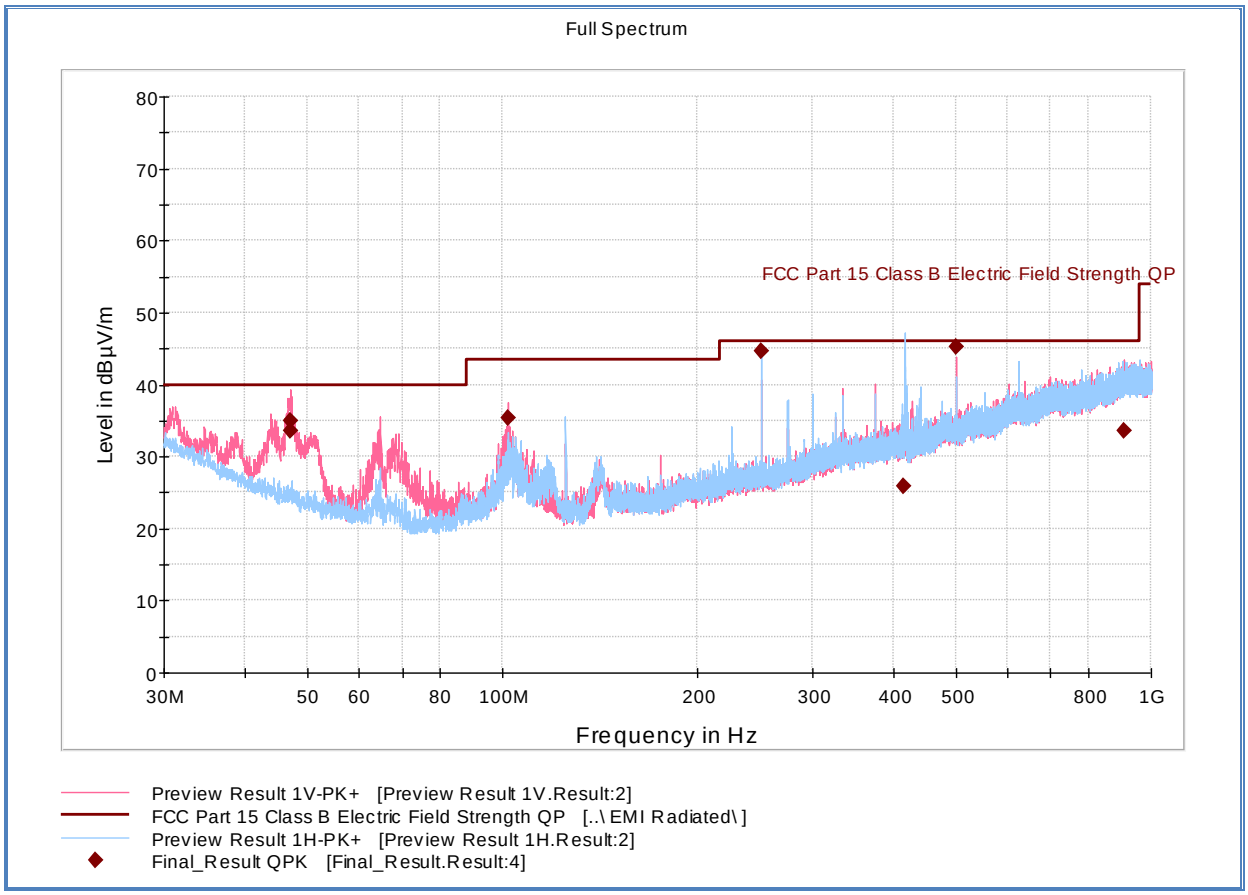
2.6.8 Sample Computation (Radiated Emission)

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**

2.6.9 Test Results

See attached plots.

2.6.10 Test Results Below 1GHz (Worst Case Configuration – 802.11g)

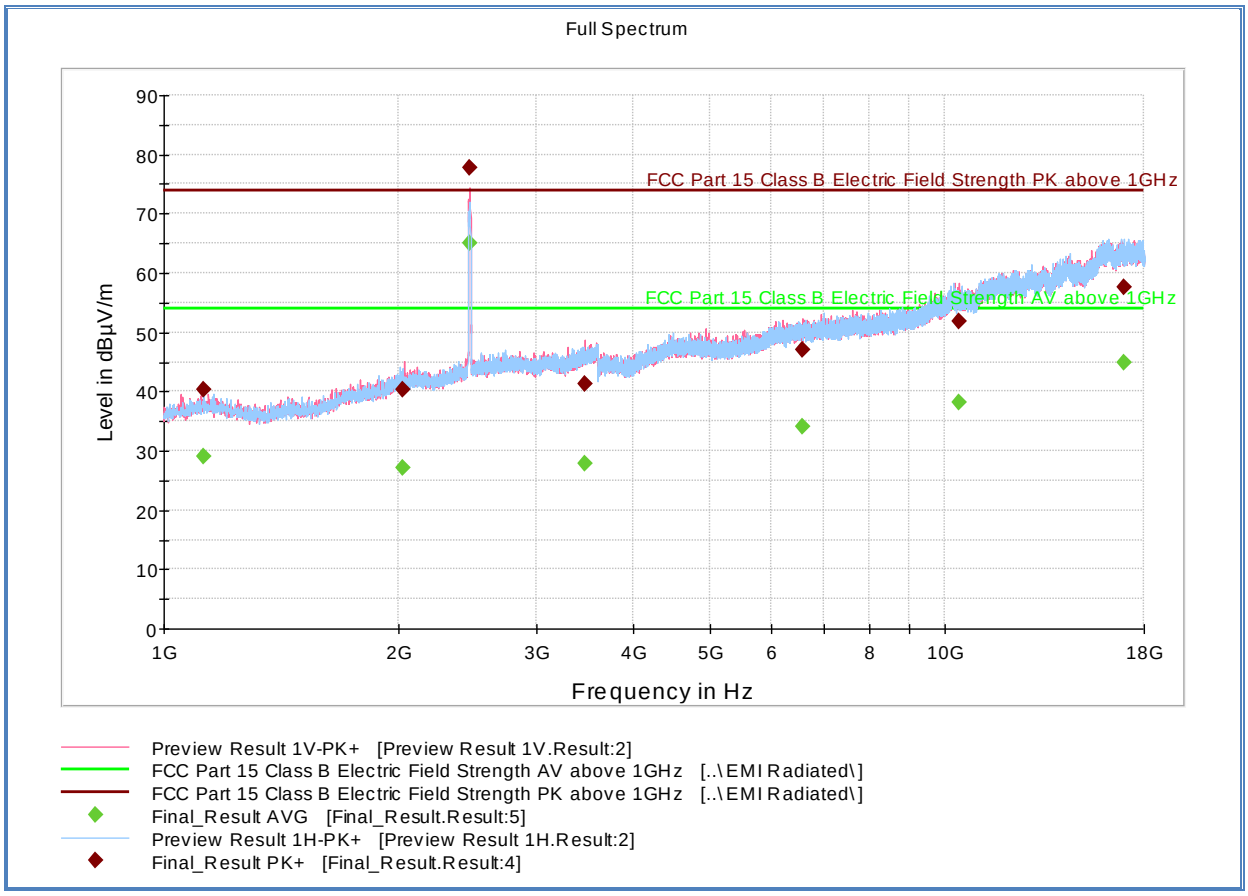


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
46.979667	34.87	40.00	5.13	1000.0	120.000	99.8	V	290.0	17.1
47.101333	33.55	40.00	6.45	1000.0	120.000	99.8	V	121.0	17.0
101.864667	35.33	43.50	8.17	1000.0	120.000	99.8	V	241.0	16.0
250.016000	44.61	46.00	1.40	1000.0	120.000	142.1	H	267.0	20.3
416.178667	25.95	46.00	20.05	1000.0	120.000	158.0	H	204.0	25.2
500.017333	45.20	46.00	0.80	1000.0	120.000	106.8	V	104.0	27.1
906.747667	33.52	46.00	12.48	1000.0	120.000	136.6	V	245.0	33.6

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

2.6.11 Test Results Above 1GHz (Worst Case Configuration – 802.11g)



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	40.35	73.90	33.55	1000.0	1000.000	385.0	H	93.0	-1.0
2022.190909	40.40	73.90	33.50	1000.0	1000.000	410.2	V	117.0	3.7
2461.772727	77.69	Fundamental		1000.0	1000.000	299.0	V	230.0	4.7
3461.227273	41.37	73.90	32.53	1000.0	1000.000	371.3	V	2.0	6.8
6570.790909	46.93	73.90	26.97	1000.0	1000.000	386.1	V	50.0	14.6
10414.09090	51.89	73.90	22.01	1000.0	1000.000	126.0	V	134.0	19.7
16973.38181	57.65	73.90	16.25	1000.0	1000.000	250.1	H	132.0	26.7

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	28.98	53.90	24.92	1000.0	1000.000	385.0	H	93.0	-1.0
2022.190909	27.13	53.90	26.77	1000.0	1000.000	410.2	V	117.0	3.7
2461.772727	65.13	Fundamental		1000.0	1000.000	299.0	V	230.0	4.7
3461.227273	27.78	53.90	26.12	1000.0	1000.000	371.3	V	2.0	6.8
6570.790909	34.03	53.90	19.87	1000.0	1000.000	386.1	V	50.0	14.6
10414.090909	38.05	53.90	15.85	1000.0	1000.000	126.0	V	134.0	19.7
16973.381818	44.79	53.90	9.11	1000.0	1000.000	250.1	H	132.0	26.7

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 18, 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	25.4 °C
Relative Humidity	47.4 %
ATM Pressure	99.2 kPa

2.7.7 Additional Observations

- This is a conducted test.
- Test procedure is per Section 10.2 of KDB 558074 (April 08, 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 kHz ≤ RBW ≤ 100 kHz
- Set the VBW ≥ 3 x RBW
- Detector is Peak
- Sweep time is Auto Couple.
- Trace mode is max hold
- Trace allowed to fully stabilize.
- The RBW used during testing shall be reported.

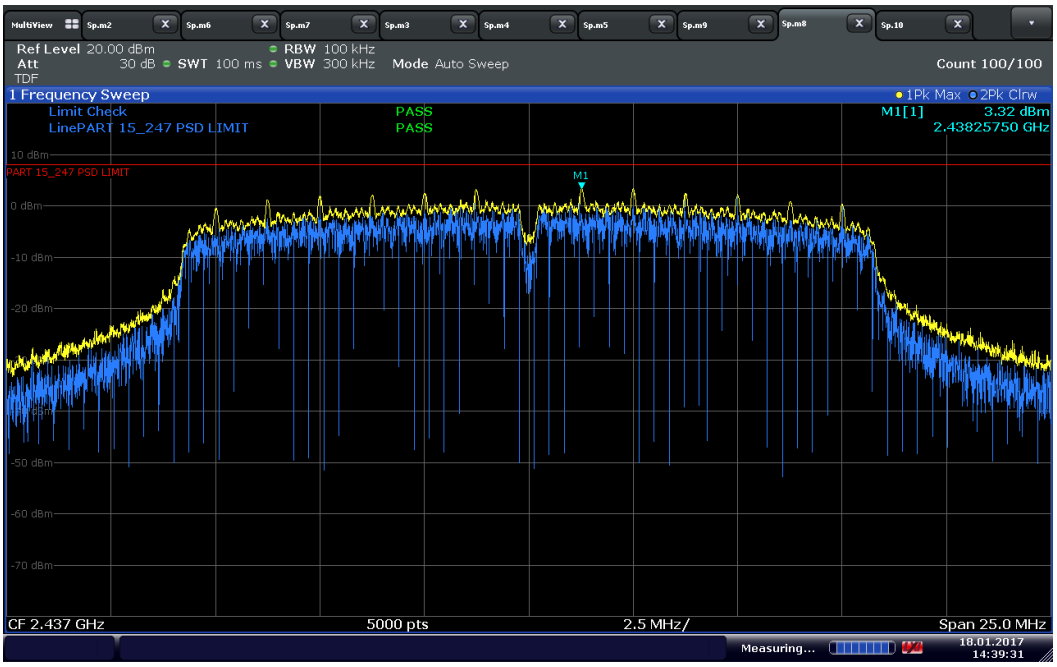
2.7.8 Test Results Summary

Mode	Channel	Marker Reading (dBm)/RBW used	PSD Limit (dBm)	Margin (dB)	Compliance
802.11g	1 (2412 MHz)	3.34/100kHz	8	4.66	Complies
	6 (2437 MHz)	3.32/100kHz	8	4.68	Complies
	11 (2462 MHz)	3.70/100kHz	8	4.30	Complies

* Only worst case mode (802.11g 6Mbps) is presented.

2.7.9 Test Results Plots

802.11g Low Channel



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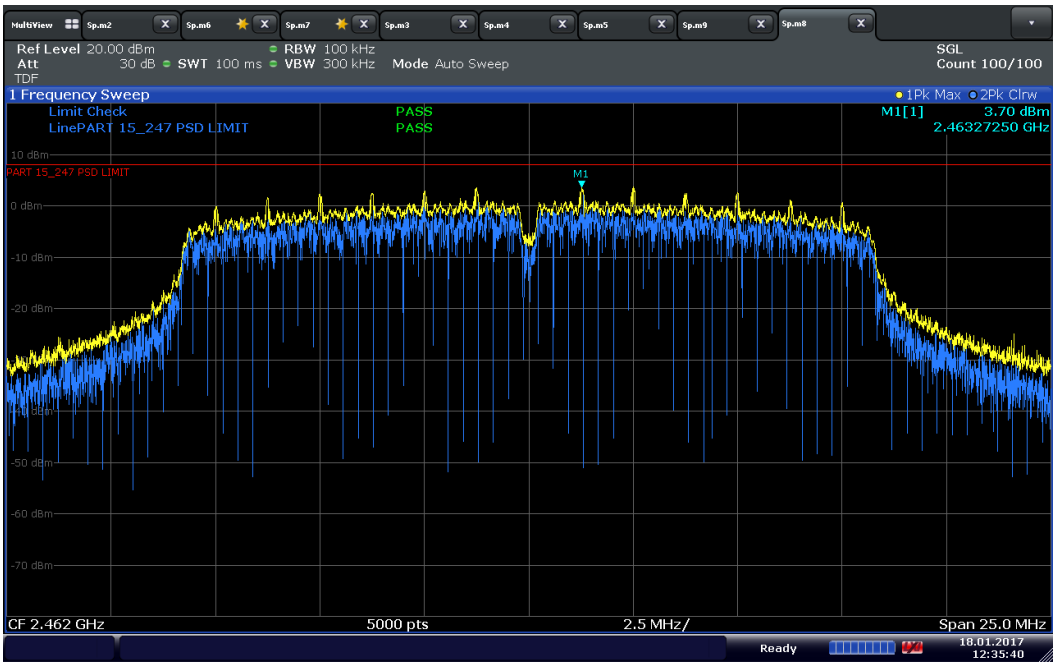
802.11g Mid Channel



12:35:40 18.01.2017

802.11g 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 Analyser	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

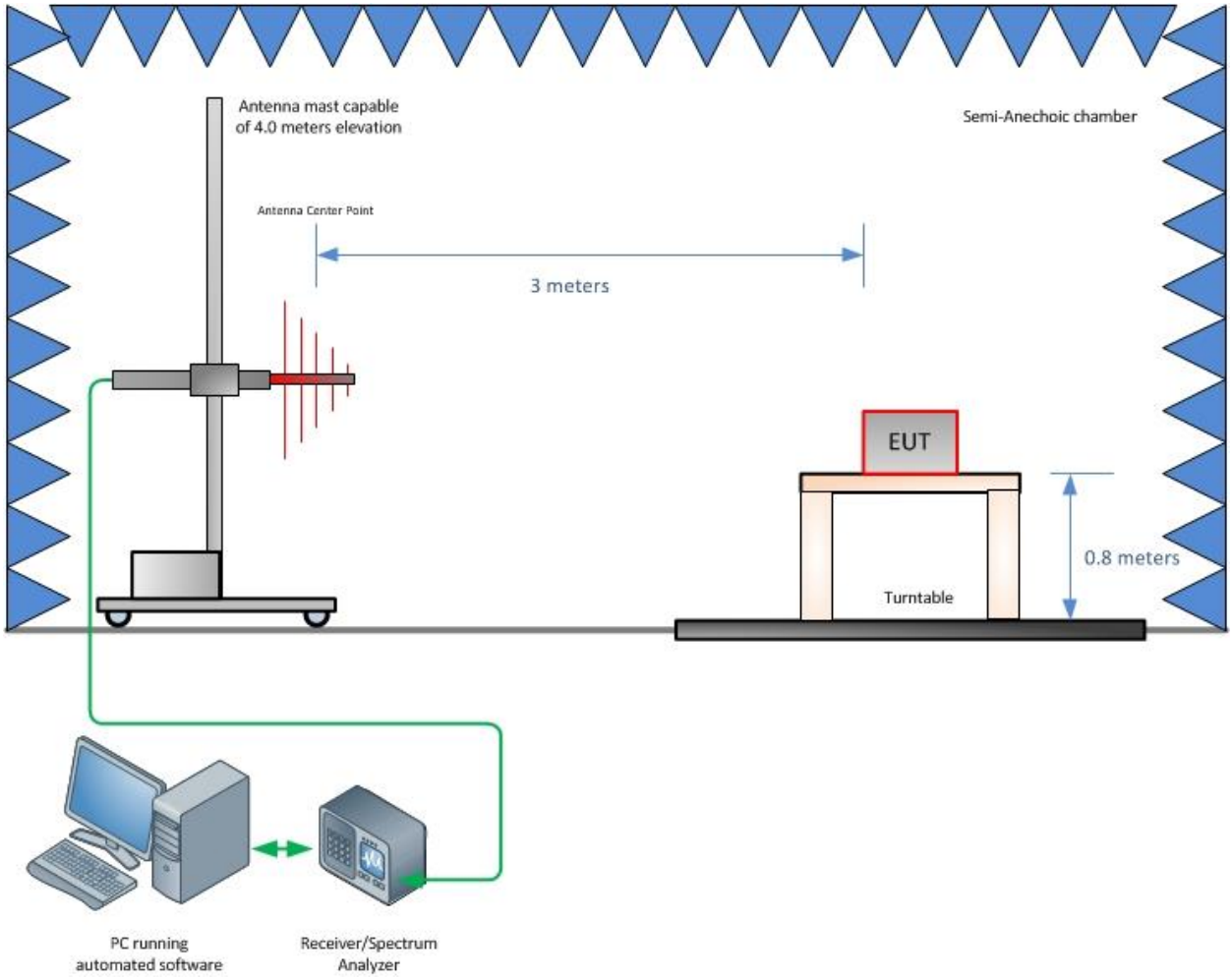
3.2.3 Conducted Antenna Port Measurement

	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

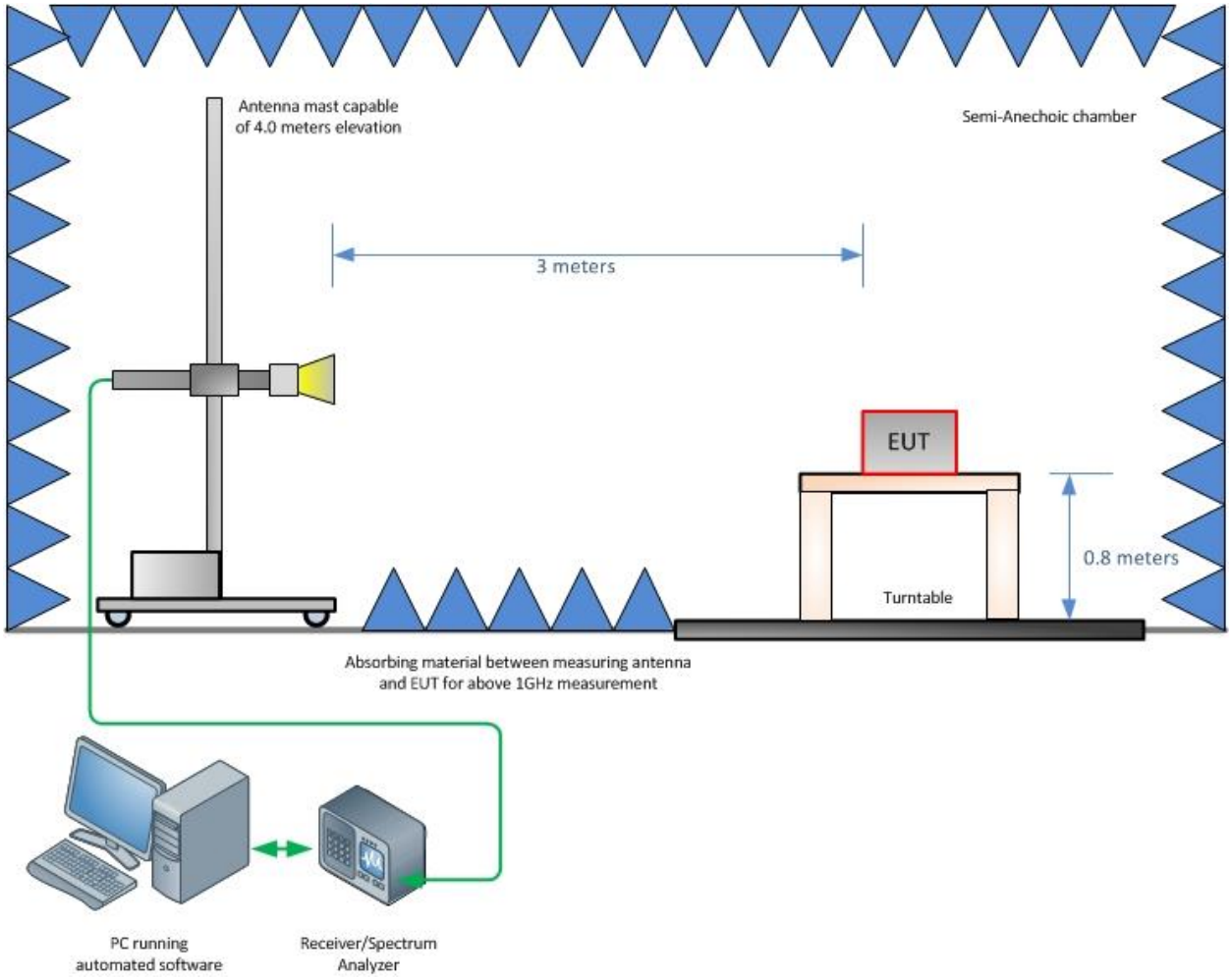
SECTION 4

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

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ANNEX - TEST DETAILS MAXIMUM CONDUCTED OUTPUT POWER VS ANTENNA GAIN

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

A1 MAXIMUM CONDUCTED OUTPUT POWER VS ANTENNA GAIN

A1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3) and RSS-247 5.4(4)

A1.2 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.

A1.3 Equipment Under Test and Modification State

Serial No: 90004024 / Test Configuration A

A1.4 Date of Test/Initial of test personnel who performed the test

December 18, 2017/NS

A1.5 Test Equipment Used

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

A1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.4 °C
Relative Humidity	47.4 %
ATM Pressure	99.2 kPa

A1.7 Additional Observations

- This is a conducted test (Maximum Peak conducted output power) using direct connection to a power meter. The manufacturer requested this verification in order to establish internal power settings when using 3, 6, 9 and 12 dBi antenna while still complies with the restricted band limits.
- An offset of 20.3dB was added to compensate for the external attenuator and cable used from the antenna port to the power sensor.
- Test methodology is per Clause 9.1.2 of KDB 558074 D01 (DTS Meas Guidance v03r05, April 08, 2016). All conditions under this Clause are satisfied.
- For every evaluated antenna gain value, Tx power settings were adjusted in order to comply with general limits for spurious radiated emissions.
- EUT complies with the 30 dBm limit.

A1.8 Test Results

WLAN Mode	Data Rates (Mbps)	Antenna gain	Maximum Peak Conducted Output Power (dBm)	Limit (dBm)	Margin (dB)	Compliance
802.11g	6	3 dBi	22.95	30	7.05	Complies
		6 dBi	21.21	30	8.79	Complies
		9 dBi	18.16	27	8.84	Complies
		12 dBi	16.06	24	7.94	Complies

* Only worst case mode and frequency channel (High channel) are presented.