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Report On

Application for Grant of Equipment Authorization of the
Novatel Wireless Inc.
T1114 Wireless Router with Cellular Voice and Data Capabilities

FCC Part 15 Subpart C §15.247

Report No. SD72118007-0616A

August 2016



REPORT ON Radio Testing of the
Novatel Wireless Inc.
Wireless Router with Cellular Voice and Data Capabilities

TEST REPORT NUMBER SD72118007-0616A

PREPARED FOR Novatel Wireless Inc.
9645 Scranton Road
San Diego, CA 92121

CONTACT PERSON Roman Olmos
Hardware Engineer II & ISO-17025 Technical Manager
(858) 812-3400
rolmos@nvtl.com

A handwritten signature in black ink, appearing to be 'Nikolay Shtin', written over a horizontal line.

PREPARED BY Nikolay Shtin
Name
Authorized Signatory
Title: EMC/Wireless Test Engineer

A handwritten signature in blue ink, appearing to be 'Juan Manuel Gonzalez', written over a horizontal line.

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

DATED August 10, 2016



Revision History

SD72118007-0616A Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
08/10/2016	Initial Release				Juan Manuel Gonzalez

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SECTION 1

REPORT SUMMARY

Radio Testing of the
Novatel Wireless Inc.
T1114 Wireless Router with Cellular Voice and Data Capabilities



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities 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	Novatel Wireless Inc.
Model Number(s)	T1114
FCC ID Number	PKRNVWT1114
IC Number	N/A
Serial Number(s)	IMEI 990000949644647
Number of Samples Tested	1
Test Specification/Issue/Date	FCC Part 15 Subpart C §15.247 (October 1, 2015).
Start of Test	June 21, 2016
Finish of Test	June 24, 2016
Name of Engineer(s)	Nikolay Shtin
Related Document(s)	- Supporting documents for EUT certification are separate exhibits. - SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



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

N/A Not performed. Conducted emissions and antenna port test results were performed and still applicable to this model and can be found at Test Report: SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) was a Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities. The EUT is a wireless device that delivers Internet connectivity and telephone service, it uses LTE Band 4 and 13 / CDMA BC0 & BC1. The EUT can make a phone call, connect up to 10 devices via Wi-Fi (b/g/n 2.4GHz and a/n 5GHz UNII-1 and UNII-3) and connect up to 3 devices via Ethernet, simultaneously. The EUT poses 2 optional antenna ports accessible to customers to improve the coverage range with custom design antenna "Sold separately". (See Exhibit PKRNVWT1114_Theory of Operation page 24-28).

1.3.2 EUT General Description

EUT Description Wireless Router with Cellular Voice and Data Capabilities

Model Number(s) T1114

Rated Voltage From AC-DC converter: 100-240VAC, 50/60Hz to 5.0VDC / 3.5A (Nominal voltage).

Mode Verified 802.11 b/g/n

Capability CDMA BC0 (CELL) & BC1 (PCS), Band 4 (1.4, 5.0, 10, 15 and 20MHz BW) and Band 13 (5 and 10MHz BW) LTE, 802.11 b/g/n 2.4 GHz & 802.11 a/n 5 GHz.

Output Power

Mode	Average (conducted)	Peak (conducted)
802.11 b	19.65 dBm	22.07 dBm
802.11 g	20.11 dBm	25.17 dBm
802.11 n	20.12 dBm	25.12 dBm

Frequency Range 2412 MHz to 2462 MHz in the 2400 MHz to 2483.5 MHz Band

Number of Operating Frequencies 11 (802.11 b/g/n)

Channels Verified (802.11 b) Channel 1 (Low Channel 2412 MHz)
Channel 6 (Mid Channel 2437 MHz)
Channel 11 (High Channel 2462 MHz)

Channels Verified (802.11 g/n) Channel 1 (Low Channel 2412 MHz)
Channel 6 (Mid Channel 2437 MHz)

Primary Unit (EUT) ☐ Production
☒ Pre-Production
☐ Engineering

Modulation used DSSS (802.11 b), OFDM/DSSS (802.11 g), OFDM (802.11 n)



1.3.3 Antenna Details

Internal Antenna Details
(Client declaration, max. Antenna gain covered
under this test report)

WWAN Antenna – CDMA

Manufacturer: Pulse
Part Number: DA-010190774
Type: PIFA
Antenna Gain:

- CDMA BC0 – 850MHz: -0.59dBi
- CDMA BC1 – 1880MHz: -0.82dBi

WWAN Antenna – LTE Band 13/4

Manufacturer: Pulse
Part Number: DA-01019775
Type: PIFA
Antenna Gain:

- LTE B13 – 700MHz: 1.21dBi
- LTE B4 – 1700MHz: 2.44dBi

WLAN – Antenna: 802.11 a/b/g/n

Manufacturer: Novatel
Type: CERAMIC CHIP
Antenna Gain:

- 802.11 b/g/n 2.4GHz: 3.0dBi
- 802.11 a/n 5GHz: 3.0dBi



1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

Test Configuration	Description
Default	Radiated emissions test configuration. The EUT connected to AC-DC power adapter transmitting through the integral antenna.

1.4.2 EUT Exercise Software

Before each test, the EUT is configured using Qualcomm Radio Control Toolkit version 3.0.54.0. The software allows configuration of operating channel, WLAN mode + data rate and power level. Power level is set according to manufacturer specification for each mode.

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Dell	Support Laptop	Latitude E6410 (Novatel Wireless Test configuration Support Laptop)
	USB cable	Shielded, Type A to Micro USB USB Revision 2.0

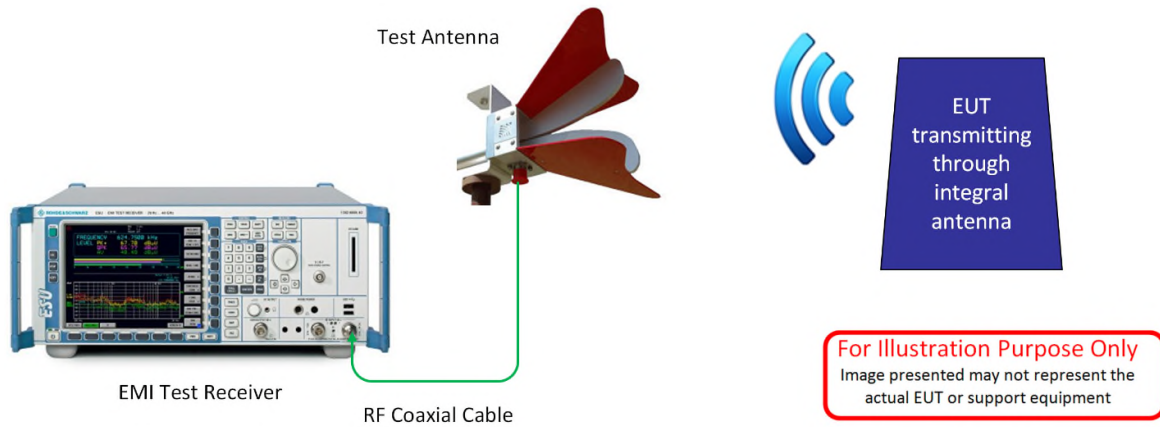
1.4.4 Worst Case Configuration

Worst-case configuration used in this test report based from Peak Output Power measurements:

Mode	Channel	Data Rate
802.11 b	1 (Low Channel)	2Mbps
802.11 g	1 (Low Channel)	36Mbps
802.11 n	1 (Low Channel)	26Mbps (MCS3)

EUT is designed for indoor use a table top operation, for radiated spurious measurement only default configuration was evaluated (See test setup picture exhibit).

1.4.5 SIMPLIFIED TEST CONFIGURATION DIAGRAM





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

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)

16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 942 5542 FAX: 858-546 0364

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Registration No.: US1146

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



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

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



SECTION 2

TEST DETAILS

Radio Testing of the
Novatel Wireless Inc.
Wireless Router with Cellular Voice and Data Capabilities



2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

Part 15 Subpart C §15.247(b)(3)

2.1.2 Standard Applicable

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

2.1.3 Equipment Under Test and Modification State

Not performed. Conducted antenna port test results from Report Number: SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

Part 15 Subpart C §15.207(a)

2.2.2 Standard Applicable

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

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

**Decreases with the logarithm of the frequency.*

2.2.3 Equipment Under Test and Modification State

Not performed. Conducted emissions test results from Report Number: SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



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: SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



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

Not performed. Conducted antenna port test results from Report Number: SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



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

(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

Not performed. Conducted antenna port test results from Report Number: SC1307899C Rev. 1 FCC Part 15 Subpart C §15.247 Test Report for Novatel Wireless Inc. T1114 Wireless Router with Cellular Voice and Data Capabilities issued by TÜV SÜD America Inc.



2.6 SPURIOUS RADIATED EMISSIONS

2.6.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.6.2 Standard Applicable

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

2.6.3 Equipment Under Test and Modification State

Serial No: IMEI 990000949644647/ Default Test Configuration

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

June 21 and June 24, 2016/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	25.7-27.0°C
Relative Humidity	40.1-47.9%
ATM Pressure	98.8-98.9 kPa

2.6.7 Additional Observations

- This is a radiated test. The spectrum was searched from 30MHz to the 10th harmonic (25GHz).
- 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 considered worst case configurations presented. There are no significant differences in radiated emissions between the evaluated modulations and data rates.



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

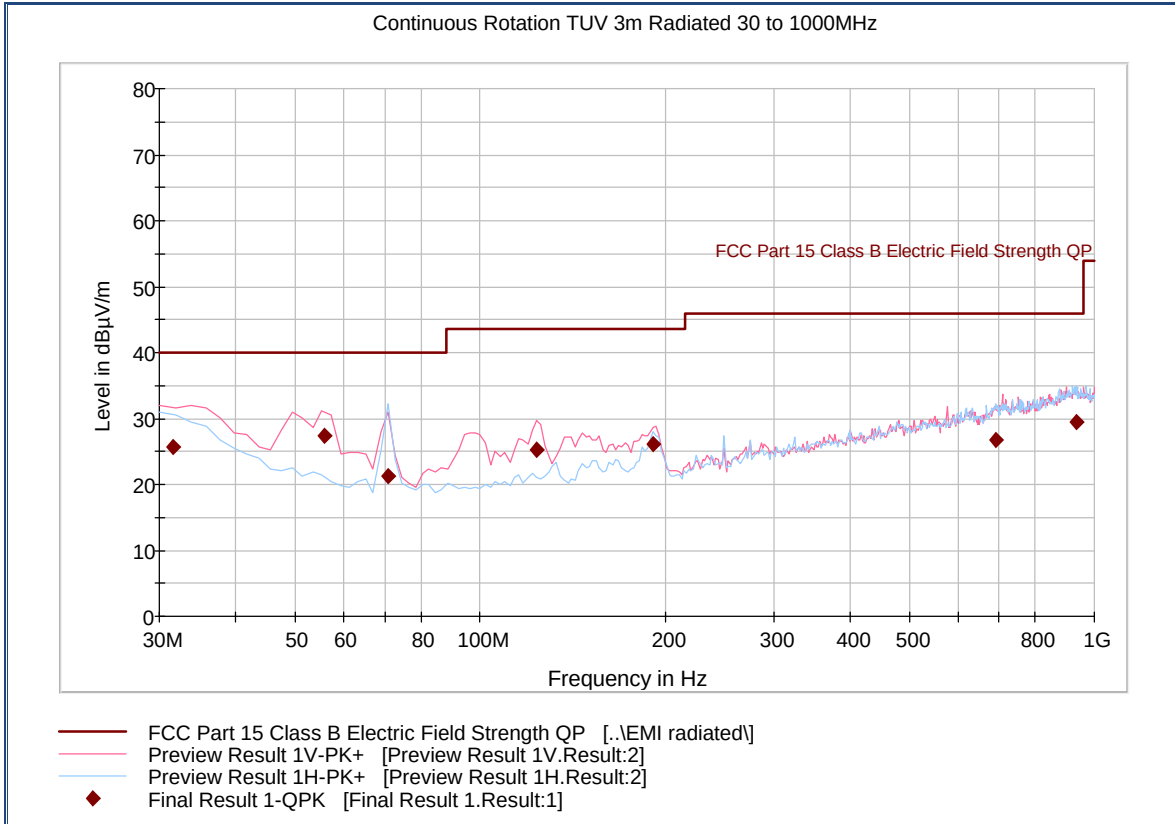
2.6.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (db μ V) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (db μ V/m) @ 30MHz			11.8

2.6.9 Test Results

See attached plots.

2.6.10 Test Results Below 1GHz (Low Channel 802.11n 26Mbps – worst case configuration)

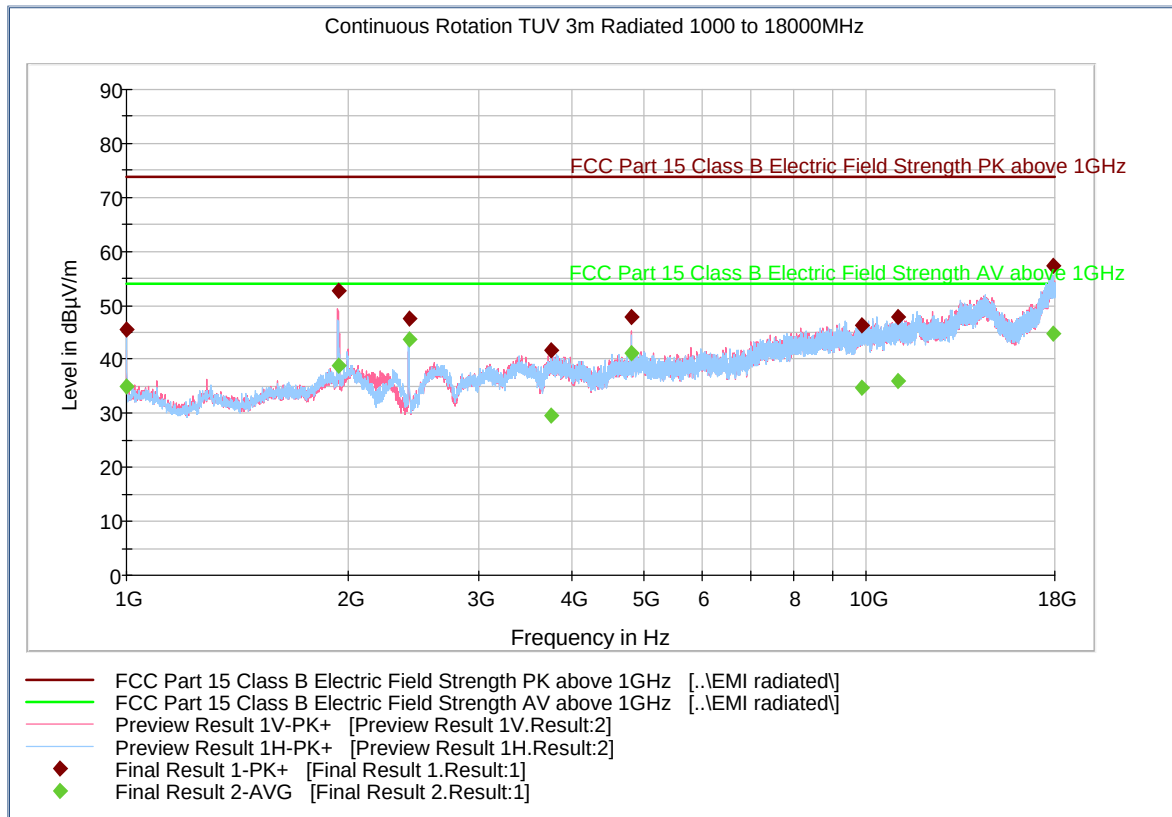


Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
31.647776	25.6	1000.0	120.000	150.0	V	241.0	-6.8	14.4	40.0
55.830541	27.3	1000.0	120.000	100.0	V	237.0	-15.5	12.7	40.0
70.821643	21.3	1000.0	120.000	200.0	H	-11.0	-16.8	18.7	40.0
123.706613	25.2	1000.0	120.000	100.0	V	103.0	-15.4	18.3	43.5
190.902685	26.1	1000.0	120.000	100.0	V	181.0	-11.0	17.4	43.5
690.881844	26.8	1000.0	120.000	100.0	H	0.0	2.6	19.2	46.0
932.827816	29.5	1000.0	120.000	140.0	H	118.0	6.3	16.5	46.0

Test Notes:

2.6.11 Test Results above 1GHz Low Channel (802.11b 2Mbps worst-case data rate)



Peak Data

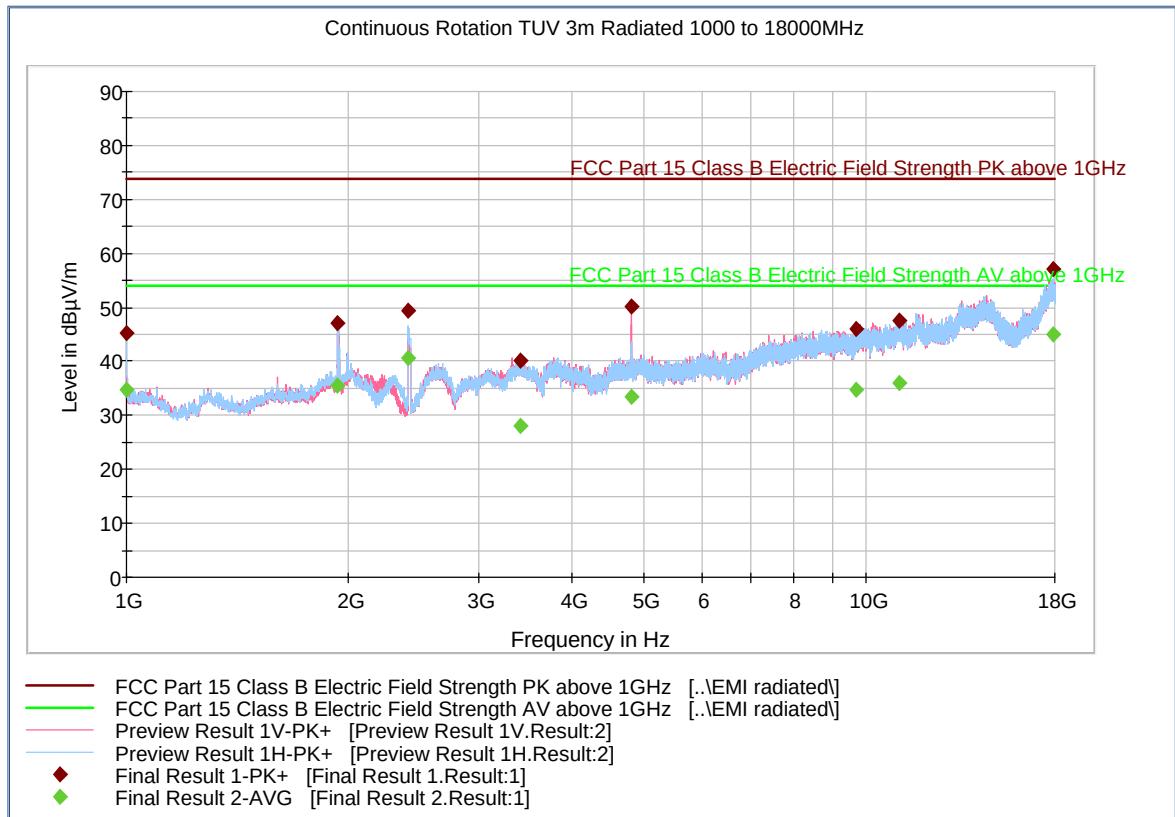
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	45.4	1000.0	1000.000	102.7	H	63.0	-11.2	28.5	73.9
1932.766667	52.7	1000.0	1000.000	346.1	V	339.0	-4.6	21.2	73.9
2410.566667	47.5	1000.0	1000.000	123.7	H	131.0	-5.1	Fundamental	
3751.366667	41.7	1000.0	1000.000	229.4	V	185.0	0.5	32.2	73.9
4824.066667	47.8	1000.0	1000.000	184.5	V	275.0	2.1	26.1	73.9
9894.233333	46.4	1000.0	1000.000	404.0	V	153.0	11.3	27.5	73.9
11065.533333	47.9	1000.0	1000.000	197.5	V	242.0	13.2	26.0	73.9
17911.966667	57.4	1000.0	1000.000	301.6	V	117.0	24.1	16.5	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	35.0	1000.0	1000.000	102.7	H	63.0	-11.2	18.9	53.9
1932.766667	38.8	1000.0	1000.000	346.1	V	339.0	-4.6	15.1	53.9
2410.566667	43.8	1000.0	1000.000	123.7	H	131.0	-5.1	Fundamental	
3751.366667	29.5	1000.0	1000.000	229.4	V	185.0	0.5	24.4	53.9
4824.066667	41.3	1000.0	1000.000	184.5	V	275.0	2.1	12.6	53.9
9894.233333	34.8	1000.0	1000.000	404.0	V	153.0	11.3	19.1	53.9
11065.533333	36.1	1000.0	1000.000	197.5	V	242.0	13.2	17.8	53.9
17911.966667	44.8	1000.0	1000.000	301.6	V	117.0	24.1	9.1	53.9

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

2.6.12 Test Results above 1GHz Low Channel (802.11g 36Mbps worst-case data rate)



Peak Data

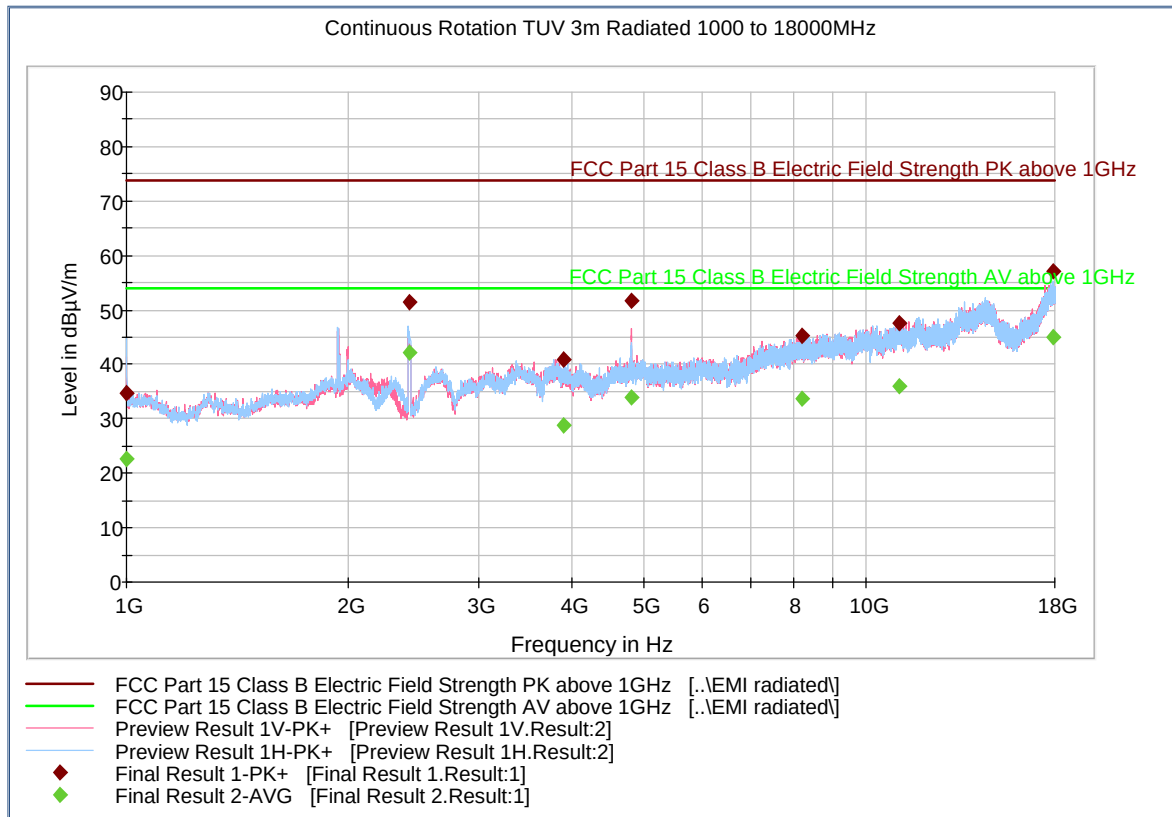
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	45.3	1000.0	1000.000	103.7	H	203.0	-11.2	28.6	73.9
1932.533333	47.0	1000.0	1000.000	372.1	H	187.0	-4.6	26.9	73.9
2407.433333	49.5	1000.0	1000.000	122.7	H	132.0	-5.1	Fundamental	
3404.766667	40.0	1000.0	1000.000	404.0	H	264.0	-1.1	33.9	73.9
4810.400000	50.3	1000.0	1000.000	103.7	V	277.0	2.0	23.6	73.9
9721.366667	46.1	1000.0	1000.000	366.0	H	339.0	10.9	27.8	73.9
11080.566667	47.6	1000.0	1000.000	321.1	H	210.0	13.2	26.3	73.9
17957.633333	57.0	1000.0	1000.000	385.0	H	10.0	24.2	16.9	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	34.8	1000.0	1000.000	103.7	H	203.0	-11.2	19.1	53.9
1932.533333	35.6	1000.0	1000.000	372.1	H	187.0	-4.6	18.3	53.9
2407.433333	40.7	1000.0	1000.000	122.7	H	132.0	-5.1	Fundamental	
3404.766667	28.1	1000.0	1000.000	404.0	H	264.0	-1.1	25.8	53.9
4810.400000	33.4	1000.0	1000.000	103.7	V	277.0	2.0	20.5	53.9
9721.366667	34.6	1000.0	1000.000	366.0	H	339.0	10.9	19.3	53.9
11080.566667	36.0	1000.0	1000.000	321.1	H	210.0	13.2	17.9	53.9
17957.633333	44.9	1000.0	1000.000	385.0	H	10.0	24.2	9.0	53.9

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

2.6.13 Test Results above 1GHz Low Channel (802.11n 26Mbps worst-case data rate)



Peak Data

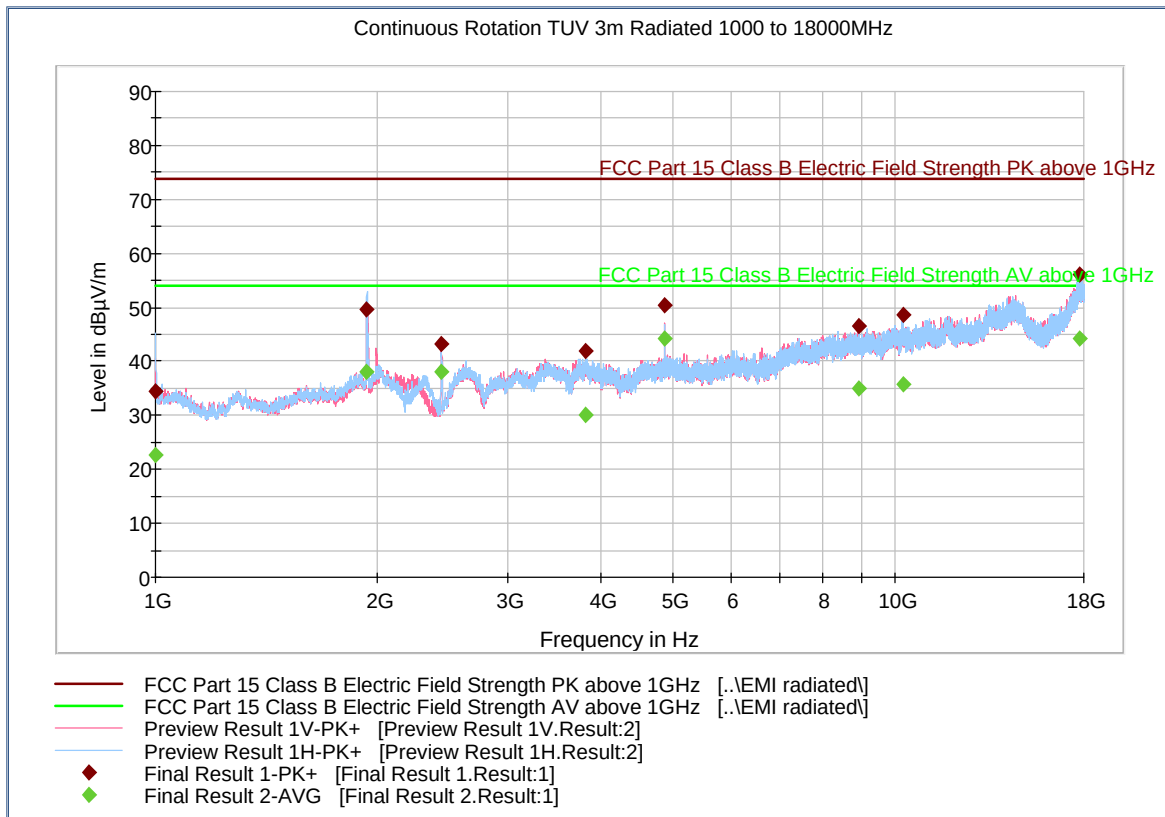
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.400000	34.8	1000.0	1000.000	194.5	H	186.0	-11.2	39.1	73.9
2409.733333	51.5	1000.0	1000.000	122.7	H	132.0	-5.1	Fundamental	
3896.466667	40.8	1000.0	1000.000	167.6	H	-1.0	1.1	33.1	73.9
4812.000000	51.6	1000.0	1000.000	181.5	V	312.0	2.0	22.3	73.9
8193.800000	45.2	1000.0	1000.000	248.3	V	28.0	8.8	28.7	73.9
11090.433333	47.6	1000.0	1000.000	210.4	V	-19.0	13.2	26.3	73.9
17915.766667	57.1	1000.0	1000.000	277.2	H	23.0	24.1	16.8	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.400000	22.7	1000.0	1000.000	194.5	H	186.0	-11.2	31.2	53.9
2409.733333	42.1	1000.0	1000.000	122.7	H	132.0	-5.1	Fundamental	
3896.466667	28.9	1000.0	1000.000	167.6	H	-1.0	1.1	25.0	53.9
4812.000000	34.1	1000.0	1000.000	181.5	V	312.0	2.0	19.8	53.9
8193.800000	33.6	1000.0	1000.000	248.3	V	28.0	8.8	20.3	53.9
11090.433333	36.0	1000.0	1000.000	210.4	V	-19.0	13.2	17.9	53.9
17915.766667	45.0	1000.0	1000.000	277.2	H	23.0	24.1	8.9	53.9

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

2.6.14 Test Results above 1GHz Mid Channel (802.11b 11Mbps worst-case data rate)



Peak Data

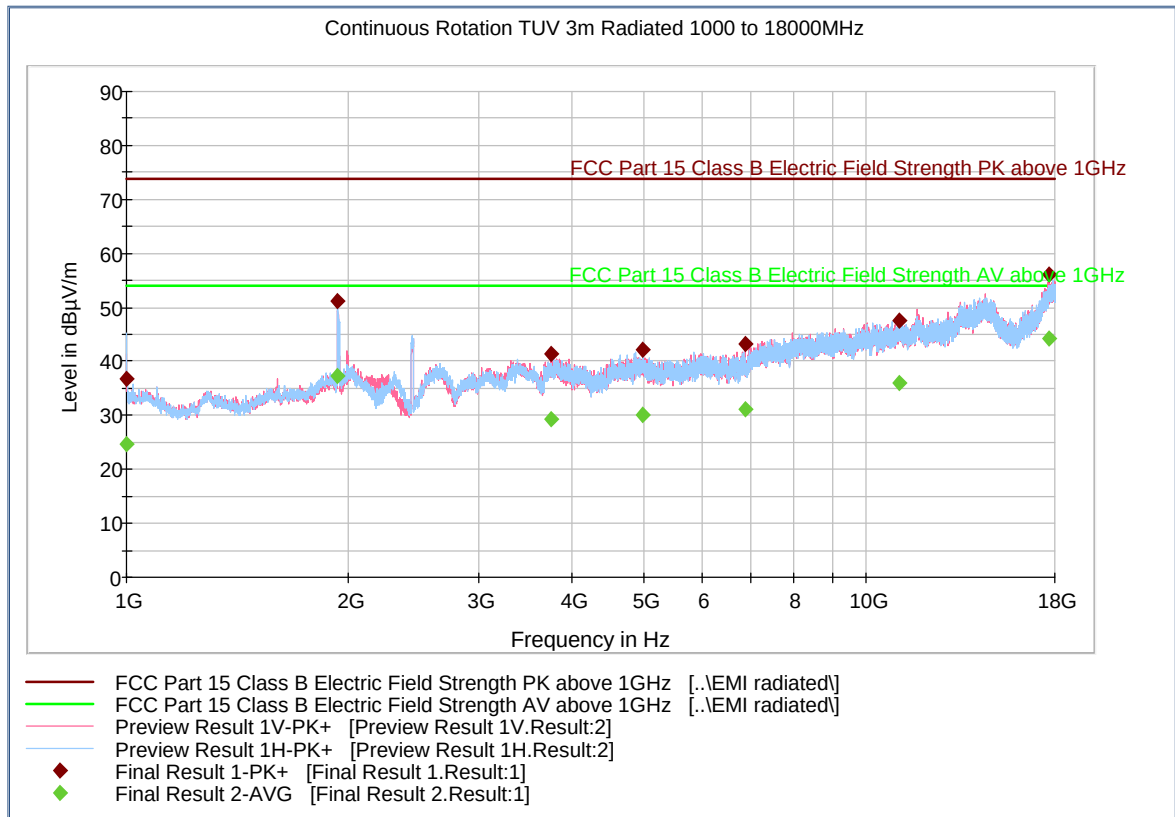
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.400000	34.4	1000.0	1000.000	202.3	H	146.0	-11.2	39.5	73.9
1932.533333	49.5	1000.0	1000.000	404.0	H	221.0	-4.6	24.4	73.9
2438.566667	43.1	1000.0	1000.000	200.5	V	255.0	-5.1	Fundamental	
3817.266667	41.8	1000.0	1000.000	130.7	H	10.0	0.9	32.1	73.9
4873.933333	50.4	1000.0	1000.000	182.5	V	286.0	2.3	23.5	73.9
8940.900000	46.7	1000.0	1000.000	124.7	H	100.0	10.1	27.2	73.9
10253.066667	48.6	1000.0	1000.000	404.0	H	61.0	12.0	25.3	73.9
17773.166667	56.0	1000.0	1000.000	112.7	H	140.0	23.3	17.9	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	22.6	1000.0	1000.000	202.3	H	146.0	-11.2	31.3	53.9
1932.533333	38.1	1000.0	1000.000	404.0	H	221.0	-4.6	15.8	53.9
2438.566667	38.1	1000.0	1000.000	200.5	V	255.0	-5.1	Fundamental	
3817.266667	30.0	1000.0	1000.000	130.7	H	10.0	0.9	23.9	53.9
4873.933333	44.2	1000.0	1000.000	182.5	V	286.0	2.3	9.7	53.9
8940.900000	35.0	1000.0	1000.000	124.7	H	100.0	10.1	18.9	53.9
10253.066667	35.8	1000.0	1000.000	404.0	H	61.0	12.0	18.1	53.9
17773.166667	44.2	1000.0	1000.000	112.7	H	140.0	23.3	9.7	53.9

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

2.6.15 Test Results above 1GHz Mid Channel (802.11g 54Mbps worst-case data rate)



Peak Data

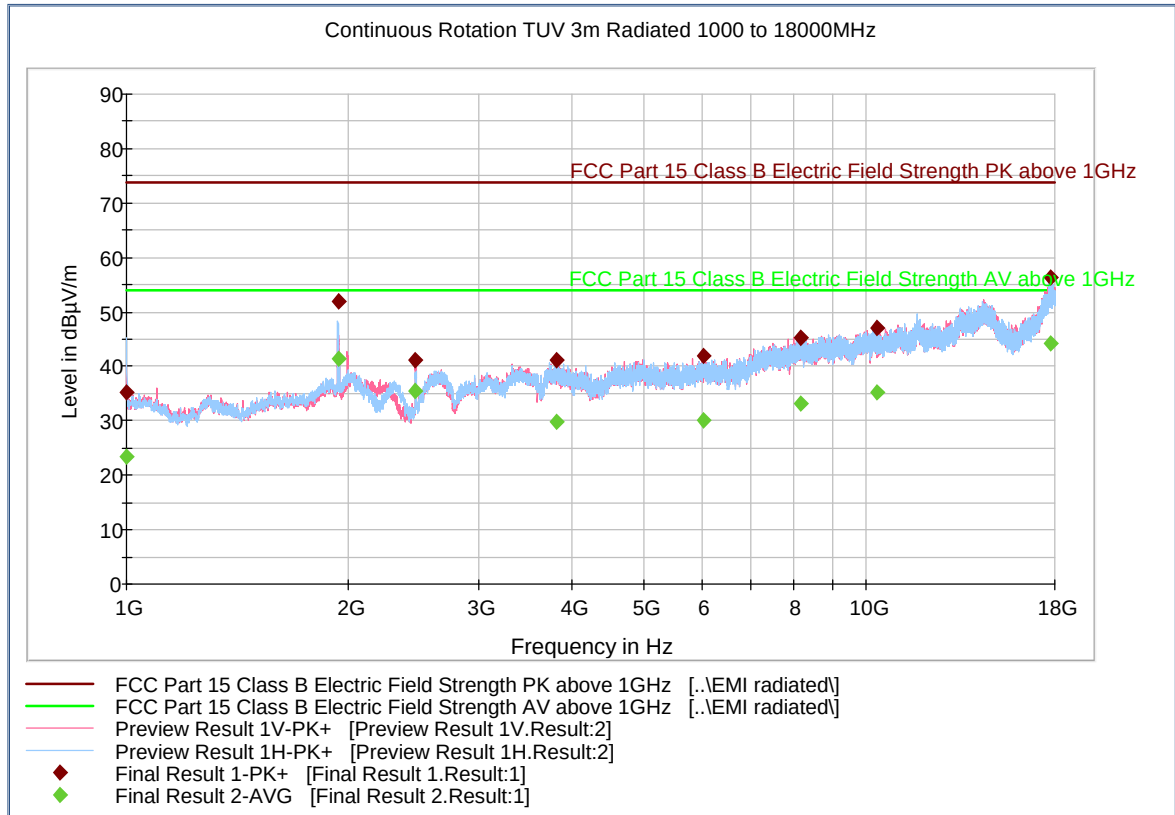
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
1000.000000	36.7	1000.0	1000.000	194.5	H	194.0	-11.2	37.2	73.9
1932.566667	51.2	1000.0	1000.000	404.0	H	163.0	-4.6	22.7	73.9
3747.433333	41.4	1000.0	1000.000	404.0	V	290.0	0.5	32.5	73.9
4981.366667	42.3	1000.0	1000.000	402.7	V	-13.0	2.2	31.6	73.9
6854.766667	43.1	1000.0	1000.000	170.6	V	251.0	5.6	30.8	73.9
11095.566667	47.6	1000.0	1000.000	337.1	V	71.0	13.2	26.3	73.9
17717.366667	56.0	1000.0	1000.000	404.0	V	80.0	22.9	17.9	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	24.6	1000.0	1000.000	194.5	H	194.0	-11.2	29.3	53.9
1932.566667	37.2	1000.0	1000.000	404.0	H	163.0	-4.6	16.7	53.9
3747.433333	29.3	1000.0	1000.000	404.0	V	290.0	0.5	24.6	53.9
4981.366667	30.1	1000.0	1000.000	402.7	V	-13.0	2.2	23.8	53.9
6854.766667	31.2	1000.0	1000.000	170.6	V	251.0	5.6	22.7	53.9
11095.566667	35.9	1000.0	1000.000	337.1	V	71.0	13.2	18.0	53.9
17717.366667	44.1	1000.0	1000.000	404.0	V	80.0	22.9	9.8	53.9

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

2.6.16 Test Results above 1GHz High Channel (802.11b 11Mbps worst-case data rate)



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	35.3	1000.0	1000.000	198.4	H	174.0	-11.2	38.6	73.9
1932.766667	51.9	1000.0	1000.000	371.0	H	159.0	-4.6	22.0	73.9
2460.266667	41.3	1000.0	1000.000	161.6	V	288.0	-5.1	Fundamental	
3814.633333	41.2	1000.0	1000.000	237.3	H	350.0	0.9	32.7	73.9
6029.366667	41.9	1000.0	1000.000	404.0	H	101.0	4.3	32.0	73.9
8153.600000	45.3	1000.0	1000.000	271.2	H	226.0	8.7	28.6	73.9
10333.033333	46.9	1000.0	1000.000	383.0	V	62.0	12.0	27.0	73.9
17752.400000	56.3	1000.0	1000.000	338.1	V	194.0	23.1	17.6	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	23.4	1000.0	1000.000	198.4	H	174.0	-11.2	30.5	53.9
1932.766667	41.5	1000.0	1000.000	371.0	H	159.0	-4.6	12.4	53.9
2460.266667	35.4	1000.0	1000.000	161.6	V	288.0	-5.1	Fundamental	
3814.633333	29.9	1000.0	1000.000	237.3	H	350.0	0.9	24.0	53.9
6029.366667	30.1	1000.0	1000.000	404.0	H	101.0	4.3	23.8	53.9
8153.600000	33.3	1000.0	1000.000	271.2	H	226.0	8.7	20.6	53.9
10333.033333	35.2	1000.0	1000.000	383.0	V	62.0	12.0	18.7	53.9
17752.400000	44.2	1000.0	1000.000	338.1	V	194.0	23.1	9.7	53.9

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



2.7 RADIATED IMMEDIATE RESTRICTED BANDS

2.7.1 Specification Reference

Part 15 Subpart C §15.247(d)

2.7.2 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)).

2.7.3 Equipment Under Test and Modification State

Serial No: IMEI 990000949644647/ Default Test Configuration

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

June 24, 2016/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

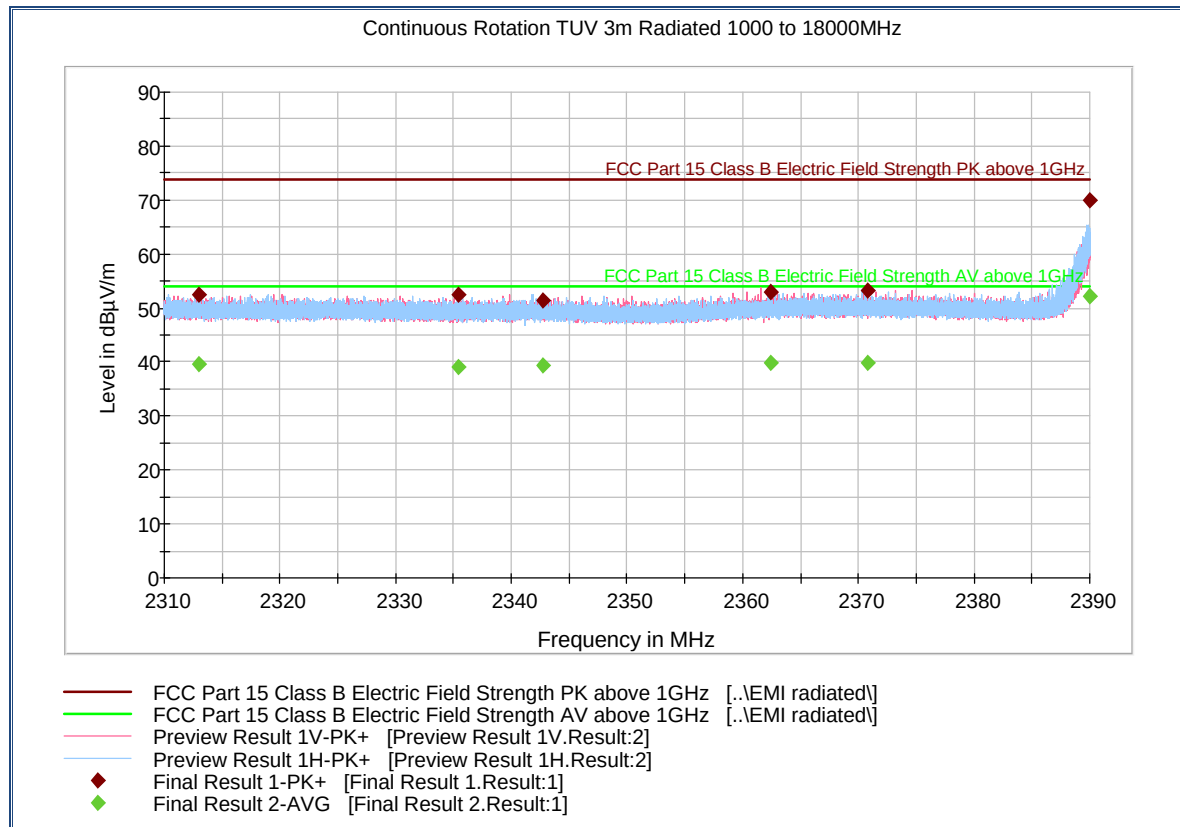
Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	27.0°C
Relative Humidity	47.9%
ATM Pressure	98.9 kPa

2.7.7 Additional Observations

- This is a radiated test. The spectrum of interest is from 2310MHz to 2390MHz for lower immediate restricted band and 2483.5MHz to 2500MHz for the upper restricted band.
- Verification of the spectrum < 2390 MHz and >2500 MHz is covered under Section 2.6 of this test report.
- Only the considered worst case configurations (802.11g 36/54Mbps and 802.11n 26Mbps) are presented.
- 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.

2.7.8 Test Results Lower Restricted Band (802.11g 36Mbps worst-case data rate)



Peak Data

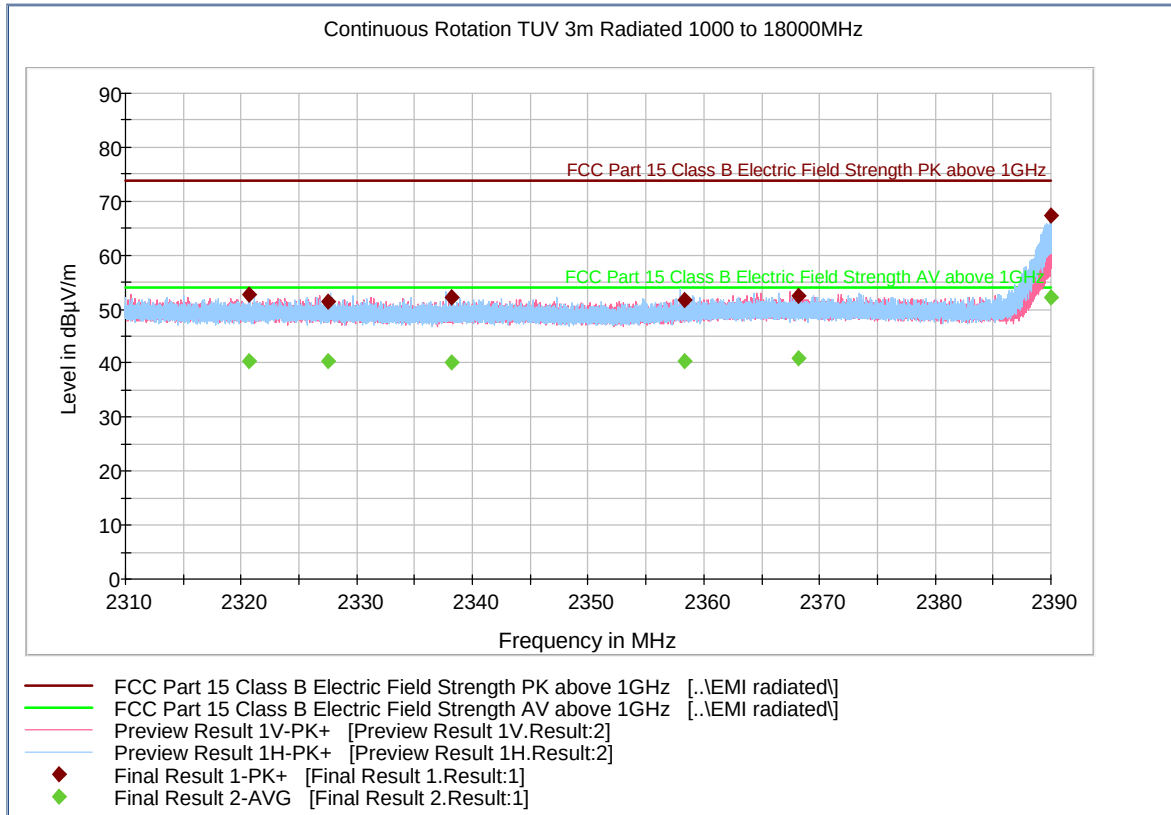
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2312.970667	52.4	1000.0	1000.000	167.6	V	53.0	10.6	21.5	73.9
2335.376000	52.5	1000.0	1000.000	190.5	V	88.0	10.6	21.4	73.9
2342.730667	51.4	1000.0	1000.000	126.7	H	45.0	10.7	22.5	73.9
2362.424000	53.0	1000.0	1000.000	167.6	V	26.0	10.7	20.9	73.9
2370.776000	53.2	1000.0	1000.000	259.3	H	2.0	10.8	20.7	73.9
2390.000000	69.9	1000.0	1000.000	149.6	H	252.0	10.9	4.0	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)
2312.970667	39.6	1000.0	1000.000	167.6	V	53.0	10.6	14.3	53.9
2335.376000	39.1	1000.0	1000.000	190.5	V	88.0	10.6	14.8	53.9
2342.730667	39.3	1000.0	1000.000	126.7	H	45.0	10.7	14.6	53.9
2362.424000	39.8	1000.0	1000.000	167.6	V	26.0	10.7	14.1	53.9
2370.776000	39.9	1000.0	1000.000	259.3	H	2.0	10.8	14.0	53.9
2390.000000	52.1	1000.0	1000.000	149.6	H	252.0	10.9	1.8	53.9

Test Notes:

2.7.9 Test Results Lower Restricted Band (802.11n 26Mbps worst-case data rate)



Peak Data

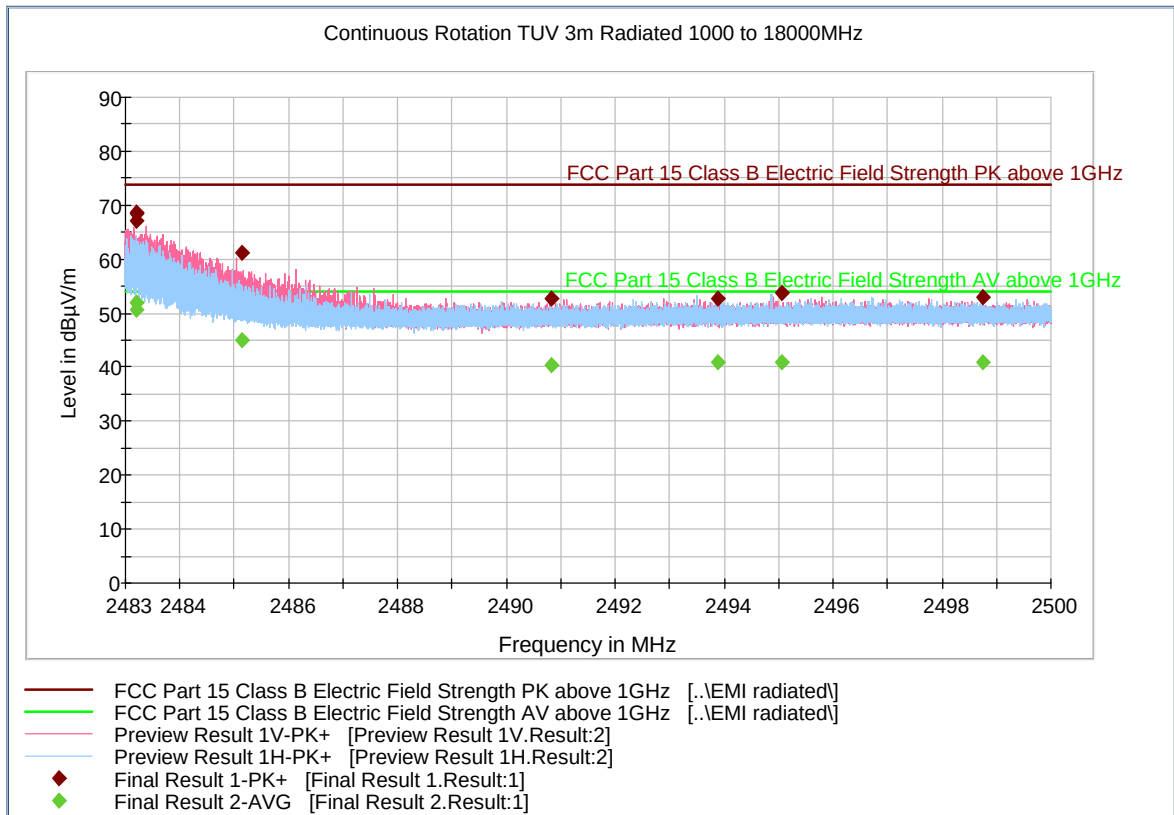
Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2320.650667	52.7	1000.0	1000.000	241.3	H	339.0	10.6	21.2	73.9
2327.549333	51.5	1000.0	1000.000	118.7	H	41.0	10.6	22.4	73.9
2338.146667	52.1	1000.0	1000.000	151.6	H	40.0	10.6	21.8	73.9
2358.338667	51.8	1000.0	1000.000	120.7	H	158.0	10.7	22.1	73.9
2368.208000	52.5	1000.0	1000.000	300.6	V	201.0	10.8	21.4	73.9
2390.000000	67.4	1000.0	1000.000	103.7	H	213.0	10.9	6.5	73.9

Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
2320.650667	40.4	1000.0	1000.000	241.3	H	339.0	10.6	13.5	53.9
2327.549333	40.3	1000.0	1000.000	118.7	H	41.0	10.6	13.6	53.9
2338.146667	40.1	1000.0	1000.000	151.6	H	40.0	10.6	13.8	53.9
2358.338667	40.3	1000.0	1000.000	120.7	H	158.0	10.7	13.6	53.9
2368.208000	40.9	1000.0	1000.000	300.6	V	201.0	10.8	13.0	53.9
2390.000000	52.1	1000.0	1000.000	103.7	H	213.0	10.9	1.8	53.9

Test Notes:

2.7.10 Test Results Upper Restricted Band (802.11g 54Mbps worst-case data rate)



Peak Data

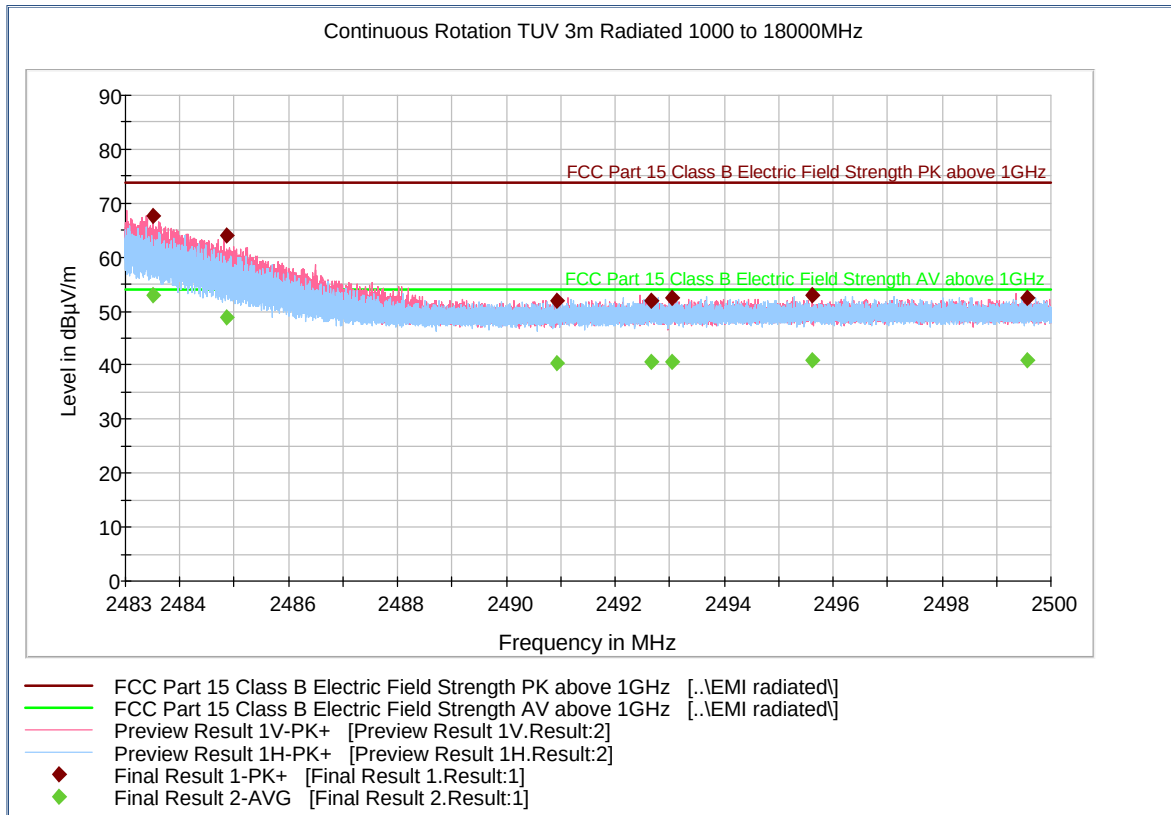
Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2483.200000	68.5	1000.0	1000.000	196.5	V	188.0	11.0	5.4	73.9
2485.137067	61.2	1000.0	1000.000	197.5	V	182.0	11.0	12.7	73.9
2490.829067	52.7	1000.0	1000.000	181.5	V	214.0	11.0	21.2	73.9
2493.895233	52.7	1000.0	1000.000	134.7	H	56.0	11.0	21.2	73.9
2495.059200	53.7	1000.0	1000.000	192.5	H	320.0	11.0	20.2	73.9
2498.752033	52.8	1000.0	1000.000	195.5	V	344.0	11.0	21.1	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2483.200000	51.9	1000.0	1000.000	196.5	V	188.0	11.0	2.0	53.9
2485.137067	45.0	1000.0	1000.000	197.5	V	182.0	11.0	8.9	53.9
2490.829067	40.4	1000.0	1000.000	181.5	V	214.0	11.0	13.5	53.9
2493.895233	40.8	1000.0	1000.000	134.7	H	56.0	11.0	13.1	53.9
2495.059200	40.8	1000.0	1000.000	192.5	H	320.0	11.0	13.1	53.9
2498.752033	40.8	1000.0	1000.000	195.5	V	344.0	11.0	13.1	53.9

Test Notes:

2.7.11 Test Results Upper Restricted Band (802.11n 26Mbps worst-case data rate)



Peak Data

Frequency (MHz)	MaxPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2483.511100	67.6	1000.0	1000.000	200.5	V	175.0	11.0	6.3	73.9
2484.871867	64.1	1000.0	1000.000	200.5	V	188.0	11.0	9.8	73.9
2490.931100	52.0	1000.0	1000.000	143.6	V	0.0	11.0	21.9	73.9
2492.651433	52.0	1000.0	1000.000	197.5	V	313.0	11.0	21.9	73.9
2493.051433	52.4	1000.0	1000.000	234.3	V	203.0	11.0	21.5	73.9
2495.622033	52.9	1000.0	1000.000	259.3	H	263.0	11.0	21.0	73.9
2499.574400	52.4	1000.0	1000.000	177.5	V	-11.0	11.0	21.6	73.9

Average Data

Frequency (MHz)	Average (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
2483.511100	53.1	1000.0	1000.000	200.5	V	175.0	11.0	0.8	53.9
2484.871867	48.8	1000.0	1000.000	200.5	V	188.0	11.0	5.1	53.9
2490.931100	40.5	1000.0	1000.000	143.6	V	0.0	11.0	13.4	53.9
2492.651433	40.6	1000.0	1000.000	197.5	V	313.0	11.0	13.3	53.9
2493.051433	40.6	1000.0	1000.000	234.3	V	203.0	11.0	13.3	53.9
2495.622033	40.8	1000.0	1000.000	259.3	H	263.0	11.0	13.1	53.9
2499.574400	40.8	1000.0	1000.000	177.5	V	-11.0	11.0	13.1	53.9

Test Notes:



SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

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

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Radiated Test Setup						
1033	Bilog Antenna	3142C	00044556	EMCO	09/25/14	09/25/16
1051	Double-ridged waveguide horn antenna	3115	9408-4329	EMCO	03/21/16	03/21/17
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	01/11/16	01/11/17
1054	Horn antenna (18-40 GHz)	3116	9407-2233	EMCO	12/22/15	12/22/17
8893	Pre-amplifier (18-40 GHz)	SLKka-30-6	15G27	Spacek Labs	Verified by 1003 and 1049	
8850	High-frequency cable	N/A	N/A	N/A	12/17/15	12/17/16
8549	High-frequency cable	SAC-26G-6.1	363	A.H.Systems	03/17/16	03/17/17
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	09/29/15	09/29/16
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 1049	
1016	Pre-amplifier	PAM-0202	187	PAM	12/15/15	12/15/16
1003	Signal Generator	SMR-40	1104.0002.40	Rhode & Schwarz	05/16/16	05/16/17
Miscellaneous						
7619	Barometer/Temperature/Humidity Transmitter	iBTHX-W	15250268	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 Emission Measurements (Below 1GHz)

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

3.2.2 Radiated Emission Measurements (Above 1GHz)

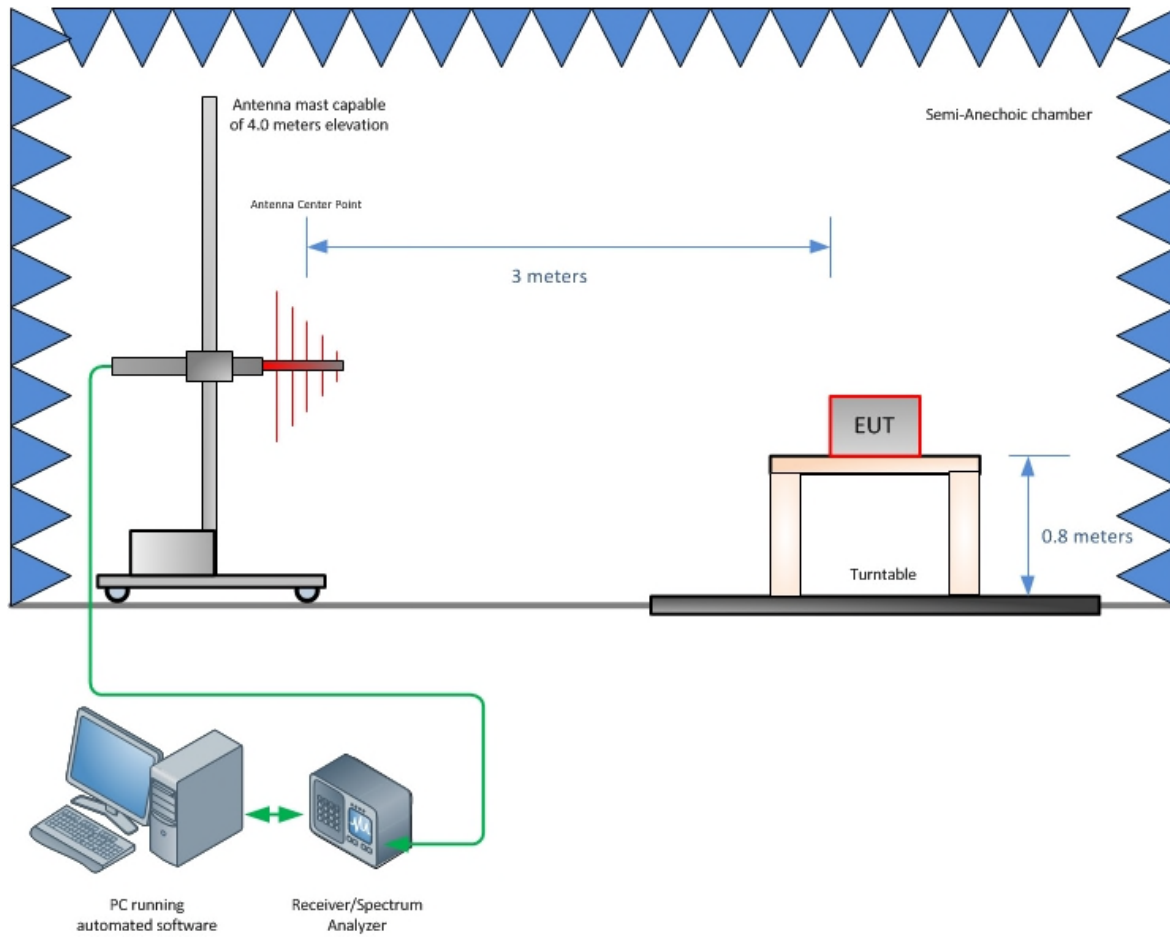
Contribution		Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	2.70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



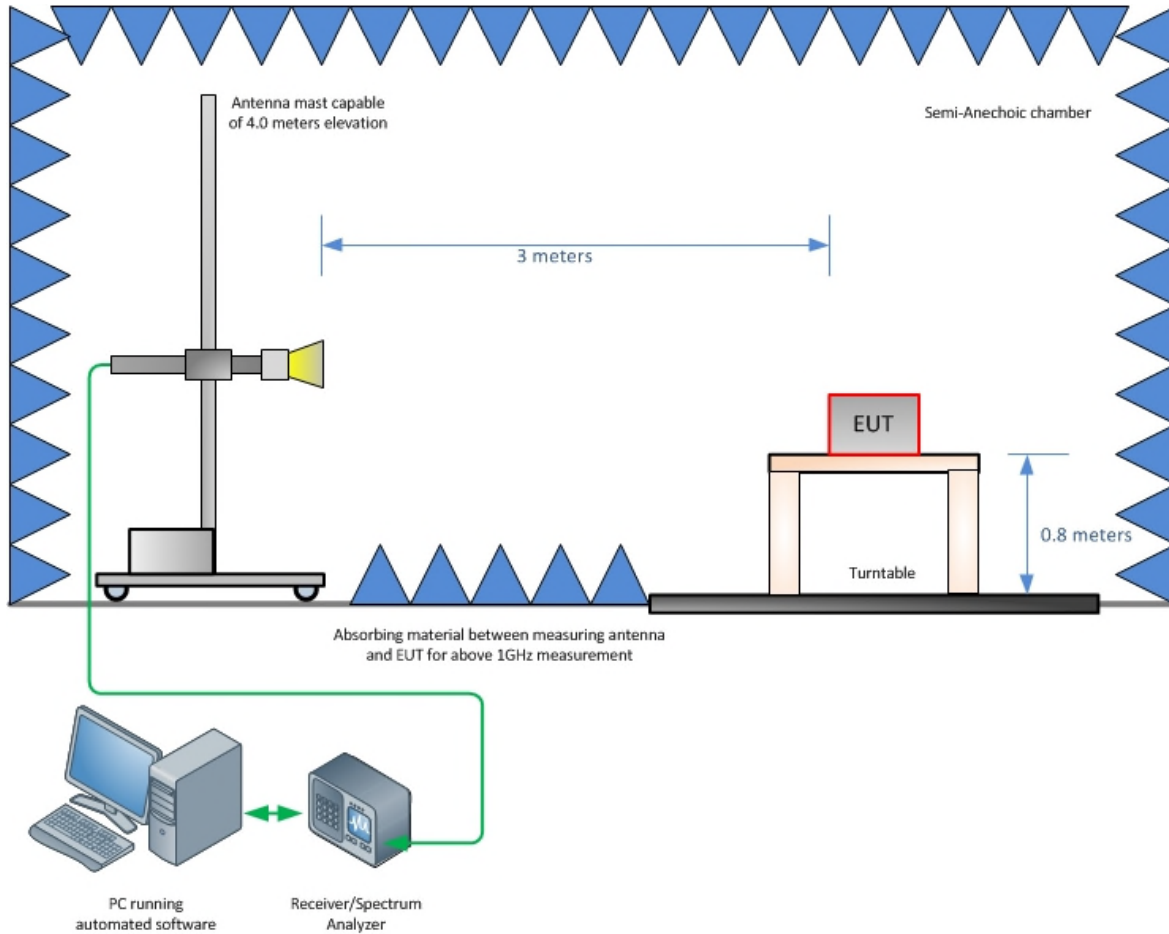
SECTION 4

DIAGRAM OF TEST SETUP

4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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