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Report On

Application for Grant of Equipment Authorization of the
Digi International
Connect WiME 9210 b/g/n 802.11 b/g/n Embedded Radio
Module (802.11 b/g/n to Serial Port Converter Module)

FCC Part 15 Subpart C §15.247 (DTS)
RSS-247 Issue 1 May 2015

Report No. SD72119678-0816 Rev. 01

September 2016



REPORT ON	Radio Testing of the Digi International 802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module)
TEST REPORT NUMBER	SD72119678-0816 Rev. 01
PREPARED FOR	Digi International 11001 Bren Road East Minnetonka, MN 55343 USA
CONTACT PERSON	Bill Kumpf Hardware Engineer (952) 912-3183 bill_kumpf@digi.com
PREPARED BY	 Alex Chang Name Authorized Signatory Title: EMC/Wireless Test Engineer
APPROVED BY	 Juan Manuel Gonzalez Name Authorized Signatory Title: Western Region EMC Service Line Manager
DATED	<u>September 16, 2016</u>



Revision History

SD72119678-0816 Rev. 01 Digi International Connect WiME 9210 b/g/n 802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module)					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
08/31/2016	Initial Release				Juan M. Gonzalez
09/16/2016	Initial Release	Rev. 01	Reduced RF output power	8, 9 and 15	Juan M. Gonzalez



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SECTION 1

REPORT SUMMARY

Radio Testing of the
Digi International
Connect WiME 9210 b/g/n
802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module)



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Digi International Connect WiME 9210 b/g/n 802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module) to the requirements of FCC Part 15 Subpart C §15.247 and RSS-247 Issue 1 May 2015.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Digi International
Model Name	Connect WiME 9210 b/g/n
Model Number(s)	Connect WiME 9210 b/g/n
FCC ID Number	MCQ-50M1745
IC Number	1846A-50M1745
Serial Number(s)	00001
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2015). • RSS-247 Issue 1 May 2015 - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices. • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 4, November 2014). • 558074 D01 DTS Meas Guidance v03r05, (April 08, 2016) Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247. • ANSI C63.10-2013. American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Start of Test	August 19, 2016
Finish of Test	August 23, 2016
Name of Engineer(s)	Alex Chang
Related Document(s)	None. Supporting documents for EUT certification are separate exhibits.



1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 with cross-reference to the corresponding IC RSS standard is shown below.

Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments/ Base Standard
2.1	§15.247(b)(3)	RSS-247 5.4(4)	Peak Output Power	Compliant	
—	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	N/A	
2.2	—	RSS-Gen 6.6	99% Emission Bandwidth	Compliant	
2.3	§15.247(a)(2)	RSS-247 5.2(1)	Minimum 6 dB RF Bandwidth	Compliant	
2.4	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.6	KDB558074 Clause 12.2.7		Spurious Radiated Emissions	Compliant	
2.7	§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 Digi International Connect WiME 9210 b/g/n 802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module). The EUT supports 802.11b, 802.11g and 802.11n. WLAN supports in 2.4GHz Band and has been verified and evaluated in this test report.

1.3.2 EUT General Description

EUT Description	802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module)
Model Name	Connect WiME 9210 b/g/n
Model Number(s)	Connect WiME 9210 b/g/n
Rated Voltage	3.3VDC
Mode Verified	802.11b, 802.11g and 802.11n (20MHz BW) in 2.4GHz band
Capability	802.11b, 802.11g and 802.11n (20MHz BW)
Primary Unit (EUT)	☐ Production ☒ Pre-Production ☐ Engineering
Antenna Type	Dipole
Antenna Manufacturer	Bobbintron Electrical Corp.
Manufacturer P/N	SA-006-1
Digi International P/N	29000095
Antenna Gain	2.0 dBi

1.3.3 Maximum Conducted Output Power

Mode	Frequency Range (MHz)	Output Power (dBm)	Output Power (mW)
802.11b	2412 – 2462	16.0	39.811
802.11g	2412 – 2462	13.1	20.417
802.11n 20MHz	2412 – 2462	13.3	21.380

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 or USB power sensor with 20dB external attenuator.
B	Radiated Test Setup (Cabinet Spurious Emissions). Antenna port terminated with 50Ω load.

1.4.2 EUT Exercise Software

The EUT is connected to the support laptop via serial port to USB. Tera Term was used to communicate with the EUT. The manufacturer provided instruction to configure the RF settings of the EUT. Parameters that could be updated for set the 802.11 mode, channels, modulation, bandwidths and TX power. For Tx power setting on “b” mode was set to 60 and “g”/“n” modes were set to 55 during evaluation.

1.4.3 Support Equipment and I/O cables

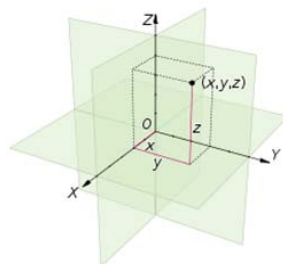
Manufacturer	Equipment/Cable	Description
Lenovo	Support Laptop	Model: X100e, Type: 3508-2AU, S/N: LR-EVAME 10/07
—	Serial to USB cable	EUT to Support Laptop
GlobTek, Inc.	EUT Support AC-DC External Power Supply	Model: GT-21089-0903-T3

1.4.4 Worst Case Configuration

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

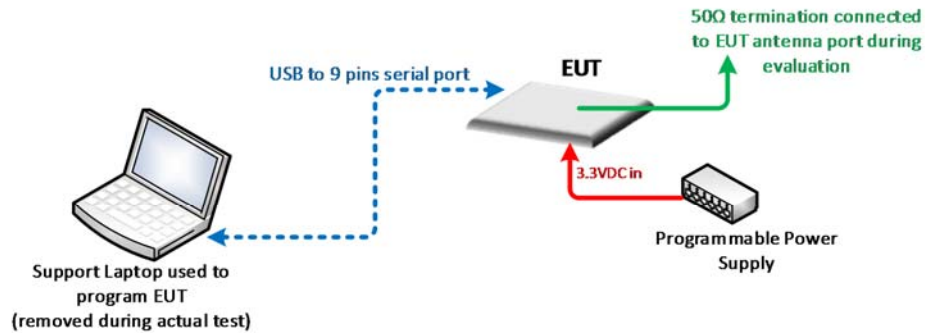
Mode	Channel	Data Rate
802.11b	1 (Low Channel)	1 Mbps
802.11g	1 (Low Channel)	24 Mbps
802.11n 20MHz BW	1 (Low Channel)	mcs 0 (6.5Mbps)

The EUT is a WiFi module and was fixed on a PCB to support laptop for connection. Therefore, for radiated measurements no X, Y and Z orientations were verified, but only X as the orientation placed on the table for final evaluation.

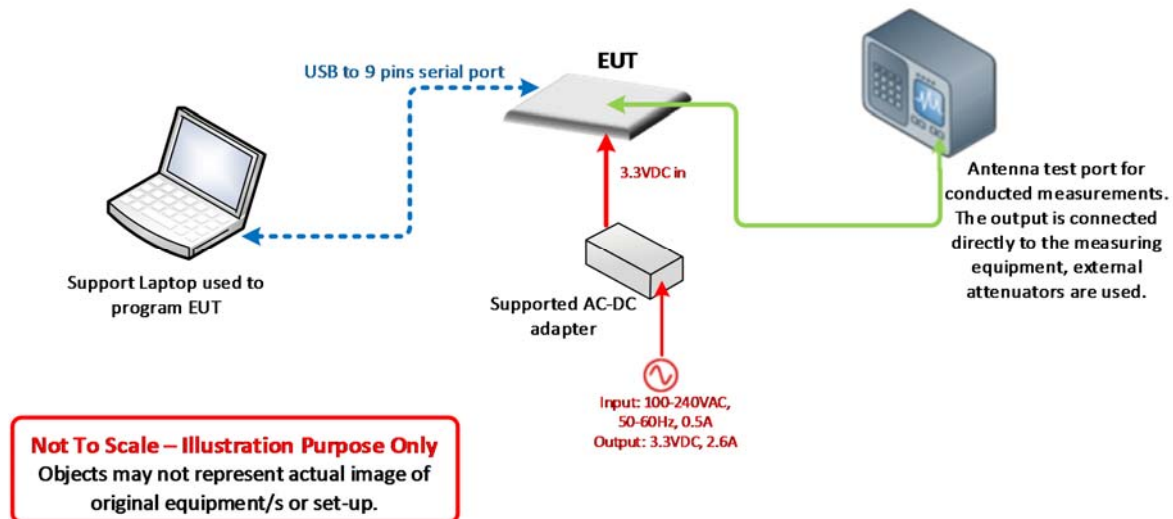


1.4.5 Simplified Test Configuration Diagram

Radiated Emission Test Setup



Conducted Port Measurement Test Setup





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: 00001		
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: 858 678 1466 Fax: 858 546 0364.

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

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



1.9.2 Innovation, Science and Economic Development Canada (ISED) Registration No.: 3067A

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



SECTION 2

TEST DETAILS

Radio Testing of the
Digi International
Connect WiME 9210 b/g/n
802.11 b/g/n Embedded Radio Module (802.11 b/g/n to Serial Port Converter Module)



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: 00001 / Test Configuration A

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

August 22 and September 16 2016 / AC

2.1.5 Test Equipment Used

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

2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	22.8 °C
Relative Humidity	54.1 %
ATM Pressure	98.7 kPa

2.1.7 Additional Observations

- This is a conducted test (Maximum conducted [average] output power) using direct connection to a USB power sensor.
- An offset of 21.0dB was added to compensate for the external attenuator and cable used from the antenna port to the power sensor.
- Test methodology is per Clause 9.2.3.1 of KDB 558074 D01 (DTS Meas Guidance v03r05, April 08, 2016). All conditions under this Clause are satisfied.
- The EUT transmits continuously. Burst Mode of the power meter was used wherein the captured burst were analysed and presented. Captured bursts includes the average power and timing data.
- EUT complies with the 30dBm limit.

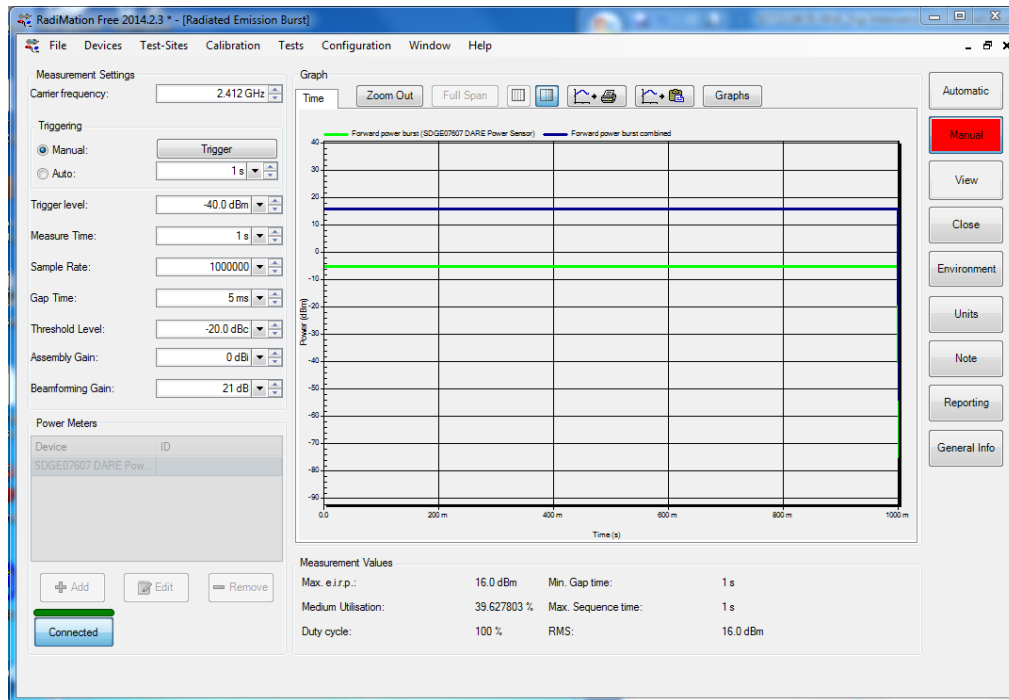
2.1.8 Test Results

WLAN Mode	Channel	Data Rates (Mbps)	Maximum Conducted Output Power (dBm)
802.11b	1 (2412 MHz)	1	16.0
		2	16.0
		5.5	16.0
		11	15.9
	6 (2437 MHz)	1	15.9
		2	15.9
		5.5	15.9
		11	15.9
	11 (2462 MHz)	1	15.7
		2	15.8
		5.5	15.8
		11	15.8

WLAN Mode	Channel	Data Rates (Mbps)	Maximum Conducted Output Power (dBm)
802.11g	1 (2412 MHz)	6	12.9
		9	12.9
		12	13.0
		18	12.9
		24	13.1
		36	13.0
		48	13.1
		54	13.1
	6 (2437 MHz)	6	12.8
		9	12.8
		12	12.7
		18	12.8
		24	12.7
		36	12.7
		48	12.8
		54	12.8
	11 (2462 MHz)	6	12.5
		9	12.5
		12	12.5
		18	12.5
		24	12.4
		36	12.4
		48	12.4
		54	12.4

WLAN Mode	Channel	Modulation and Coding Scheme	Maximum Conducted Output Power (dBm)
802.11n 20MHz BW	1 (2412 MHz)	mcs 0 (6.5Mbps)	13.3
		mcs 1 (13Mbps)	13.3
		mcs 2 (19.5Mbps)	13.3
		mcs 3 (26Mbps)	13.3
		mcs 4 (39Mbps)	13.3
		mcs 5 (52Mbps)	13.3
		mcs 6 (58.5Mbps)	13.3
		mcs 7 (65Mbps)	13.3
	6 (2437 MHz)	mcs 0 (6.5Mbps)	12.9
		mcs 1 (13Mbps)	12.9
		mcs 2 (19.5Mbps)	12.9
		mcs 3 (26Mbps)	12.9
		mcs 4 (39Mbps)	12.9
		mcs 5 (52Mbps)	12.9
		mcs 6 (58.5Mbps)	12.9
		mcs 7 (65Mbps)	12.9
	11 (2462 MHz)	mcs 0 (6.5Mbps)	12.7
		mcs 1 (13Mbps)	12.7
		mcs 2 (19.5Mbps)	12.7
		mcs 3 (26Mbps)	12.7
		mcs 4 (39Mbps)	12.6
		mcs 5 (52Mbps)	12.7
		mcs 6 (58.5Mbps)	12.7
		mcs 7 (65Mbps)	12.7

2.1.9 Sample Test Plots



802.11b Low Channel



2.2 99% EMISSION BANDWIDTH

2.2.1 Specification Reference

RSS-Gen Clause 6.6

2.2.2 Standard Applicable

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

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

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

Note: Video averaging is not permitted.

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

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

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

2.2.3 Equipment Under Test and Modification State

Serial No: 00001 / Test Configuration A

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

August 22, 2016 / AC

2.2.5 Test Equipment Used

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



2.2.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature 26.0 °C
 Relative Humidity 47.7 %
 ATM Pressure 98.9 kPa

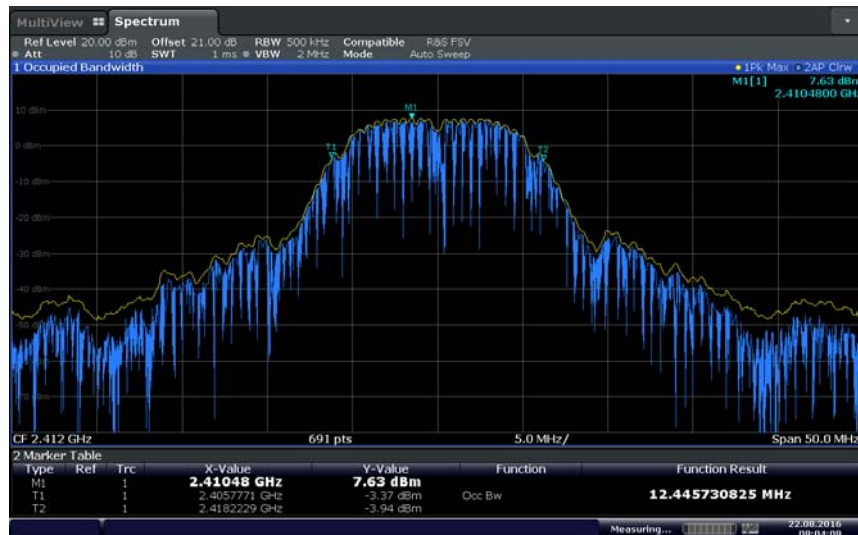
2.2.7 Additional Observations

- This is a conducted test.
- An offset of 21.0 dB was used to compensate for the external attenuator and cable used.
- Span is wide enough to capture the channel transmission.
- RBW is 1% of the span.
- VBW is 3X RBW.
- Sweep is auto.
- Detector is peak.
- The % Power Bandwidth setting in the spectrum analyser was set to 99% (default).
- The Channel Bandwidth measurement function of the spectrum analyser was used for this test.

2.2.8 Test Results (For reporting purposes only)

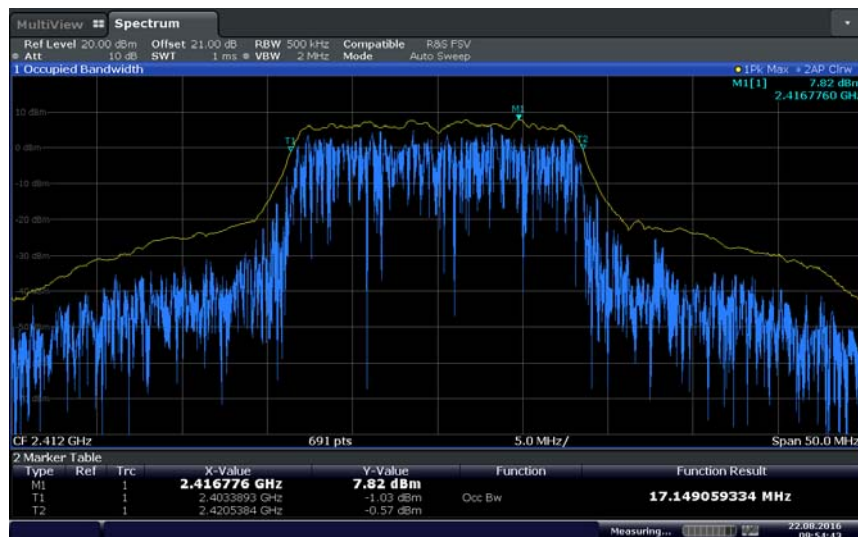
Mode	Channel	Measured 99% Bandwidth (MHz)
802.11b	1 (2412 MHz)	12.446
	6 (2437 MHz)	12.084
	11 (2462 MHz)	12.084
802.11g	1 (2412 MHz)	17.149
	6 (2437 MHz)	17.583
	11 (2462 MHz)	17.438
802.11n 20MHz BW	1 (2412 MHz)	18.307
	6 (2437 MHz)	18.452
	11 (2462 MHz)	18.524

2.2.9 Sample Test Results Plots



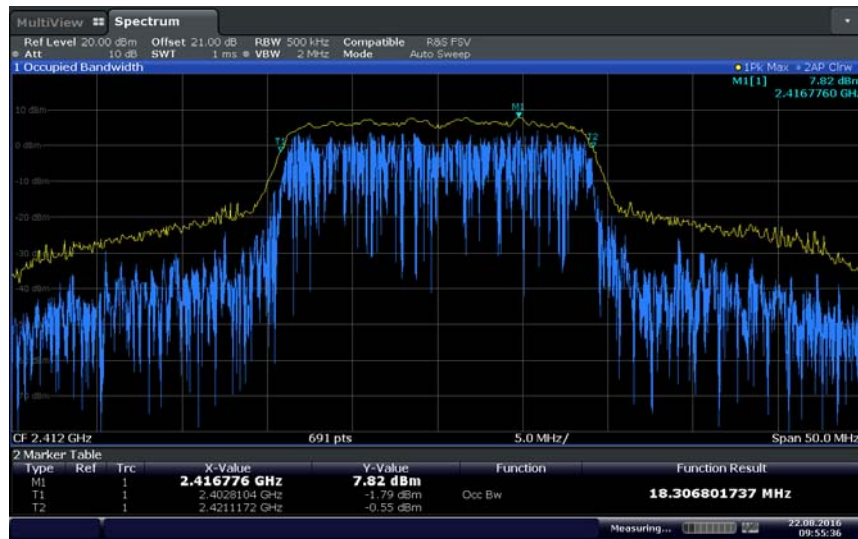
Date: 22 AUG 2016 09:04:09

802.11b Low Channel



Date: 22 AUG 2016 09:54:43

802.11g Mid Channel



Date: 22 AUG 2016 09:55:37

802.11n 20MHz BW High Channel



2.3 MINIMUM 6 DB RF BANDWIDTH

2.3.1 Specification Reference

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

2.3.2 Standard Applicable

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

2.3.3 Equipment Under Test and Modification State

Serial No: 00001 / Test Configuration A

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

August 22, 2016 / AC

2.3.5 Test Equipment Used

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

2.3.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	26.0 °C
Relative Humidity	47.7 %
ATM Pressure	98.9 kPa

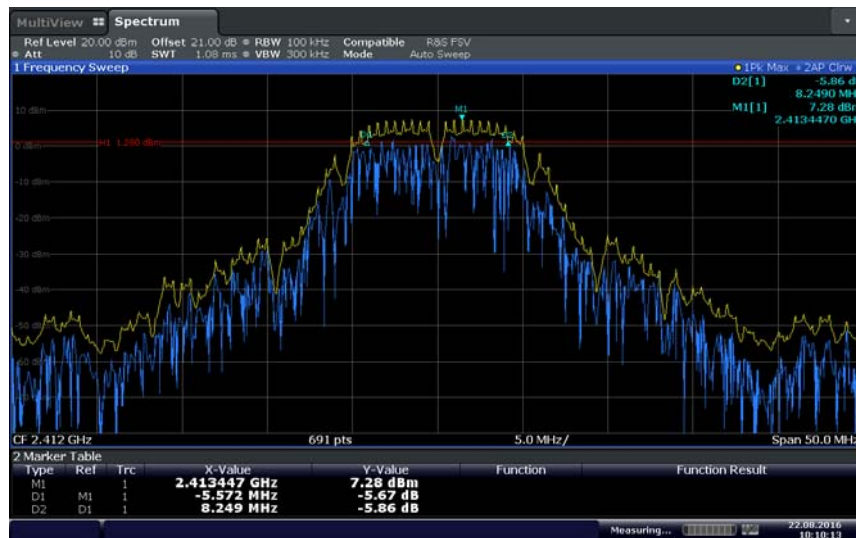
2.3.7 Additional Observations

- This is a conducted test.
- An offset of 21.0 dB was used to compensate for the external attenuator 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.

2.3.8 Test Results

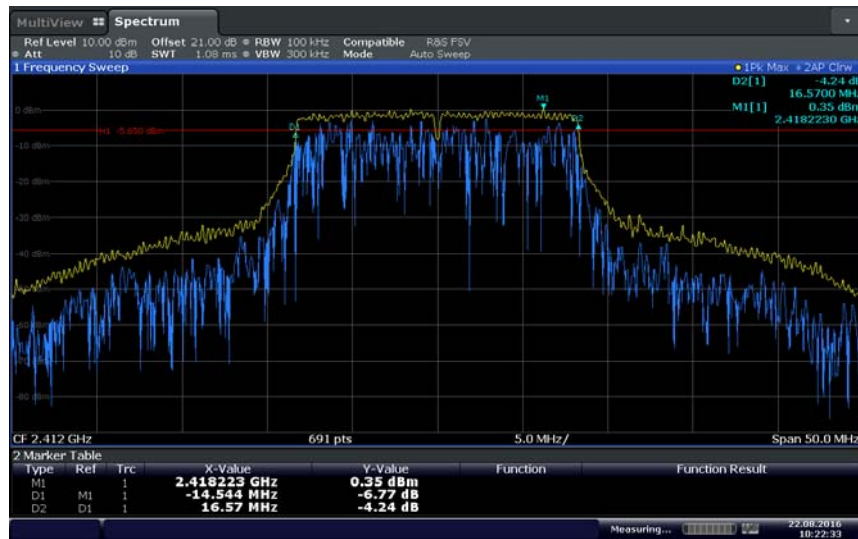
Mode	Channel	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Compliance
802.11b	1 (2412 MHz)	8.25	0.500	Complies
	6 (2437 MHz)	9.70	0.500	Complies
	11 (2462 MHz)	10.20	0.500	Complies
802.11g	1 (2412 MHz)	16.57	0.500	Complies
	6 (2437 MHz)	16.57	0.500	Complies
	11 (2462 MHz)	16.57	0.500	Complies
802.11n 20MHz BW	1 (2412 MHz)	17.80	0.500	Complies
	6 (2437 MHz)	17.80	0.500	Complies
	11 (2462 MHz)	17.80	0.500	Complies

2.3.9 Sample Test Results Plots



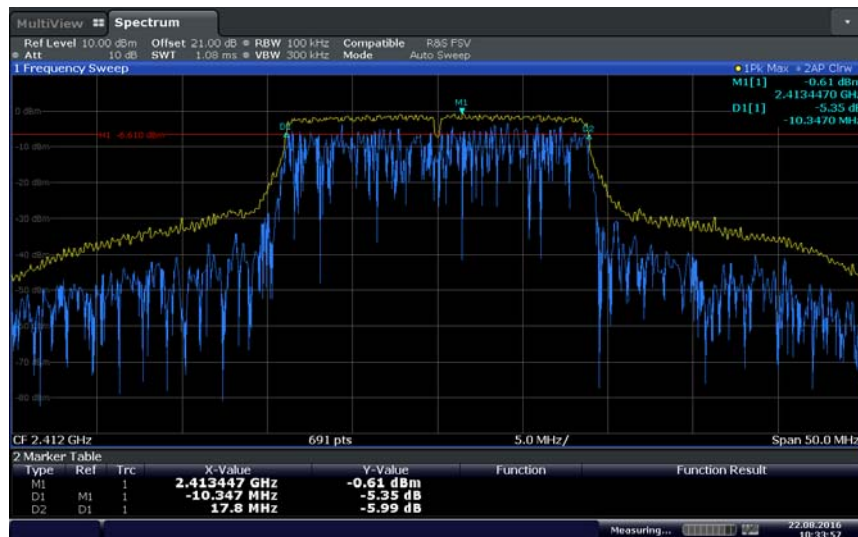
Date: 22 AUG 2016 10:10:13

802.11b Low Channel



Date: 22 AUG 2016 10:22:34

802.11g Mid Channel



Date: 22 AUG 2016 10:23:57

802.11n 20MHz BW High Channel



2.4 OUT-OF-BAND EMISSIONS - CONDUCTED

2.4.1 Specification Reference

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

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: 00001 / Test Configuration A

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

August 22, 2016 / AC

2.4.5 Test Equipment Used

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

2.4.6 Environmental Conditions/ Test Location

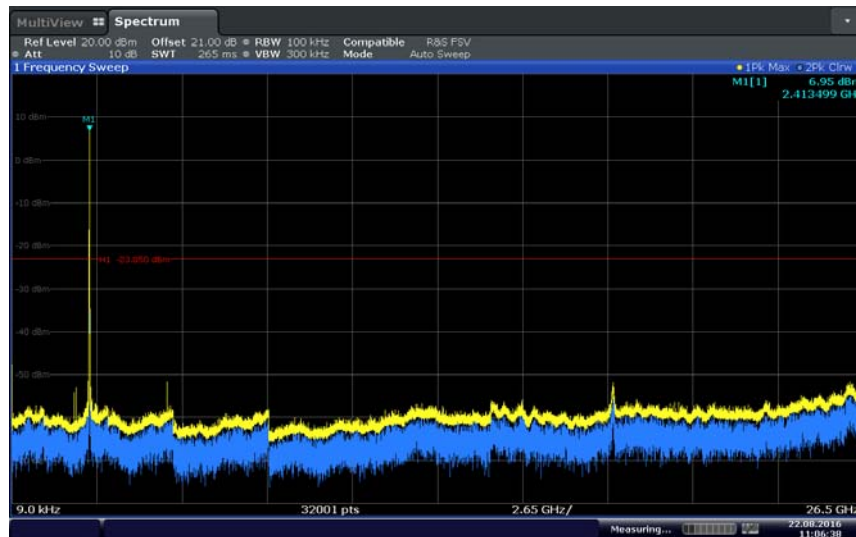
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	26.0 °C
Relative Humidity	47.7 %
ATM Pressure	98.9 kPa

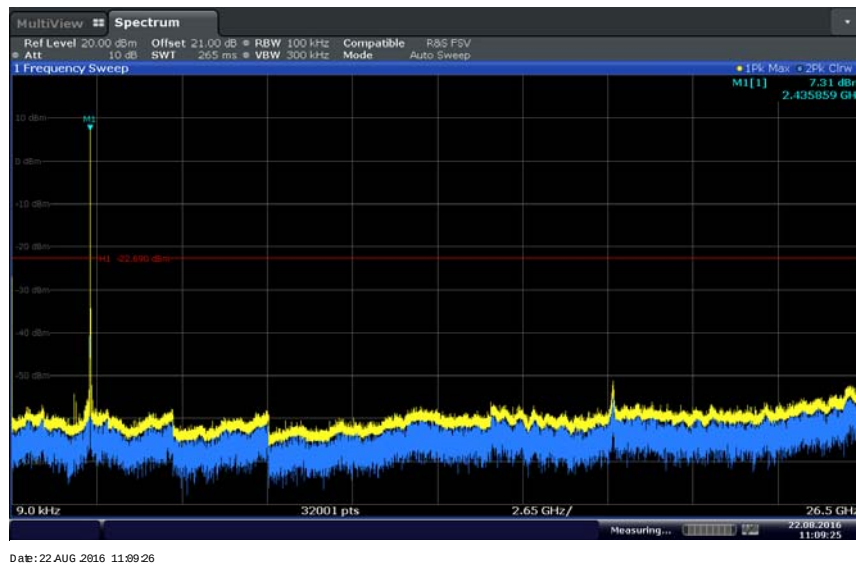
2.4.7 Additional Observations

- This is a conducted test.
- An offset of 21.0 dB 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.
- Test performed on the worst case antenna port, there were no spurious emissions observed within 10dB of the limit so EUT complies.

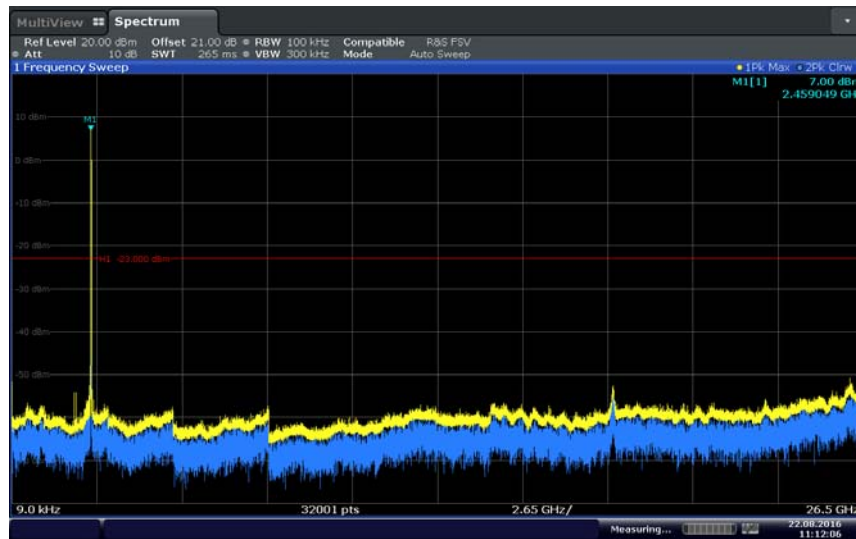
2.4.8 Test Results Plots



802.11b Low Channel

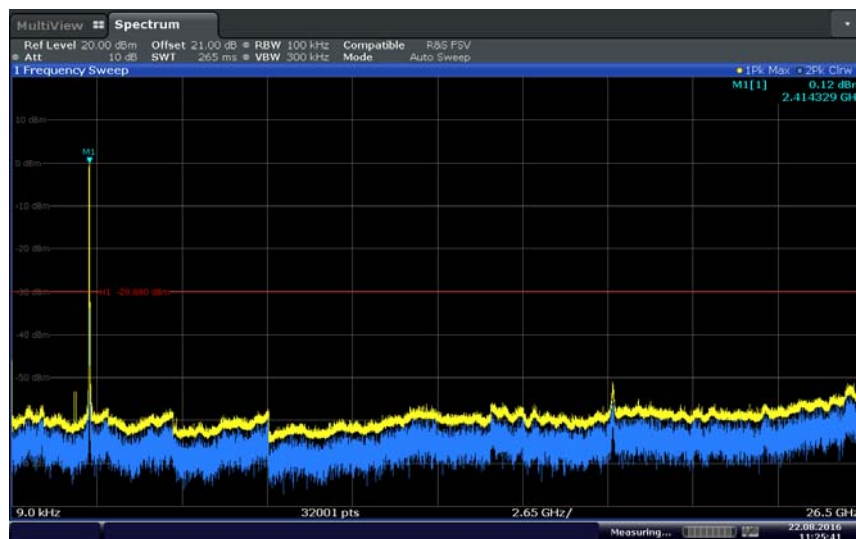


802.11b Mid Channel



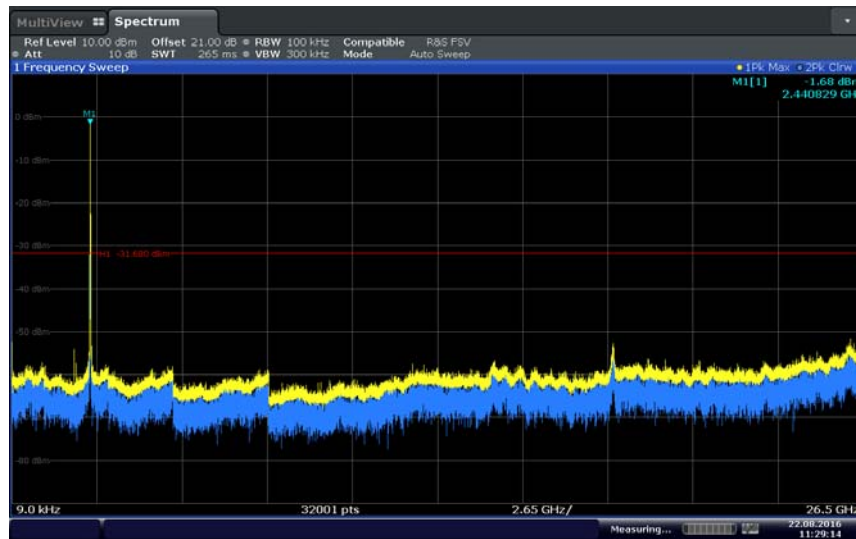
Date: 22 AUG 2016 11:12:07

802.11b High Channel



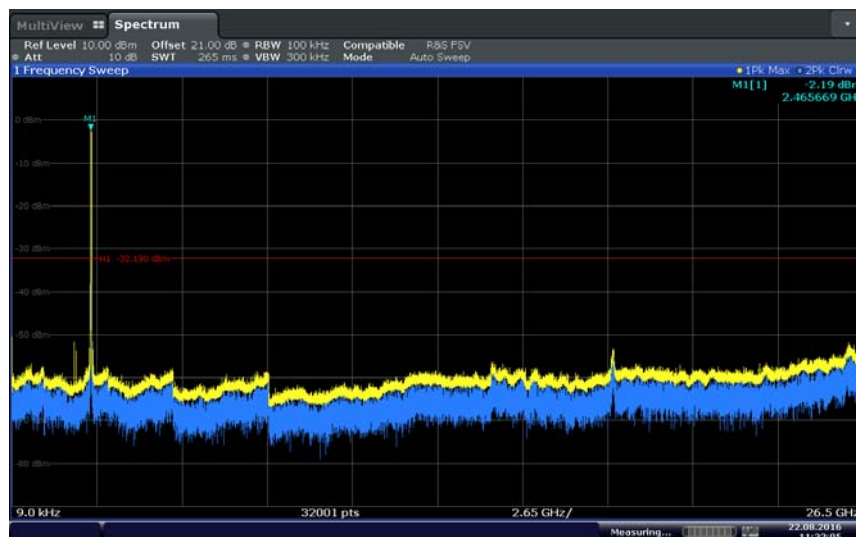
Date: 22 AUG 2016 11:25:41

802.11g Low Channel



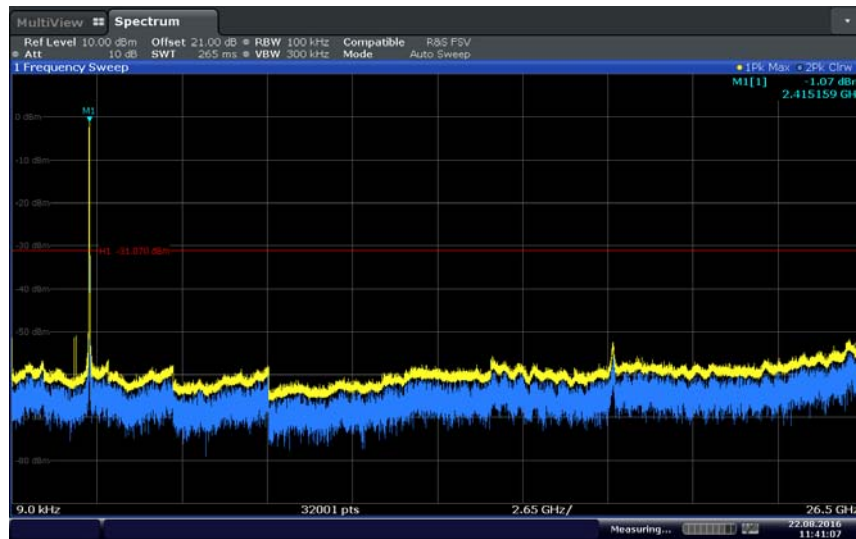
Date: 22 AUG 2016 11:29:13

802.11g Mid Channel



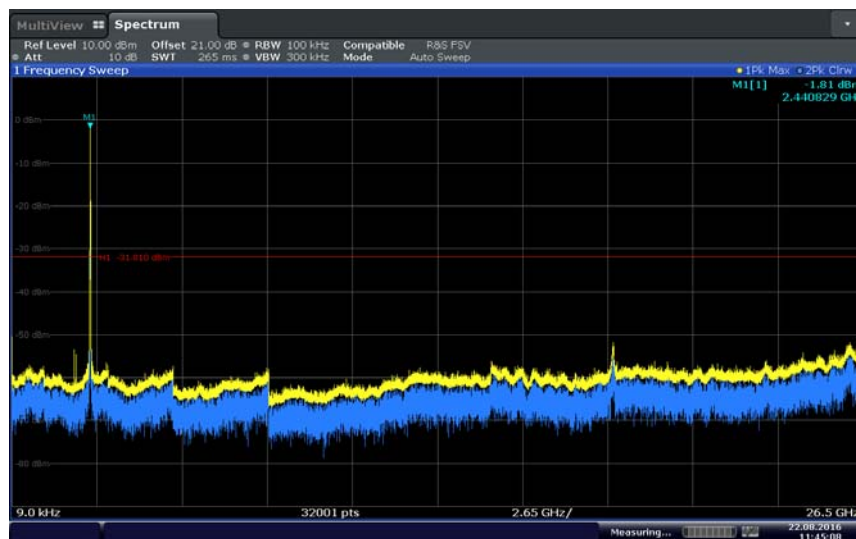
Date: 22 AUG 2016 11:32:05

802.11g High Channel



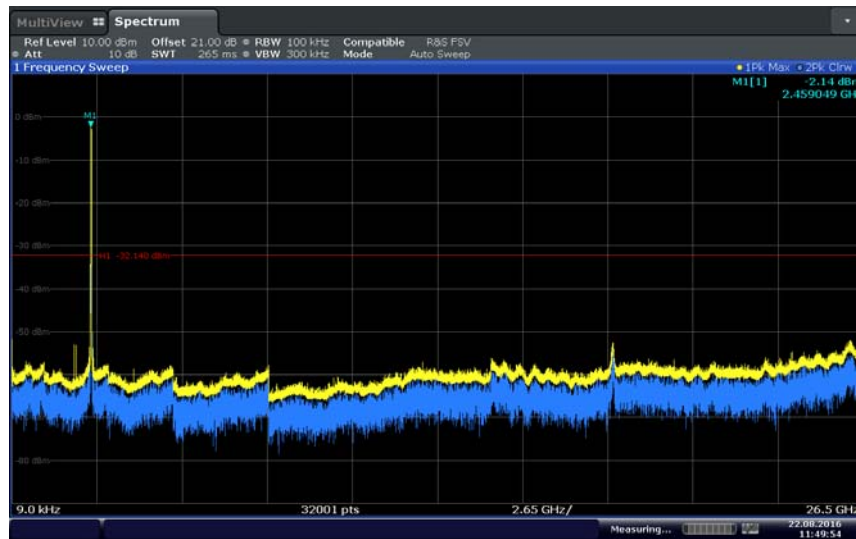
Date: 22 AUG 2016 11:41:07

802.11n 20MHz BW Low Channel



Date: 22 AUG 2016 11:45:08

802.11n 20MHz BW Mid Channel



Date: 22 AUG 2016 11:49:54

802.11n 20MHz BW High Channel



2.5 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.5.1 Specification Reference

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

2.5.2 Standard Applicable

See previous test.

2.5.3 Equipment Under Test and Modification State

Serial No: 00001 / Test Configuration A

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

August 22, 2016 / AC

2.5.5 Test Equipment Used

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

2.5.6 Environmental Conditions/ Test Location

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	26.0 °C
Relative Humidity	47.7 %
ATM Pressure	98.9 kPa

2.5.7 Additional Observations

- This is a conducted test.
- An offset of 21.0 dB 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
802.11n 20MHz BW	Clause 12.2.4	Clause 13.3.2

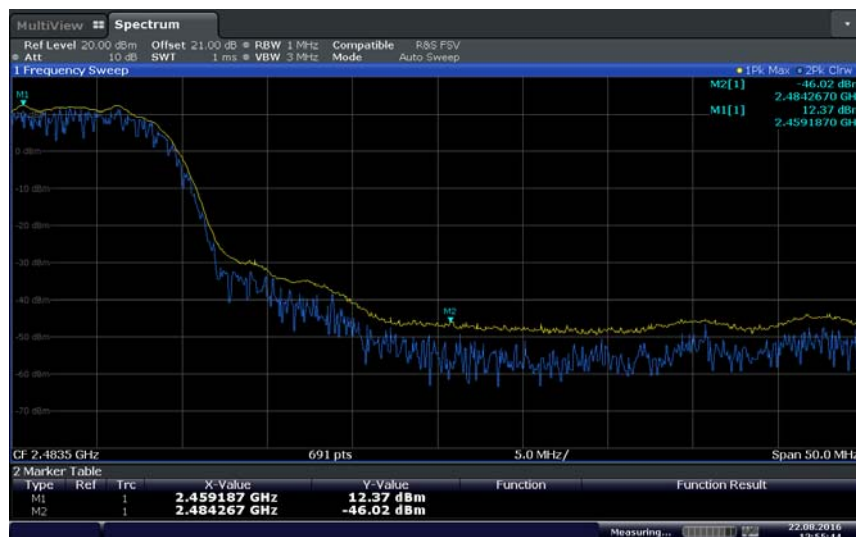
2.5.8 Test Results

Complies. See attached plots.



Date: 22 AUG 2016 13:54:06

802.11b Low Channel (2412 MHz)



Date: 22 AUG 2016 13:55:44

802.11b 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 = -46.02 dBm, since antenna gain is 2.0 dBi then EIRP is -44.02 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 = (-46.02 + 2.0 dBi) dBm – (20log 3 meters) + 104.8
 = 51.24 dBμV/m @ 3 meters (complies with 74 dBμV/m Peak limits)



Date: 22 AUG 2016 14:02:29

802.11b High Channel (2462 MHz Average)

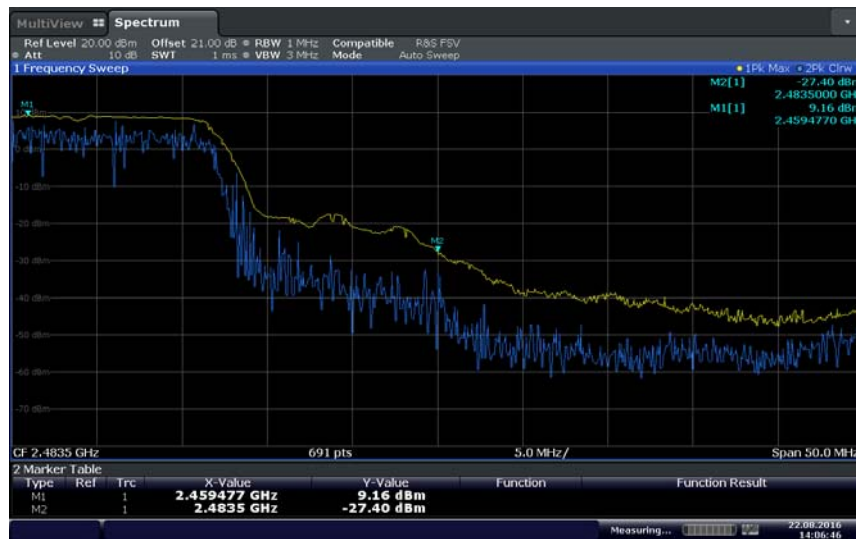
Upper Band Edge (in Restricted Band) measurement using Trace averaging with continuous EUT transmission at full power as per Clause 12.2.5.1 of KDB558074

E is therefore = (-57.01 + 2.0 dBi) dBm – (20log 3 meters) + 104.8
 = 40.25 dBμV/m @ 3 meters (complies with 54 dBμV/m Average limits)



Date: 22 AUG 2016 14:04:01

802.11g Low Channel (2412 MHz)



Date: 22 AUG 2016 14:06:46

802.11g High Channel (2462 MHz Peak)

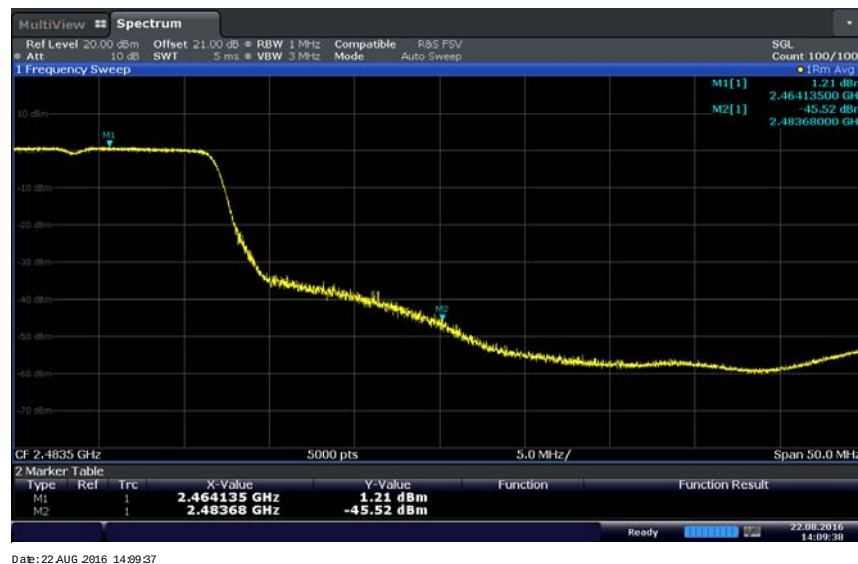
Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074

Measured Peak = -27.4 dBm, since antenna gain is 2.0 dBi then EIRP is -25.4 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 = (-27.4 + 2.0 dBi) dBm – (20log 3 meters) + 104.8
 = 69.86 dBμV/m @ 3 meters (complies with 74 dBμV/m Peak limits)



802.11g High Channel (2462 MHz Average)

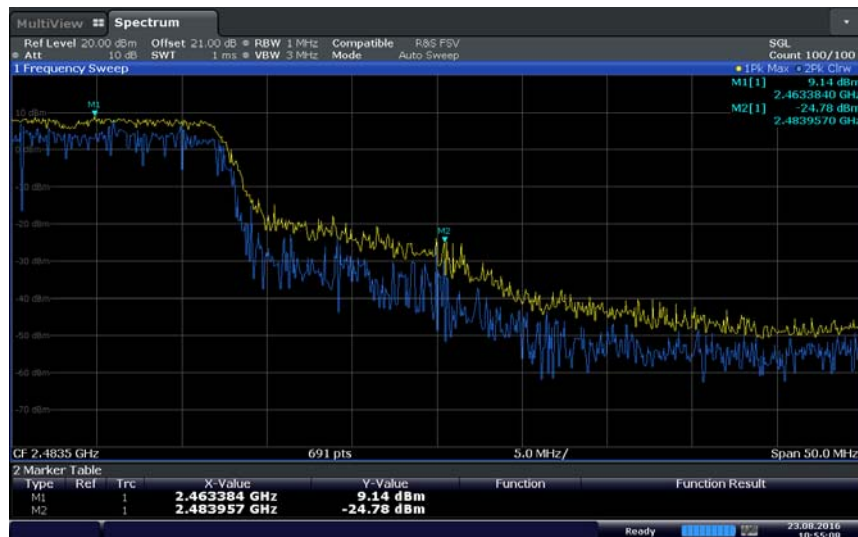
Upper Band Edge (in Restricted Band) measurement using Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction as per Clause 12.2.5.2 of KDB558074

E is therefore = (-45.52 + 2.0 dBi) dBm – (20log 3 meters) + 104.8
 = 51.74dBμV/m @ 3 meters (complies with 54 dBμV/m Average limits)



Date: 22 AUG 2016 14:11:39

802.11n 20MHz BW Low Channel (2412 MHz)



Date: 23 AUG 2016 10:55:08

802.11n 20MHz BW High Channel (2462 MHz Peak)



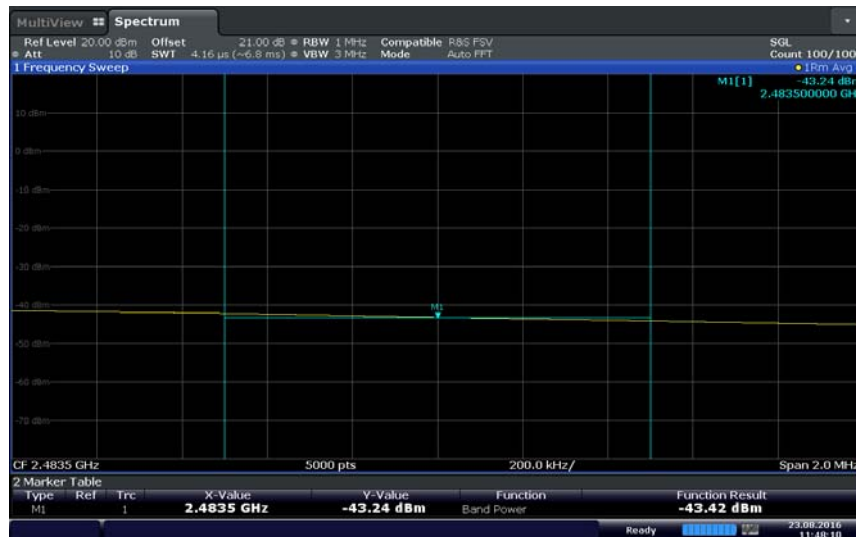
Upper Band Edge (in Restricted Band) measurement using Peak Power measurement procedure as per Clause 12.2.4 of KDB558074

Measured Peak = -24.78dBm, since antenna gain is 2.0 dBi then EIRP is -22.78 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 = (-24.78 + 2.0 dBi) dBm – (20log 3 meters) + 104.8
 = 72.48 dBμV/m @ 3 meters (complies with 74 dBμV/m Peak limits)



Date: 23 AUG 2016 11:48:10

802.11n 20MHz BW High Channel (2462 MHz Average)

Upper Band Edge (in Restricted Band) measurement using Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction as per Clause 13.3.2 of KDB558074

E is therefore = (-43.42 + 2.0 dBi) dBm – (20log 3 meters) + 104.8
 = 53.84 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: 00001 / Test Configuration B

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

August 22 and 23, 2016 / AC

2.6.5 Test Equipment Used

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

2.6.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	26.0 °C
Relative Humidity	47.7 %
ATM Pressure	98.9 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 2.6.8 for sample computation.

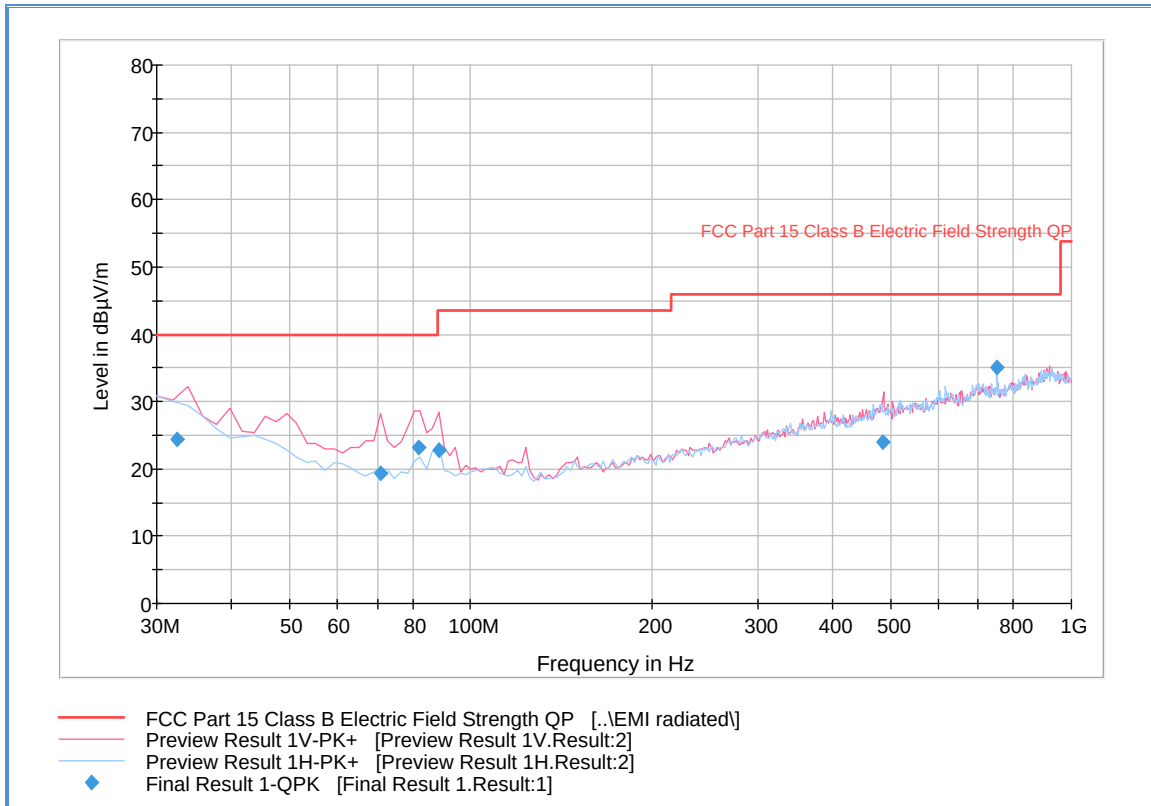
2.6.8 Sample Computation (Radiated Emission)

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 Quasi Peak 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 – 802.11b)

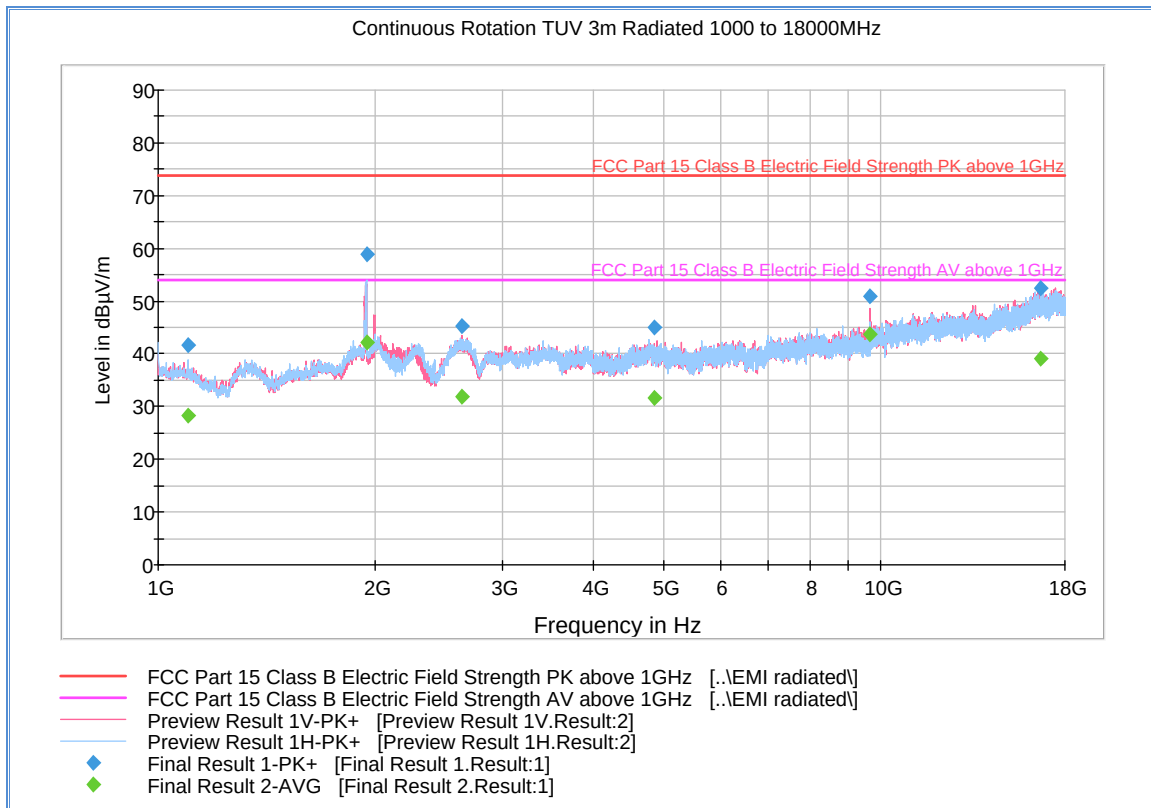


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
32.487776	24.3	1000.0	120.000	196.0	V	138.0	-7.2	15.7	40.0
70.741643	19.3	1000.0	120.000	300.0	V	-12.0	-16.8	20.7	40.0
81.821082	23.2	1000.0	120.000	115.0	V	-10.0	-16.4	16.8	40.0
88.316633	22.9	1000.0	120.000	100.0	V	7.0	-15.7	20.6	43.5
485.853627	24.1	1000.0	120.000	183.0	V	140.0	-1.6	21.9	46.0
749.542365	35.0	1000.0	120.000	100.0	H	235.0	3.3	11.0	46.0

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

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



Peak Data

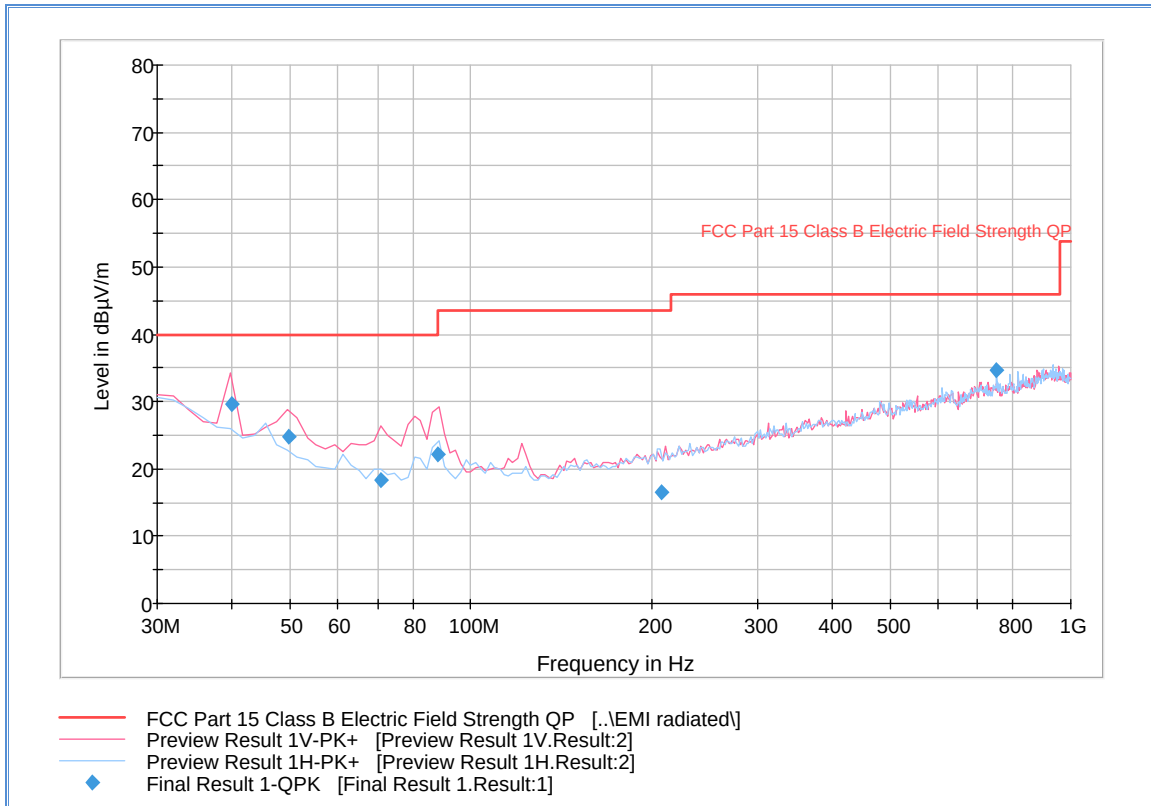
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1100.166667	41.6	1000.0	1000.000	131.7	H	124.0	-6.9	32.3	73.9
1941.266667	58.9	1000.0	1000.000	403.3	H	216.0	-0.6	15.0	73.9
2628.966667	45.4	1000.0	1000.000	203.3	V	57.0	-0.9	28.5	73.9
4864.066667	45.1	1000.0	1000.000	254.3	V	138.0	3.4	28.8	73.9
9648.100000	50.9	1000.0	1000.000	371.1	V	71.0	10.2	23.0	73.9
16654.133333	52.6	1000.0	1000.000	111.7	H	3.0	19.6	21.3	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1100.166667	28.2	1000.0	1000.000	131.7	H	124.0	-6.9	25.7	53.9
1941.266667	42.1	1000.0	1000.000	403.3	H	216.0	-0.6	11.8	53.9
2628.966667	31.9	1000.0	1000.000	203.3	V	57.0	-0.9	22.0	53.9
4864.066667	31.6	1000.0	1000.000	254.3	V	138.0	3.4	22.3	53.9
9648.100000	43.8	1000.0	1000.000	371.1	V	71.0	10.2	10.1	53.9
16654.133333	39.2	1000.0	1000.000	111.7	H	3.0	19.6	14.7	53.9

Test Notes: A 2.4GHz notch filter was used for this test and no significant emissions observed above 10GHz. Measurements above 10GHz were noise floor figures.

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

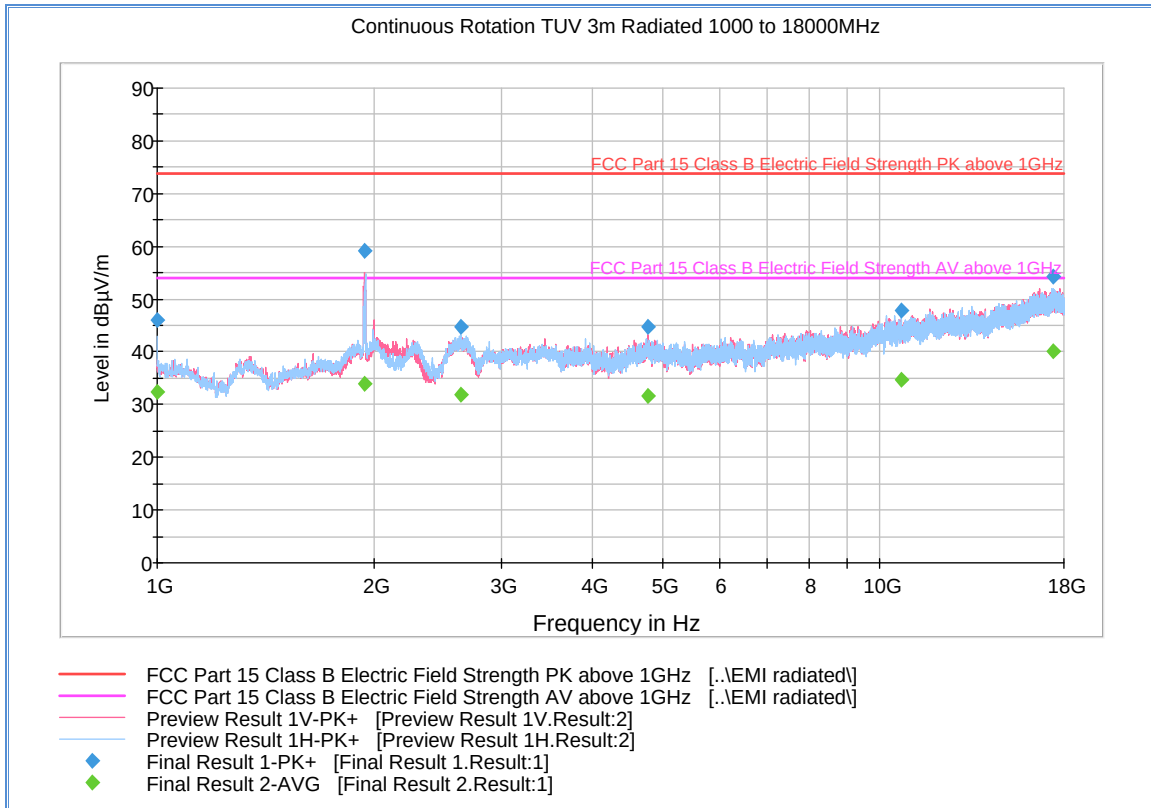


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
39.919439	29.7	1000.0	120.000	100.0	V	192.0	-11.2	10.3	40.0
49.598878	24.7	1000.0	120.000	127.0	V	97.0	-14.3	15.3	40.0
70.821643	18.3	1000.0	120.000	300.0	V	94.0	-16.8	21.7	40.0
88.236633	22.2	1000.0	120.000	100.0	V	161.0	-15.7	21.3	43.5
207.741563	16.6	1000.0	120.000	365.0	V	332.0	-11.0	26.9	43.5
749.542365	34.7	1000.0	120.000	100.0	H	210.0	3.3	11.3	46.0

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

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



Peak Data

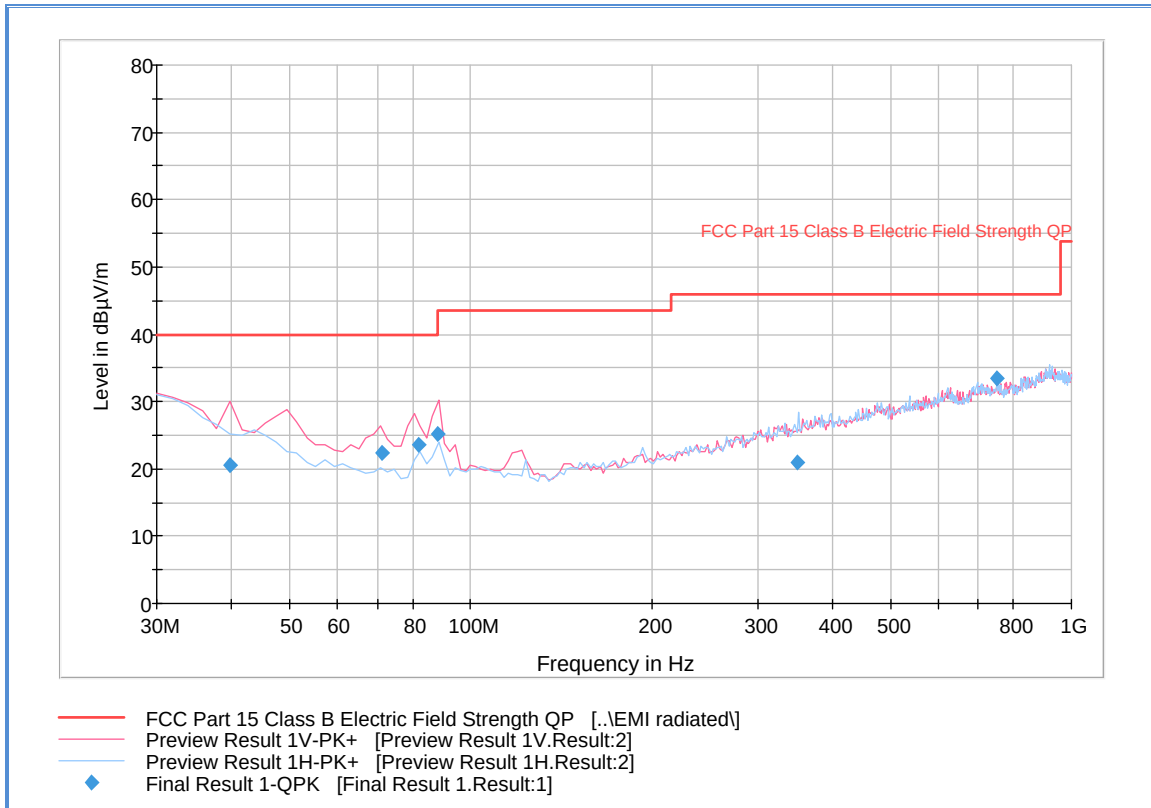
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.400000	46.0	1000.0	1000.000	122.7	H	60.0	-7.7	27.9	73.9
1938.200000	59.1	1000.0	1000.000	403.3	V	215.0	-0.7	14.8	73.9
2632.233333	44.8	1000.0	1000.000	403.3	H	38.0	-0.9	29.1	73.9
4776.800000	44.6	1000.0	1000.000	366.0	V	176.0	3.1	29.3	73.9
10720.266667	47.8	1000.0	1000.000	401.7	H	290.0	12.4	26.1	73.9
17399.000000	54.2	1000.0	1000.000	165.6	H	126.0	20.1	19.7	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.400000	32.3	1000.0	1000.000	122.7	H	60.0	-7.7	21.6	53.9
1938.200000	33.9	1000.0	1000.000	403.3	V	215.0	-0.7	20.0	53.9
2632.233333	31.9	1000.0	1000.000	403.3	H	38.0	-0.9	22.0	53.9
4776.800000	31.7	1000.0	1000.000	366.0	V	176.0	3.1	22.2	53.9
10720.266667	34.7	1000.0	1000.000	401.7	H	290.0	12.4	19.2	53.9
17399.000000	40.2	1000.0	1000.000	165.6	H	126.0	20.1	13.7	53.9

Test Notes: A 2.4GHz notch filter was used for this test and no significant emissions observed above 10GHz. Measurements above 10GHz were noise floor figures.

2.6.14 Test Results Below 1GHz (Worst Case Configuration – 802.11n 20MHz BW)

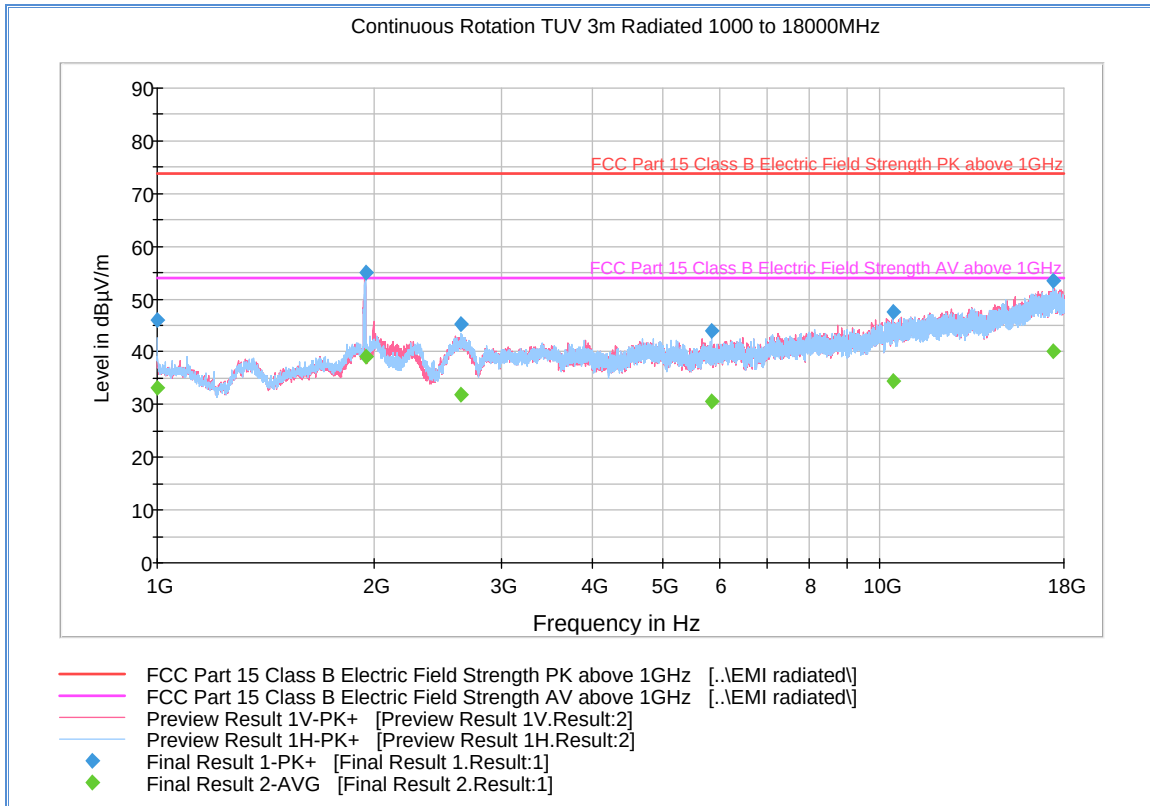


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
39.799439	20.6	1000.0	120.000	120.0	V	31.0	-11.1	19.4	40.0
71.141643	22.5	1000.0	120.000	100.0	V	141.0	-16.8	17.5	40.0
81.741082	23.6	1000.0	120.000	109.0	V	8.0	-16.4	16.4	40.0
88.236633	25.2	1000.0	120.000	100.0	V	166.0	-15.7	18.3	43.5
349.061483	21.0	1000.0	120.000	400.0	H	228.0	-5.5	25.0	46.0
749.582365	33.4	1000.0	120.000	195.0	H	196.0	3.3	12.6	46.0

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

2.6.15 Test Results Above 1GHz (Worst Case Configuration – 802.11n 20MHz BW)



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	46.0	1000.0	1000.000	133.7	H	119.0	-7.7	27.9	73.9
1941.466667	55.1	1000.0	1000.000	403.3	V	158.0	-0.6	18.8	73.9
2629.000000	45.3	1000.0	1000.000	332.1	H	275.0	-0.9	28.6	73.9
5857.833333	43.9	1000.0	1000.000	252.3	H	183.0	4.8	30.0	73.9
10430.100000	47.5	1000.0	1000.000	388.0	H	60.0	12.0	26.4	73.9
17368.133333	53.5	1000.0	1000.000	343.1	H	-13.0	19.9	20.4	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	33.2	1000.0	1000.000	133.7	H	119.0	-7.7	20.7	53.9
1941.466667	39.1	1000.0	1000.000	403.3	V	158.0	-0.6	14.8	53.9
2629.000000	31.9	1000.0	1000.000	332.1	H	275.0	-0.9	22.0	53.9
5857.833333	30.7	1000.0	1000.000	252.3	H	183.0	4.8	23.2	53.9
10430.100000	34.5	1000.0	1000.000	388.0	H	60.0	12.0	19.4	53.9
17368.133333	40.2	1000.0	1000.000	343.1	H	-13.0	19.9	13.7	53.9

Test Notes: A 2.4GHz notch filter was used for this test and no significant emissions observed above 10GHz. Measurements above 10GHz were noise floor figures.



2.7 POWER SPECTRAL DENSITY

2.7.1 Specification Reference

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

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: 00001 / Test Configuration A

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

August 22, 2016 / AC

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	26.0 °C
Relative Humidity	47.7 %
ATM Pressure	98.9 kPa

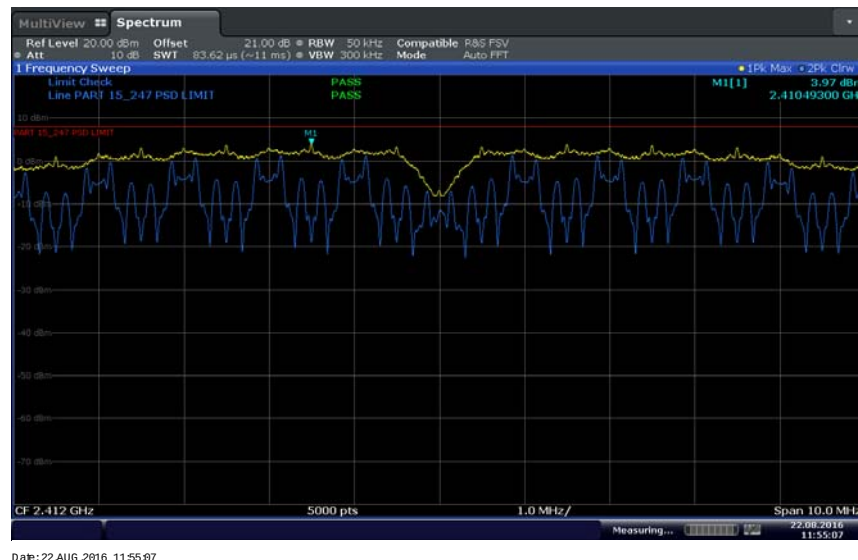
2.7.7 Additional Observations

- 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.
- An offset of 21.0 dB 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.

2.7.8 Test Results Summary

Mode	Channel	Marker Reading (dBm)/RBW used	PSD Limit (dBm)	Margin (dB)	Compliance
802.11b	1 (2412 MHz)	3.97/50kHz	8	4.03	Complies
	6 (2437 MHz)	3.61/50kHz	8	4.39	Complies
	11 (2462 MHz)	4.10/50kHz	8	3.90	Complies
802.11g	1 (2412 MHz)	0.08/100kHz	8	7.92	Complies
	6 (2437 MHz)	-1.61/100kHz	8	9.61	Complies
	11 (2462 MHz)	-1.39/100kHz	8	9.39	Complies
802.11n 20MHz BW	1 (2412 MHz)	-0.77/100kHz	8	8.77	Complies
	6 (2437 MHz)	-0.83/100kHz	8	8.83	Complies
	11 (2462 MHz)	-1.67/100kHz	8	9.67	Complies

2.7.9 Test Results Plots

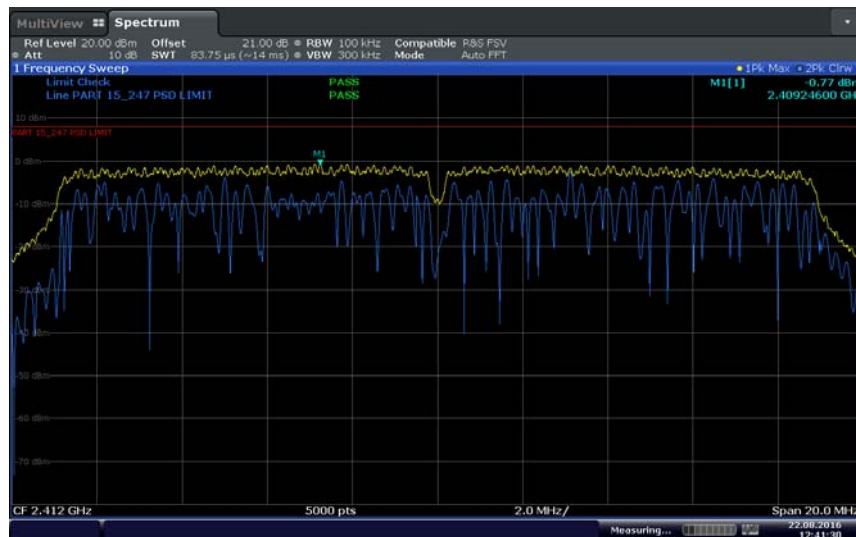


802.11b Low Channel



Date: 22 AUG 2016 12:01:03

802.11g Mid Channel



Date: 22 AUG 2016 12:41:31

802.11n 20MHz BW 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						
7607	USB RF Power Sensor	RadiPower RPR3006W	14I00048SNO047	DARE!! Instruments	11/18/15	11/18/16
7582	Signal/Spectrum Analyzer	FSW26	101614	Rhode & Schwarz	10/05/15	10/05/16
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
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 1003 and 7611	
Radiated Test Setup						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	11/06/15	11/06/17
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	09/29/15	09/29/16
1016	Pre-amplifier	PAM-0202	187	PAM	12/15/15	12/15/16
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	05/12/16	05/12/17
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/16	03/17/17
6815	2.4GHz Band Notch Filter	BRM50702	008	Micro-Tronics	Verified by 1003 and 7611	
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	01/11/16	01/11/17
1153	High-frequency cable	SucoFlex 100 SX	N/A	Suhner	Verified by 1003 and 7611	
8543	High-frequency cable	Micropore 19057793	N/A	United Microwave Products	Verified by 1003 and 7611	
Miscellaneous						
7560	Barometer/Temperature/Humidity Transmitter	iBTHX-W	1240476	Omega	10/19/15	10/19/16
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

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

3.2.1 Radiated 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

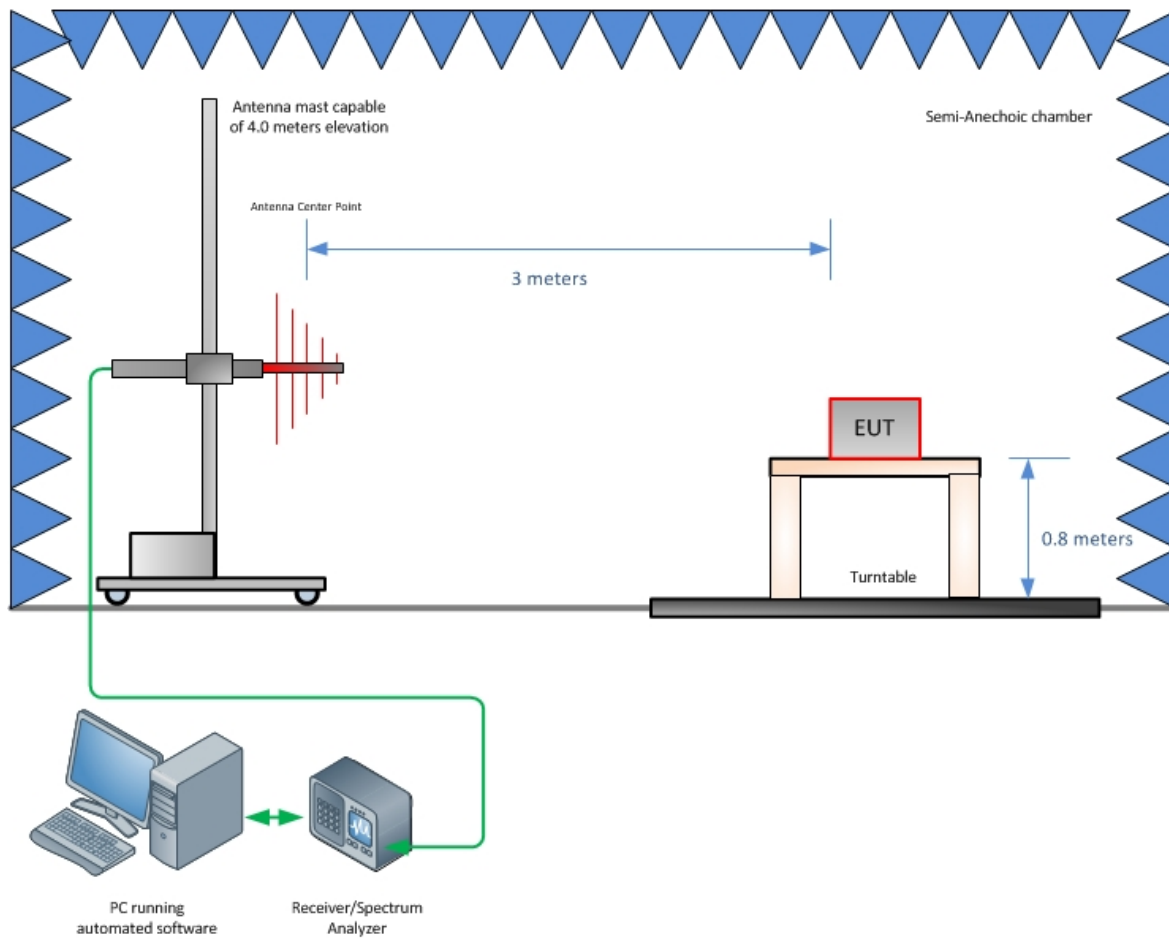
Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.50	0.29	0.08
3	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty (u_c):					0.72
Coverage Factor (k):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



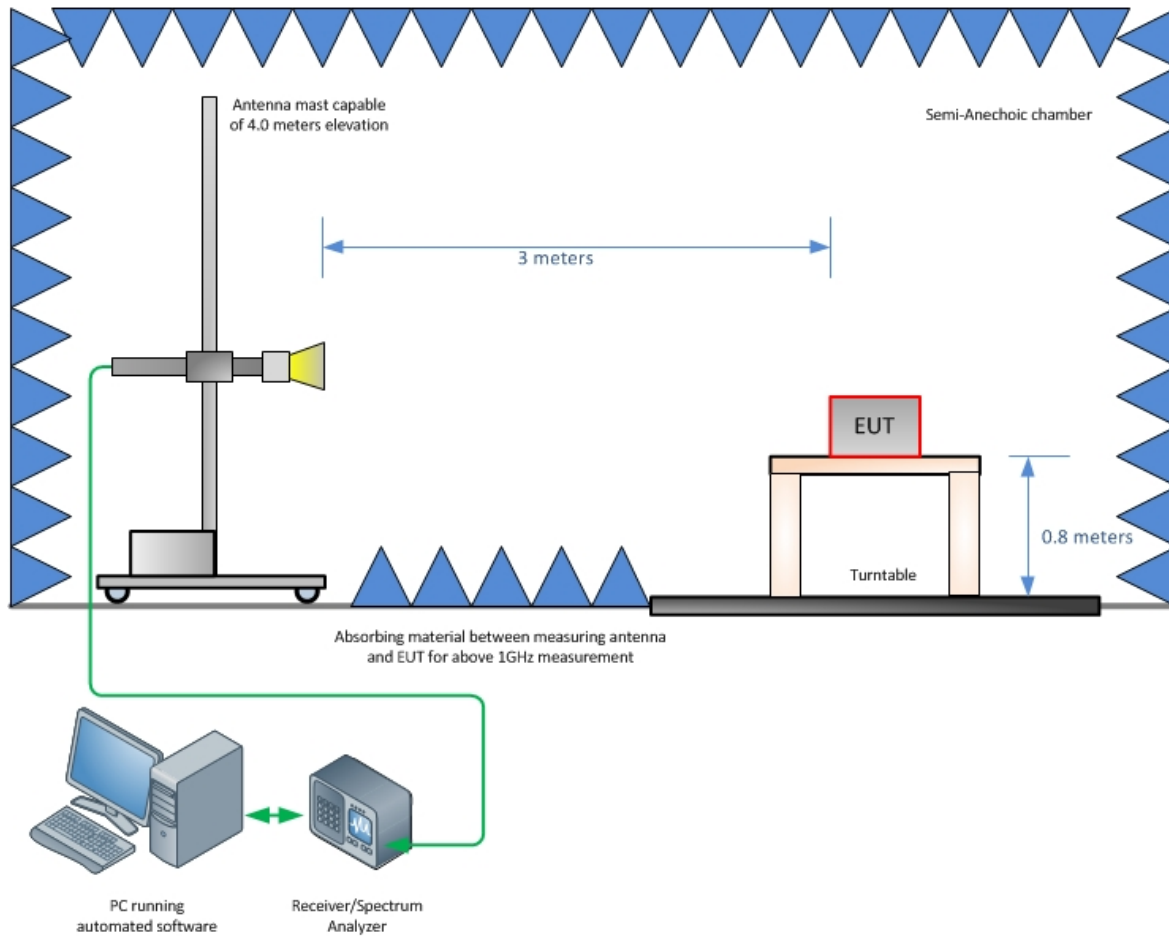
SECTION 4

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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