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## Report On

Application for Grant of Equipment Authorization of the  
Globalstar, Inc.

SatFi2 Multi-Media Broadband Data WiFi Terminal

FCC Part 15 Subpart C §15.247 (DTS)

RSS-247 Issue 2 February 2017

**Report No. SD72134149-1217B**

**March 2018**

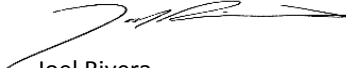



**REPORT ON** Radio Testing of the  
Globalstar, Inc.  
Multi-Media Broadband Data WiFi Terminal

**TEST REPORT NUMBER** SD72134149-1217B

**PREPARED FOR** Globalstar, Inc.  
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Title: Senior Test Engineer EMC/ Wireless Team Lead

**DATED** March 29, 2018



**Revision History**

SD72134149-1217B Globalstar, Inc. Multi-Media Broadband Data WiFi Terminal SatFi2					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
03/29/2018	Initial Release				Ferdinand Custodio



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## **SECTION 1**

### **REPORT SUMMARY**

Radio Testing of the  
Globalstar, Inc.  
Multi-Media Broadband Data WiFi Terminal



## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Globalstar, Inc. SatFi2 Multi-Media Broadband Data WiFi Terminal to the requirements of FCC Part 15 Subpart C §15.247 and RSS-247 Issue 2 February 2017.

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	Globalstar, Inc.
Model Number(s)	SatFi2
FCC ID Number	L2V-SATFI2
IC Number	3989A-ATFI2
Serial Number(s)	N/A
Number of Samples Tested	2
Test Specification/Issue/Date	<ul style="list-style-type: none"><li>• FCC Part 15 Subpart C §15.247 (October 1, 2016).</li><li>• RSS-247 Issue 2 February 2017 - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.</li><li>• RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 4, November 2014 with Amendment 1).</li><li>• 558074 D01 DTS Meas Guidance v04, (April 05, 2017) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.</li><li>• ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices</li></ul>
Start of Test	March 12, 2018
Finish of Test	March 28, 2018
Name of Engineer(s)	Joel Rivera
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	Compliant	
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	Compliant	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	KDB558074 Clause 12.2.7		Spurious Radiated Emissions	Compliant	
2.8	§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) was a Globalstar, Inc. Model SatFi2 Multi-Media Broadband Data WiFi Terminal. The EUT provides location-based messaging and emergency notification technology, voice and data that allows a user to communicate from remote locations through a commercial satellite network. The SatFi2 incorporates a Satellite radio and a GPS receiver. The WLAN radio functions of the EUT were verified in this test report.

**1.3.2 EUT General Description**

EUT Description	Multi-Media Broadband Data WiFi Terminal
Model Name	SatFi2
Model Number(s)	SatFi2
Rated Voltage	10.0 VDC - 48 VDC (Supplied AC/DC Adapter for USB was a Model BX-0502000 with an output of 5VDC @ 2.0A)
Frequency	2412 MHz in the 2.4GHz band
Mode Verified	802.11b and 802.11g
Capability	802.11b, 802.11g and 1610.73 – 1625.49 MHz in the 1610.0-1626.5 MHz L-Band Mobile Satellite Service
Primary Unit (EUT)	<input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> Engineering
Antenna Type	Ceramic Chip antenna
Antenna Manufacturer	Pulse Finland Oy
Antenna Model Number	W3008C
Antenna Gain	2.2 dBi Peak Linear Max Gain

**1.3.3 Maximum Conducted Output Power**

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
802.11b	2412	14.4	27.54
802.11g	2412	9.9	9.78





**1.4 EUT TEST CONFIGURATION**

**1.4.1 Test Configuration Description**

Test Configuration	Description
A	Antenna Conducted Port Test Setup. Antenna port connected directly to the Spectrum Analyser with 20dB external attenuator. Manufacturer provided a sample with temporary antenna connector.
B	Radiated Test Setup (Cabinet Spurious Emissions). Manufacturer provided a Wi-Fi only radiated sample. The EUT was configured as a client and connected to a Master AP.

**1.4.2 EUT Exercise Software**

The EUT is connected to the support laptop via USB. PuTTY was used to communicate with the EUT. The manufacturer provided command lines to configure EUT for each test case. For WLAN specific test cases, a supplemental application was also utilized (DutApiWiFiMW30XBridgeUart).

**1.4.3 Support Equipment and I/O cables**

Manufacturer	Equipment/Cable	Description
Lenovo	Support Laptop (ideapad 110)	M/N 80UD S/N MP14GJ94
-	2x USB (EUT to Support Laptop)	Type A 2.0 to Micro B USB Cable, 40 cm shielded
Sparkfun	USB to Serial Breakout	FT232RL Breakout with USB to serial UART interface

**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
802.11b	1 (Low Channel)	1Mbps
802.11g	1 (Low Channel)	6 Mbps

The EUT is a mobile device. For radiated measurements, X, Y and Z were not verified as the EUT is primarily designed as a table top equipment. The EUT was verified using standard axis configuration as recommended.

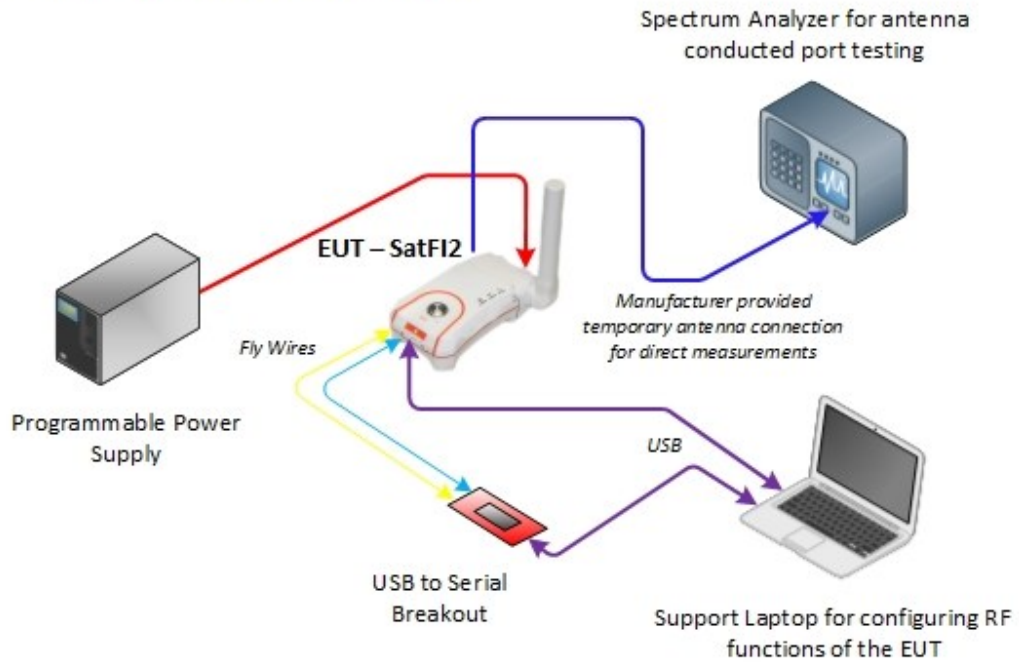
**1.4.5 Duty Cycle and Transmission Duration Used (Worst Case Configuration)**

Mode	T (μs)	Duty Cycle (x)	DCCF
802.11b	-	-	-
802.11g	-	-	-

DCCF not required as the EUT transmits at >99% duty cycle. See test plots starting at Section 2.1.9 of this test report.

### 1.4.6 Simplified Test Configuration Diagram

#### Antenna Conducted Port Test Configuration



#### 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 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 Designation is US1146.

**1.8.2 Innovation, Science and Economic Development Canada (IC) Registration No.: 3067A-1 & 22806-1**

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TUV SUD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.



**1.8.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)**

TUV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

**1.8.4 NCC (National Communications Commission - US0102)**

TUV SUD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP002 for Low-Power RF Device type of testing.

**1.8.5 VCCI – Registration No. A-0280 and A-0281**

TUV SUD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

**1.8.6 RRA – Identification No. US0102**

TUV SUD America Inc. (San Diego) is National Radio Research Agency (RRA) recognized laboratory under Phase I of the APEC Tel MRA.

**1.8.7 OFCA – U.S. Identification No. US0102**

TUV SUD America Inc. (San Diego) is recognized by Office of the Communications Authority (OFCA) under Appendix B, Phase I of the APEC Tel MRA.



## **SECTION 2**

### **TEST DETAILS**

Radio Testing of the  
Globalstar, Inc.  
Multi-Media Broadband Data WiFi Terminal



## **2.1 MAXIMUM CONDUCTED OUTPUT POWER**

### **2.1.1 Specification Reference**

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

### **2.1.2 Standard Applicable**

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

### **2.1.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration A

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

March 27, 2018/JR

### **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	23.4 °C
Relative Humidity	46.7 %
ATM Pressure	99.3 kPa

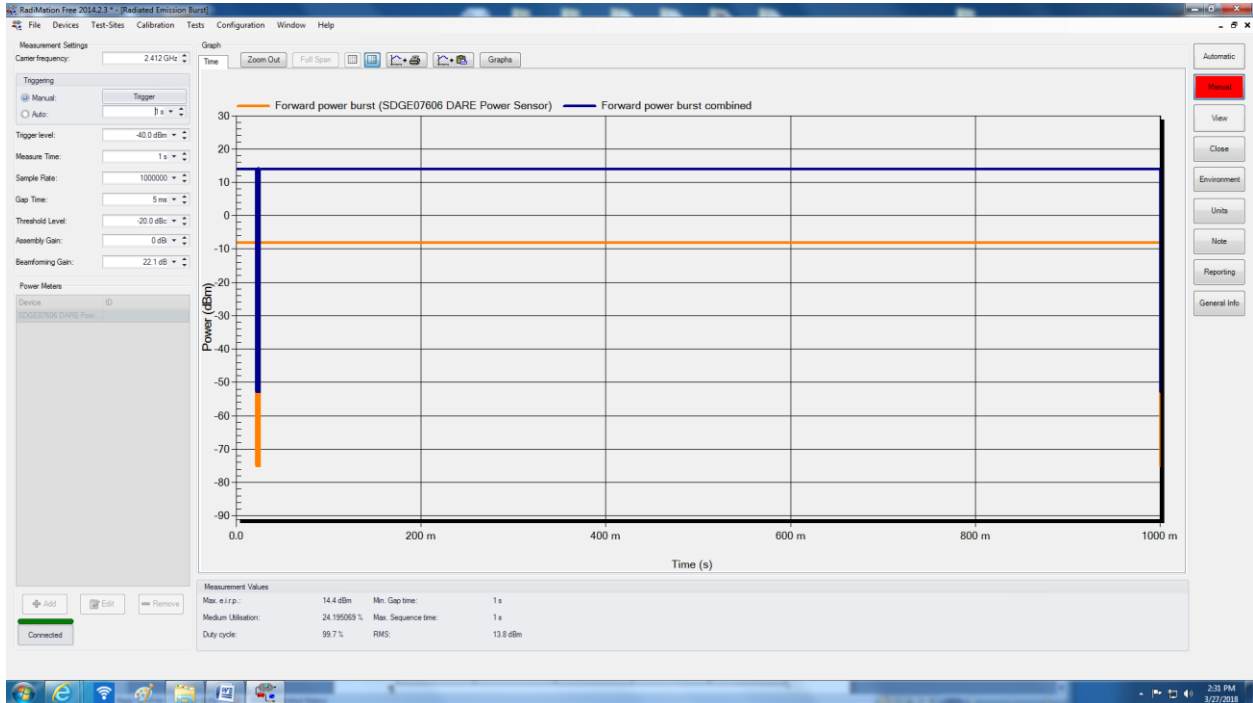
### **2.1.7 Additional Observations**

- This is a conducted test (Maximum conducted [average] output power) using direct connection to a power meter.
- An offset of 22.10dB was added to compensate for the external attenuator, EUT pigtail and cable used from the antenna port to the power sensor.
- Test methodology is per Clause 9.2.3.1 of KDB 558074 D01 (DTS Meas Guidance v04, April 05, 2017). All conditions under this Clause were satisfied.
- The EUT transmits continuously. Burst Mode of the power meter was used wherein the captured burst were analysed and presented. Captured bursts include the average power and timing data.
- EUT complies with the 30dBm limit.

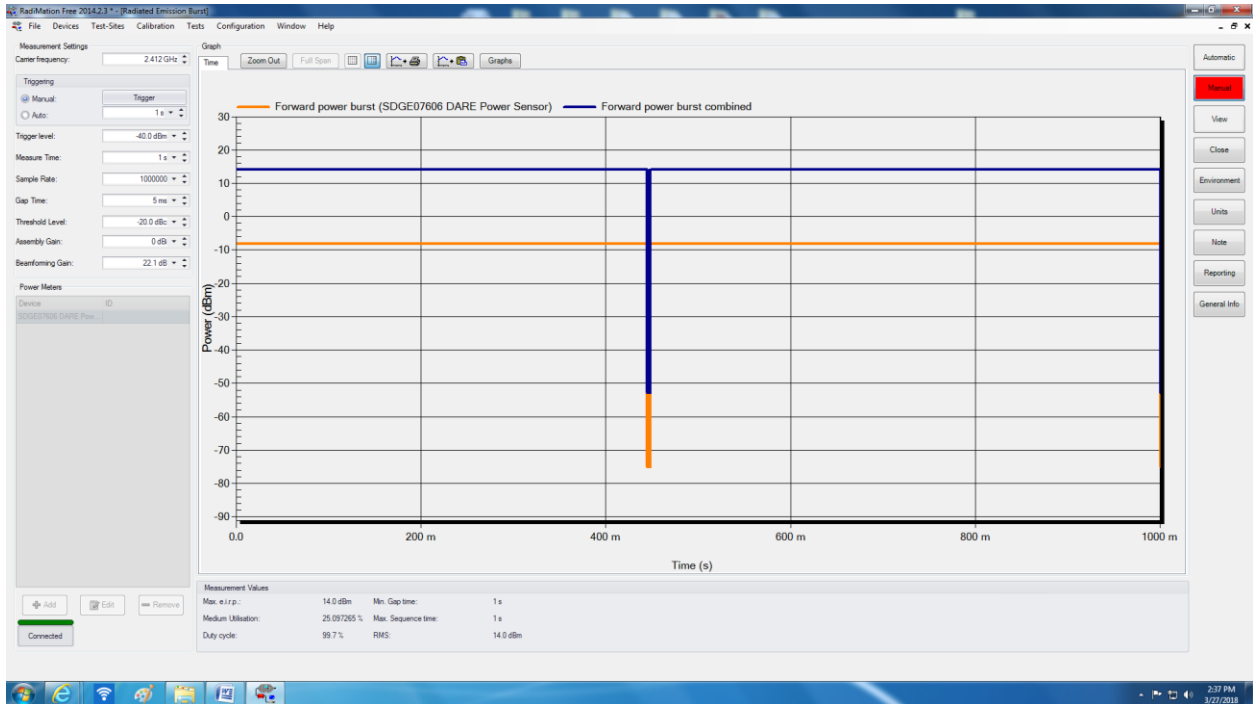
**2.1.8 Test Results**

WLAN Mode	Channel	Data Rates (Mbps)	Maximum Conducted Output Power	
			Burst	RMS
802.11b	1 (2412 MHz)	1	14.4	13.8
		2	14.0	14.0
		5.5	13.9	13.9
		11	14.3	13.9
802.11g	1 (2412 MHz)	6	9.9	9.7
		9	9.7	9.7
		12	9.8	9.7
		18	9.9	9.7
		24	9.8	9.6
		36	9.6	9.5
		48	9.7	9.5
	54	5.5	9.5	

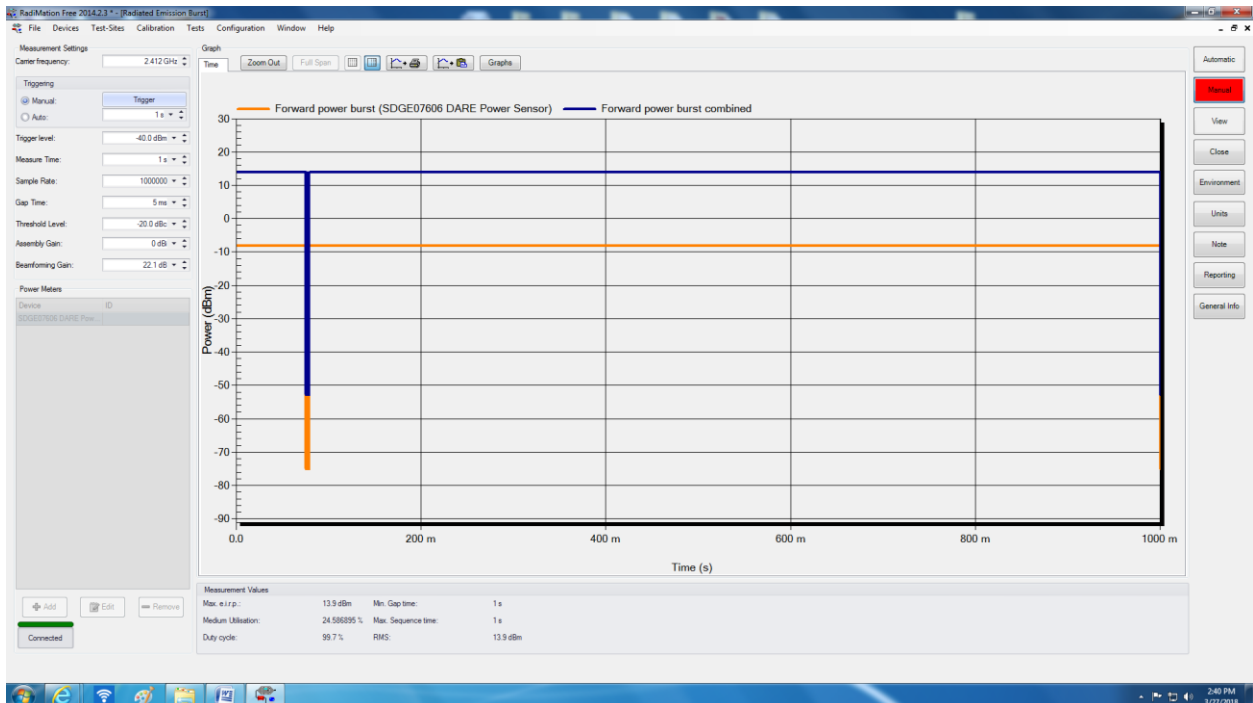
**2.1.9 Test Plots**



**802.11b 1Mbps**

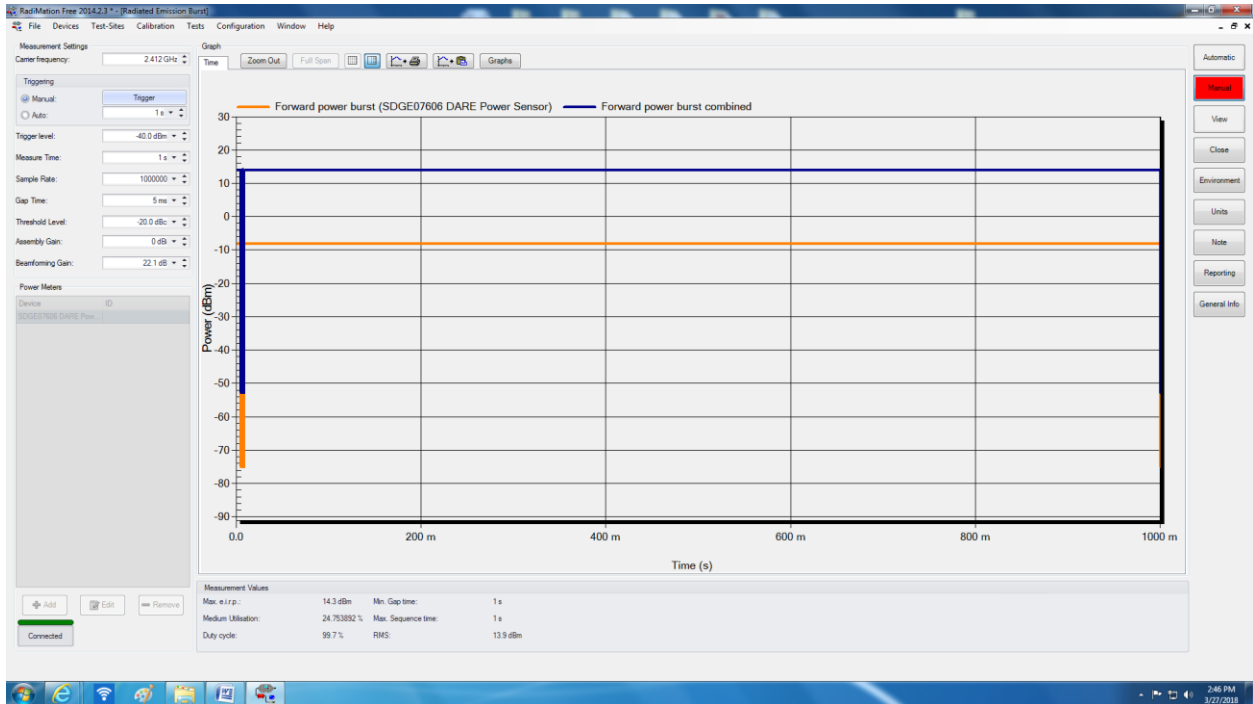


802.11b 2Mbps

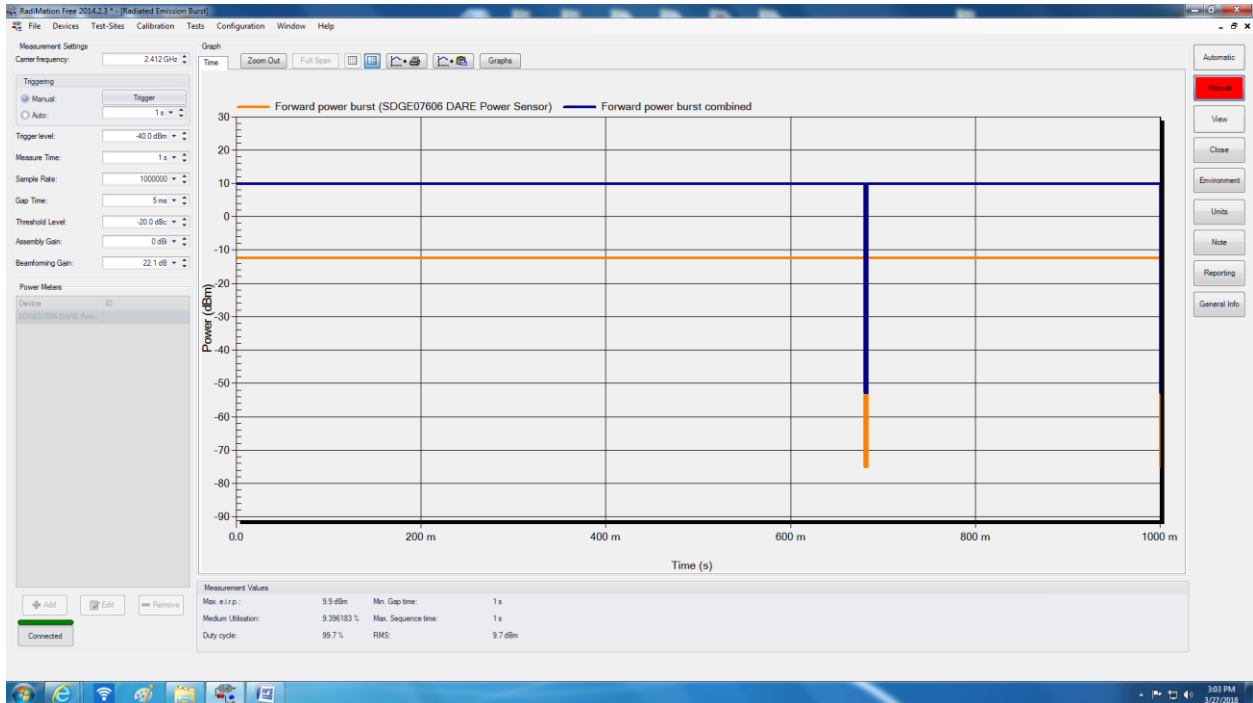


802.11b 5.5Mbps

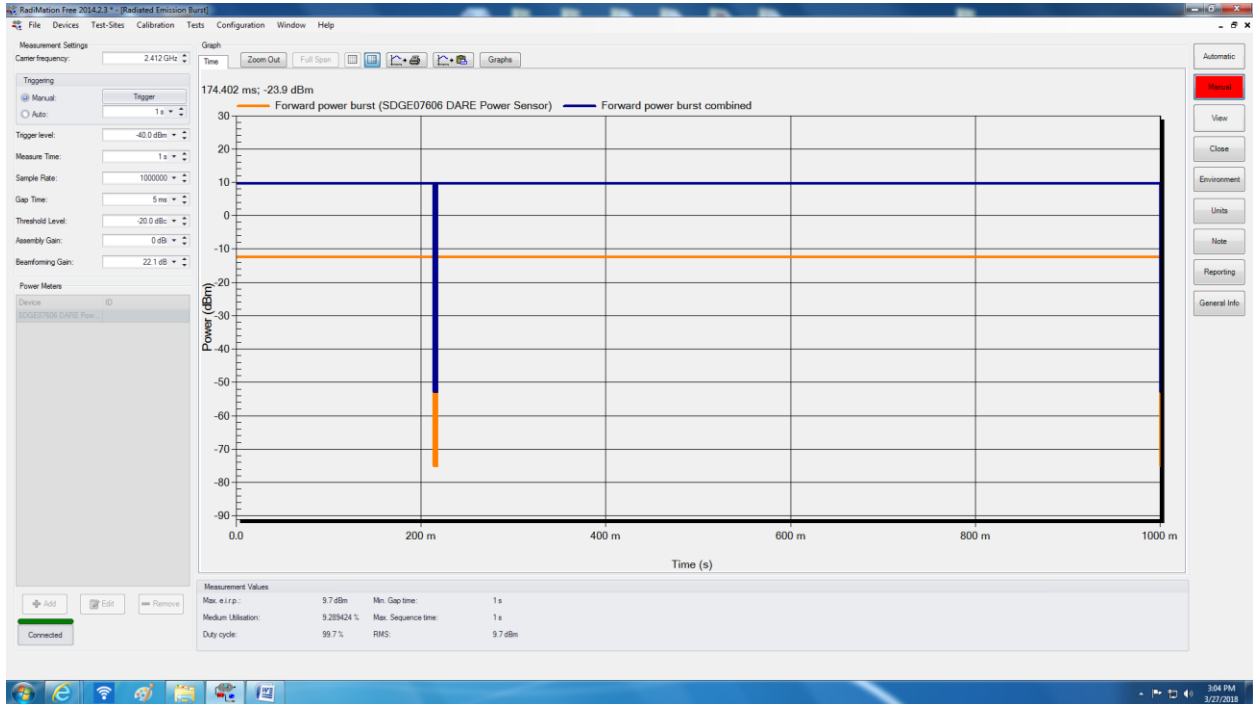




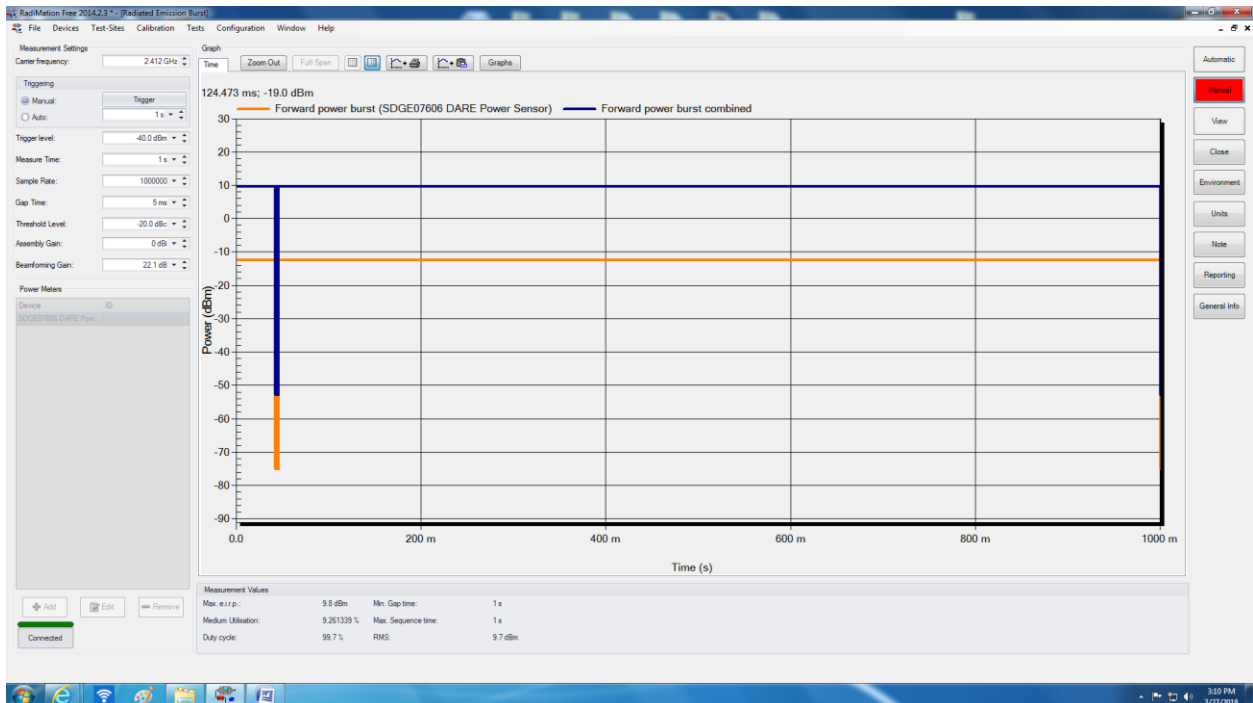
802.11b 11Mbps



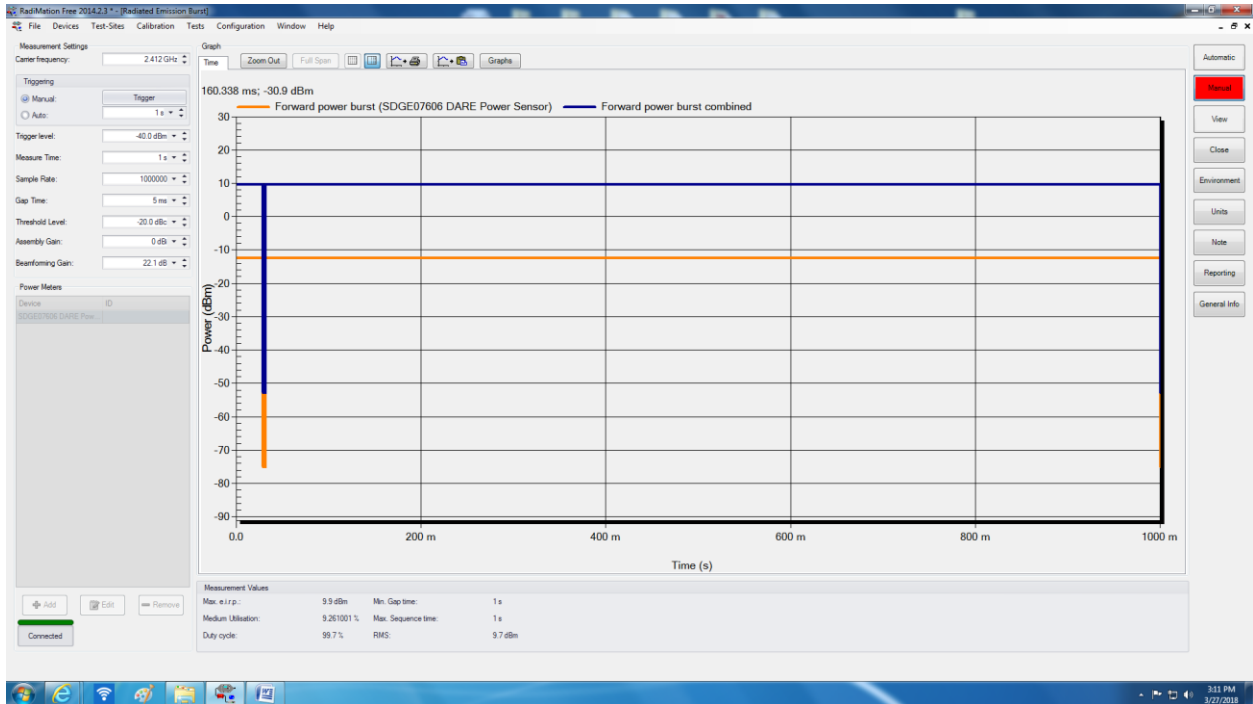
802.11g 6Mbps



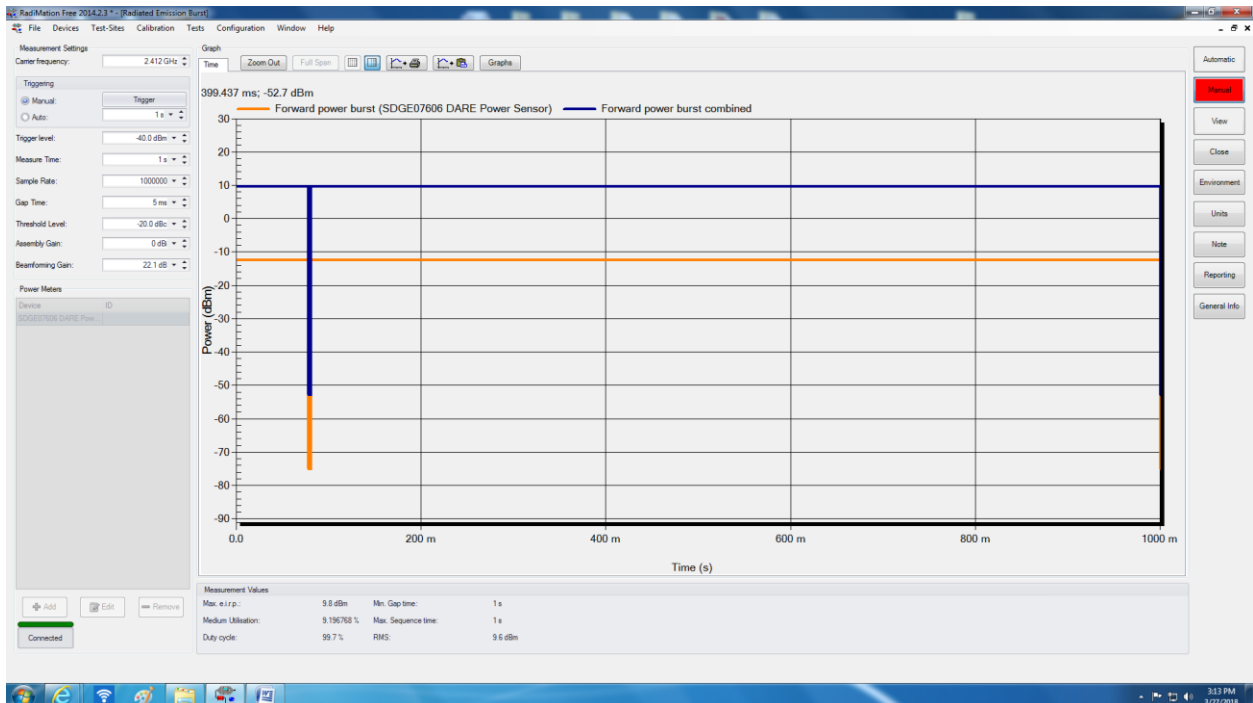
802.11g 9Mbps



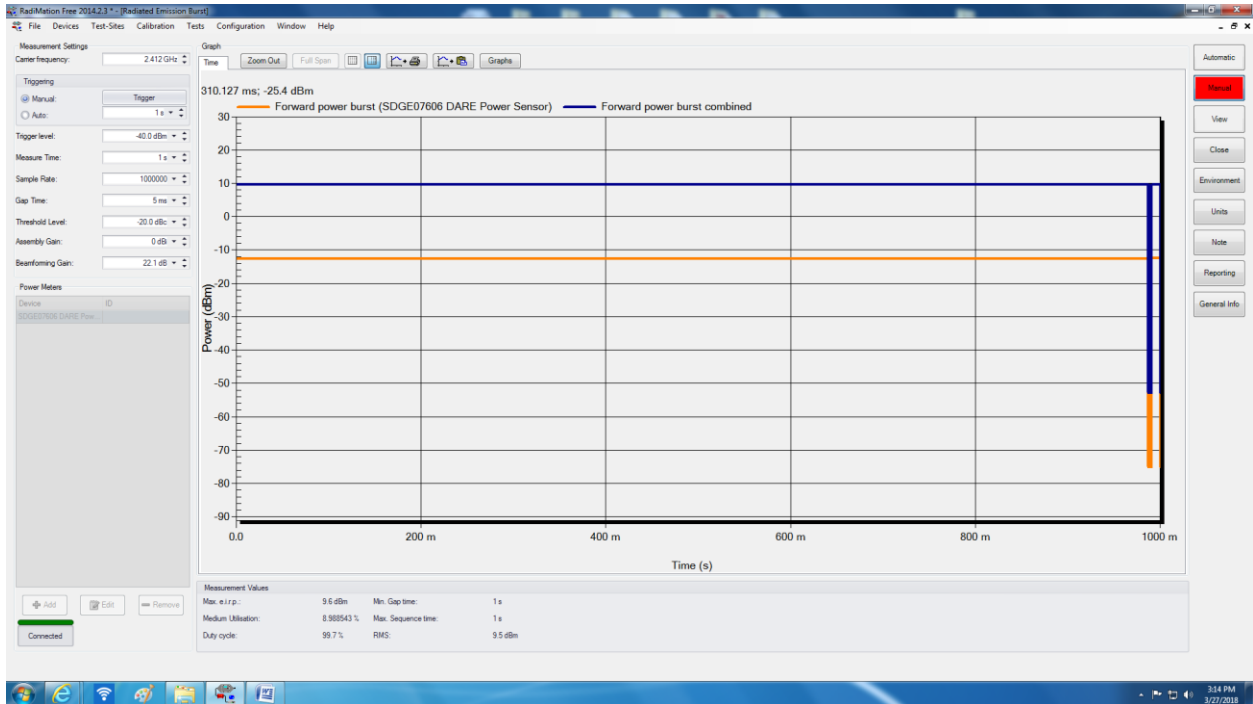
802.11g 12Mbps



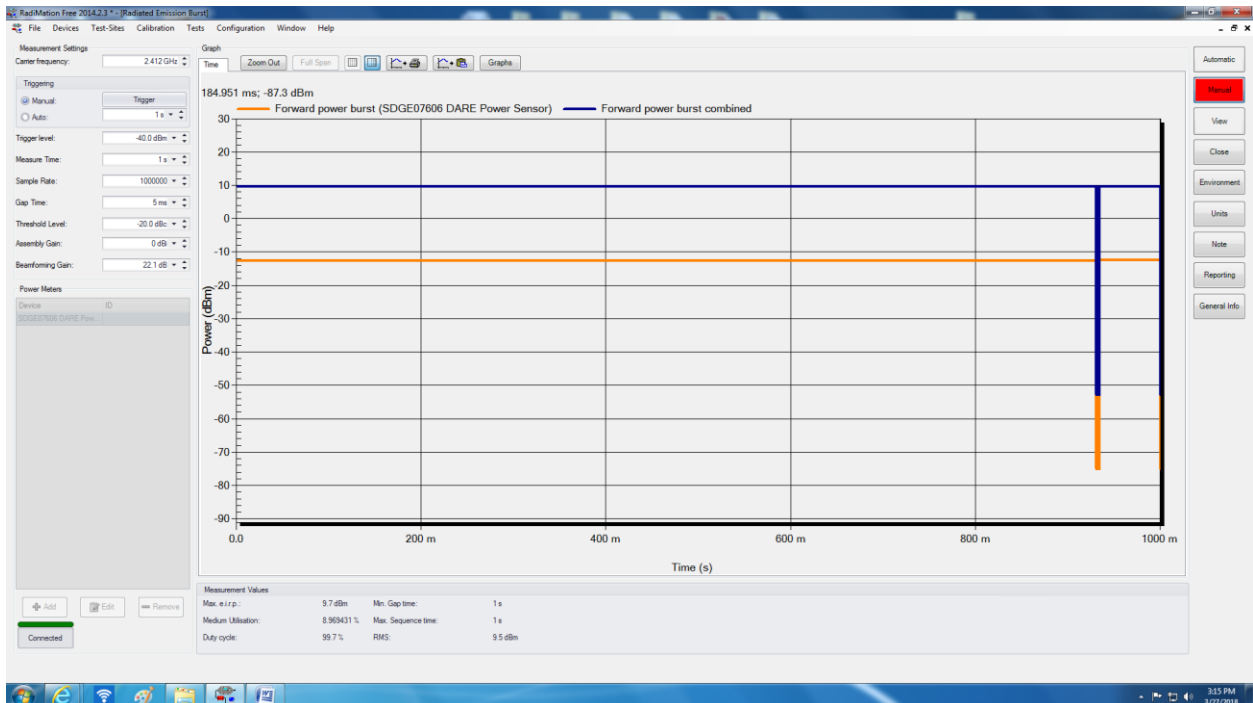
802.11g 18Mbps



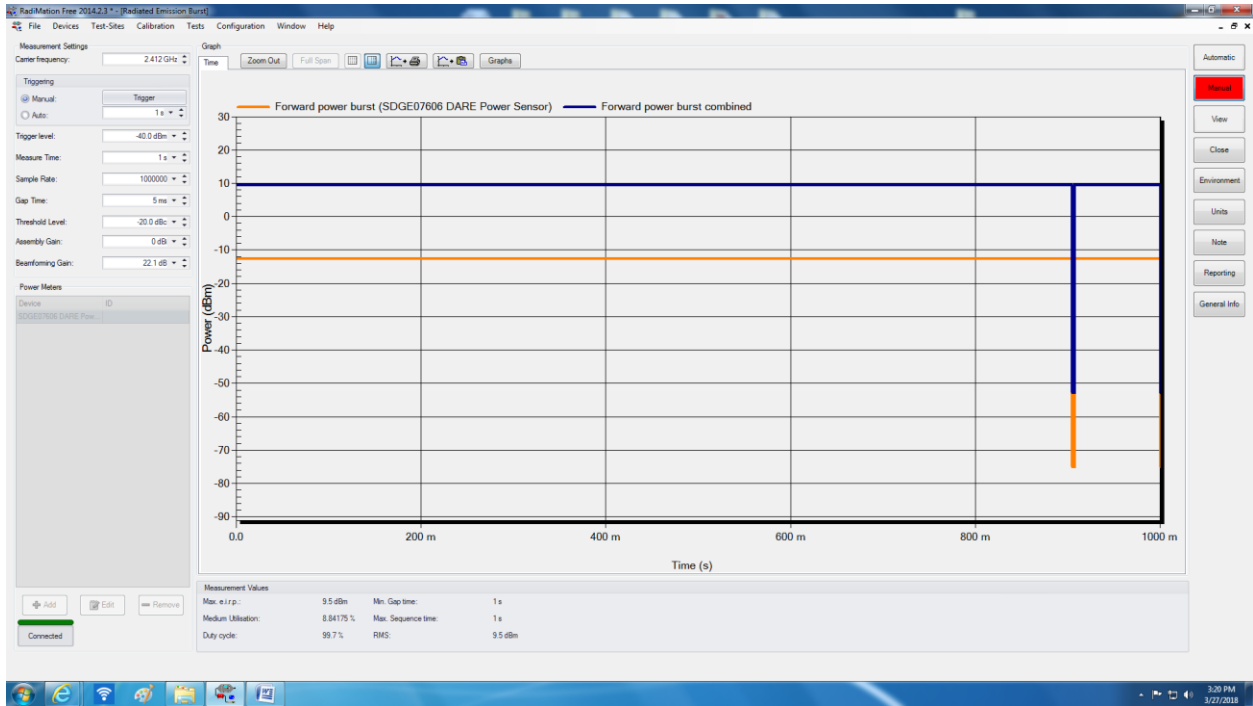
802.11g 24Mbps



802.11g 36Mbps



802.11g 48Mbps



802.11g 54Mbps



**2.2 CONDUCTED EMISSIONS**

**2.2.1 Specification Reference**

Part 15 Subpart C §15.207(a) and RSS-Gen 8.8

**2.2.2 Standard Applicable**

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*\*Decreases with the logarithm of the frequency.*

**2.2.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration A

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

March 28, 2018/JR

**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      24.7 °C  
 Relative Humidity          44.8 %  
 ATM Pressure                99.8 kPa

**2.2.7 Additional Observations**

Measurement was done using EMC32 V8.53 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 2.2.8 for sample computation.



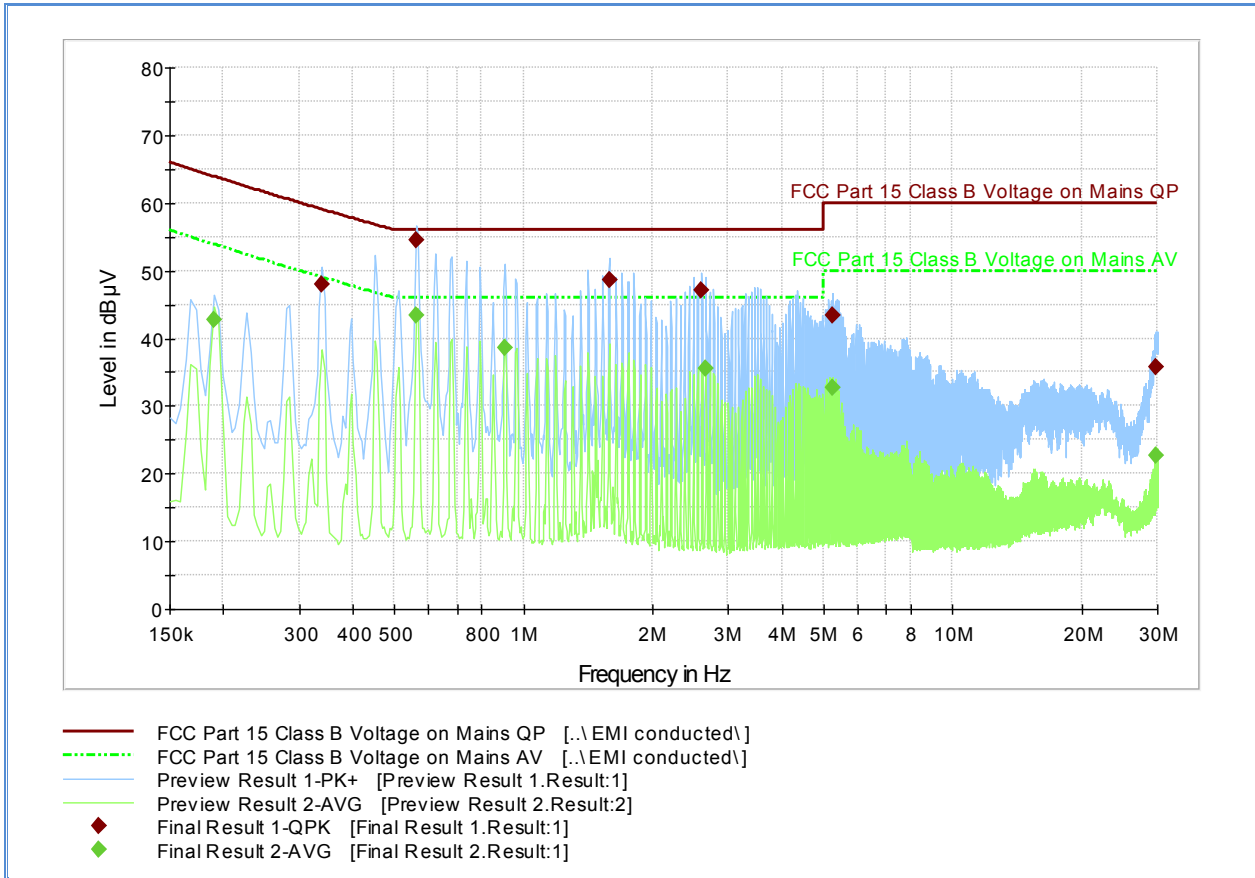
**2.2.8 Sample Computation (Conducted Emission – Quasi Peak)**

Measuring equipment raw measurement (db $\mu$ V) @ 150kHz		5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9
	Asset# 1177 (cable)	0.15
	Asset# 1176 (cable)	0.35
	Asset# 7568 (LISN)	0.30
<b>Reported QuasiPeak Final Measurement (db<math>\mu</math>V) @ 150kHz</b>		<b>26.2</b>

**2.2.9 Test Results**

**Compliant.** See attached plots and tables.

**2.2.10 SatFi2 (Line 1 on the supplied AC/DC Adapter)**



**Quasi Peak**

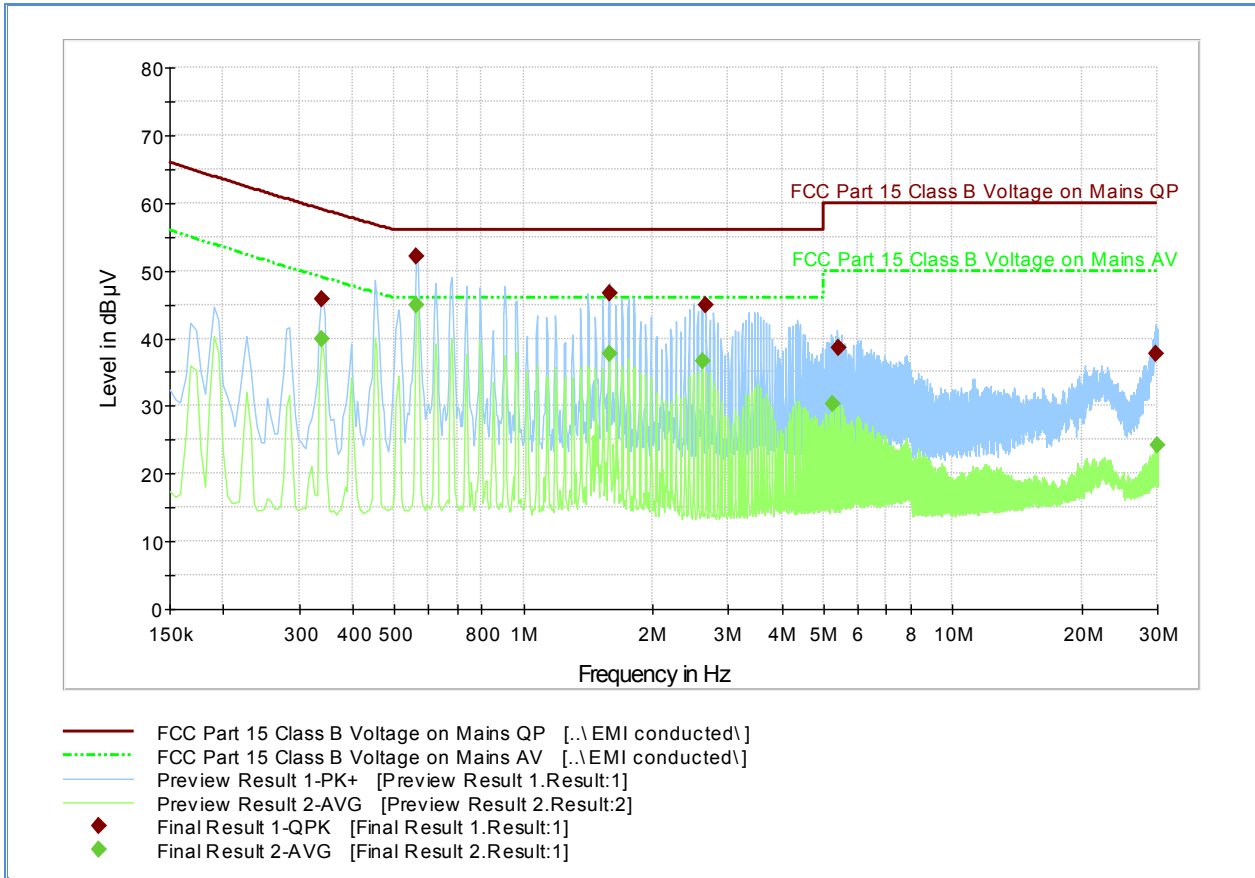
Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.339000	47.9	1000.0	9.000	Off	L1	20.4	11.2	59.0
0.564000	54.4	1000.0	9.000	Off	L1	20.2	1.6	56.0
1.585500	48.6	1000.0	9.000	Off	L1	20.3	7.4	56.0
2.602500	47.2	1000.0	9.000	Off	L1	20.3	8.8	56.0
5.262000	43.3	1000.0	9.000	Off	L1	20.4	16.7	60.0
29.854500	35.7	1000.0	9.000	Off	L1	20.8	24.3	60.0

**Average**

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.190500	42.7	1000.0	9.000	Off	L1	20.2	11.2	53.9
0.564000	43.5	1000.0	9.000	Off	L1	20.2	2.5	46.0
0.906000	38.5	1000.0	9.000	Off	L1	20.2	7.5	46.0
2.661000	35.5	1000.0	9.000	Off	L1	20.3	10.5	46.0
5.266500	32.7	1000.0	9.000	Off	L1	20.4	17.3	50.0
29.751000	22.6	1000.0	9.000	Off	L1	20.8	27.4	50.0



**2.2.11 SatFi2 (Line 2 on the supplied AC/DC Adapter)**



**Quasi Peak**

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.339000	45.8	1000.0	9.000	Off	N	20.3	13.3	59.0
0.564000	52.0	1000.0	9.000	Off	N	20.2	4.0	56.0
1.585500	46.6	1000.0	9.000	Off	N	20.2	9.4	56.0
2.661000	44.9	1000.0	9.000	Off	N	20.3	11.1	56.0
5.433000	38.6	1000.0	9.000	Off	N	20.4	21.4	60.0
29.805000	37.6	1000.0	9.000	Off	N	20.8	22.4	60.0

**Average**

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.339000	39.9	1000.0	9.000	Off	N	20.3	9.1	49.0
0.564000	44.9	1000.0	9.000	Off	N	20.2	1.1	46.0
1.585500	37.7	1000.0	9.000	Off	N	20.2	8.3	46.0
2.607000	36.6	1000.0	9.000	Off	N	20.3	9.4	46.0
5.266500	30.3	1000.0	9.000	Off	N	20.4	19.7	50.0
29.937000	24.2	1000.0	9.000	Off	N	20.8	25.8	50.0



## **2.3 99% EMISSION BANDWIDTH**

### **2.3.1 Specification Reference**

RSS-Gen Clause 6.6

### **2.3.2 Standard Applicable**

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- • The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- • The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

### **2.3.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration A

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

March 28, 2018/JR

### **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 24.7 °C  
 Relative Humidity 44.8 %  
 ATM Pressure 99.8 kPa

**2.3.7 Additional Observations**

- This is a conducted test.
- An offset of 22.10dB was added to compensate for the external attenuator, EUT pigtail and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% to 5% of the occupied bandwidth (OBW).
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyser was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyser was used for this test.

**2.3.8 Test Results (For reporting purposes only)**

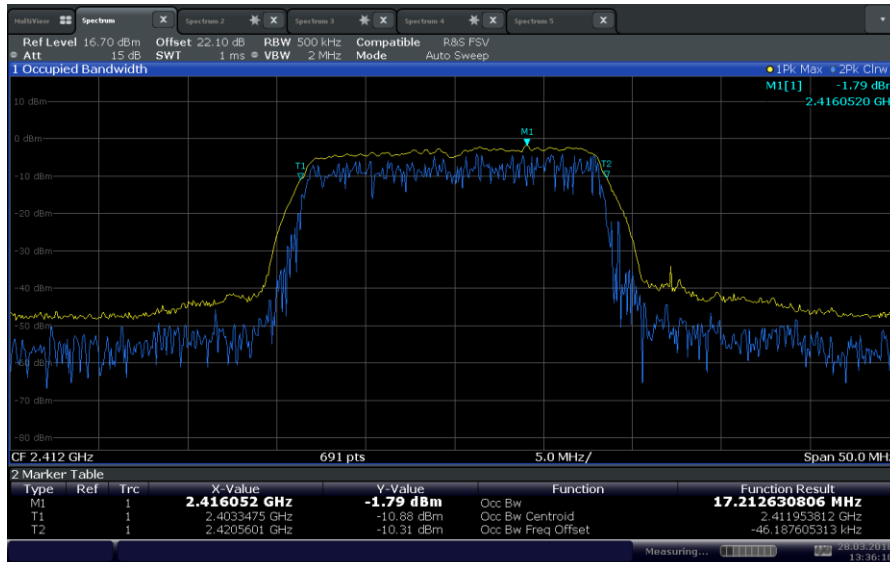
Mode	Channel	Measured 99% Bandwidth (MHz)
802.11b	1 (2412 MHz)	13.553
802.11g	1 (2412 MHz)	17.213

**2.3.9 Test Results Plots**



08:36:06 28.03.2018

**802.11b Channel 1**



13:36:11 28.03.2018

**802.11g Channel 1**



## **2.4 MINIMUM 6 DB RF BANDWIDTH**

### **2.4.1 Specification Reference**

Part 15 Subpart C §15.247(a)(2) and RSS-247 5.2(1)

### **2.4.2 Standard Applicable**

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### **2.4.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration A

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

March 28, 2018/JR

### **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	24.7 °C
Relative Humidity	44.8 %
ATM Pressure	99.8 kPa

### **2.4.7 Additional Observations**

- This is a conducted test.
- An offset of 22.10dB was added to compensate for the external attenuator, EUT pigtail and cable used.
- Span is wide enough to capture the channel transmission.
- RBW was set to 100 kHz while VBW is  $\geq 3X$  RBW.
- Sweep is auto while Detector used is peak.
- If the “n” dB down marker function of the spectrum analyser is not appropriate for the type of signal being measured, then a horizontal line will be drawn where the signal is 6 dB down from the peak measurement. The BW will be measured using the outermost points where the signal intersects the line.



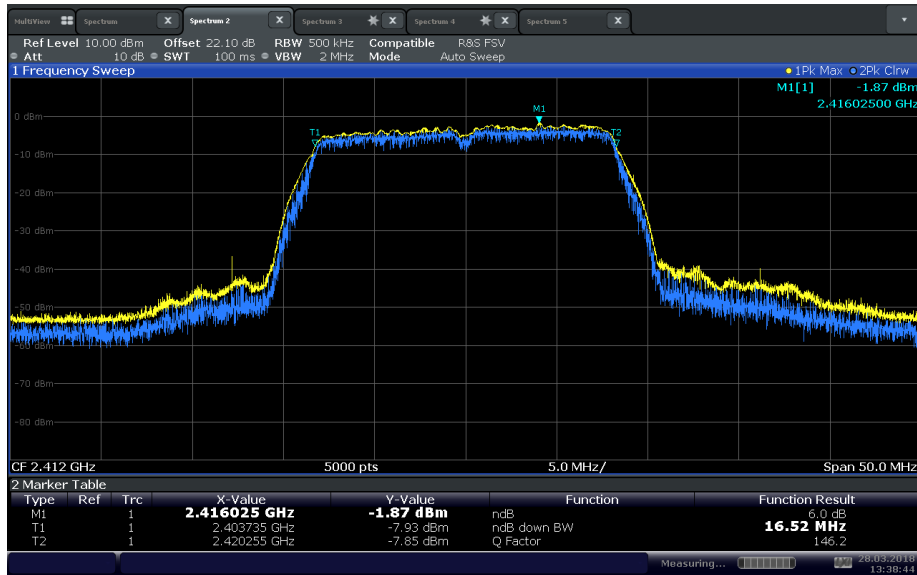
**2.4.8 Test Results**

Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
802.11b	1 (2412 MHz)	9.44	0.500	Complies
802.11g	1 (2412 MHz)	16.52	0.500	Complies

**2.4.9 Test Results Plots**



**802.11b Channel 1**



802.11g Channel 1



## **2.5 OUT-OF-BAND EMISSIONS - CONDUCTED**

### **2.5.1 Specification Reference**

Part 15 Subpart C §15.247(d) and RSS-247 5.5

### **2.5.2 Standard Applicable**

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### **2.5.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration A

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

March 28, 2018/JR

### **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

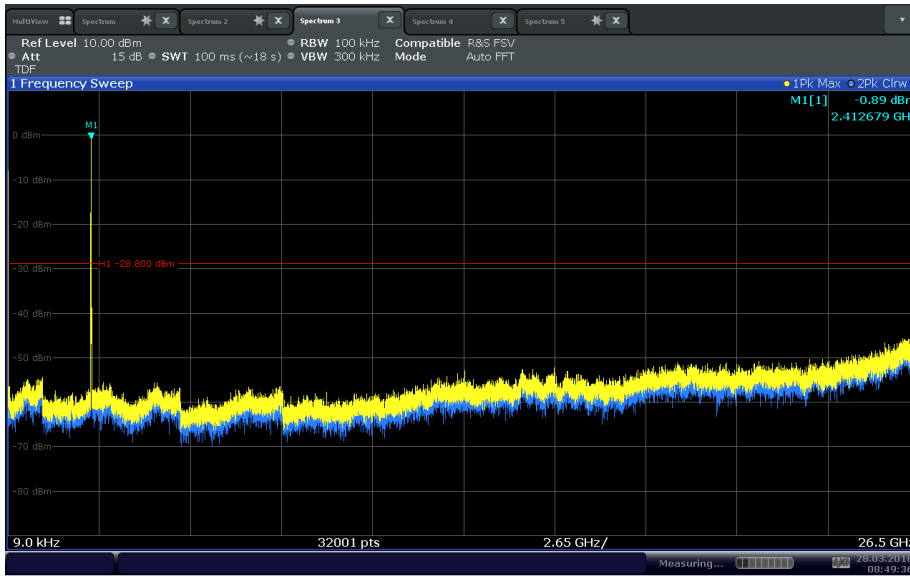
Ambient Temperature	24.7 °C
Relative Humidity	44.8 %
ATM Pressure	99.8 kPa

### **2.5.7 Additional Observations**

- This is a conducted test.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cables 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.

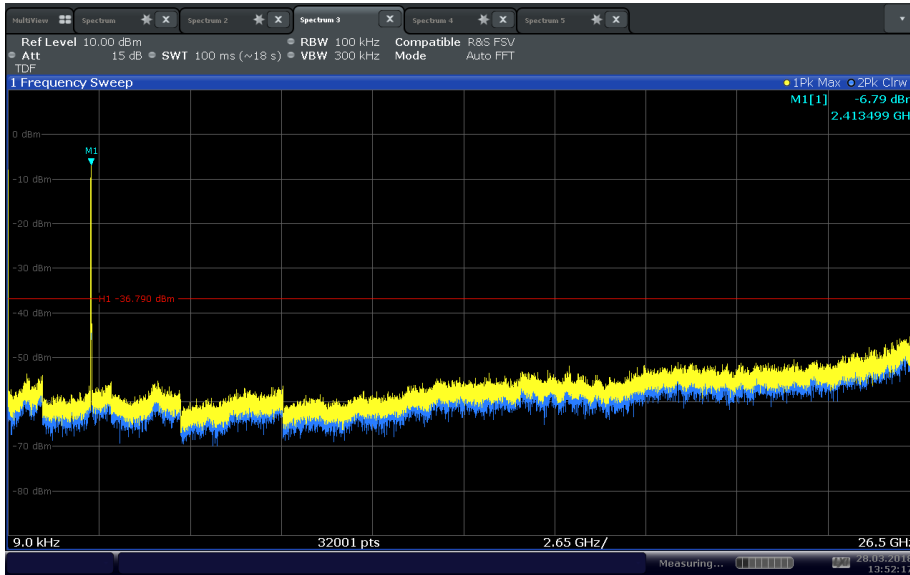


### 2.5.8 Test Results Plots



08:49:37 28.03.2018

802.11b Channel 1



13:52:17 28.03.2018

802.11g Channel 1



**2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS**

**2.6.1 Specification Reference**

Part 15 Subpart C §15.247(d) and RSS-247 5.5

**2.6.2 Standard Applicable**

See previous test.

**2.6.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration A

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

March 28, 2018/JR

**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      24.7 °C  
 Relative Humidity          44.8 %  
 ATM Pressure                99.8 kPa

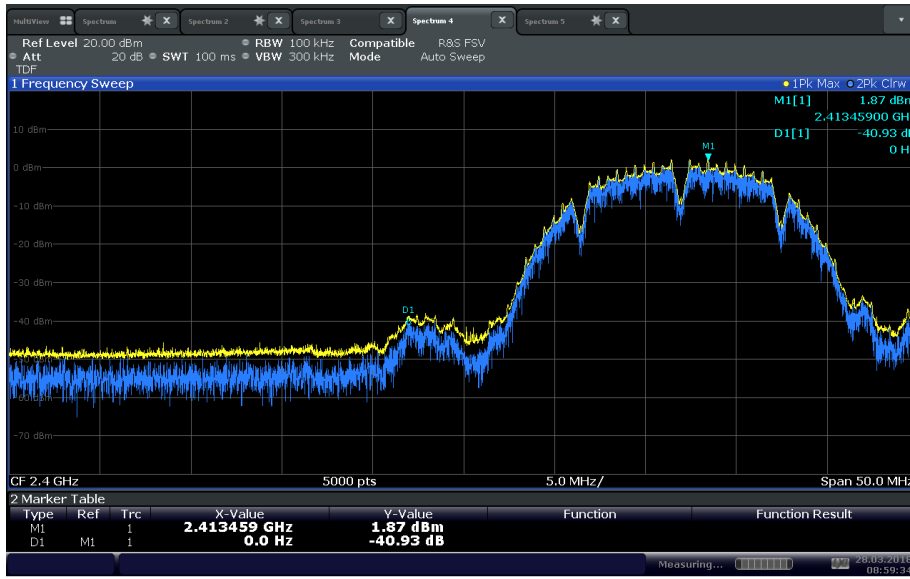
**2.6.7 Additional Observations**

- 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.

WLAN Mode	Peak Verification	Average Verification
802.11b	Clause 12.2.4	Clause 12.2.5.1
802.11g	Clause 12.2.4	Clause 12.2.5.2

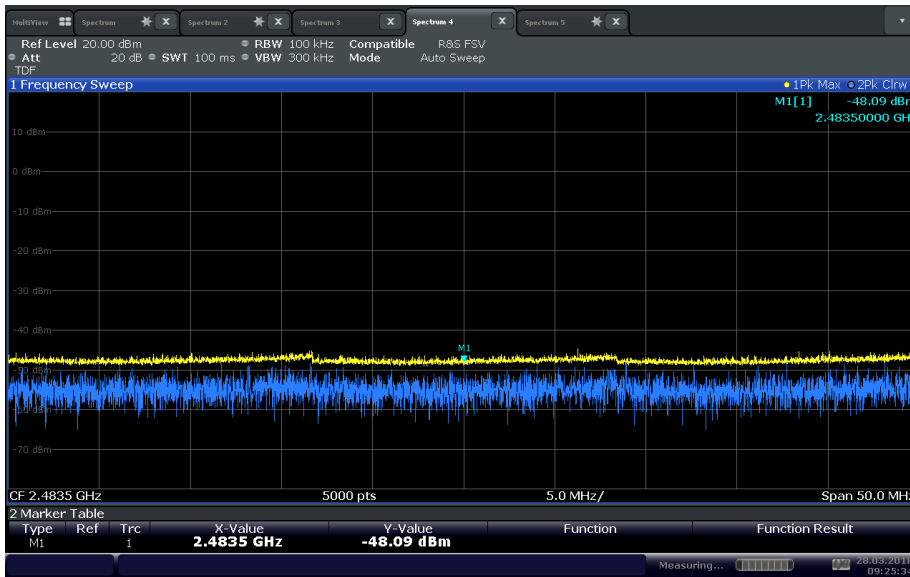
**2.6.8 Test Results**

**Complies.** See attached plots.



08:59:35 28.03.2018

**802.11b Low Channel (2402 MHz)**



09:25:34 28.03.2018

**Upper Band Edge Verification (EUT transmits at Channel 1 only)**

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

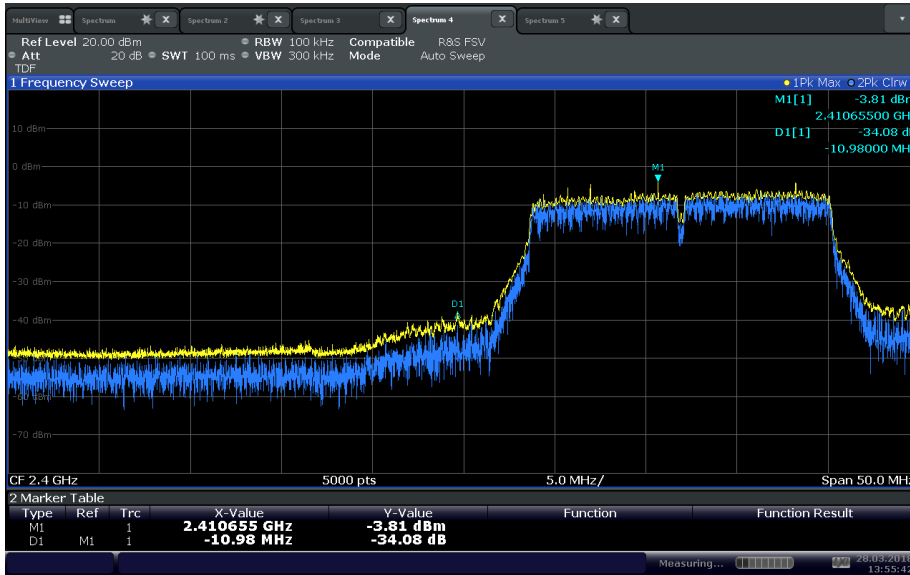


Measured Peak = -48.09 dBm, since antenna gain is 2.2 dBi then EIRP is -45.89 dBm. Electric field strength in dBµV/m is then calculated using the formula:

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

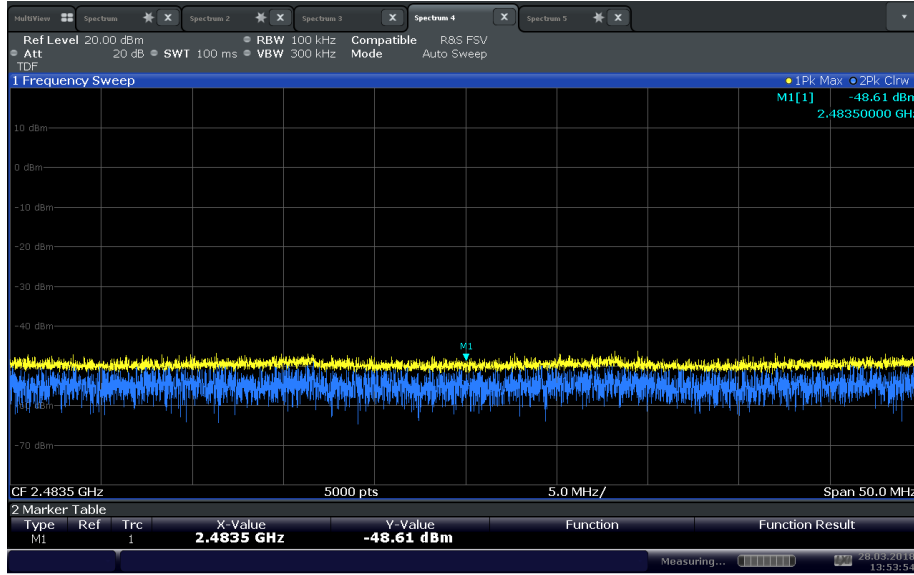
Where: E = electric field strength in dBµV/m  
 EIRP = equivalent isotropic radiated power in dBm  
 D = specific measurement distance in meters

E is therefore = (-48.09 + 2.2 dBi) dBm – (20log 3 meters) + 104.8  
 = 49.36 dBµV/m @ 3 meters (complies with 54 dBµV/m Average limits, Average verification not required)



13:55:43 28.03.2018

**802.11g Channel 1 (2412 MHz)**



13:53:55 28.03.2018

**Upper Band Edge Verification (EUT transmits at Channel 1 only)**

***Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074. Noise floor measurement observed. Results identical to 802.11 b***



## **2.7 SPURIOUS RADIATED EMISSIONS**

### **2.7.1 Specification Reference**

KDB558074 D01 DTS Meas Guidance v04 Clause 12.2.7

### **2.7.2 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.

### **2.7.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration B

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

March 12, 2018/JR

### **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 performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.1 °C
Relative Humidity	52.7 %
ATM Pressure	99.2 kPa

### **2.7.7 Additional Observations**

- This is a radiated test. The spectrum was searched from 30MHz to the 10<sup>th</sup> harmonic.
- Test Methodology is per Clause 12.2.7 of KDB558074 D01 DTS Meas Guidance v04.
- 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 data rate presented.
- Only noise floor measurements observed above 18GHz.



- For emissions not in restricted band, the 107.33 dBµV/m @ 3 meter calculated field strength measurement from 802.11 n (12.1 dBm EIRP, worse case as a limit between 802.11 b and g) will be used. 30dBc limit therefore will be 77.33 dBµV/m.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

**2.7.8 Sample Computation (Radiated Emission)**

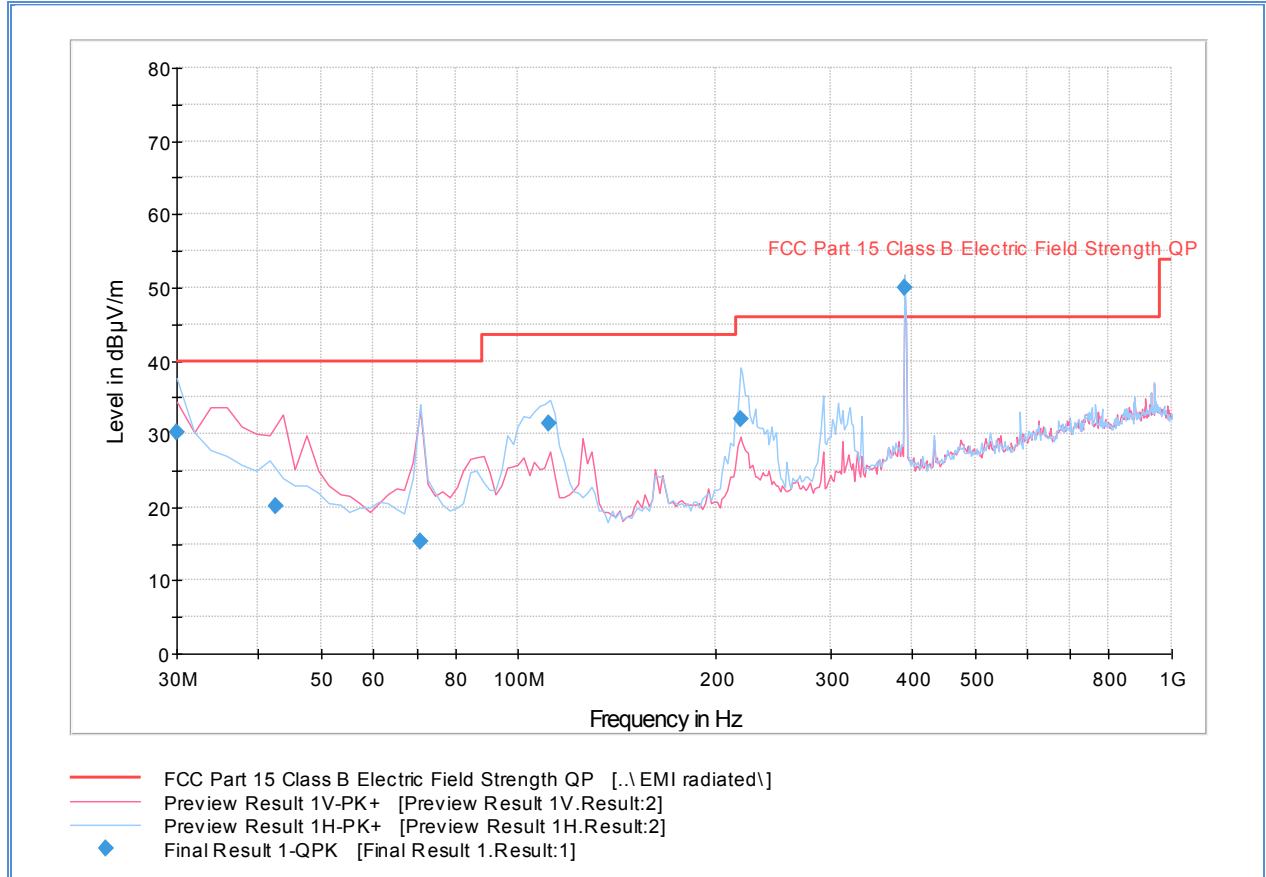
Measuring equipment raw measurement (dbµV) @ 30 MHz		24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3
	Asset# 1172 (cable)	0.3
	Asset# 1016 (preamplifier)	-30.7
	Asset# 1175(cable)	0.3
	Asset# 1002 (antenna)	17.2
<b>Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz</b>		<b>11.8</b>

**2.7.9 Test Results**

See attached plots.



**2.7.10 Test Results Below 1GHz (Worst Case Configuration – 802.11b)**



**Quasi Peak Data**

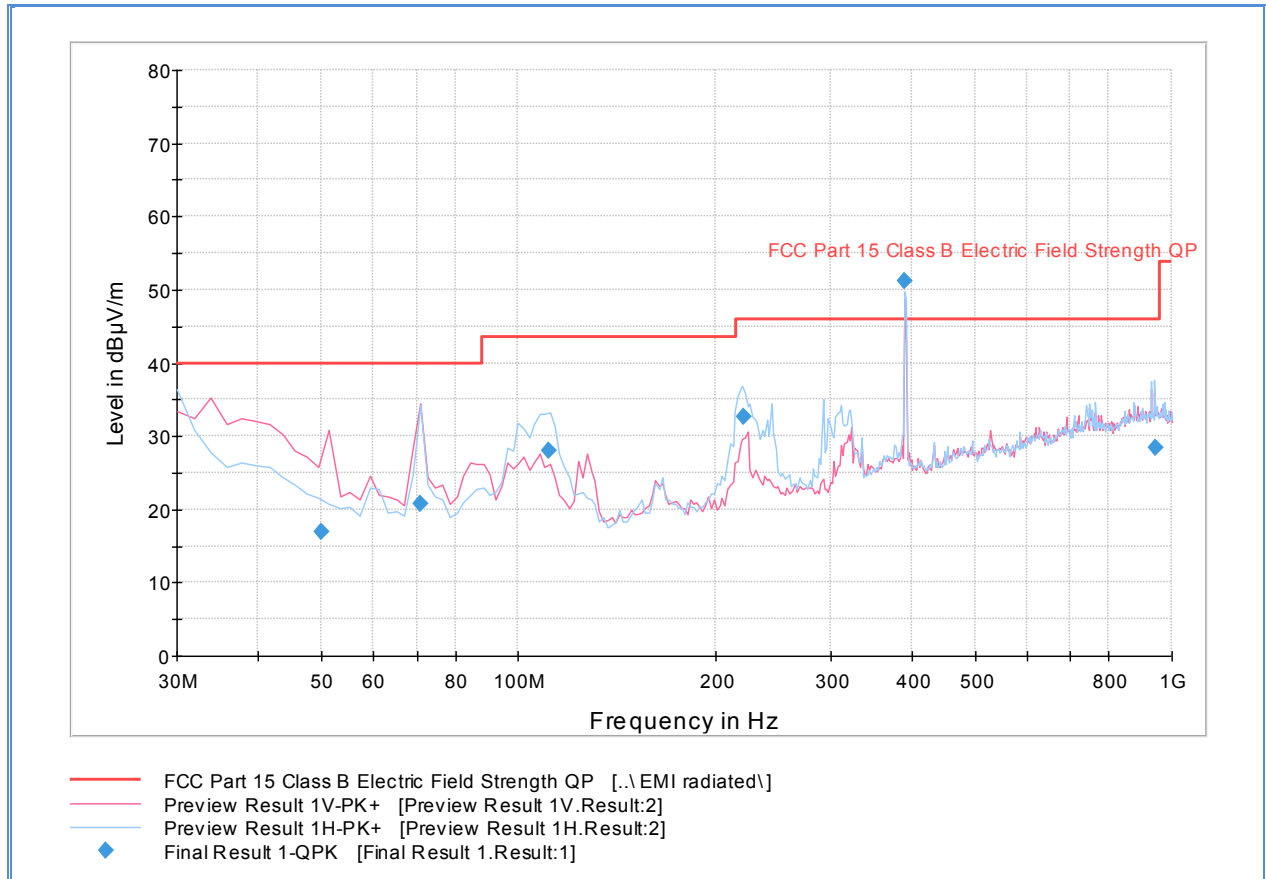
Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
30.000000	30.1	1000.0	120.000	155.0	H	18.0	-5.2	9.9	40.0
42.567214	20.2	1000.0	120.000	100.0	V	326.0	-12.5	19.8	40.0
70.781643	15.4	1000.0	120.000	400.0	H	18.0	-16.1	24.6	40.0
111.443287	31.5	1000.0	120.000	184.0	H	173.0	-14.6	12.0	43.5
218.837114	32.1	1000.0	120.000	150.0	H	-8.0	-10.1	13.9	46.0
389.859238	50.1	1000.0	120.000	100.0	H	318.0	-3.4	-4.1	46.0

**Test Notes:** 389.86 MHz not in restricted band, complies with the worst case 30 dBc limit of 77.33 dBµV/m.





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

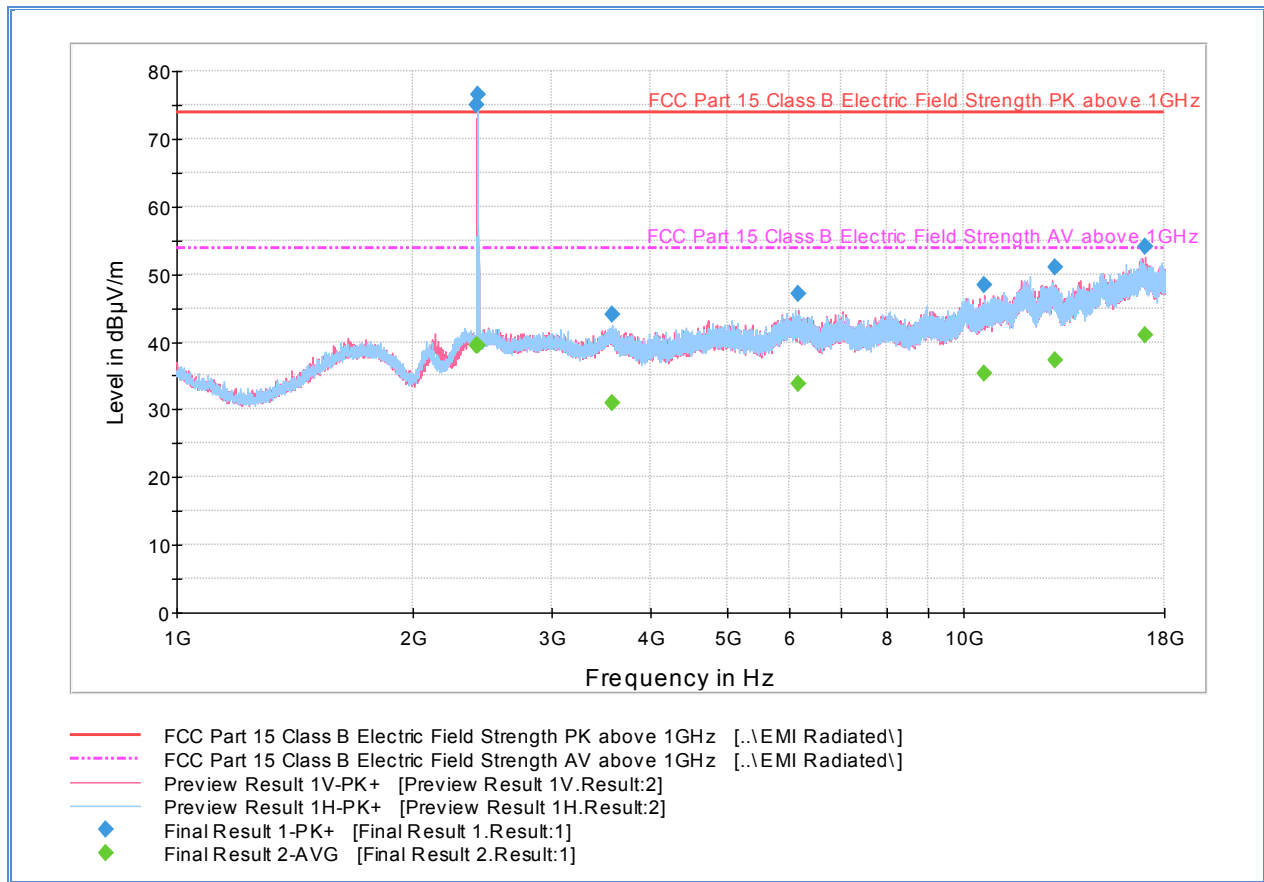


**Quasi Peak Data**

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
50.062766	16.9	1000.0	120.000	100.0	V	22.0	-13.7	23.1	40.0
70.781643	20.8	1000.0	120.000	200.0	V	11.0	-16.1	19.2	40.0
111.259399	28.1	1000.0	120.000	288.0	H	147.0	-14.6	15.4	43.5
220.821002	32.6	1000.0	120.000	150.0	H	348.0	-9.9	13.4	46.0
390.019238	51.2	1000.0	120.000	100.0	H	327.0	-3.4	-5.2	46.0
942.723367	28.5	1000.0	120.000	389.0	H	11.0	6.8	17.5	46.0

**Test Notes:** 390.02 MHz not in restricted band, complies with the worst case 30 dBc limit of 77.33 dBµV/m.

**2.7.12 Test Results Above 1GHz (Worst Case Configuration – 802.11b)**



**Peak Data**

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2408.966667	75.1	1000.0	1000.000	151.6	V	12.0	-0.8	-1.2	73.9
2413.300000	76.4	1000.0	1000.000	151.6	H	202.0	-0.7	-2.5	73.9
3580.166667	44.0	1000.0	1000.000	410.7	H	52.0	1.6	29.9	73.9
6162.000000	47.0	1000.0	1000.000	250.5	V	58.0	6.6	26.9	73.9
10624.066667	48.4	1000.0	1000.000	169.6	V	64.0	11.8	25.5	73.9
13049.600000	51.0	1000.0	1000.000	152.2	V	65.0	13.5	22.9	73.9
16986.633333	54.1	1000.0	1000.000	152.2	V	-12.0	18.9	19.8	73.9

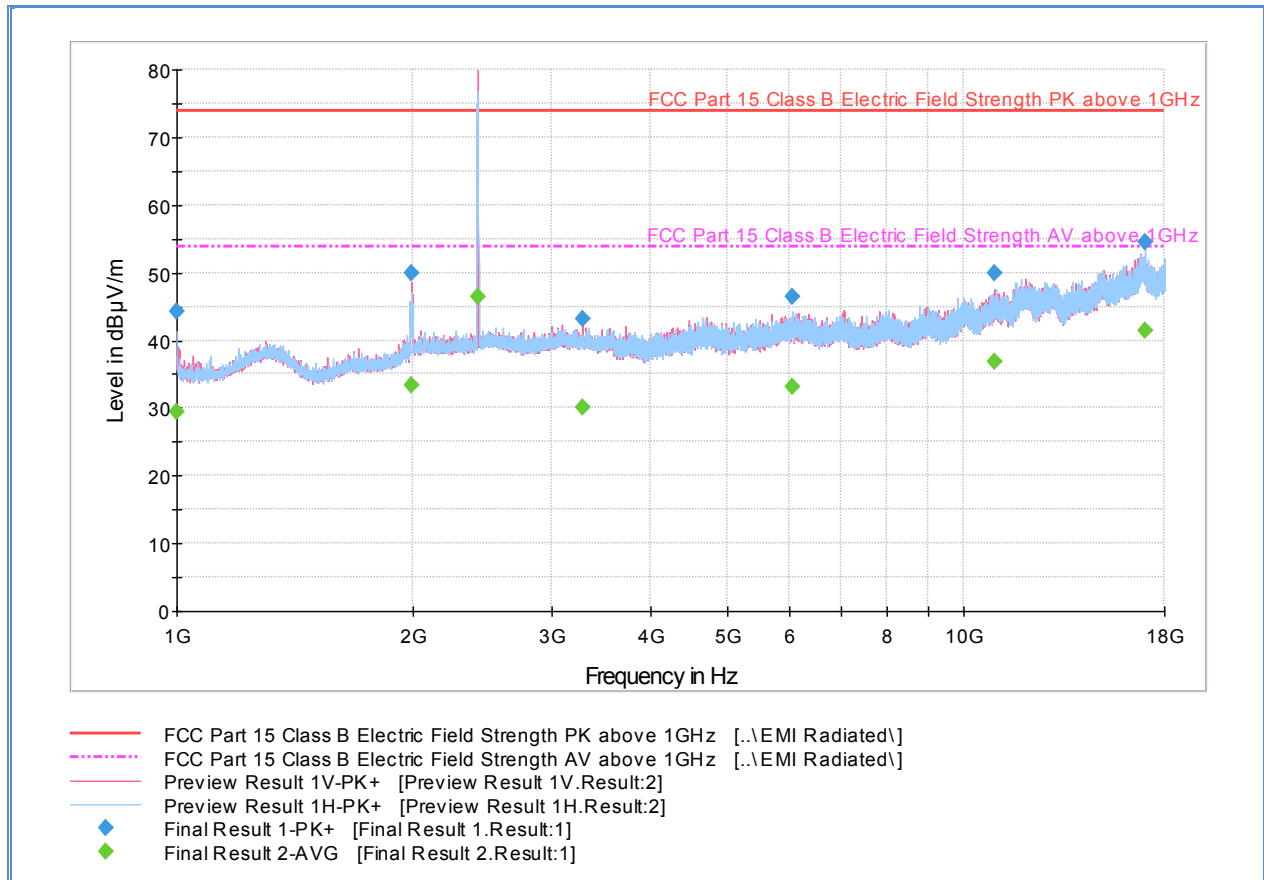
**Average Data**

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2408.966667	39.5	1000.0	1000.000	151.6	V	12.0	-0.8	14.4	53.9
2413.300000	39.5	1000.0	1000.000	151.6	H	202.0	-0.7	14.4	53.9
3580.166667	30.9	1000.0	1000.000	410.7	H	52.0	1.6	23.0	53.9
6162.000000	33.8	1000.0	1000.000	250.5	V	58.0	6.6	20.1	53.9
10624.066667	35.4	1000.0	1000.000	169.6	V	64.0	11.8	18.5	53.9
13049.600000	37.3	1000.0	1000.000	152.2	V	65.0	13.5	16.6	53.9
16986.633333	40.9	1000.0	1000.000	152.2	V	-12.0	18.9	13.0	53.9

**Test Notes:** No significant emissions observed above 18GHz. Measurements above 18GHz were noise floor figures. Emissions within the boundary of the notch filter will be ignored for this test.



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



**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	44.2	1000.0	1000.000	152.2	H	152.0	-7.1	29.7	73.9
1990.333333	50.0	1000.0	1000.000	303.2	V	203.0	-2.0	23.9	73.9
2413.400000	85.2	1000.0	1000.000	201.5	V	8.0	-0.7	-11.3	73.9
3284.666667	43.2	1000.0	1000.000	196.5	V	186.0	1.1	30.7	73.9
6049.133333	46.5	1000.0	1000.000	192.5	H	115.0	6.4	27.4	73.9
10973.700000	49.9	1000.0	1000.000	352.7	V	314.0	12.1	24.0	73.9
17001.366667	54.5	1000.0	1000.000	103.7	H	183.0	18.9	19.4	73.9

**Average Data**

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	29.4	1000.0	1000.000	152.2	H	152.0	-7.1	24.5	53.9
1990.333333	33.3	1000.0	1000.000	303.2	V	203.0	-2.0	20.6	53.9
2413.400000	46.4	1000.0	1000.000	201.5	V	8.0	-0.7	7.5	53.9
3284.666667	30.0	1000.0	1000.000	196.5	V	186.0	1.1	23.9	53.9
6049.133333	33.2	1000.0	1000.000	192.5	H	115.0	6.4	20.7	53.9
10973.700000	36.9	1000.0	1000.000	352.7	V	314.0	12.1	17.0	53.9
17001.366667	41.3	1000.0	1000.000	103.7	H	183.0	18.9	12.6	53.9

**Test Notes:** No significant emissions observed above 18GHz. Measurements above 18GHz were noise floor figures. Emissions within the boundary of the notch filter will be ignored for this test.



## **2.8 POWER SPECTRAL DENSITY**

### **2.8.1 Specification Reference**

Part 15 Subpart C §15.247(e) and RSS-247 5.2(2)

### **2.8.2 Standard Applicable**

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

### **2.8.3 Equipment Under Test and Modification State**

Serial No: N/A / Test Configuration B

### **2.8.4 Date of Test/Initial of test personnel who performed the test**

March 12, 2018/JR

### **2.8.5 Test Equipment Used**

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

### **2.8.6 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.1 °C
Relative Humidity	52.7 %
ATM Pressure	99.2 kPa

### **2.8.7 Additional Observations**

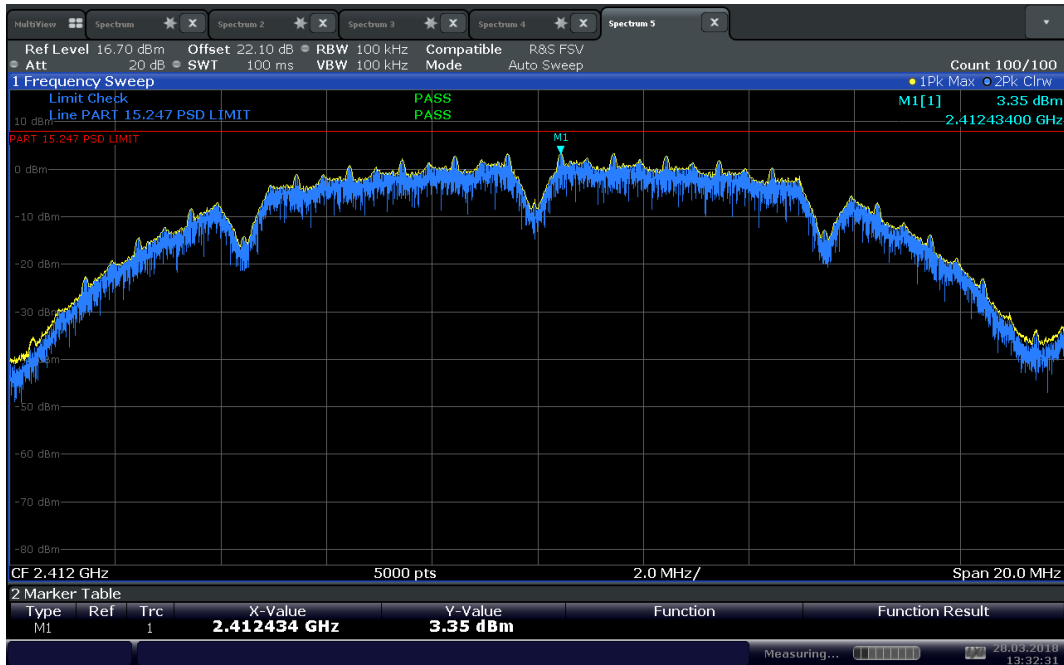
- This is a conducted test.
- Test procedure is per Section 10.2 of KDB 558074 v04 (April 05, 2017).
- Span is 1.5 times the DTS bandwidth.
- TDF (Transducer Factor) was used to compensate for the external attenuator and cable used.
- Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
- 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.
- The RBW used during testing shall be reported.



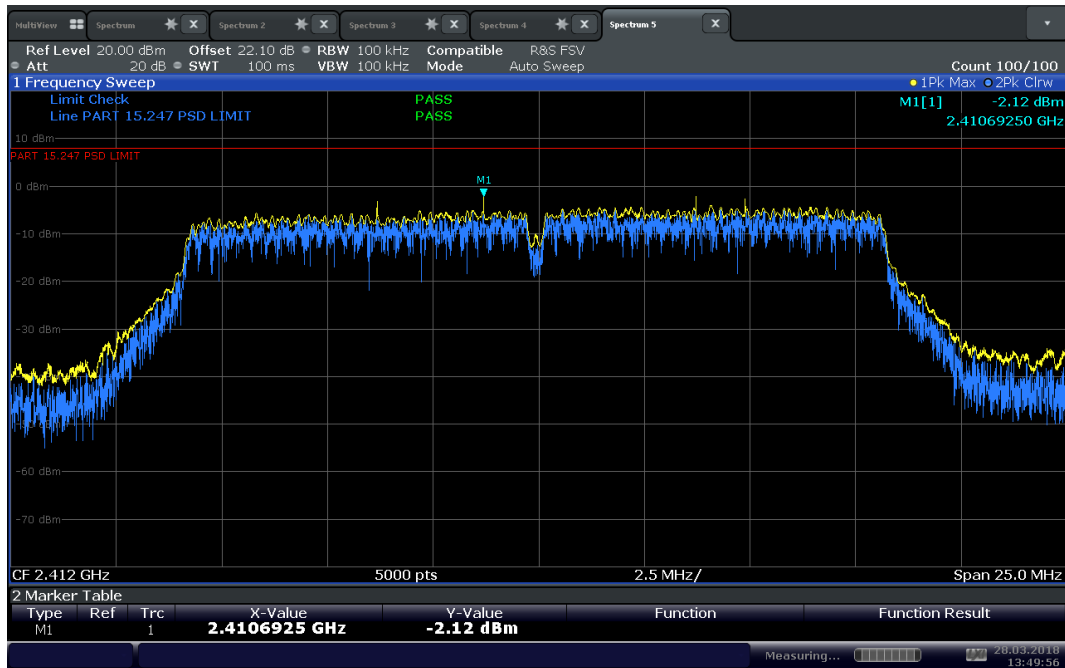
**2.8.8 Test Results Summary**

Mode	Channel	Marker Reading (dBm)/RBW used	PSD Limit (dBm)	Margin (dB)	Compliance
802.11b	1 (2412 MHz)	3.35/100kHz	8	4.65	Complies
802.11g	1 (2412 MHz)	-2.12/100kHz	8	10.12	Complies

**2.8.9 Test Results Plots**



**802.11b Channel 1**



13:49:56 28.03.2018

### 802.11g Channel 1



### **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
<b>Antenna Conducted Port Setup</b>						
7606	USB RF Power Sensor	RadiPower RPR3006W	14I00048SNO048	DARE!! Instruments	01/02/18	01/02/19
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	12/14/17	12/14/18
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	05/30/17	05/30/18
7608	Vector Signal Generator	SMBV100A	259021	Rhode & Schwarz	09/19/17	09/19/19
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 1003 and 7582	
8832	20dB Attenuator	34-20-34	BP4150	MCE/Weinschel	Verified by 1003 and 7582	
<b>AC Conducted Emissions Test Setup</b>						
1024	EMI Test Receiver	ESCS 30	847793/001	Rhode & Schwarz	09/15/17	09/15/18
7567	LISN	FCC-LISN-50-25-2-10	120304	Fischer Custom Comm.	12/14/17	12/14/18
6837	LISN	FCC-LISN-50-25-2	5025	Fischer Custom Comm.	05/30/17	05/30/18
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/06/18	03/06/19
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	03/06/18	03/06/19
<b>Radiated Test Setup</b>						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/20/17	11/20/19
8891	Pre-Amplifier	PE15A3262	1012	TUV SUD America	06/15/17	06/15/18
7620	EMI Test Receiver	ESU40	100399	Rhode & Schwarz	10/17/17	10/17/18
7631	Double-ridged waveguide horn antenna	3117	00205418	ETS-Lindgren	08/03/17	08/03/18
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	07/13/17	07/13/18
6815	2.4GHz Band Notch Filter	BRM50702	008	Micro-Tronics	Verified by 1003 and 7582	
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	03/06/18	03/06/19
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 1003 and 7582	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 1003 and 7582	
<b>Miscellaneous</b>						
6708	Multimeter	34401A	US36086974	Hewlett Packard	07/05/17	07/05/18
7560	Barometer/ Temperature/ Humidity Transmitter	iBTHX-W	1240476	Omega	01/17/17	01/17/18
	DC Power Supply	35010M	D102007S	Protek	Verified by 6708	





### 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	0.75	0.44	0.19
4	Antenna	Rectangular	3.52	1.44	2.07
5	Site	Rectangular	1.00	0.58	0.33
6	EUT Setup	Rectangular	0.45	0.26	0.07
Combined Uncertainty ( $u_c$ ):					1.66
Coverage Factor (k):					2
Expanded Uncertainty:					3.31

#### 3.2.2 Radiated Emission Measurements (Above 1GHz)

Contribution		Probability Distribution Type	Probability Distribution $x_i$	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	3.00	1.22	1.50
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty ( $u_c$ ):					1.49
Coverage Factor (k):					2
Expanded Uncertainty:					2.99

#### 3.2.3 Conducted Antenna Port Measurements

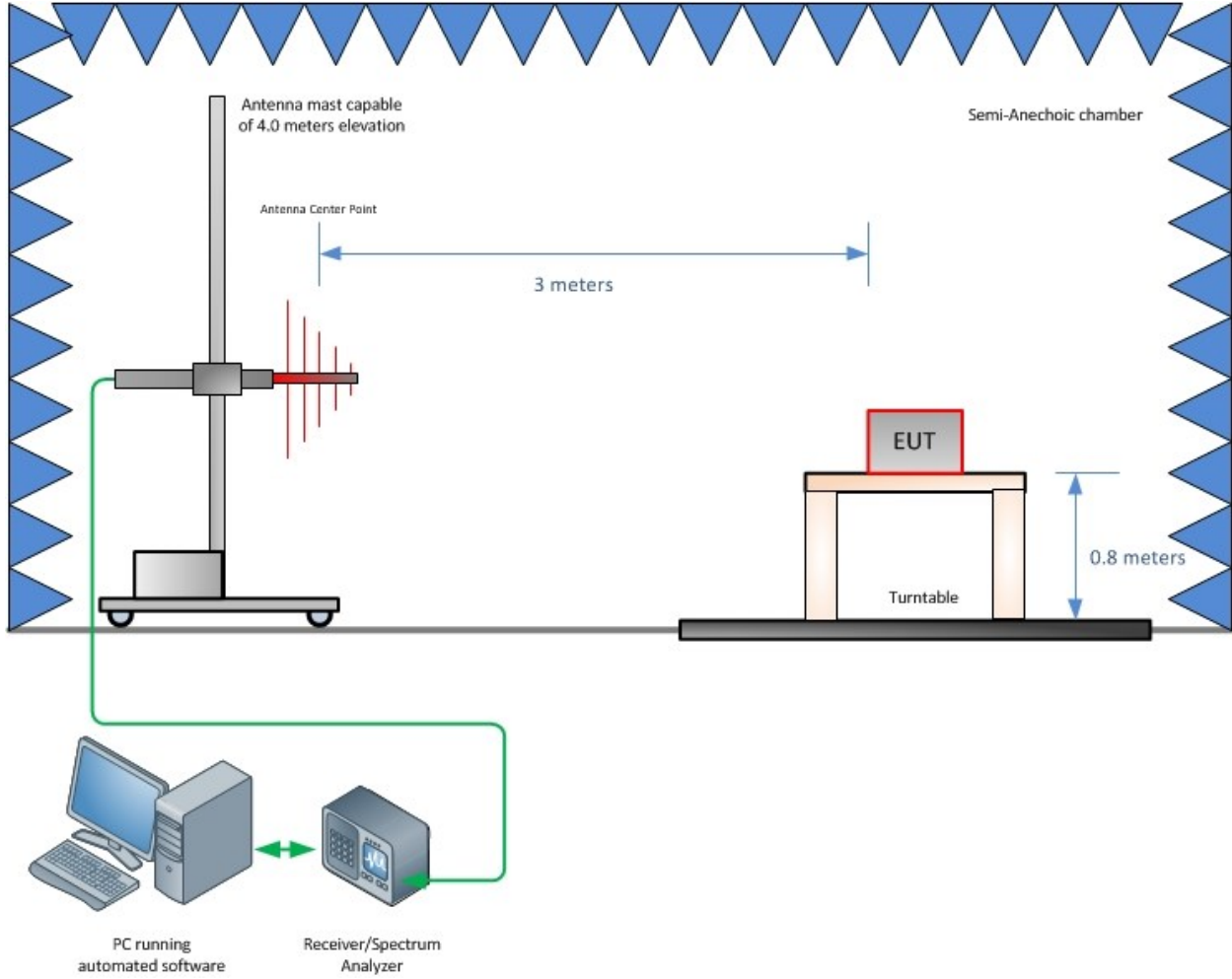
Contribution		Probability Distribution Type	Probability Distribution $x_i$	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.08	0.05	0.00
2	Cables	Rectangular	0.30	0.17	0.03
3	EUT Setup	Rectangular	0.50	0.29	0.08
Combined Uncertainty ( $u_c$ ):					0.34
Coverage Factor (k):					1.96
Expanded Uncertainty:					0.67



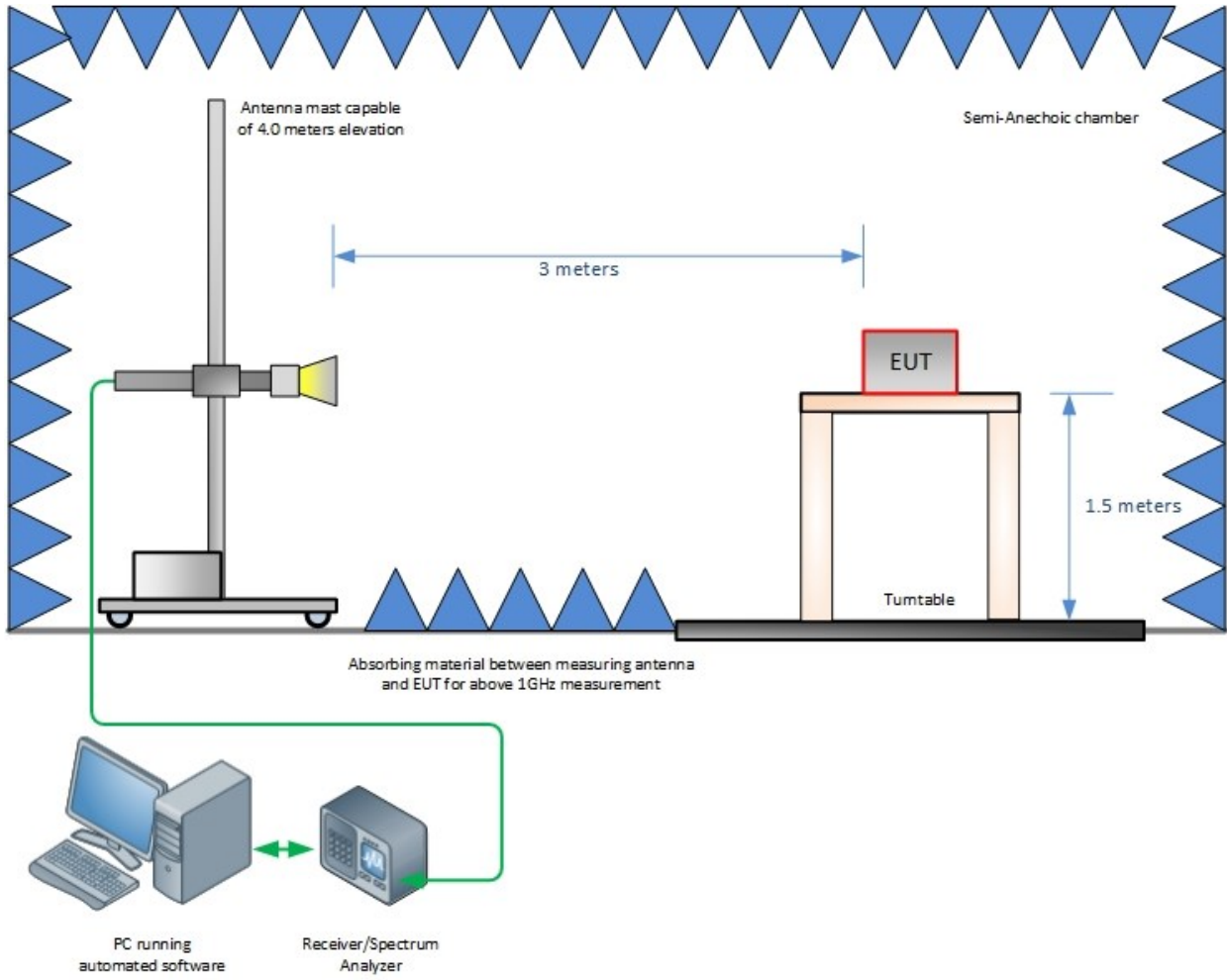
## SECTION 4

### DIAGRAM OF TEST SETUP

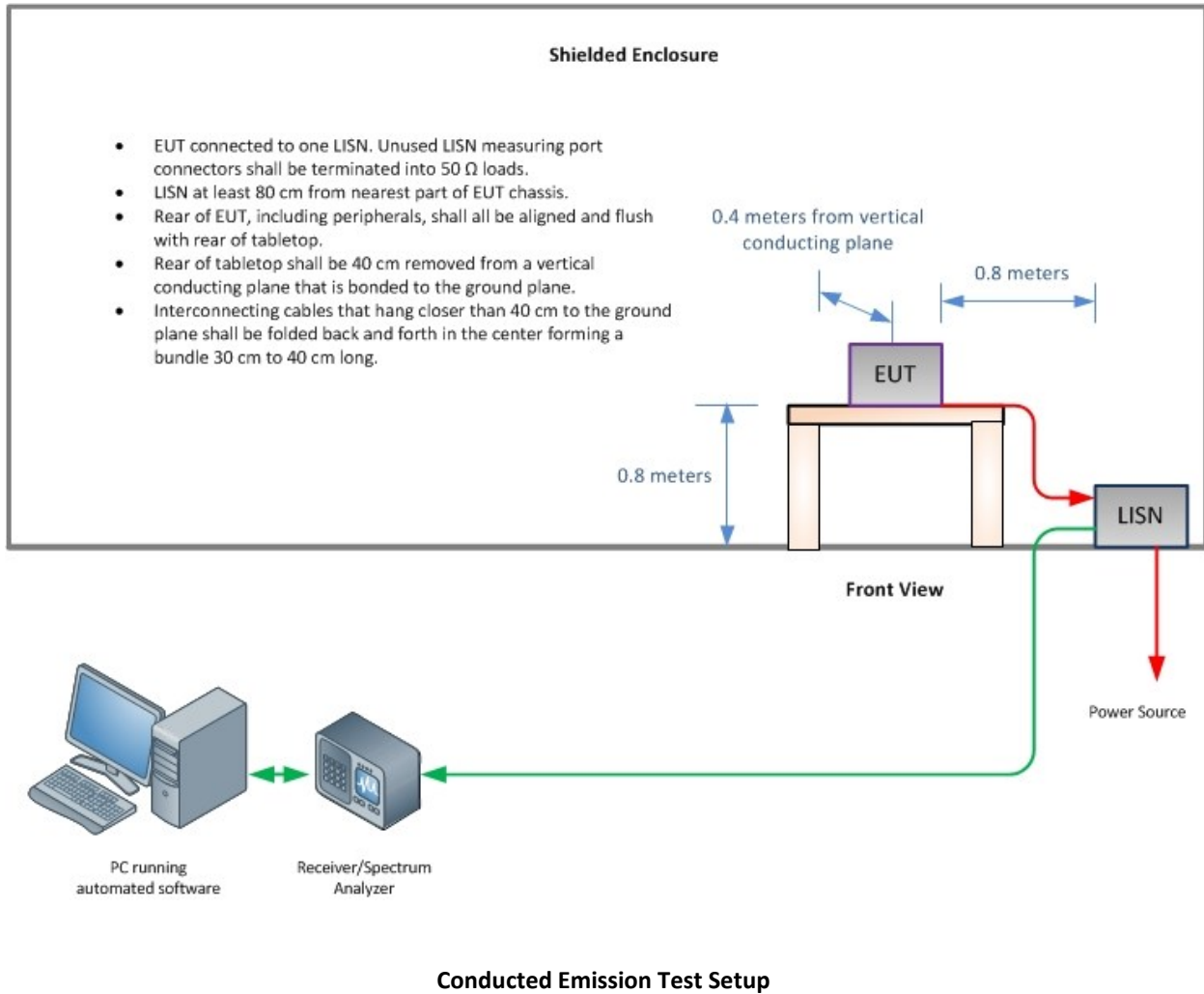
#### 4.1 TEST SETUP DIAGRAM



**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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