RADIO TEST REPORT

For

MODEL NO.: 1836
FCC ID: C3K1836
IC ID: 3048A-1836

Test Report No. R-TR484-FCCISED-WLAN-3
Issue Date: Jun 07, 2018

FCC CFR47 Part 15 Subpart C
Innovation, Science and Economic Development
Canada RSS-247 Issue 2

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TESTING CERT #3472.01

1 Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	5/23/2018	All	All	Version 1.0	Andy Shen
2.0	5/30/2018	4	7	Updated MU Table.	Andy Shen
		8.1	14	Added test site specific details for <30MHz testing.	
		9.4.4	29	Added Average conducted power data.	
		9.8.2	44	Corrected typo on freq range of test.	
		9.8.2	45	Added test setup details for <30MHz testing.	
3.0	06/07/2018	5.6	9	Added section for FW and driver details of the test samples.	Andy Shen

Table of Contents

1 Record of Revisions 2
2 Deviations from Standards 7
3 Facilities and Accreditations 7
3.1 Test Facility 7
3.2 Accreditations 7
3.3 Test Equipment 7
4 Measurement Uncertainty 7
5 Product Description 8
5.1 Test Configurations 9
5.2 Environmental Conditions 9
5.3 Antenna Requirements 9
5.4 Modifications 9
5.5 Dates of Testing 9
5.6 Test Sample Details 9
6 Test Results Summary 10
7 Test Equipment List 11
8 Test Site Description 14
8.1 Radiated Emissions Test Site 14
8.1.1 Radiated Measurements in 9kHz- 30 MHz 14
8.1.2 Radiated Measurements in 30 MHz - 1000 MHz 14
8.1.3 Radiated Measurements above 1GHz 14
8.2 Antenna port conducted measurements 15
8.3 Test Setup Diagrams 15
9 Test Results- Conducted 18
9.1 Duty Cycle 18
9.1.1 Test Requirement: 18
9.1.2 Test Method: 18
9.1.3 Limits: 18
9.1.4 Test Results: 18
9.1.5 Test Data: 19
9.2 DTS Bandwidth 20
9.2.1 Test Requirement: 20
9.2.2 Test Method: 20

9.2.3 Limits: 20
9.2.4 Test Results: 21
9.2.5 Test Data: 22
9.3 99% Bandwidth 24
9.3.1 Test Requirement: 24
9.3.2 Test Method: 24
9.3.3 Limit: 24
9.3.4 Test Results: 25
9.3.5 Test Data: 26
9.4 Output Power 28
9.4.1 Test Requirement: 28
9.4.2 Test Method: 28
9.4.3 Limits: 28
9.4.4 Test Results: 29
9.5 Power Spectral Density 30
9.5.1 Test Requirement: 30
9.5.2 Test Method: 30
9.5.3 Limits: 30
9.5.4 Test Results: 31
9.5.5 Test Data: 32
9.6 Conducted Spurious Emissions 34
9.6.1 Test Requirement: 34
9.6.2 Test Method: 34
9.6.3 Limits: 34
9.6.4 Test Result: 34
9.6.5 Test Data: 35
9.7 Conducted Band Edge Emissions 41
9.7.1 Test Requirement: 41
9.7.2 Test Method: 41
9.7.3 Limits: 41
9.7.4 Test Result: 41
9.7.5 Test Data: 42

9.8 Radiated Spurious and Band Edge Emissions 44
9.8.1 Test Requirement: 44
9.8.2 Test Method: 44
9.8.3 Limits: 47
9.8.4 Test Result: 47
9.8.5 Test Data: 48
9.9 AC Line Conducted Emissions 60
9.9.1 Test Requirements 60
9.9.2 Test Method 60
9.9.3 Limit 60
9.9.4 Test Result: 60
9.9.5 Test Data: 61

Test Report Attestation

Microsoft Corporation
Model: 1836
FCC ID: C3K1836
IC ID: 3048A-1836

Applicable Standards

Specification	Test Result
FCC 47CFR Rule Parts 15.207, 15.209, 15.247	Pass
Innovation, Science and Economic Development Canada RSS-247 Issue 2, RSS-GEN Issue 5	Pass

Microsoft EMC Laboratory attests that the product model identified in this report has been tested to and meets the requirements identified in the above standards. The test results in this report solely pertains to the specific sample tested, under the conditions and operating modes as provided by the customer.

This report shall not be used to claim product certification, approval, or endorsement by A2LA or any agency of any Government. Reproduction, duplication or publication of extracts from this test report is prohibited and requires prior written approval of Microsoft EMC Laboratory.

This report replaces the previously issued report #R-TR484-FCCISED-WLAN-2 issued by Microsoft EMC Labs on 5/30/2018.

Written By: Andy Shen

Radio Test Engineer

Reviewed/ Issued By: Sajay Jose

EMC/RF Compliance Lab Manager

2 Deviations from Standards

None.

3 Facilities and Accreditations

3.1 Test Facility

All test facilities used to collect the test data are located at
Microsoft EMC Laboratory,
17760 NE 67th Ct,
Redmond WA, 98052, USA

3.2 Accreditations

The lab is established and follows procedures as outlined in IEC/ISO 17025 and A2LA accreditation requirements.
A2LA Accredited Testing Certificate Number: 3472.01
FCC Registration Number: US1141
IC Site Registration Numbers: 3048A-3, 3048A-4

3.3 Test Equipment

The site and related equipment are constructed in conformance with the requirements of ANSI C63.4:2014 and other equivalent applicable standards.
Test site requirements for measurements above 1 GHz are in accordance with ANSI C63.4:2014.
ANSI C63.10:2013 and the appropriate KDB test methods were followed.

4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the product, as specified in ETSI TR 100 028. This represents an expanded uncertainty expressed at 95% confidence level using a coverage factor k=2. These levels are for reference only and not included to determine product compliance.
Expanded uncertainty calculations are available upon request.

Test item	Uncertainty	Unit
Radiated disturbance (9 kHz to 30 MHz)	5.45	dB
Radiated disturbance (30 MHz to 1 GHz)	5.99	dB
Radiated disturbance (1 GHz to 18 GHz)	5.12	dB
Radiated disturbance (18 GHz to 26.5 GHz)	5.34	dB
Radiated disturbance (26.5 GHz to 40 GHz)	5.08	dB
Conducted Disturbance at Mains Port	3.31	dB
Uncertainty for Conducted Power test	1.277	dB
Uncertainty for Conducted Spurious emission test	2.742	dB
Uncertainty for Bandwidth test	83	kHz
Uncertainty for DC power test	0.05	%
Uncertainty for test site temperature	0.5	ºC
Uncertainty for test site Humidity	3	%
Uncertainty for time	0.189	%

5 Product Description

Company Name:	Microsoft Corporation
Address:	One Microsoft Way
City, State, Zip:	Redmond, WA 98052-6399
Customer Contact:	Pamela Galvan
Functional Description of the EUT:	Wireless Input Device
Model:	1836
FCC ID:	C3K1836
IC ID:	3048A-1836
Radio under test:	IEEE 802.11 g/n Radio supporting 20 MHz Bandwidth (2.4 GHz- 2.4835 GHz)
Modulation(s):	CCK, BPSK, OFDM, and QAM modulation
Antenna Information:	2.4 GHz Integral Antenna. **Manufacturer declared Peak Antenna Gain:** +4.7 dBi
EUT Classification:	DTS
Equipment Design State:	Prototype/Production Equivalent
Equipment Condition:	Good

5.1 Test Configurations

Test software "MTK MT7637 QA V0.0.1.63, Indium QA Tool V1.17, V1.19" provided by the customer was used to program the EUT to transmit continuously.
All modes of operation were investigated initially with full testing performed on the worst-case modes. This report contains data from the following worst-case modes of operation:
802.11g: 6Mbps
802.11n: MCS0

5.2 Environmental Conditions

Ambient air temperature of the test site was within the range of 10 ºC to 40 ºC (50 ºF to 104 ºF) unless the EUT specified testing over a different temperature range. Humidity levels were in the range of 10% to 90% relative humidity. Testing conditions were within tolerance, and any deviations required from the EUT are reported.

5.3 Antenna Requirements

The antennas are permanently attached and there are no provisions for connection to an external antenna.

5.4 Modifications

No modifications were made during testing.

5.5 Dates of Testing

Testing was performed from March 26, 2018 to May 21, 2018.

5.6 Test Sample Details

RF Conducted Test Samples:

SN	Internal Lab ID	Design State
02560000893802	R-484-032218-09	EV2

RF Radiated Test Samples:

SN	Internal Lab ID	Design State
02560000517814	R-484-041918-07	DV
02560000597814	R-484-041918-08	DV

Radio FW: 4.5.213.0
Radio Driver Version: WDM Driver v0.0.3.40/ FTDI Driver v2.12.28.0

6 Test Results Summary

Test Description	FCC CFR 47/ ISED Rule Part	Limit	Test Result
Duty Cycle	Reporting & Measurements	Reporting & Measurements Purposes only	N/A
6dB Bandwidth	15.247 (a)(2) RSS-247 [5.2]	≥ 500kHz	Pass
Occupied Bandwidth	Reporting & Measurements	Reporting & Measurements Purposes only	N/A
Output Power	15.247 (b)(3) RSS-247 [5.4]	≤ 1 Watt	Pass
Equivalent Isotropic Radiated Power	RSS-247 [5.4]	≤ 4 Watt	Pass
Power Spectral Density	15.247 (e) RSS-247 [5.2]	≤ 8dBm/3kHz	Pass
Conducted Band Edge/Spurious Emissions	15.247 (d) RSS-247 [5.5]	At least 20dBc	Pass
Radiated Spurious Emissions/ Restricted Band Emissions	15.205, 15.209 RSS-247 [5.5] RSS-Gen [8.9]	FCC CFR 47 15.209 limits RSS-Gen [8.9]	Pass
AC Power Line Conducted Emissions	15.207 RSS-Gen [8.8]	FCC CFR 47 15.207 limits RSS-Gen [8.8]	Pass

7 Test Equipment List

Equipment used for Radiated and Conducted Measurements				
Description	**Manufacturer**	**Model #**	**Asset #**	**Calibration Due**
Spectrum Analyzer	Agilent	N9020A	EMC-054	11/27/2018
EMI Test Receiver	Rohde & Schwarz	ESU40	RF-248	4/9/2019
EMI Test Receiver	Rohde & Schwarz	ESU40	RF-229	4/9/2019
Signal Analyzer	Rohde & Schwarz	FSV40	RF-245	4/10/2019
EMI Test Receiver	Rohde & Schwarz	ESU40	RF-192	4/8/2019
Open Switch and Control Unit	Rohde & Schwarz	OSP130	RF-193	N/A
Open Switch and Control Unit	Rohde & Schwarz	OSP150	RF-194	N/A
Open Switch and Control Unit	Rohde & Schwarz	OSP130	RF-018	N/A
Open Switch and Control Unit	Rohde & Schwarz	OSP150	RF-019	N/A
Antenna - Broadband	Sunol Sciences	JB6	EMC-639	7/17/2018
Antenna - Double-Ridged	ETS-Lindgren	3117	RF-138	6/13/2018
Antenna - Double-Ridged	ETS-Lindgren	3117	RF-139	5/22/2018
Antenna - Standard Gain	ETS-Lindgren	3160-09	RF-179	N/A
ETS-Lindgren	Antenna - Passive Loop	6512	EMC-440	8/31/2018
Custom Filter Bank	Rohde & Schwarz	SFUNIT RX	RF-324	12/20/2018
Custom Filter Bank	Rohde & Schwarz	SFUNIT RX	RF-323	12/6/2018
Preamplifier	Rohde & Schwarz	TS-PR26	RF-199	N/A
RF Cable	Micro-Coax	UFB311A-1-0787-50U50U	EMC-351	N/A
RF Cable	MegaPhase	EMC3-N1N1-394	EMC-1037	N/A
RF Cable	Sucoflex	104PE	RF-430	N/A
RF Cable	Huber & Suhner	Sucoflex 102A	RF-269	N/A

Description	Manufacturer	Model #	Asset #	Calibration Due
RF Cable	Murata	MXHQ87WA3000	RF-591	N/A
RF Cable	Pasternack	PE304-200CM	RF-447	N/A
RF Cable	Murata	MXHQ87WA3000	RF-591	N/A
RF Cable	Micro- Coax	UFA2105	RF-644	N/A
RF Cable	Murata	MXHQ87WA3000	RF-596	N/A
RF Cable	MegaPhase	EMC3-N1N1-394	EMC-1036	N/A
RF Cable	Pasternack	PE304-200CM	RF-446	N/A
RF Cable	Huber & Suhner	SucoFlex 100	RF-350	N/A
RF Cable	Teledyne	57500	EMC-1025	N/A
RF Cable	Huber and Suhner	SucoFlex 100	RF-599	N/A
RF Cable	Micro-Coax	UTI Flex	RF-354	N/A
RF Cable	Micro-Coax	UTI Flex	RF-359	N/A
THP Monitor	Madge Tech	PRHTemp2000	EMC-681	10/26/2018
THP Monitor	Madge Tech	PRHTemp2000	EMC-170	8/28/2018
THP Monitor	Madge Tech	PRHTemp2000	EMC-680	11/2/2018
Test Software	Rohde-Schwarz	EMC-32 V9.25.00 and V10.01.00	N/A	N/A

Equipment used for Line Conducted Emissions Measurement				
Manufacturer	**Description**	**Model #**	**Asset #**	**Calibration Due**
Rohde & Schwarz	EMI Test Receiver	ESR3	EMC-669	4/8/2019
Teseq	LISN	NNB 51	EMC-642	7/28/2018
Fluke	Multimeter	87V	EMC-096	10/23/2018
Madge Tech	THP Monitor	PRHTemp2000	EMC-881	7/17/2018
Chroma	AC Power Source	61602	EMC-055	N/A
Micro-Coax	RF Cable	UFA210A-1-1800-50U50U	EMC-367	8/9/2018
ETS-Lindgren	License Dongle	TILE V7.2.5.7	EMC-985	N/A

Note: Items with Calibration Due data marked as N/A are characterized before test, where applicable.

8 Test Site Description

8.1 Radiated Emissions Test Site

Radiated measurements are performed in a 3m semi-anechoic chamber, which meets NSA requirements for the frequency range of 30MHz to 1000MHz. For measurements above 1 GHz, absorbers are placed on the ground plane between the receiving antenna and the EUT to meet Site VSWR requirements in accordance with ANSI C63.4:2014.

Testing below 30MHz is also performed in the semi-anechoic chamber. Per KDB 414788, comparison measurements were performed between an open area site and the semi-anechoic chamber and the results from the chamber is higher than those measured from the open area site.

8.1.1 Radiated Measurements in 9kHz- 30 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A loop antenna is positioned at 3m from the EUT periphery at 1m height from the ground. The turntable is rotated 360 degrees to determine the highest emissions. This is repeated for three orientations of the measurement antenna- parallel, perpendicular and ground-parallel. All possible orientations of the EUT were investigated for emissions and the flat orientation was identified as the worst-case configuration.

8.1.2 Radiated Measurements in 30 MHz - 1000 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A linearly polarized broadband antenna is positioned at 3m from the EUT periphery. The turntable is rotated 360 degrees and the antenna height varied from 1m to 4m to determine the highest emissions. This is repeated for both horizontal and vertical polarizations of the measurement antenna. All possible orientations of the EUT were investigated for emissions and the flat orientation was identified as the worst-case configuration.

8.1.3 Radiated Measurements above 1GHz

The EUT is positioned on a Turntable at a height of 1.5m. A Linearly polarized antenna is positioned at 3m from the EUT periphery. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions. The measurement antenna is set at a fixed 1.5m height while the turntable is rotated 360 degrees and the EUT elevation angle is varied from 0 to 150 degrees in 30 degree increments to determine the highest emissions. This is repeated for both horizontal and vertical Polarizations of the Measurement Antenna. Measurements above 18GHz were performed at a 3m distance. Near field scanning is performed to identify frequencies above 1 GHz.

8.2 Antenna port conducted measurements

All antenna port conducted measurements were performed on a bench-top setup consisting of a spectrum analyzer, power meter (as necessary), splitters/combiners (as necessary), attenuators, and pre-characterized RF cables.

The correction factors between the EUT and the spectrum analyzer were added internally in the analyzer settings, where applicable. The plots displayed take these correction factors into account.

8.3 Test Setup Diagrams

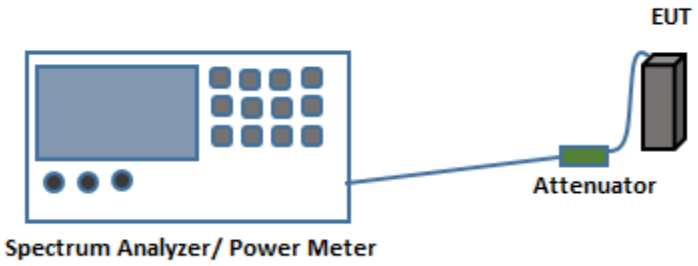


Figure 8-1 Test Setup for Antenna port conducted measurements

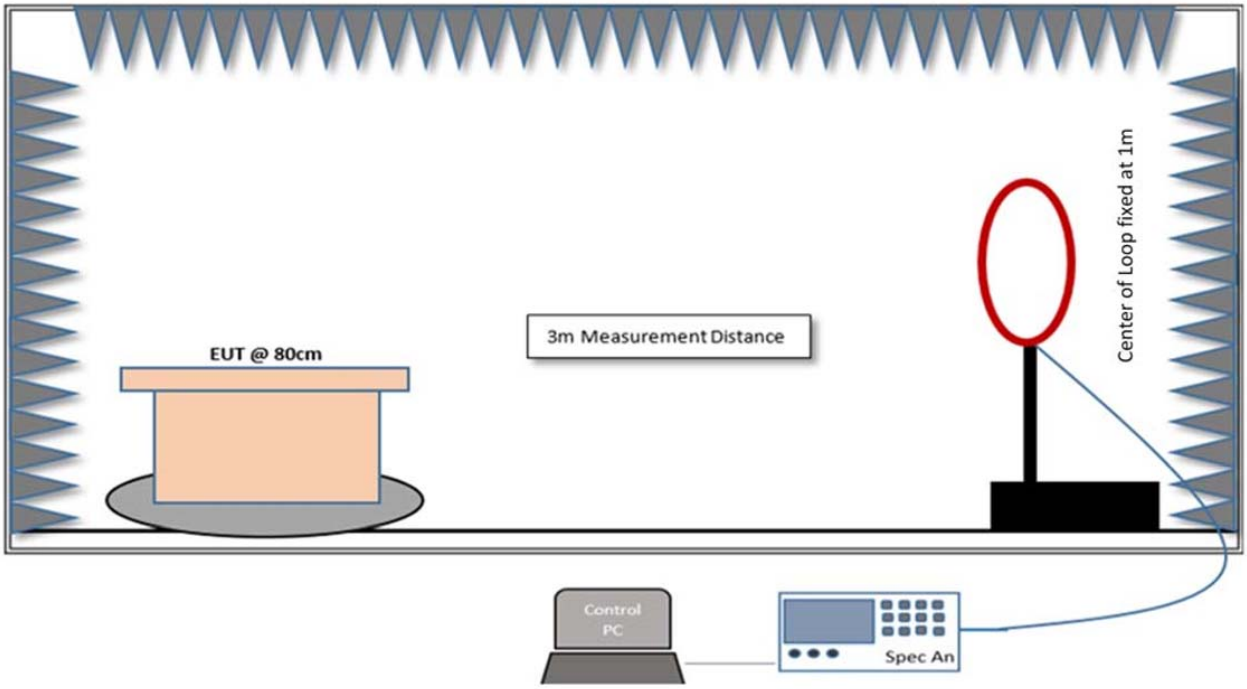


Fig.2. Test Setup for Radiated measurements in 9kHz - 30MHz Range

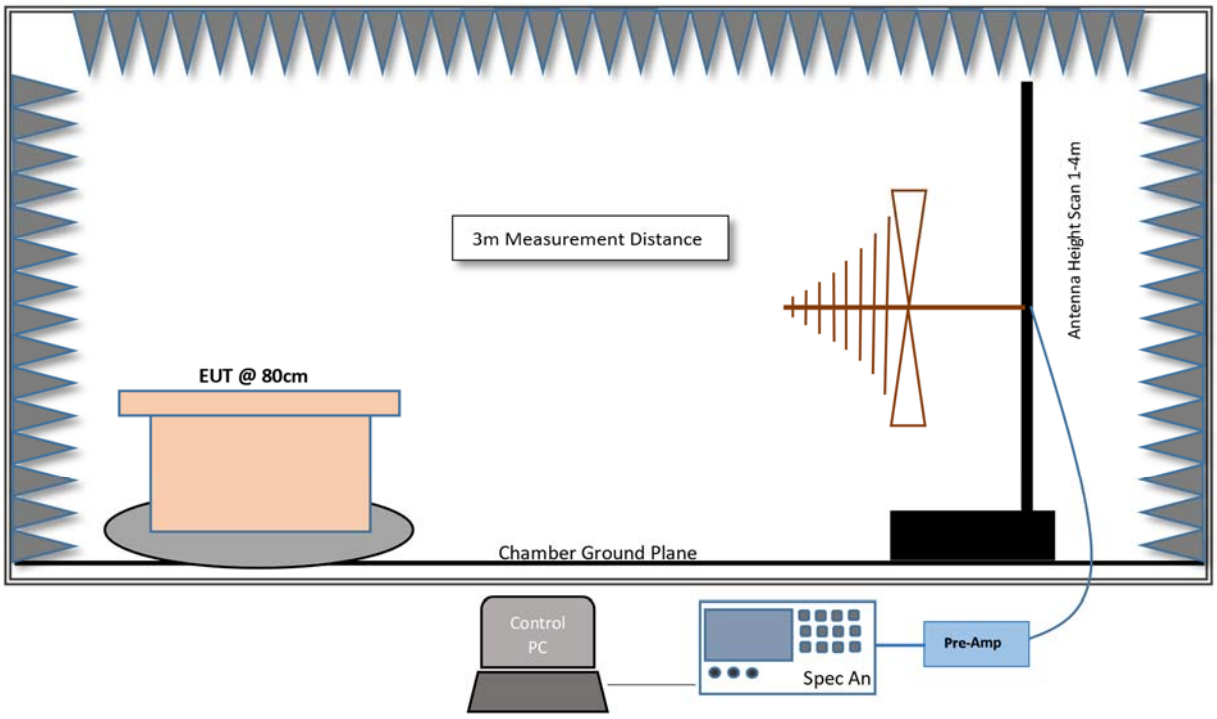


Fig.3. Test Setup for Radiated measurements in 30MHz- 1GHz Range

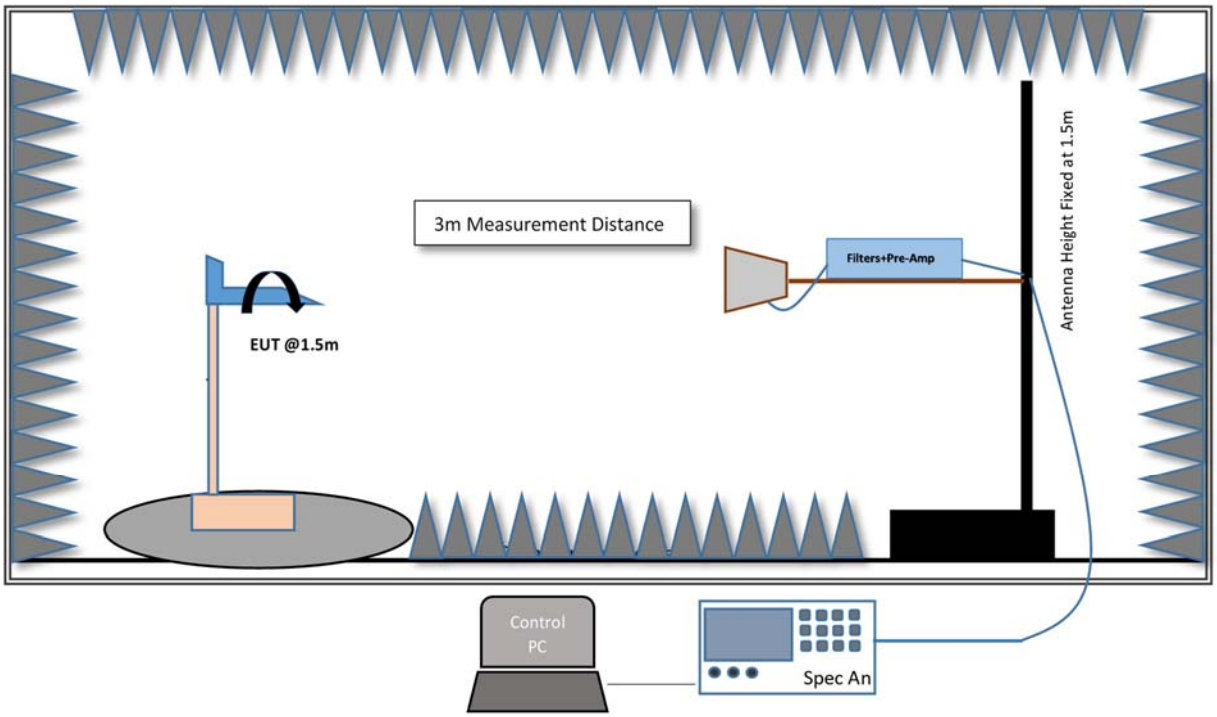


Fig.4. Test Setup for Radiated measurements in 1GHz- 18GHz Range

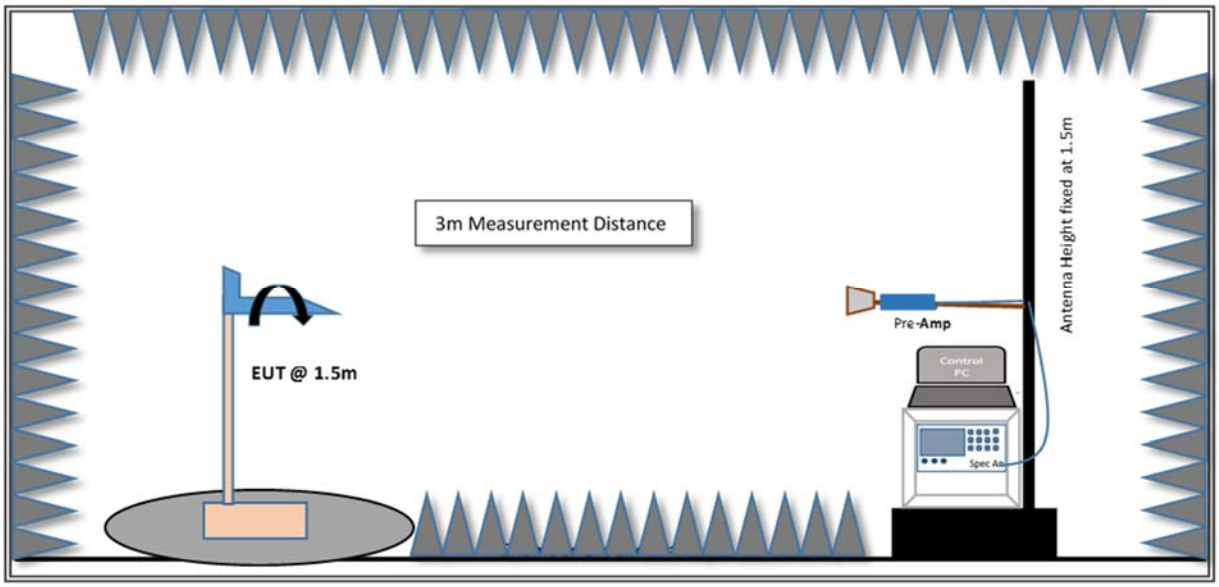


Fig.5. Test Setup for Radiated measurements >18GHz

9 Test Results- Conducted

9.1 Duty Cycle

9.1.1 Test Requirement:

Reporting and measurement purposes only.

9.1.2 Test Method:

Measurements were performed according to the procedure defined in ANSI C63.10: 2013.

Spectrum Analyzer Settings:
RBW ≥ Occupied Bandwidth if possible; otherwise, set RBW to the largest available value
VBW ≥ RBW ≥ Signal Period
Detector = Peak
Span = 0 Hz
Sweep points > 100

9.1.3 Limits:

Reporting and measurement purposes only. Duty Cycles > 98% are considered to have a Duty Cycle Correction Factor = 0 dB.

9.1.4 Test Results:

Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11g	1.394	1.458	0.956	0.19
802.11n	1.394	1.458	0.956	0.19

9.1.5 Test Data:

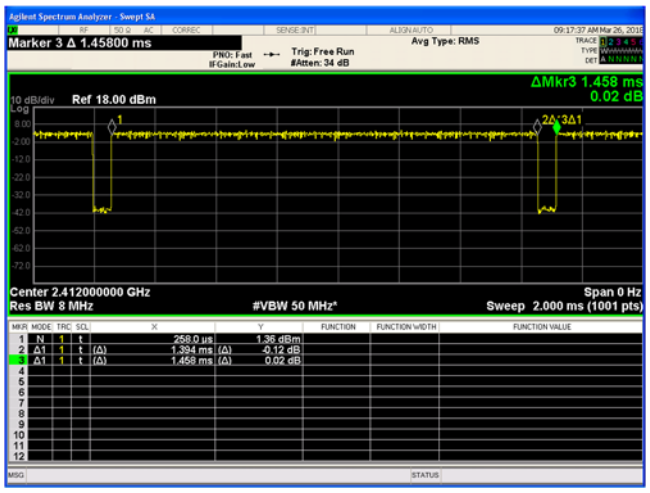


Figure 9-1 Duty Cycle 802.11g – Channel 1

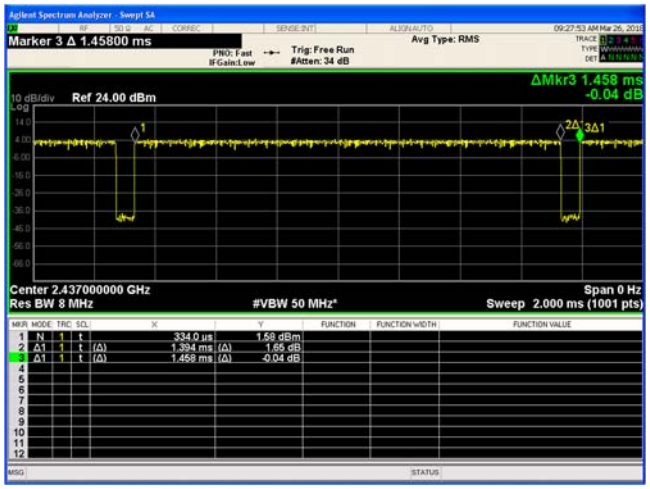


Figure 9-2 Duty Cycle 802.11n- Channel 6

9.2 DTS Bandwidth

9.2.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(2)

ISED RSS-247 [5.2]

9.2.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V04 and ANSI C63.10: 2013.

Spectrum Analyzer Settings:
RBW= 100 kHz
VBW≥ 3 × RBW
Detector = Peak
Span = 30MHz
Trace Mode= Max Hold
Sweep time= Auto Couple
The in-built functionality of the Spectrum Analyzer is used to measure the 6-dB bandwidth.

9.2.3 Limits:

The 6-dB bandwidth shall be at least 500 kHz

9.2.4 Test Results:

802.11g 6-dB Emission Bandwidth				
Channel No.	**Frequency (MHz)**	**6-dB Emission Bandwidth (MHz)**	**Limit (MHz)**	**Result**
1	2412	15.13	≥ 0.5	Pass
6	2437	15.13	≥ 0.5	Pass
11	2462	15.13	≥ 0.5	Pass
802.11n 6-dB Emission Bandwidth				
Channel No.	**Frequency (MHz)**	**6-dB Emission Bandwidth (MHz)**	**Limit (MHz)**	**Result**
1	2412	15.13	≥ 0.5	Pass
6	2437	15.13	≥ 0.5	Pass
11	2462	15.13	≥ 0.5	Pass

9.2.5 Test Data:

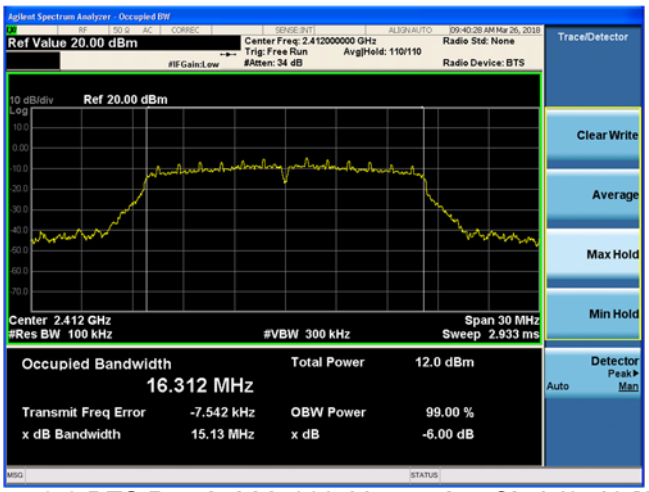


Figure 9-3 DTS Bandwidth 802.11g mode - Ch.1 (2412 MHz)

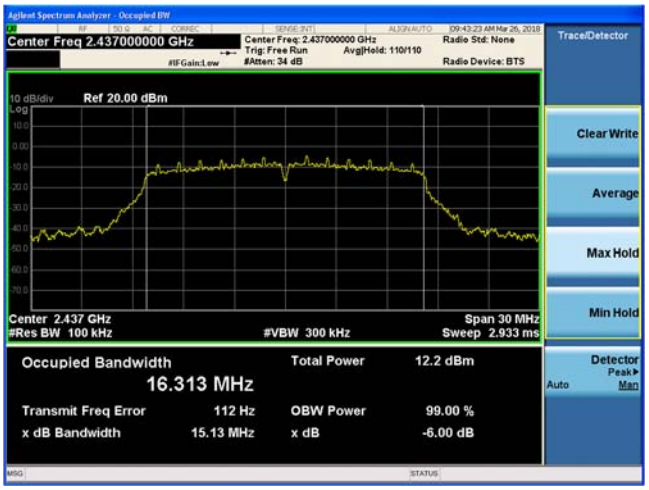


Figure 9-4 DTS Bandwidth 802.11g mode - Ch.6 (2437 MHz)

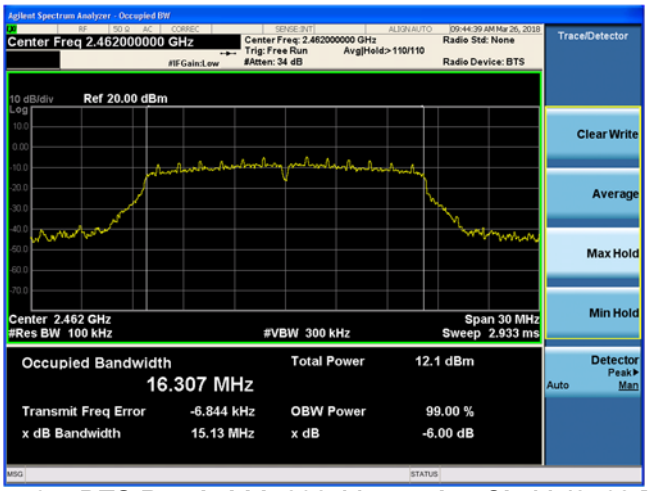


Figure 9-5 DTS Bandwidth 802.11g mode - Ch.11 (2462 MHz)

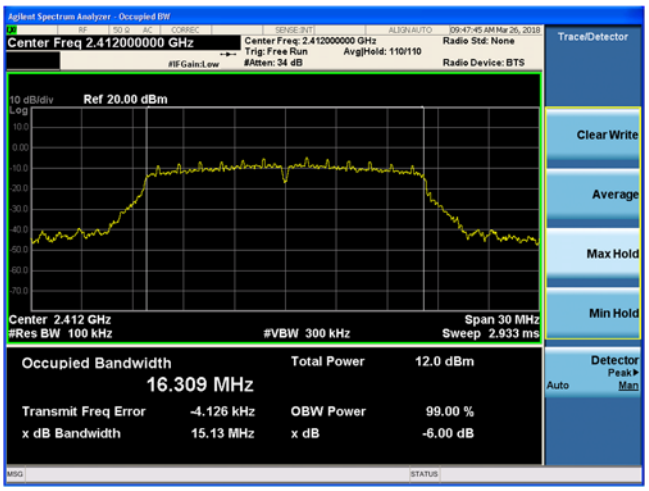


Figure 9-6 DTS Bandwidth 802.11n mode - Ch.1 (2412 MHz)

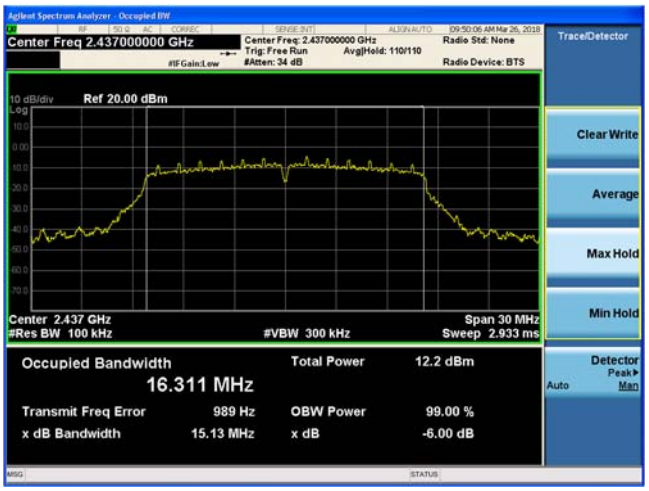


Figure 9-7 DTS Bandwidth 802.11n mode - Ch.6 (2437 MHz)

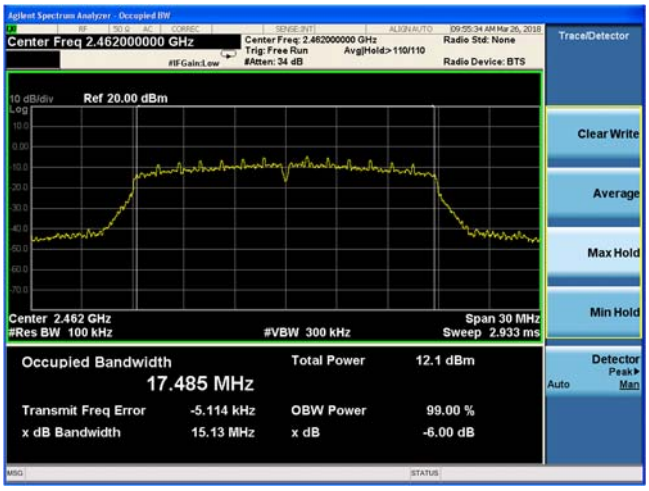


Figure 9-8 DTS Bandwidth 802.11n mode - Ch.11 (2462 MHz)

9.3 99% Bandwidth

9.3.1 Test Requirement:

The 99% Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. This test is performed for reporting and measurement purposes only.

9.3.2 Test Method:

Measurements were performed according to the procedure defined in ANSI C63.10:2013.

Spectrum Analyzer settings:

Set analyzer center frequency to the nominal EUT channel frequency
Span set to between 1.5 and 5.0 times the DTS bandwidth
RBW to: 1% to 5% of the OBW
VBW ≥ 3 RBW
Detector = Peak
Sweep time = auto couple
Trace mode = max hold
Use the 99% power bandwidth function of the instrument.

9.3.3 Limit:

Reporting and measurement purposes only.

9.3.4 Test Results:

802.11g 99% Bandwidth (MHz)		
Channel No.	**Frequency (MHz)**	**99% Bandwidth (MHz)**
1	2412	16.47
6	2437	16.48
11	2462	16.47
802.11n 99% Bandwidth (MHz)		
Channel No.	**Frequency (MHz)**	**99% Bandwidth (MHz)**
1	2412	17.50
6	2437	17.51
11	2462	17.50

9.3.5 Test Data:

Figure 9-9 99% Bandwidth 802.11g - Ch.1 (2412 MHz)

Figure 9-10 99% Bandwidth 802.11g - Ch.6 (2437 MHz)

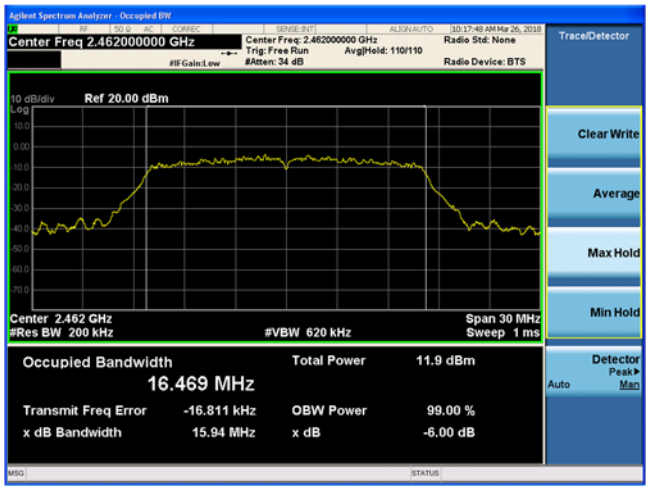


Figure 9-11 99% Bandwidth 802.11g - Ch.11 (2462 MHz)

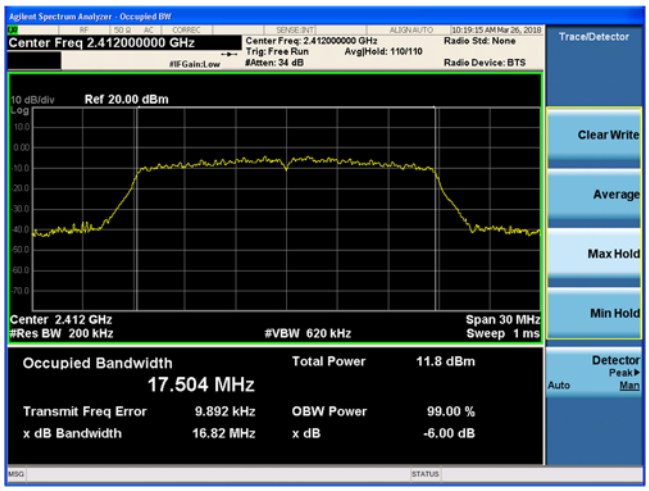


Figure 9-12 99% Bandwidth 802.11n - Ch.1 (2412 MHz)

Figure 9-13 99% Bandwidth 802.11n - Ch.6 (2437 MHz)

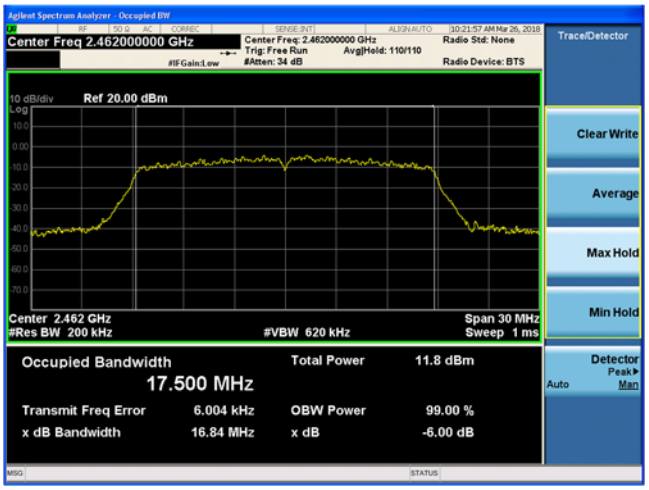


Figure 9-14 99% Bandwidth 802.11n - Ch.11 (2462 MHz)

9.4 Output Power

9.4.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (b)(3)

ISED RSS-247 [5.4]

9.4.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V04 and ANSI C63.10: 2013.

Power Meter Settings:

Peak Power:

The maximum peak conducted output power was measured using a broadband peak RF power meter. The power meter had a video bandwidth that is greater than or equal to the DTS bandwidth and utilized a fast-responding diode detector.

9.4.3 Limits:

15.247: The maximum permissible peak output power is 30 dBm (1 W)

RSS-247: The maximum peak conducted output power shall not exceed 30dBm (1 W) and the maximum radiated output power shall not exceed 36dBm (4 W) EIRP.

9.4.4 Test Results:

802.11 mode	Freq (MHz)	Total Average Power (incl DCF=0.19) (dBm)	Total Peak Cond Power (dBm)	Conducted Peak Limit (dBm)	Margin (dB)	Result
g	2412	5.41	14.49	30.00	-15.51	Pass
g	2437	5.12	14.06	30.00	-15.94	Pass
g	2462	5.18	14.22	30.00	-15.78	Pass
n	2412	5.05	14.17	30.00	-15.83	Pass
n	2437	5.29	14.25	30.00	-15.75	Pass
n	2462	5.27	14.18	30.00	-15.82	Pass

802.11 mode	Freq (MHz)	Total Peak Cond Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
g	2412	14.49	4.7	19.19	36	-16.81	Pass
g	2437	14.06	4.7	18.76	36	-17.24	Pass
g	2462	14.22	4.7	18.92	36	-17.08	Pass
n	2412	14.17	4.7	18.87	36	-17.13	Pass
n	2437	14.25	4.7	18.95	36	-17.05	Pass
n	2462	14.18	4.7	18.88	36	-17.12	Pass

9.5 Power Spectral Density

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (e)
ISED RSS-247 Issue 1 [5.2]

9.5.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V04 and ANSI C63.10: 2013.

Spectrum Analyzer settings:
Set analyzer center frequency to DTS channel center frequency.
Span to 1.5 times the DTS bandwidth
RBW to: 3 kHz ≤ RBW ≤ 100 kHz
VBW ≥ 3 RBW
Detector = Peak
Sweep time = auto couple
Trace mode = max hold
Use the peak marker function to determine the maximum amplitude level within the RBW
If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

9.5.3 Limits:

The maximum permissible power density is 8 dBm/3kHz, however if the antenna gain is >6 dBi, the limit is reduced by the total Directional Antenna Gain –6 dBi.

No adjustments to test limits is required here.

9.5.4 Test Results:

802.11 mode	Frequency (MHz)	Power Spectral Density (dBm/100kHz)	Limit (dBm/3kHz)	Pass/Fail
g	2412	-4.256	8.0	Pass
g	2437	-4.513	8.0	Pass
g	2462	-4.256	8.0	Pass
n	2412	-4.284	8.0	Pass
n	2437	-4.186	8.0	Pass
n	2462	-4.204	8.0	Pass

The test data shows that the EUT passes the requirement using 100kHz RBW setting and hence will meet the requirement for 3kHz BW.

9.5.5 Test Data:

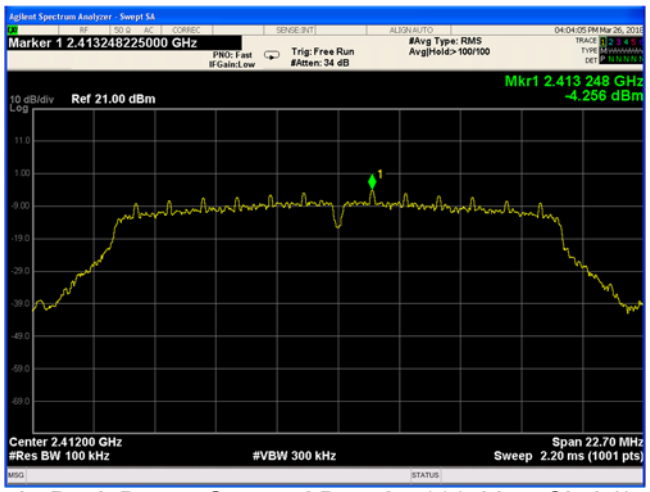


Figure 9-15 Peak Power Spectral Density 802.11g - Ch.1 (2412 MHz)

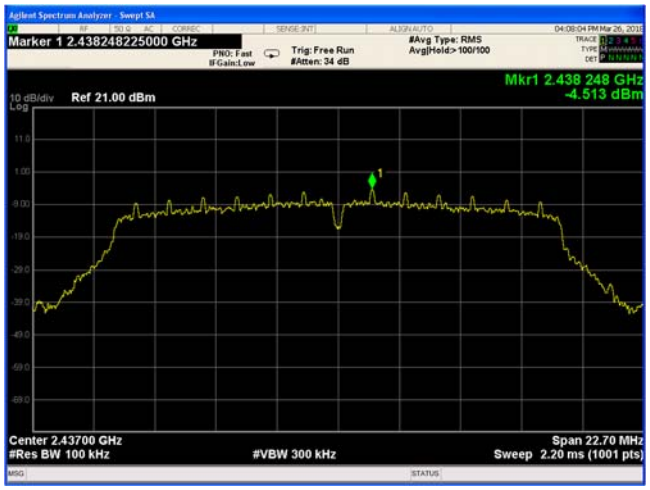


Figure 9-16 Peak Power Spectral Density 802.11g - Ch.6 (2437 MHz)

Figure 9-17 Peak Power Spectral Density 802.11g - Ch.11 (2462 MHz)

Figure 9-18 Peak Power Spectral Density 802.11n - Ch.1 (2412 MHz)

Figure 9-19 Peak Power Spectral Density 802.11n - Ch.6 (2437 MHz)

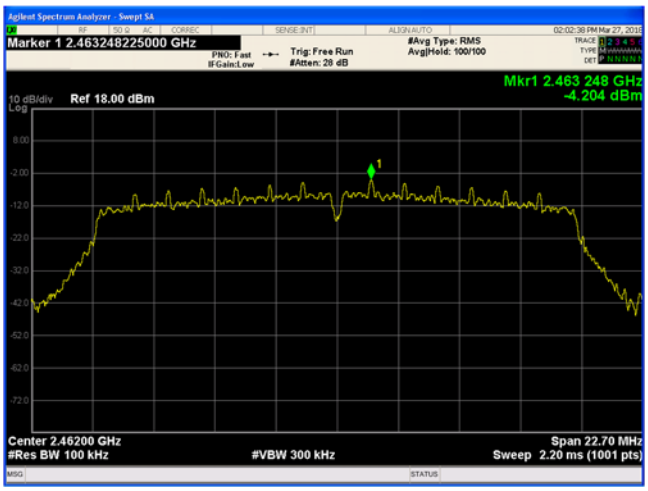


Figure 9-20 Peak Power Spectral Density 802.11n - Ch.11 (2462 MHz)

9.6 Conducted Spurious Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)
ISED RSS-247 [5.5]

9.6.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V04 and ANSI C63.10: 2013.

Spectrum Analyzer settings:
Identification of Reference Level:
RBW= 100 kHz
VBW ≥ 3 x RBW
Trace Mode= Peak Detector (Max Hold)
Sweep time= auto couple
Span ≥1.5 times DTS Bandwidth
Peak Marker function to determine the max PSD level.
Conducted Spurious Emissions:
RBW= 1 MHz
VBW≥ 3 x RBW = 3 MHz
Trace Mode= Peak Detector (Max Hold)
Sweep time= auto couple

Span= 30 MHz- 12 GHz; 12 GHz – 25 GHz
Sweep Points= 30000

9.6.3 Limits:

All spurious emissions at least 20 dBc.

9.6.4 Test Result:

Pass.

9.6.5 Test Data:

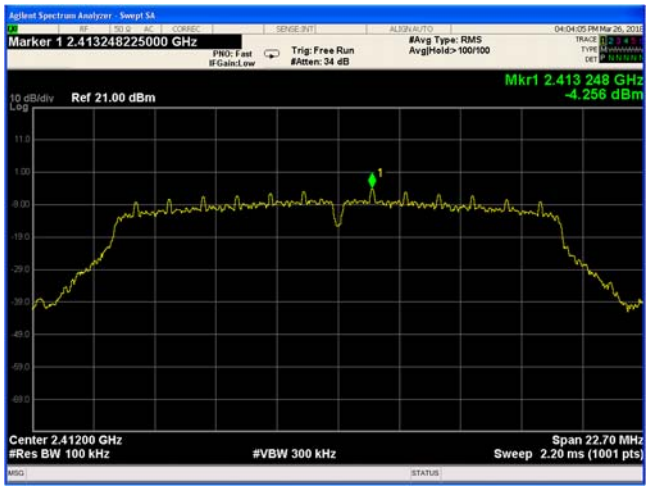


Figure 9-21 Reference Level 802.11g - Ch.1 (2412 MHz)

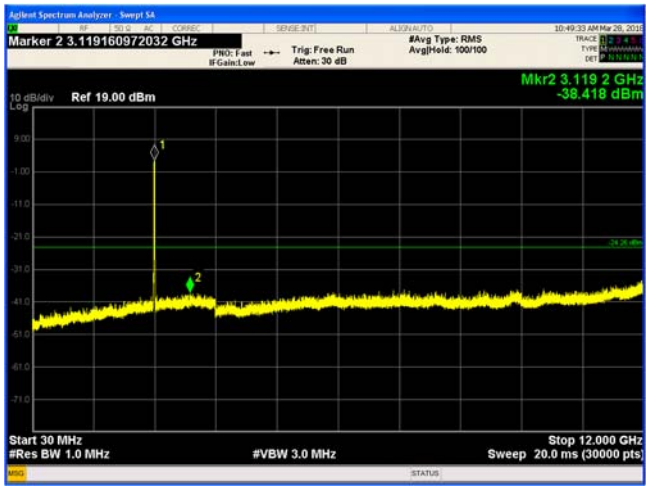


Figure 9-22 Conducted Spurious Emissions 30 MHz - 12 GHz 802.11g - Ch.1 (2412 MHz)

Figure 9-23 Conducted Spurious Emissions 12 - 25 GHz 802.11g - Ch.1 (2412 MHz)

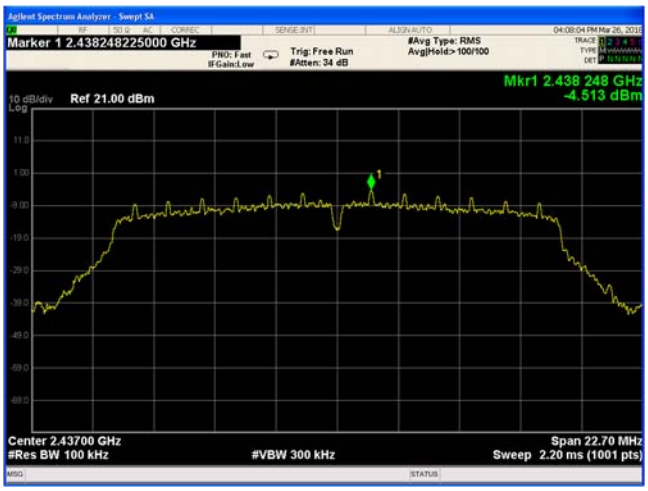


Figure 9-24 Reference Level 802.11g - Ch.6 (2437 MHz)

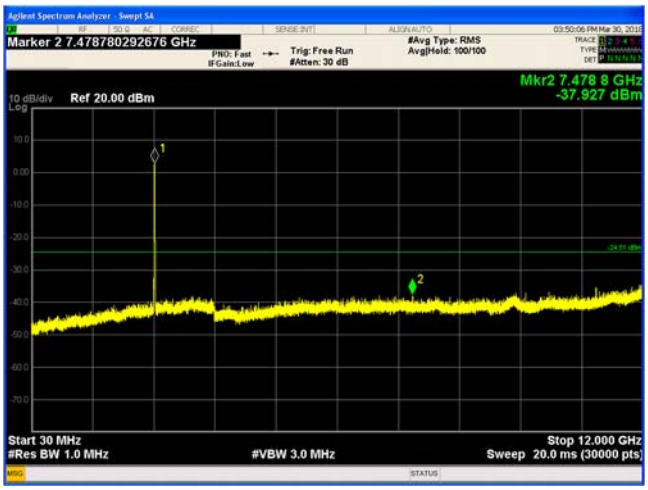


Figure 9-25 Conducted Spurious Emissions 30 MHz - 12 GHz 802.11g - Ch.6 (2437 MHz)

Figure 9-26 Conducted Spurious Emissions 12 - 25 GHz 802.11g - Ch.6 (2437 MHz)

Figure 9-27 Reference Level 802.11g - Ch.11 (2462 MHz)

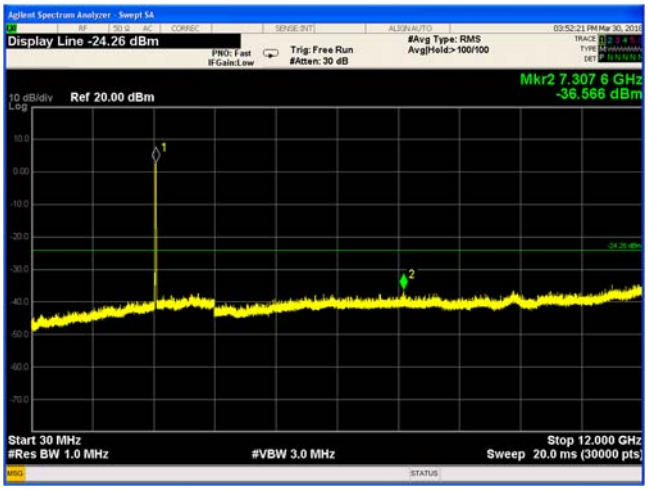


Figure 9-28 Conducted Spurious Emissions 30 MHz - 12 GHz 802.11g - Ch.11 (2462 MHz)

Figure 9-29 Conducted Spurious Emissions 12 - 25 GHz 802.11g - Ch.11 (2462 MHz)

Figure 9-30 Reference Level 802.11n - Ch.1 (2412 MHz)

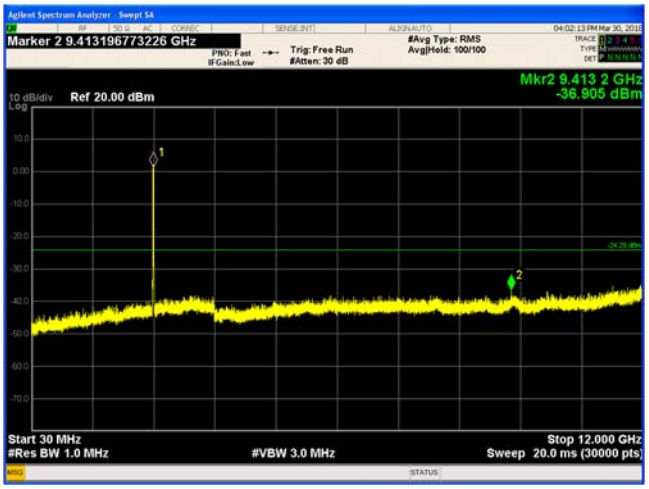


Figure 9-31 Conducted Spurious Emissions 30 MHz - 12 GHz 802.11n - Ch.1 (2412 MHz)

Figure 9-32 Conducted Spurious Emissions 12 - 25 GHz 802.11n - Ch.1 (2412 MHz)

Figure 9-33 Reference Level 802.11n - Ch.6 (2437 MHz)

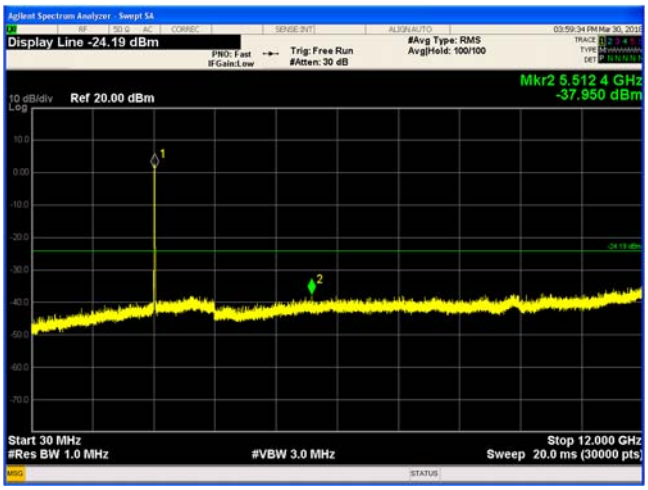


Figure 9-34 Conducted Spurious Emissions 30 MHz - 12 GHz 802.11n - Ch.6 (2437 MHz)

Figure 9-35 Conducted Spurious Emissions 12 - 25 GHz 802.11n - Ch.6 (2437 MHz)

Figure 9-36 Reference Level 802.11n - Ch.11 (2462 MHz)

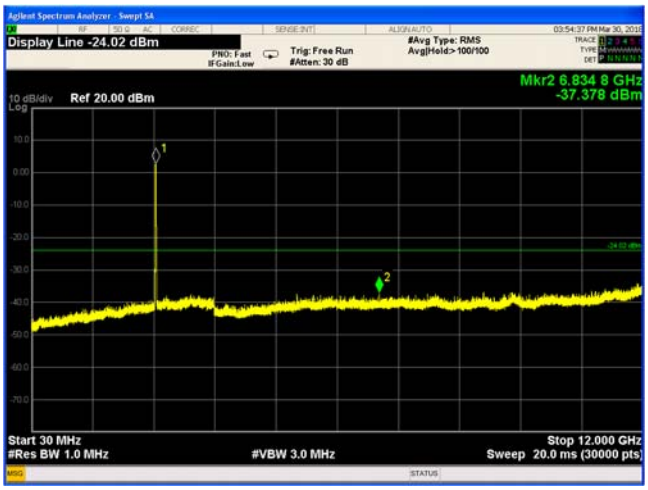


Figure 9-37 Conducted Spurious Emissions 30 MHz - 12 GHz 802.11n - Ch.11 (2462 MHz)

Figure 9-38 Conducted Spurious Emissions 12 - 25 GHz 802.11n - Ch.11 (2462 MHz)

9.7 Conducted Band Edge Emissions

9.7.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.7.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V04 and ANSI C63.10 2013.

Spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
RBW = 100 kHz
VBW = 300 kHz
Sweep = auto couple
Detector function = Peak
Trace = Max Hold
The trace was allowed to stabilize. The marker was set on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. The delta marker function was set and the marker-to-peak function moved to the peak of the in-band emission.

9.7.3 Limits:

All spurious emissions at least 20 dBc.

9.7.4 Test Result:

Pass.

9.7.5 Test Data:

Figure 9-39 Conducted Band Edge 802.11g - Ch. 1 (2412 MHz)

Figure 9-40 Conducted Band Edge 802.11g - Ch. 11 (2462 MHz)

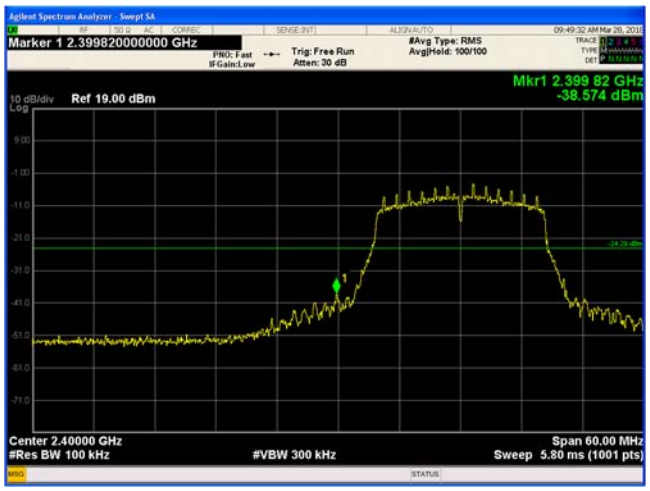


Figure 9-41 Conducted Band Edge 802.11n - Ch. 1 (2412 MHz)

s

Figure 9-42 Conducted Band Edge 802.11n - Ch. 11 (2462 MHz)

9.8 Radiated Spurious and Band Edge Emissions

9.8.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)
ISED RSS-247 [5.5] and RSS GEN [8.9]

9.8.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V04 and ANSI C63.10: 2013.

Radiated spurious measurements are made from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter. The limit for radiated spurious emissions is per 15.209 and RSS-247 [5.5]. Additionally, emissions found in the restricted bands as listed in 15.205 were tested for compliance per limits in 15.209 and RSS-Gen.

The EUT was tested near the low, middle and high channels of operation in each sub band. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions.

A pre-amp and a high pass filter were required for this test to provide the measuring system with sufficient sensitivity. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength.

Both horizontal and vertical antenna polarizations were investigated. Worst-case maximized data for both polarizations is shown in this test report.

Radiated Spurious Emissions

Spectrum Analyzer Settings:

9 kHz- 30 MHz:

RBW= 1 kHz | 10kHz
VBW ≥ 3 X RBW
Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector and RBW's as defined in ANSI C63.2.
Span= 9kHz – 150kHz and 150kHz- 30 MHz
Sweep time= Auto

30 MHz- 1 GHz:

RBW= 120 kHz
VBW ≥ 3 X RBW
Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector.
Span= 30 MHz- 1 GHz
Sweep time= Auto
Sweep points ≥ 2 x Span/RBW

Above 1 GHz:

RBW= 1 MHz
VBW= 3 MHz
Trace Mode: Peak Detector (Max Hold) and RMS Average Detector (Max Hold)
Span= 1- 18 GHz and 18- 26.5 GHz.
Sweep time= Auto
Sweep points ≥ 2 x Span/RBW

Final Measurements above 1 GHz

Peak Measurements

Spectrum Analyzer Settings:

RBW= 1 MHz
VBW= 3 MHz
Trace Mode: Peak Detector (Max Hold)
Span= wide enough to encompass the emission
Sweep Points ≥ 2 × Span/RBW
Sweep Time = Auto

RMS Average Measurements

Spectrum Analyzer Settings:

RBW= 1 MHz
VBW≥ 3 × RBW
Detector= RMS
Span= wide enough to encompass the emission
Sweep points≥ 2 × Span/RBW
Sweep time = auto
Trace= Average at least 100 traces
Trace Averaging Type= power (RMS)
The duty cycle correction factor is added to the emission level.

Restricted Band-Edge Emissions

Peak Measurements

Spectrum Analyzer Settings:

RBW= 1 MHz
VBW= 3 MHz
Trace Mode: Peak Detector (Max Hold)
Span= 2310 – 2500 MHz
Sweep Points = 401
Sweep Time = Auto

Average Measurements (Reduced Video Bandwidth Method)

Spectrum Analyzer Settings:

RBW= 1 MHz
VBW= 2 kHz
VBW Mode = Linear
Trace Mode: Peak Detector (Max Hold)
Span= 2310 – 2500 MHz
Sweep Points = 401
Sweep Time = Auto
Sweep Count = 200

Sample Calculation:

Field Strength Level: Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain = 50 dBuV + 33 dB – 25 dB = 58dBuV/m

9.8.3 Limits:

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (meters)	Corrected Field Strength for 3m measurement distance (dBµV/m)
0.009-0.490	2400/F (kHz)	300	48.5- 13.8
0.490-1.705	24000/F (kHz)	30	33.8- 23.0
1.705-30	30	30	29.5
30-88	100	3	40
88-216	150	3	43.5
216-960	200	3	46
960-1000	500	3	54
Above 1000 (Restricted Frequency Bands)	500	3	54 (Average) 74 (Peak)

9.8.4 Test Result:

Pass.

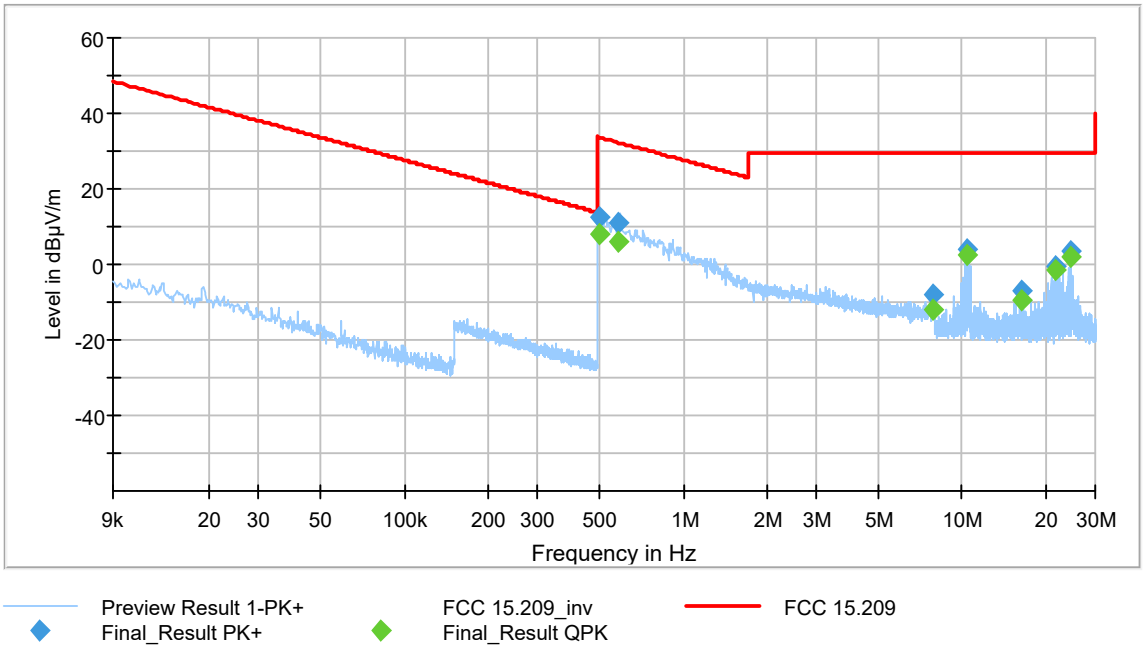
9.8.5 Test Data:

9.8.5.1 Emissions in 9kHz- 30MHz range

All channels and modes of operations were tested and worst-case emissions in 802.11g mode, Ch 6 shown below.

Where average limits apply, QP data is used to determine compliance.

Carrier Frequency (MHz)	Frequency (MHz)	Raw Quasi-Peak Field Strength (dBµV/m)	Correction Factor (dB)	Corrected Quasi-Peak Field Strength (dBµV/m)	QP Limit (dBµV/m)	Margin (dB)
2437	0.50	-3.95	12.10	8.15	33.59	-25.44
2437	0.59	-4.70	10.80	6.10	32.22	-26.12
2437	7.92	-7.47	-4.70	-12.17	29.50	-41.67
2437	10.49	7.69	-5.00	2.69	29.50	-26.81
2437	16.23	-4.48	-4.90	-9.38	29.50	-38.88
2437	21.66	3.39	-5.10	-1.71	29.50	-31.21

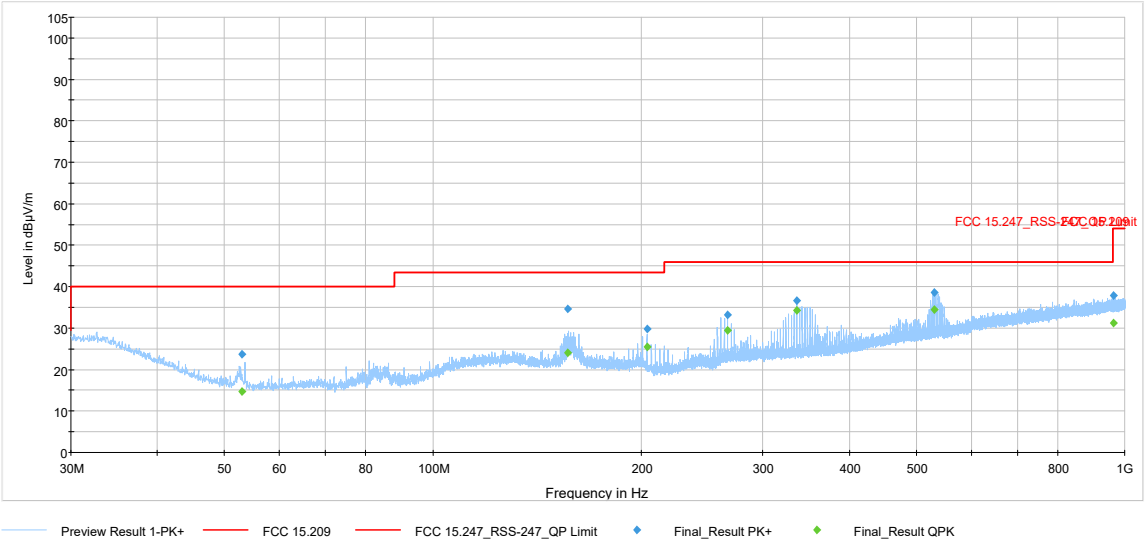


Plot 9-43. Radiated Spurious Emissions (Ch. 6) 802.11g (9kHz- 30MHz)

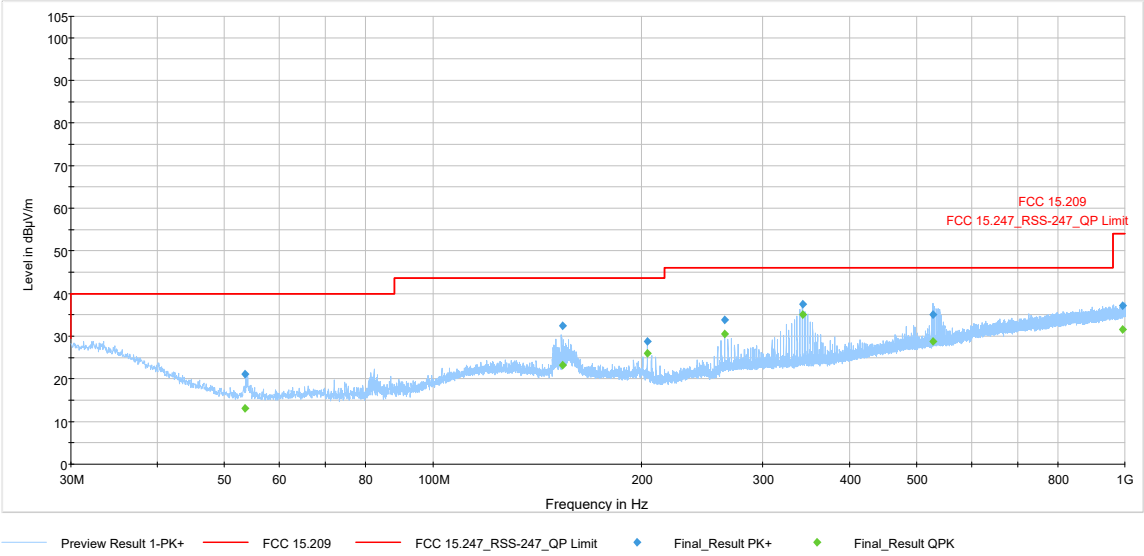
9.8.5.2 Emissions in 30 MHz- 1 GHz range

All channels and modes were tested and worst case results shown here.

RSE 30-1000 MHz							
Mode	**Tx Freq (MHz)**	**Spurious Frequency (MHz)**	**Raw Quasi-Peak Amplitude (dBµV/m)**	**System Correction Factor (dB)**	**Corrected Quasi-Peak Field Strength (dBµV/m)**	**Quasi-Peak Limit (dBµV/m)**	**Quasi-Peak Margin (dB)**
802.11 g	2412.00	52.96	0.61	14.10	14.71	40.00	-25.29
802.11 g	2412.00	156.70	4.29	19.80	24.09	43.52	-19.43
802.11 g	2412.00	204.01	6.76	18.80	25.56	43.52	-17.96
802.11 g	2412.00	267.04	8.79	20.70	29.49	46.02	-16.53
802.11 g	2412.00	336.04	12.35	21.90	34.25	46.02	-11.77
802.11 g	2412.00	531.20	7.82	26.60	34.42	46.02	-11.60
802.11 g	2412.00	962.75	-0.75	32.00	31.25	54.00	-22.75
802.11n	2437.00	53.56	-0.90	14.00	13.10	40.00	-26.90
802.11n	2437.00	153.90	3.45	19.80	23.25	43.52	-20.27
802.11n	2437.00	204.08	7.32	18.70	26.02	43.52	-17.50
802.11n	2437.00	264.10	10.13	20.40	30.53	46.02	-15.49
802.11n	2437.00	342.13	13.04	22.10	35.14	46.02	-10.88
802.11n	2437.00	528.25	2.35	26.50	28.85	46.02	-17.17
802.11n	2437.00	991.40	-0.59	32.10	31.51	54.00	-22.49



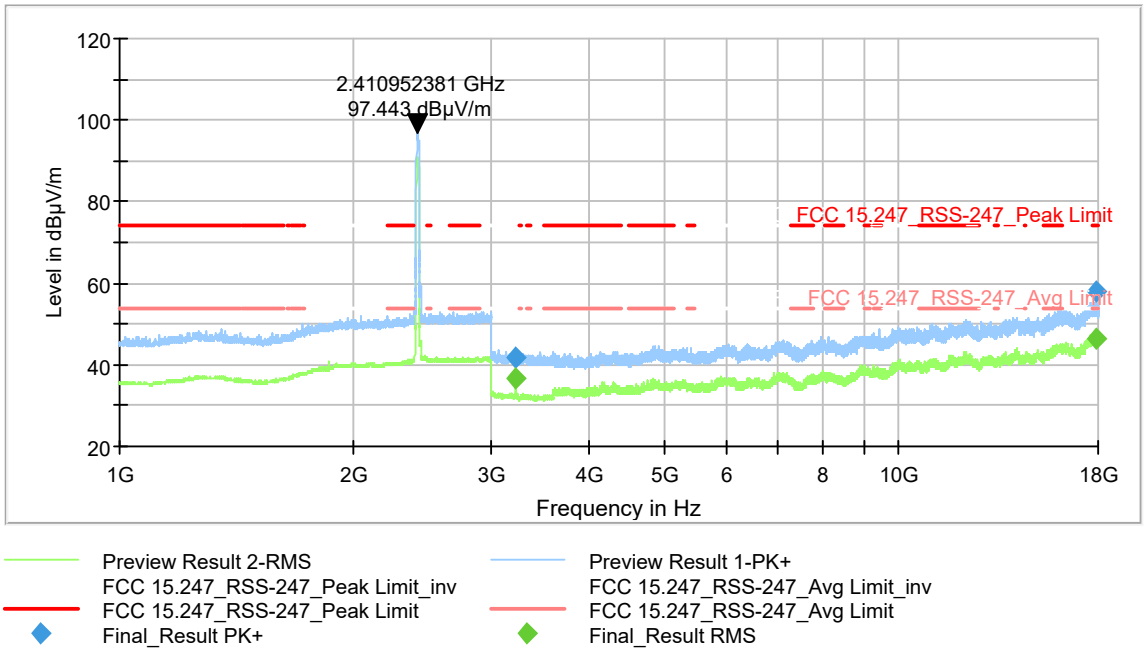
Plot 9-44 Radiated Spurious Emissions 30 – 1000 MHz 802.11g - Ch. 1 (2412 MHz)



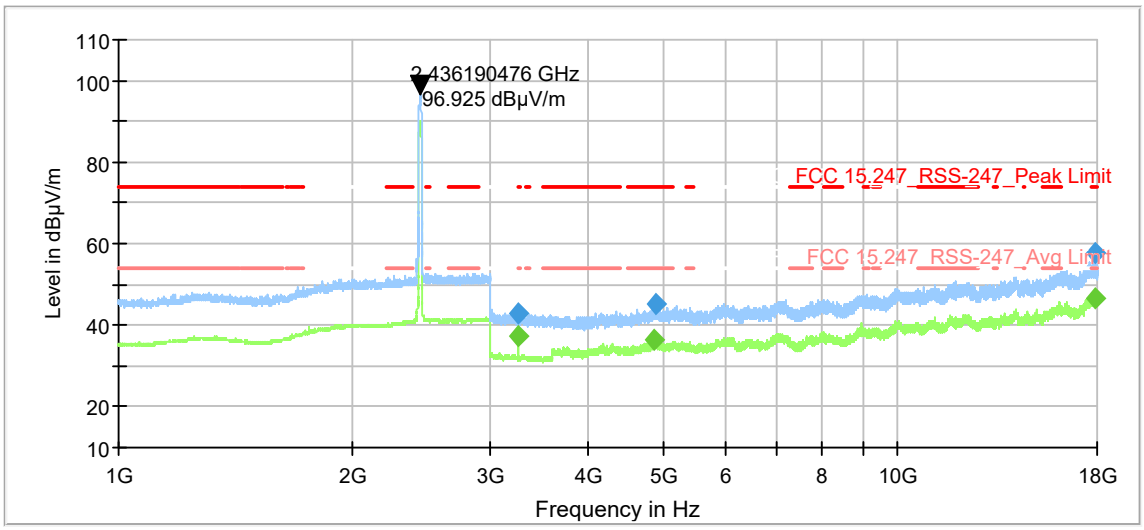
Plot 9-45 Radiated Spurious Emissions 30 – 1000 MHz 802.11n - Ch. 6 (2437 MHz)

9.8.5.3 Emissions in 1-18 GHz range

RSE 1 - 18GHz Peak/Average Data: 802.11g							
Carrier Frequency (MHz)	Spurious Emissions Frequency (MHz)	System Correction Factor (dB)	DC Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Corrected Avg. Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2412.00	3215.90	8.70	---	---	36.45	54.00	-17.55
2412.00	3222.00	8.70	---	41.86	---	74.00	-32.14
2412.00	17870.70	27.60	---	---	46.61	54.00	-7.39
2412.00	17948.50	27.40	---	58.02	---	74.00	-15.98
2437.00	3249.40	8.50	---	---	37.31	54.00	-16.69
2437.00	3252.90	8.50	---	42.82	---	74.00	-31.18
2437.00	4874.00	10.80	---	---	36.25	54.00	-17.75
2437.00	4880.50	10.80	---	45.10	---	74.00	-28.90
2437.00	17857.90	27.40	---	57.59	---	74.00	-16.41
2437.00	17872.70	27.60	---	---	46.67	54.00	-7.33
2462.00	3282.50	8.60	---	---	37.29	54.00	-16.71
2462.00	3288.90	8.60	---	42.47	---	74.00	-31.53
2462.00	4923.90	10.40	---	---	35.05	54.00	-18.95
2462.00	4924.20	10.40	---	46.75	---	74.00	-27.25
2462.00	17800.40	26.70	---	---	46.26	54.00	-7.74
2462.00	17872.90	27.60	---	58.34	---	74.00	-15.66

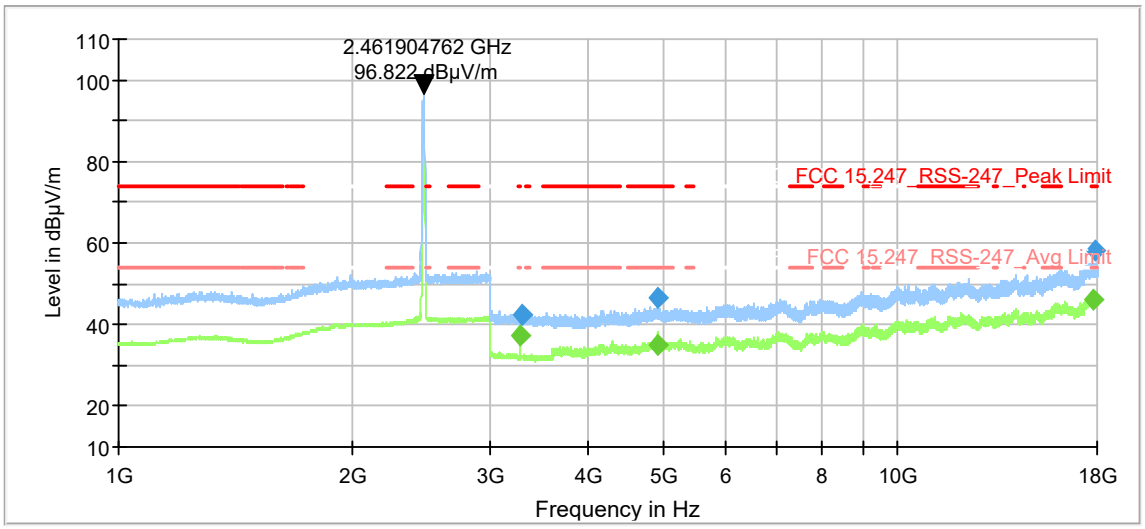


Plot 9-46 Radiated Spurious Emission 1-18GHz 802.11g - Ch.1 (2412 MHz)



Preview Result 2-RMS
FCC 15.247_RSS-247_Peak Limit_inv
FCC 15.247_RSS-247_Peak Limit
Final_Result PK+
Preview Result 1-PK+
FCC 15.247_RSS-247_Avg Limit_inv
FCC 15.247_RSS-247_Avg Limit
Final_Result RMS

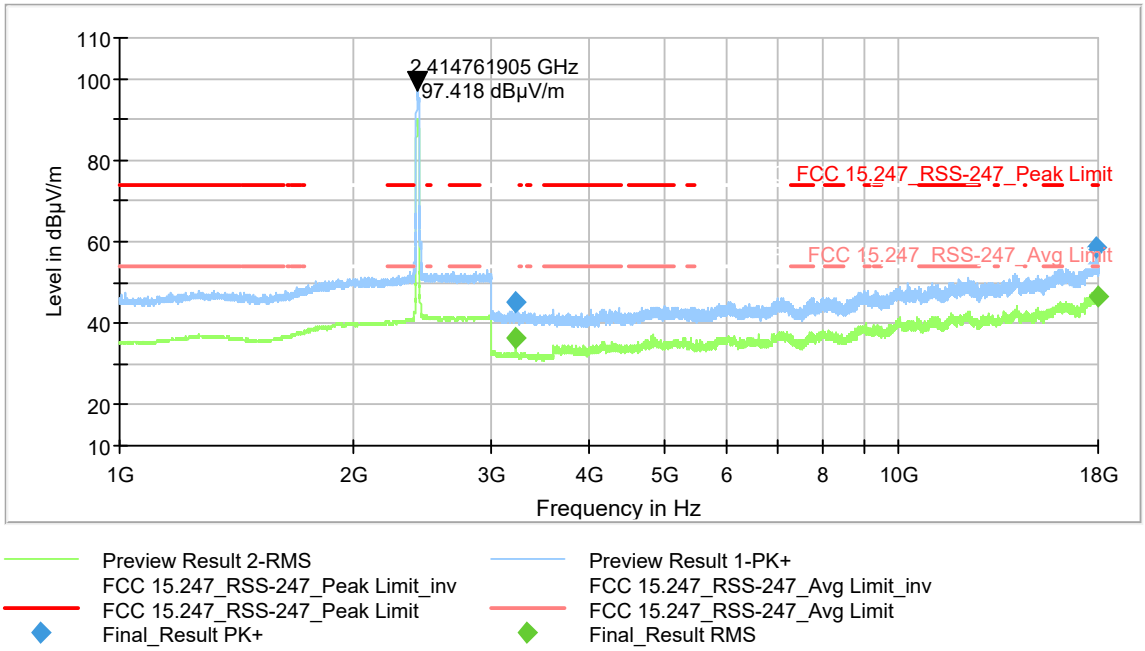
Plot 9-47 Radiated Spurious Emission 1-18GHz 802.11g - Ch.6 (2437 MHz)



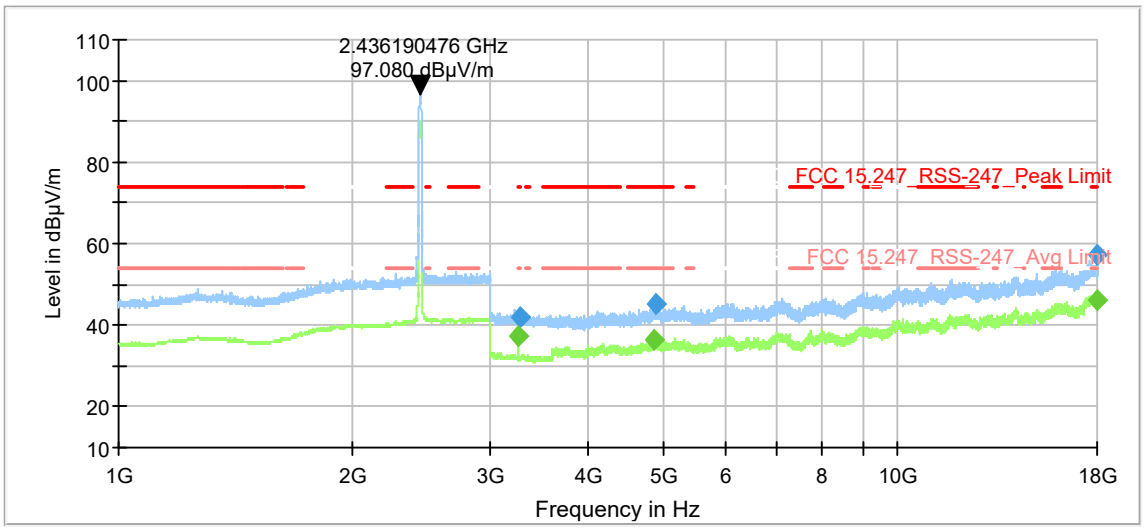
Preview Result 2-RMS
FCC 15.247_RSS-247_Peak Limit_inv
FCC 15.247_RSS-247_Peak Limit
Final_Result PK+
Preview Result 1-PK+
FCC 15.247_RSS-247_Avg Limit_inv
FCC 15.247_RSS-247_Avg Limit
Final_Result RMS

Plot 9-48 Radiated Spurious Emission 1-18GHz 802.11g - Ch.11 (2462 MHz)

RSE 1 - 18GHz Peak/Average Data: 802.11n							
Carrier Frequency (MHz)	Spurious Emissions Frequency (MHz)	System Correction Factor (dB)	DC Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Corrected Avg. Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2412.00	3216.00	8.70	---	---	36.56	54.00	-17.44
2412.00	3216.00	8.70	---	44.96	---	74.00	-29.04
2412.00	17870.00	27.60	---	58.54	---	74.00	-15.46
2412.00	17999.90	27.50	---	---	46.34	54.00	-7.66
2437.00	3249.40	8.50	---	---	37.42	54.00	-16.58
2437.00	3268.90	8.60	---	42.16	---	74.00	-31.84
2437.00	4873.90	10.80	---	---	36.48	54.00	-17.52
2437.00	4878.10	10.80	---	45.41	---	74.00	-28.59
2437.00	17990.90	27.20	---	57.41	---	74.00	-16.59
2437.00	17998.60	27.40	---	---	46.29	54.00	-7.71
2462.00	3282.50	8.60	---	---	36.75	54.00	-17.25
2462.00	3282.50	8.60	---	45.37	---	74.00	-28.63
2462.00	4924.00	10.40	---	---	35.89	54.00	-18.11
2462.00	4927.20	10.40	---	46.42	---	74.00	-27.58
2462.00	17949.50	27.40	---	---	46.52	54.00	-7.48
2462.00	18000.00	27.50	---	58.01	---	74.00	-15.99

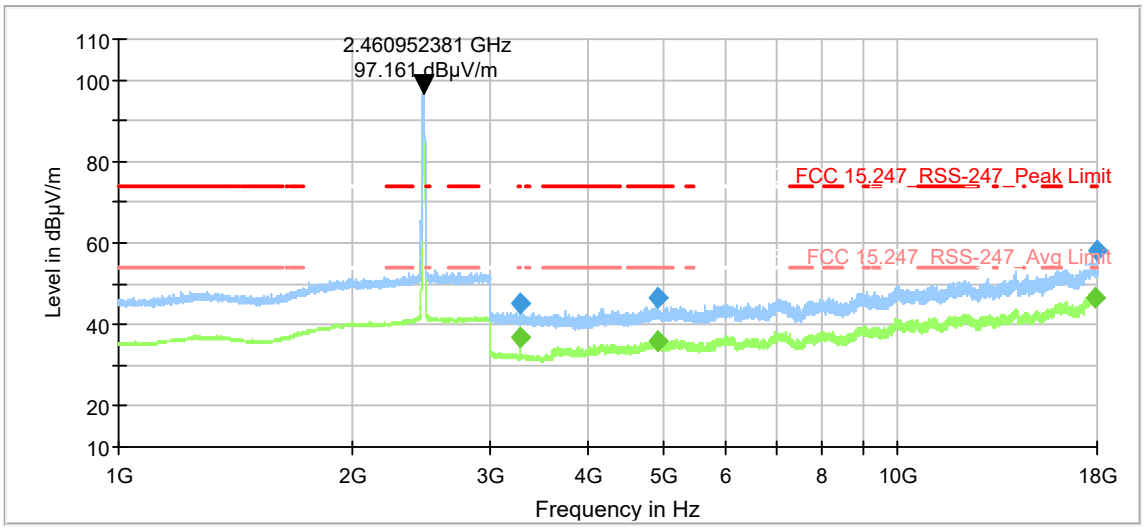


Plot 9-49 Radiated Spurious Emission 1-18GHz 802.11n - Ch.1 (2412 MHz)



Preview Result 2-RMS
FCC 15.247_RSS-247_Peak Limit_inv
FCC 15.247_RSS-247_Peak Limit
Final_Result PK+
Preview Result 1-PK+
FCC 15.247_RSS-247_Avg Limit_inv
FCC 15.247_RSS-247_Avg Limit
Final_Result RMS

Plot 9-50 Radiated Spurious Emission 1-18GHz 802.11n - Ch.6 (2437 MHz)

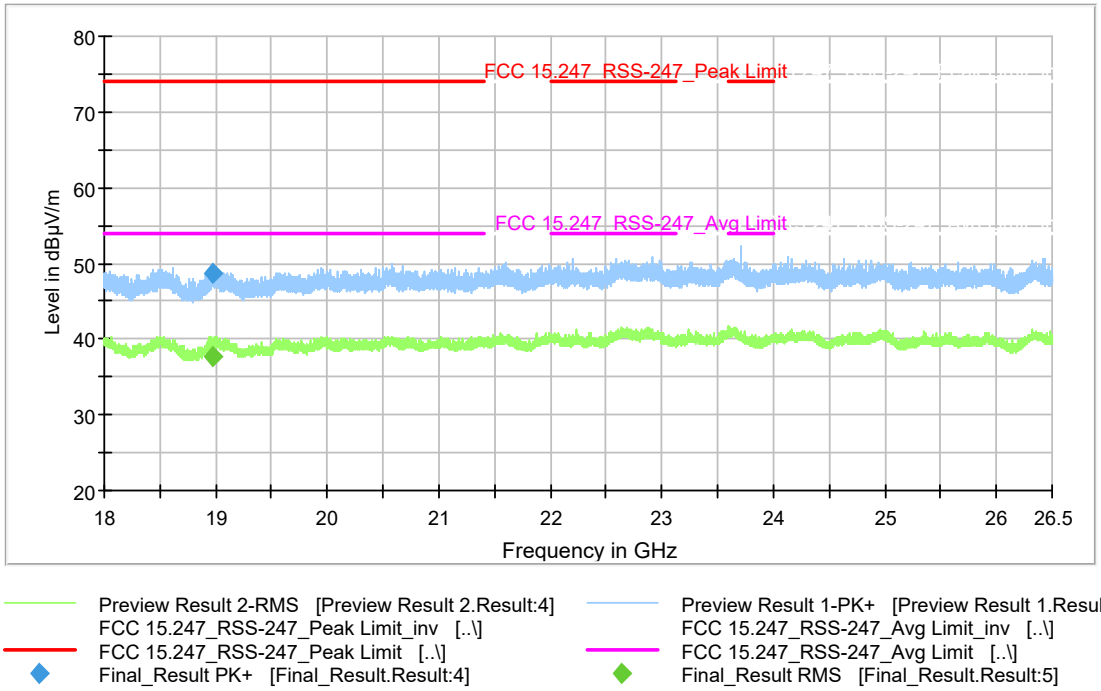


Preview Result 2-RMS
FCC 15.247_RSS-247_Peak Limit_inv
FCC 15.247_RSS-247_Peak Limit
Final_Result PK+
Preview Result 1-PK+
FCC 15.247_RSS-247_Avg Limit_inv
FCC 15.247_RSS-247_Avg Limit
Final_Result RMS

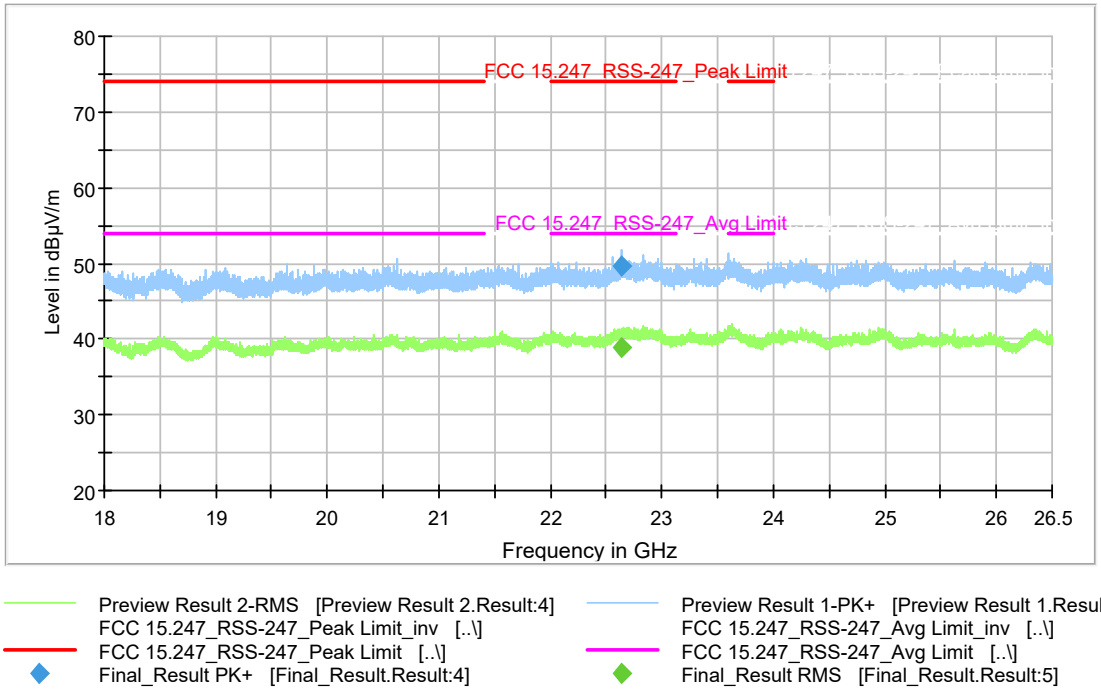
Plot 9-51 Radiated Spurious Emission 1-18GHz 802.11n - Ch.11 (2462 MHz)

9.8.5.4 Emissions in 18-26.5 GHz range

All modes and channels were tested and worst case data from mid channel of operation shown here. No significant emissions to report above noise floor.

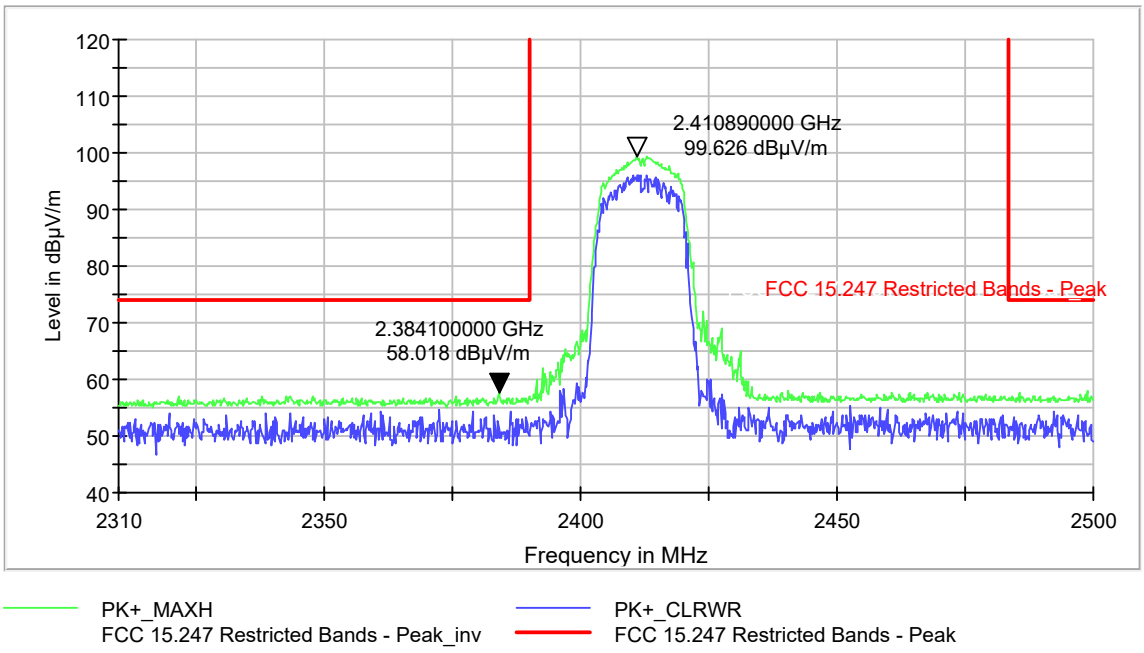


Plot 9-52 Radiated Spurious Emissions 18-26.5GHz 802.11g - Ch.11 (2412 MHz)

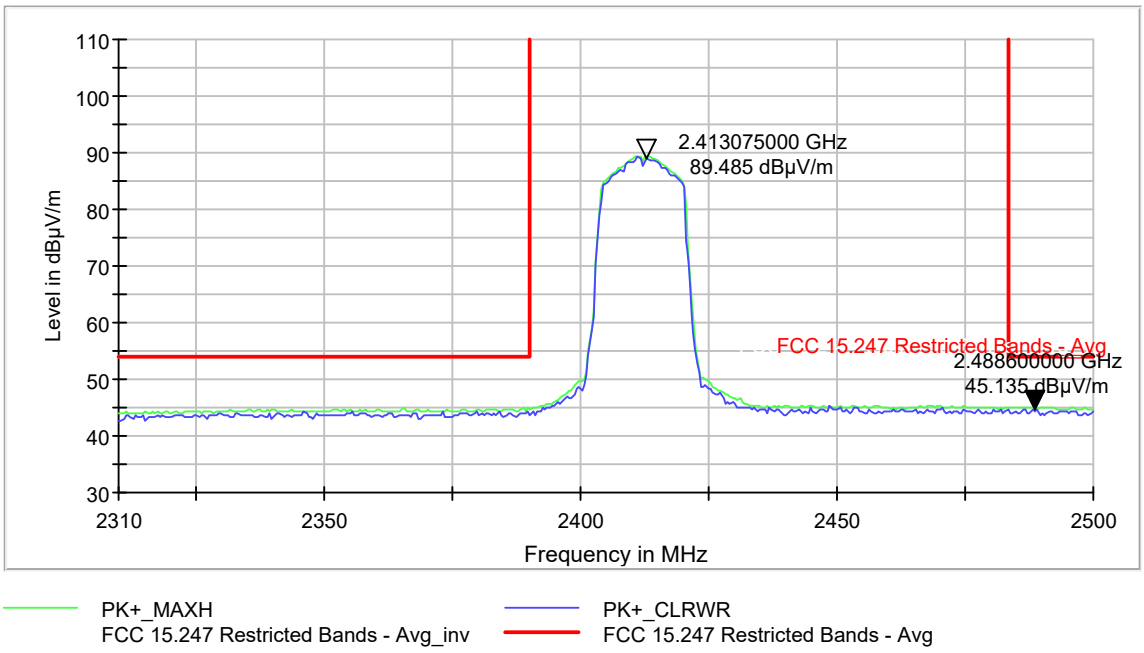


Plot 9-53 Radiated Spurious Emissions 18-26.5GHz 802.11n - Ch.6 (2437 MHz)

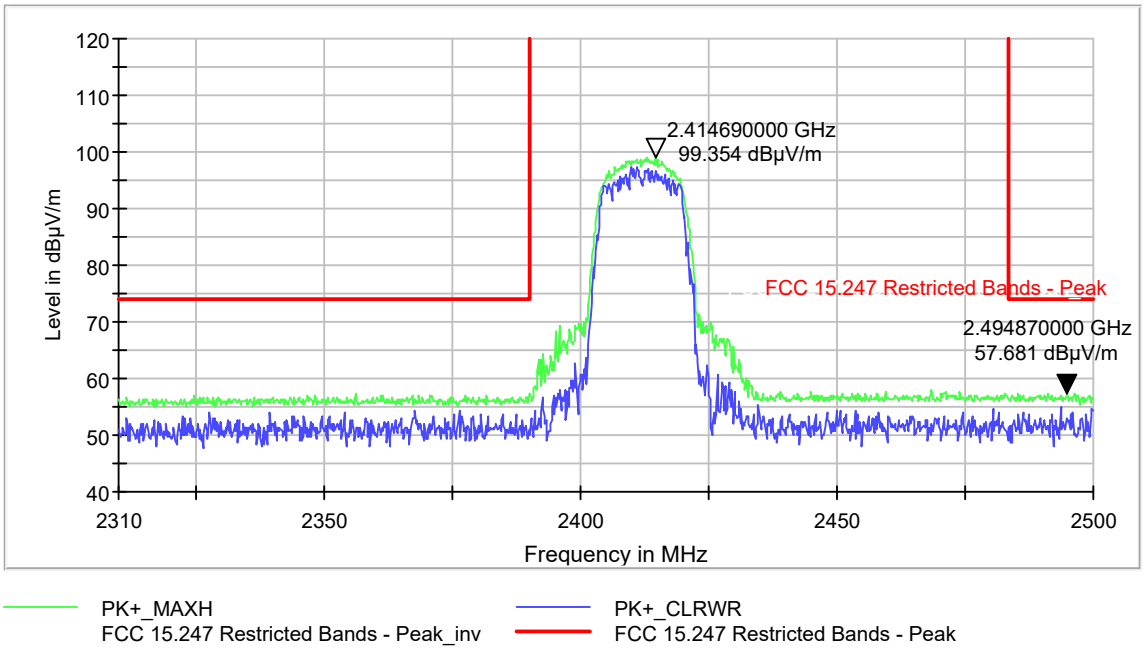
9.8.5.5 Radiated restricted Band-edge emissions



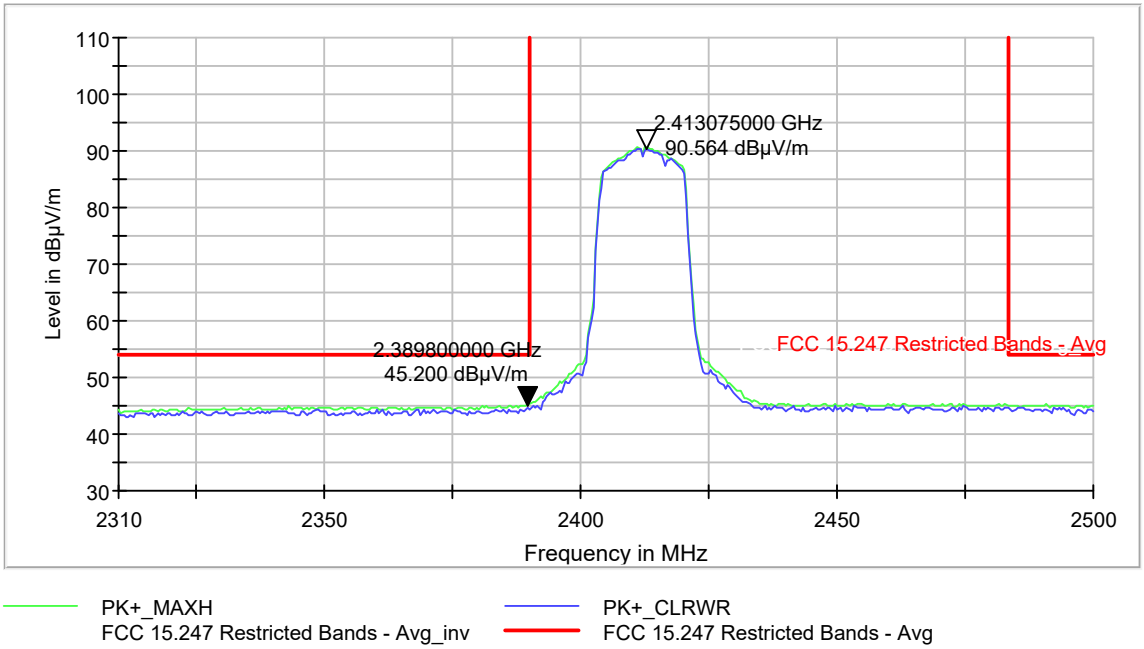
Plot 9-54 Radiated Band Edge Peak 802.11g - Ch.1 (2412 MHz)



Plot 9-55 Radiated Band Edge Average 802.11g - Ch.1 (2412 MHz)



Plot 9-56 Radiated Band Edge Peak 802.11n - Ch.1 (2412 MHz)



Plot 9-57 Radiated Band Edge Average 802.11n - Ch.1 (2412 MHz)

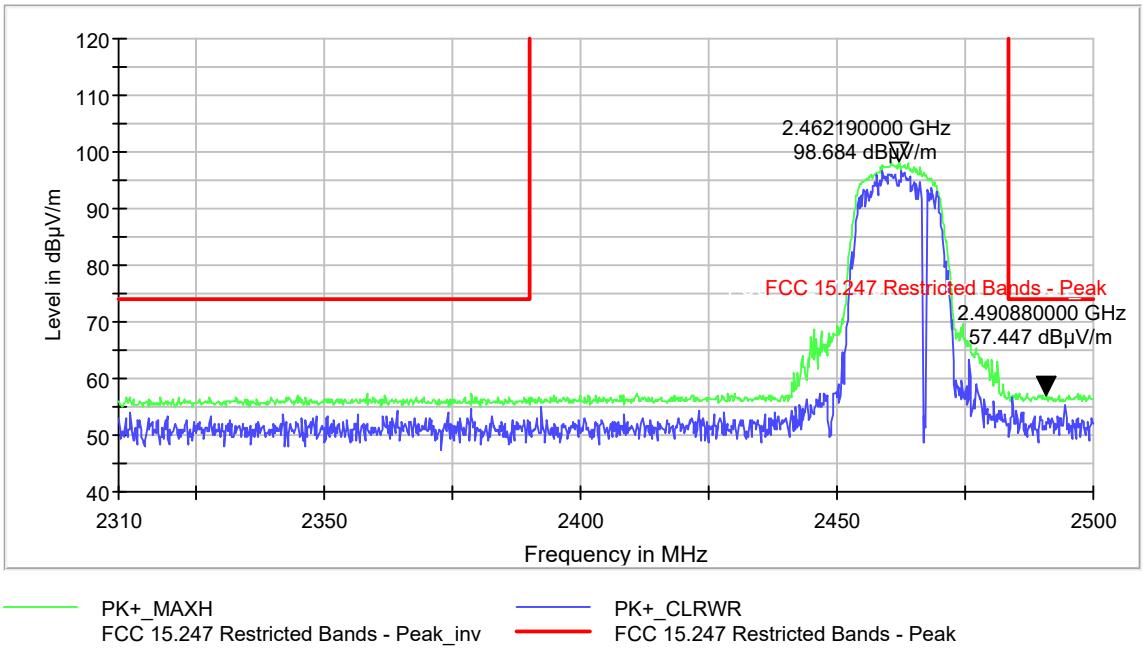


Figure 9-58 Radiated Band Edge Peak 802.11g - Ch.11 (2462 MHz)

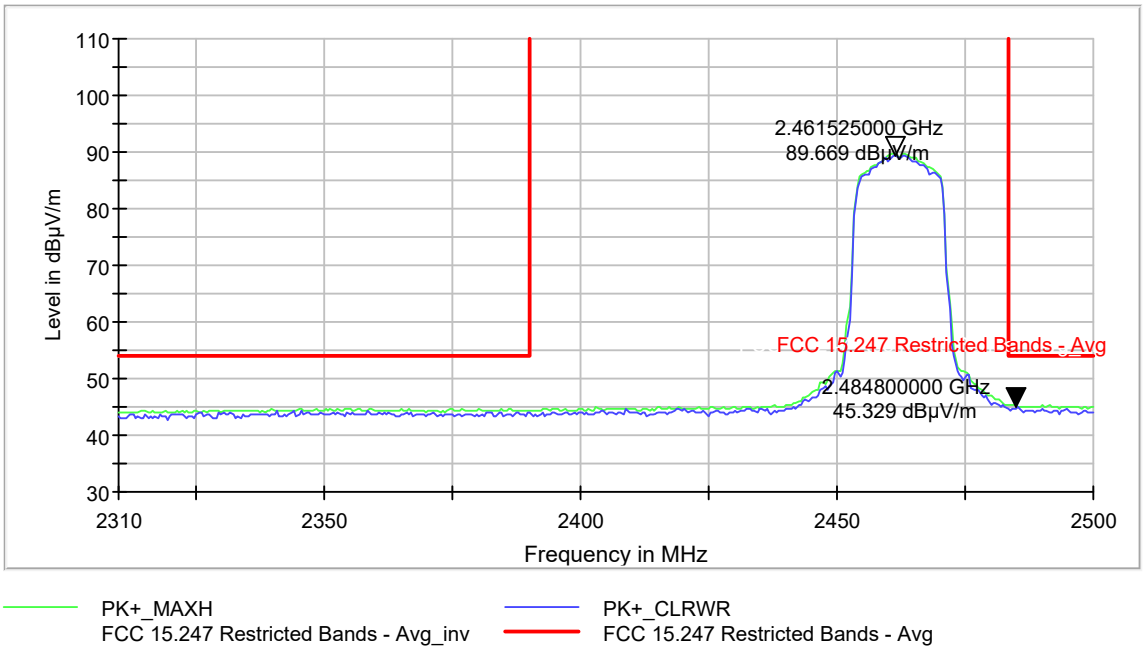


Figure 9-59 Radiated Band Edge Average 802.11g - Ch.11 (2462 MHz)

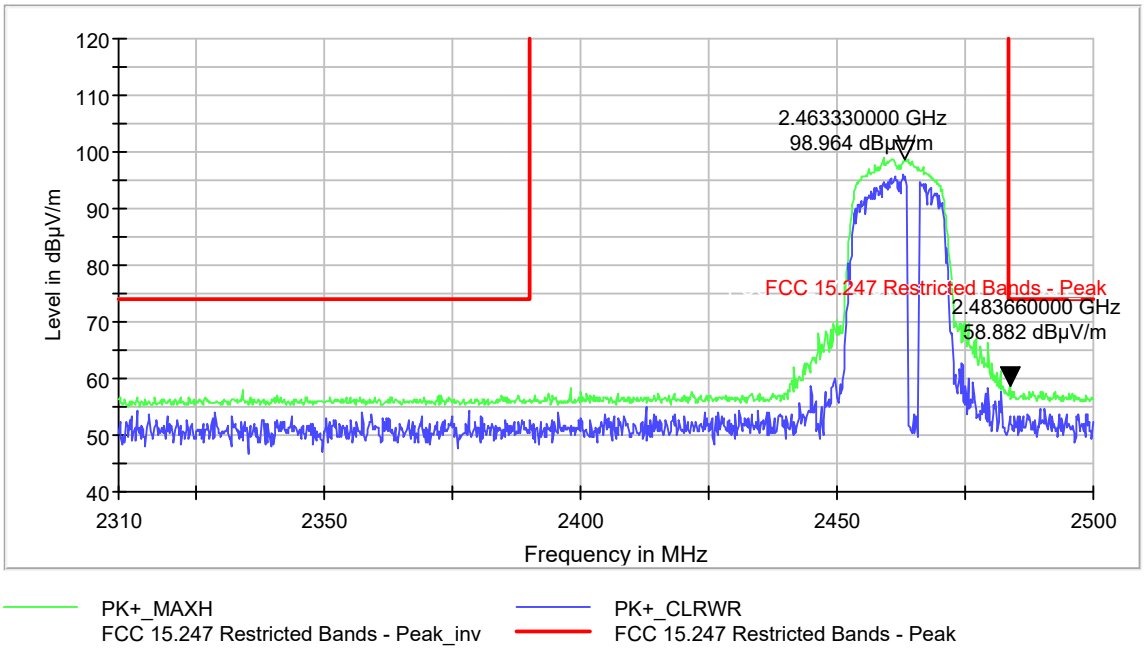


Figure 9-60 Radiated Band Edge Peak 802.11n - Ch.11 (2462 MHz)

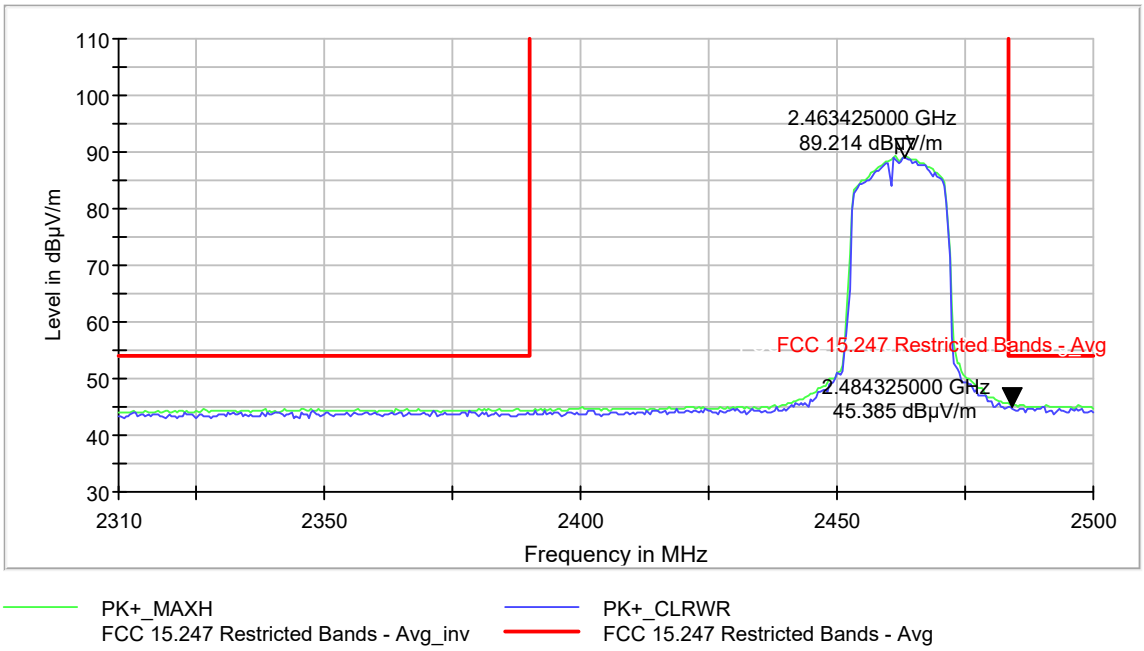


Figure 9-61 Radiated Band Edge Average 802.11n - Ch.11 (2462 MHz)

9.9 AC Line Conducted Emissions

9.9.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)
Innovation Science and Economic Development Canada RSS-Gen [8.8]

9.9.2 Test Method

Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the unsymmetric radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with the power cords that are used under normal operating conditions. These measurements are made using a LISN (Line Impedance Stabilization Network). AC powered peripherals are attached to a second LISN with the 50 ohm measuring port terminated by a 50 ohm resistive load.

The EUT is set to continuously transmit on Ch.6, 802.11g mode at max power settings. Measurements from the USB-C port reported here.

EMI Receiver Settings:
150 kHz – 30 MHz:
RBW= 9 kHz
VBW ≥ 3 X RBW
Trace Mode: Peak Detector (Max Hold).
Final measurements performed using Quasi-Peak and Average Detectors.
Span= 150 kHz – 30 MHz
Sweep time= Auto

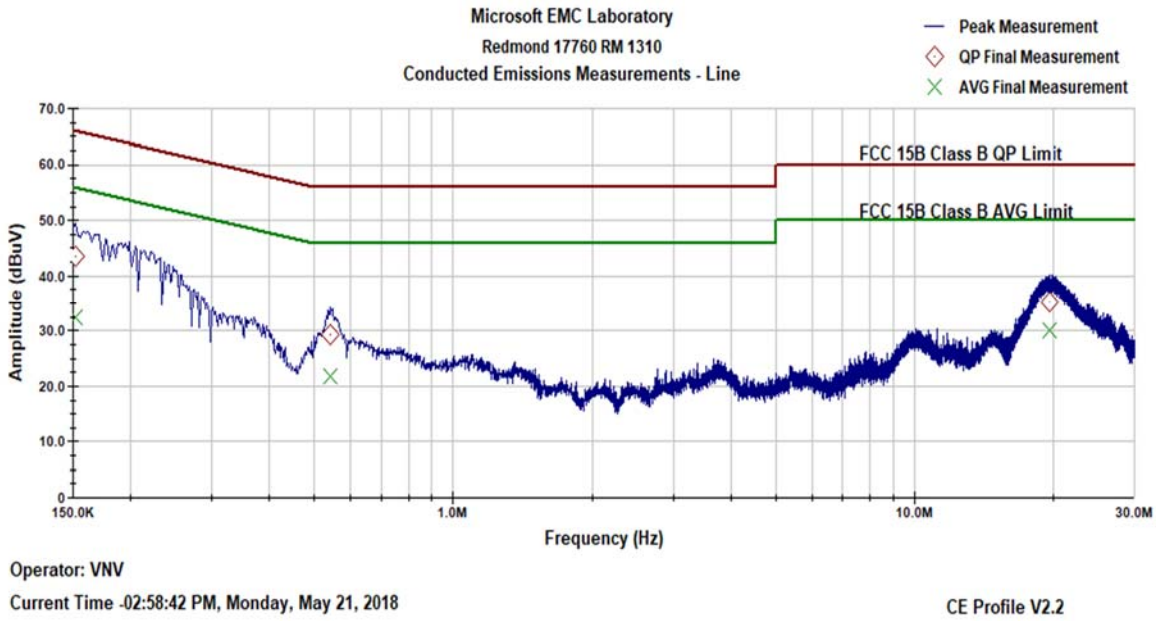
9.9.3 Limit

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

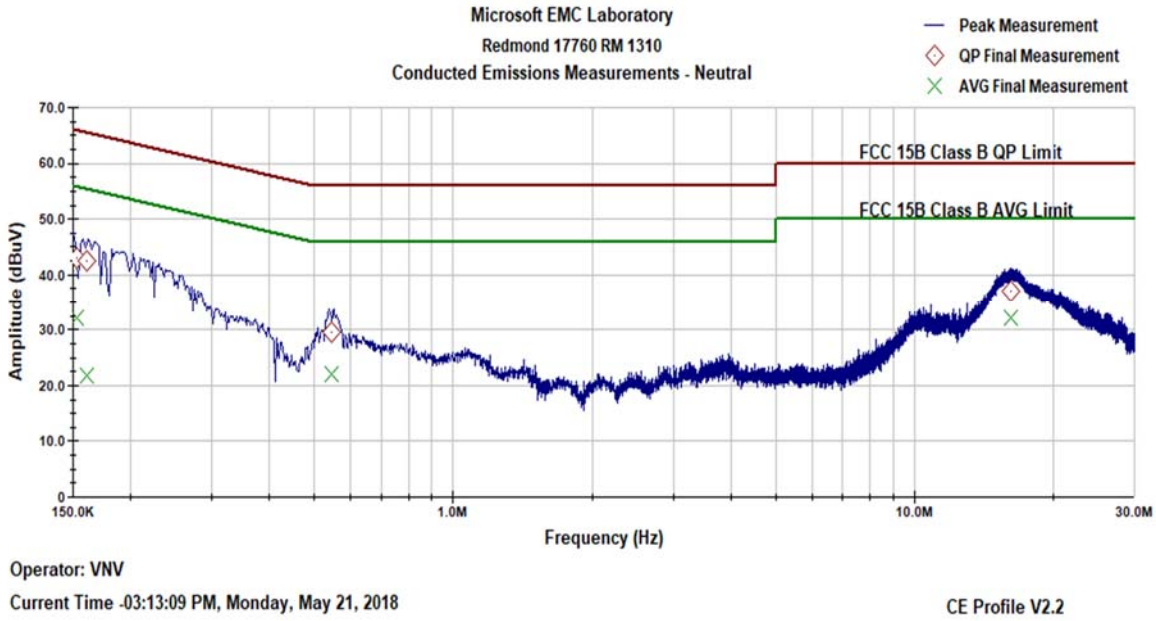
9.9.4 Test Result:

Pass

9.9.5 Test Data:



Plot 9-62 Conducted Emissions Measurements-Line



Plot 9-63 Conducted Emissions Measurements- Neutral

Frequency (MHz)	Line Tested (L or N)	AVG Amplitude (dBµV)	QP Amplitude (dBµV)	AVG Limit (dBµV)	QP Limit (dBµV)	AVG Margin (dB)	QP Margin (dB)
0.152	L	32.44	43.43	55.95	65.95	-23.51	-22.52
0.543	L	21.76	29.35	46.00	56.00	-24.24	-26.65
19.641	L	30.07	35.29	50.00	60.00	-19.93	-24.71
0.153	N	32.24	43.12	55.92	65.92	-23.69	-22.81
0.161	N	21.83	42.61	55.68	65.68	-33.85	-23.07
0.544	N	22.07	29.43	46.00	56.00	-23.93	-26.57
16.168	N	32.11	37.05	50.00	60.00	-17.89	-22.95

End of Report