TÜVRheinland®
Precisely Right.

Emissions
Test Report

EUT Name: FB40-ND1

Model No.: FB40-ND1

CFR 47 Part 15.247: 2018 and RSS 247: 2017

Prepared for:

Continental Automotive
21440 West Lake Cook Road
Deer Park, Illinois 60010, USA

Prepared by:

TUV Rheinland of North America, Inc.
1279 Quarry Lane
Pleasanton, CA 94566
Tel: (925) 249-9123
Fax: (925) 249-9124
http://www.tuv.com/

Report/Issue Date: December 5, 2018
Job # 0000159900
Report Number: 31854171.001

Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
0	10/22/2018	Original Document	DA
1	11/30/2018	Updated per comments from TCB review	DA
2	12/5/2018	Updated per comments from final TCB review	DA

Note: Latest revision report will replace all previous reports.

Statement of Compliance

Manufacturer:	Continental Automotive 21440 West Lake Cook Road Deer Park, Illinois 60010, USA
Requester / Applicant:	Continental Automotive
Name of Equipment:	FB40-ND1
Model No.	FB40-ND1
Type of Equipment:	Intentional Radiator
Application of Regulations:	CFR 47 Part 15.247: 2018 and RSS 247: 2017
Test Dates:	September 28, 2018 to October 19, 2018

Guidance Documents:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v05

Test Methods:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v05

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by A2LA or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.

Douglas Antioco		Josie Sabado	
Test Engineer	Date December 5, 2018	A2LA Signatory	Date December 5, 2018

Testing Cert #3331.02 **US1131** **2932M**

1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247: 2018 and RSS 247: 2017 based on the results of testing performed on September 28, 2018 to October 19, 2018 on the FB40-ND1 Model FB40-ND1 manufactured by Continental Automotive. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report. The 2412 MHz to 2462 MHz frequency band for WiFi are covered in this document.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.4	Worse Case (Measured)	Result
AC Power Conducted Emission	CFR47 15.207, RSS-GEN Sect.8.8	N/A	**N/A (See Note 3)**
DTS Bandwidth (6dB)	CFR47 15.247 (a)(2), RSS 247 Sect. 5.2 (a)	8.1 MHz (802.11b CCK Mode)	**Complied**
Maximum Output Power	CFR47 15.247 (b), RSS 247 Sect. 5.4 (d)	17.3 dBm (802.11b CCK mode)	**Complied**
Peak Power Spectral Density	CFR47 15.247 (e), RSS 247 Sect. 5.2 (b)	4.1 dBm/200KHz (802.11b CCK mode)	**Complied**
Out of Band Emissions: Non-Restricted	CFR47 15.247 (d), RSS 247 Sect.5.5	-30.9 dBc @ 2400 MHz (802.11g NoHT Mode)	**Complied**
Out of Band Emissions: Restricted	CFR47 15.247 (d), RSS 247 Sect.5.5	2.9 dB Margin @ 2484 MHz, Average (802.11g NoHT Mode)	**Complied**
Transmitter Spurious Emissions	CFR47 15.247 (d), RSS 247 Sect.5.5	2.1 dB margin @ 9648 MHz, Average (802.11b Mode)	**Complied**

Note 1: This test report covers 2400 MHz to 2483.5 MHz band.

Note 2: Class B limits were applied where applicable.

Note 3: EUT is DC powered

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US1131). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2017 (Lab Code Testing Cert #3331.02). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated biennially.

2.1.3 Canada – Industry Canada

TUV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.

VCCI Registration No. for Pleasanton: A-0261

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 and 5 meters. The site is listed with the FCC and accredited by A2LA (Lab Code Testing Cert #3331.02). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 meter and 5 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.2 Measurement Uncertainty

Per CISPR 16-4-2	U_{lab}	U_{cispr}
Radiated Disturbance @ 10 meters		
30 – 1,000 MHz	2.25 dB	4.51 dB
Radiated Disturbance @ 3 meters		
30 – 1,000 MHz	2.26 dB	4.52 dB
1 – 6 GHz	2.12 dB	4.25 dB
6 – 18 GHz	2.47 dB	4.93 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.09 dB	2.18 dB
Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.3 dB

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

3 Product Information

3.1 Product Description

The Model FB40-ND1 is an Embedded communication device for automotive.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section (Section 6). The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of an EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation (Section 3.5).

The final configuration was selected to produce the worst case radiation for emissions testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing.

3.4 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

The FB40-ND1 has an internal, PCB type F dual band antenna that has maximum gain of + 3.1 dBi. This antenna is not easily accessible to the end user.

Refer to Table 10 for additional antenna information.

3.5 Worst Case Test Modes

The worst case modulation was determined by using a gated RMS power meter as described by ANSI C63.10-2013 Section 11.9.2.3.2.

3.5.1 Worse Case Modulation

Channel 6 (2437MHz) measured conducted per ANSI C63.10-2013 section 11.9.2.3.2 at the 2.4GHz WLAN antenna port. The measured power is for reference only and is not corrected for cable losses.

Mode	Modulation	Data Rate (Mbps)	Power Setting	Power Measured (dBm)
802.11b CCK	BPSK	1	16	15.0
	QPSK	2_S	16	15.4
	QPSK	2_L	16	15.1
	QPSK	5.5_S	16	15.3
	QPSK	5.5_L	16	15.1
	QPSK	11_S	16	15.3
	QPSK	11_L	16	15.0
802.11g No HT	BPSK	6	15	14.3
	BPSK	9	15	14.2
	QPSK	12	15	14.2
	QPSK	18	15	14.4
	16-QAM	24	15	14.8
	16-QAM	36	15	14.7
	64-QAM	48	15	14.6
	64-QAM	54	14	13.6
802.11n HT20	BPSK (MCS0)	6.5	15	14.2
	QPSK (MCS1)	13	15	14.0
	QPSK (MCS2)	19.5	15	14.2
	16-QAM (MCS3)	26	14	13.9
	16-QAM (MCS4)	39	14	13.9
	64-QAM (MCS5)	54	14	13.9
	64-QAM (MCS6)	58.5	14	13.9
	64-QAM (MCS7)	65	13	12.9

802.11b 2_S and 802.11g 24mbps data rates were used for further testing.

4 Emissions

Testing was performed in accordance with CFR 47 Part 15.247: 2018 and RSS 247: 2017. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in section 8 of the standard were used.

4.1 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

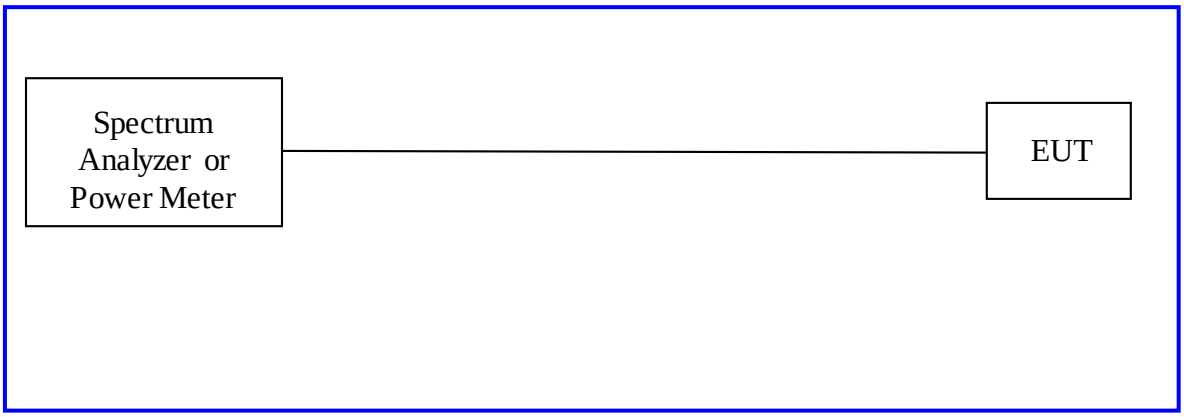
The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b):2016 and RSS 247: 2017 Sect. 5.4 (d).

The maximum transmitted power in the band 2400-2483.5 MHz: 1 W

4.1.1 Test Method

Conducted method was used to measure the channel power output. The preliminary investigation was performed at different data rate to determine the highest power output for each mode. The worst findings were conducted on 3 channels in each operating range per CFR47 Part 15.247(b) and RSS 247 Sect. 5.4(d); 2400 MHz to 2483.5 MHz. The worst mode results indicated below.

Test Setup:



For CCK and HT20 Mode, the measurement method from 11.9.2.2.4 Method AVGSA-2 was used.

4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 2: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature			
Antenna Type: PCB type F dual band antenna		**Power Setting:** 16 (CCK), 15 (NoHT)	
Max. Antenna Gain: 3.1 dBi			
Signal State: See Section 4.1.2.2			
Ambient Temp.: 23° C		**Relative Humidity:** 37%	
802.11b (CCK)			
Operating Channel (MHz)	**Limit [dBm]**	**Total Power (RMS) [dBm]**	**Margin [dB]**
2412.00	30.00	17.3	12.7
2437.00	30.00	14.8	15.2
2462.00	30.00	15.4	14.6
Note: 1.The highest output power was observed at 802.11b mode, 2_S Mbps, 1 Data Streams.			
802.11n (HT20)			
Operating Channel (MHz)	**Limit [dBm]**	**Total Power (RMS) [dBm]**	**Margin [dB]**
2412.00	30.00	14.9	15.4
2437.00	30.00	14.4	15.6
2462.00	30.00	15.0	15.0
Note: 1. The highest output power was observed at NoHT 24mbps, 1 Data Streams.			

4.1.3 Measurement Plots

4.1.3.1 RF Output Power

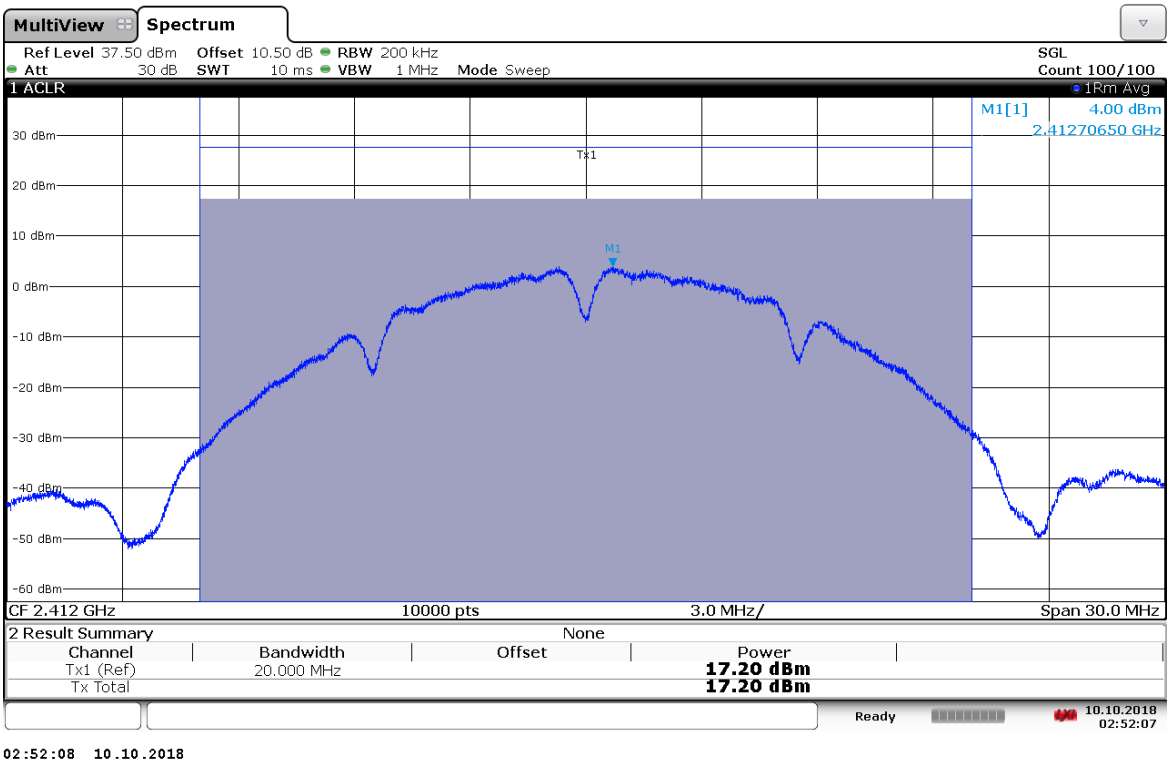


Figure 1: Power Spectral Density, 2412 MHz at 802.11b Mode

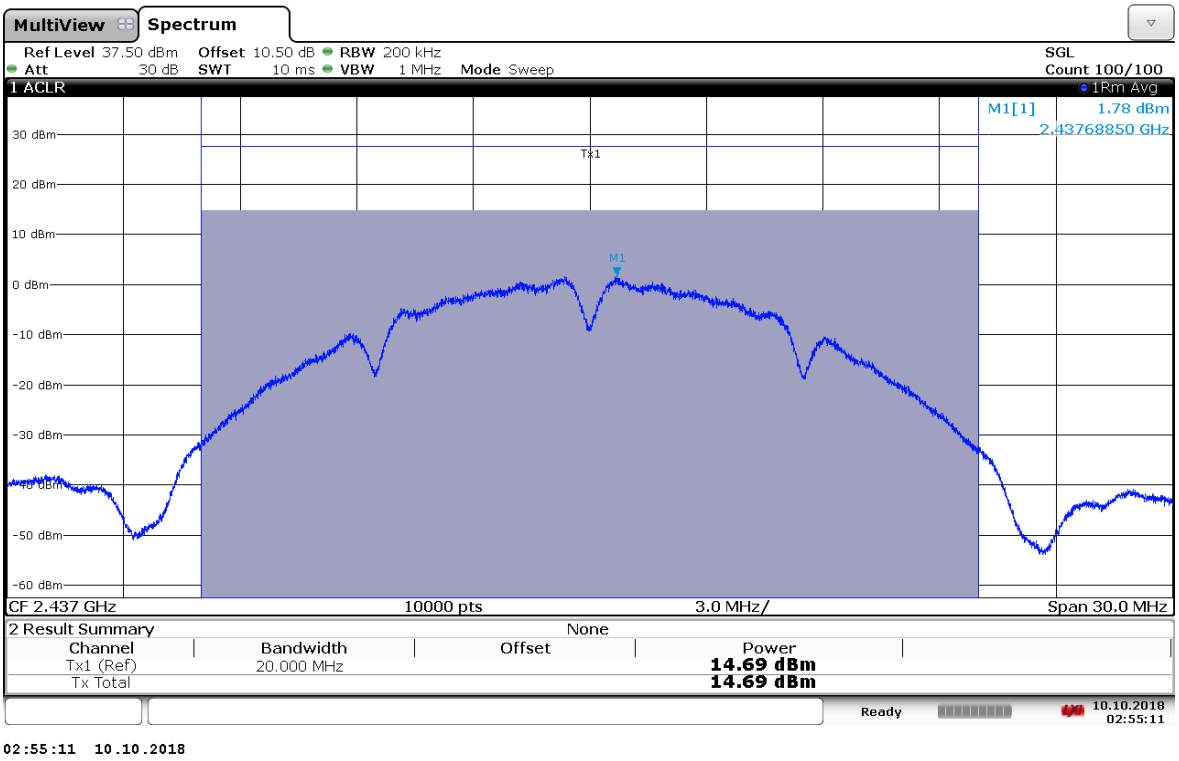


Figure 2: Power Spectral Density, 2437 MHz at 802.11b Mode

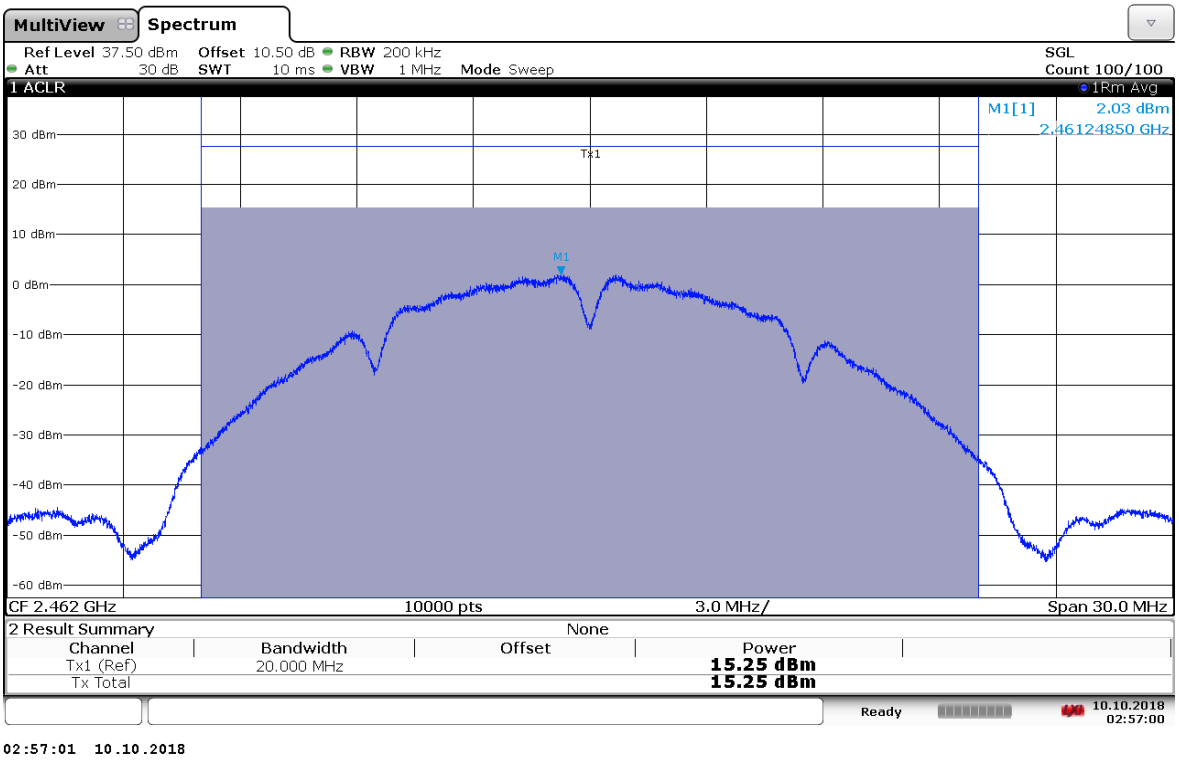


Figure 3: Power Spectral Density, 2462 MHz at 802.11b Mode

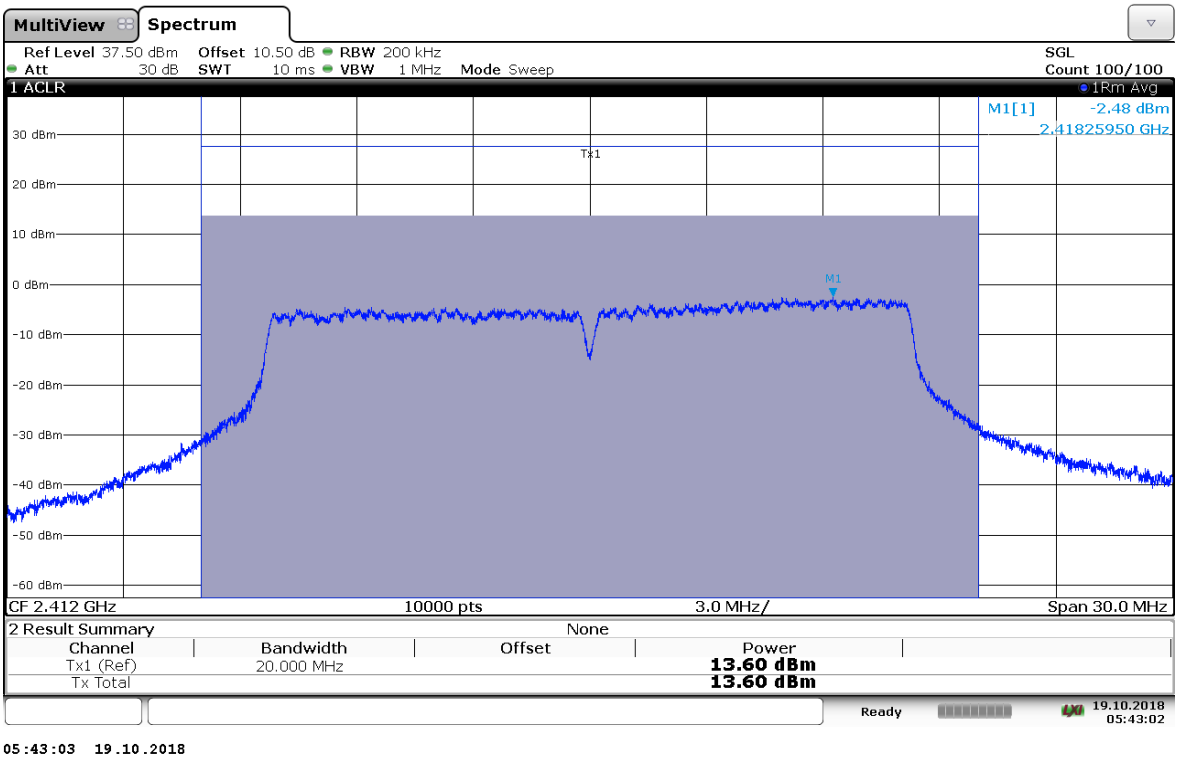


Figure 4: Power Spectral Density, 2412 MHz at 802.11g Mode

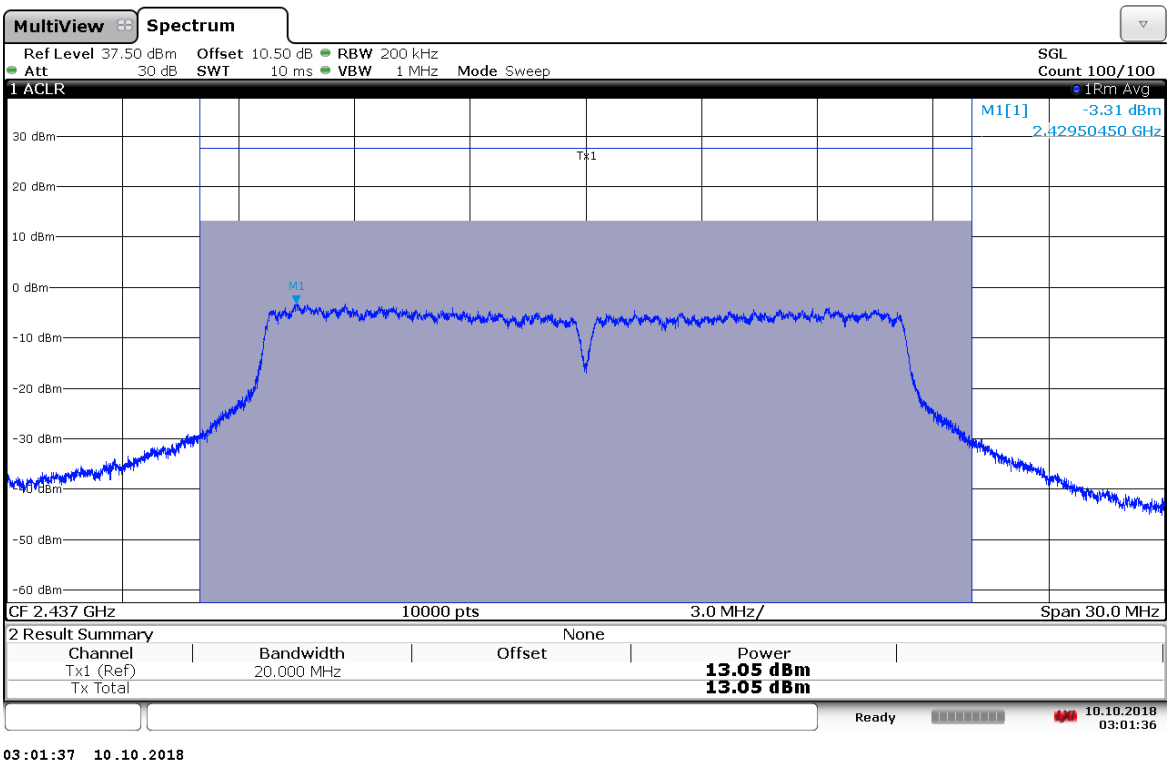


Figure 5: Power Spectral Density, 2437 MHz at 802.11g Mode

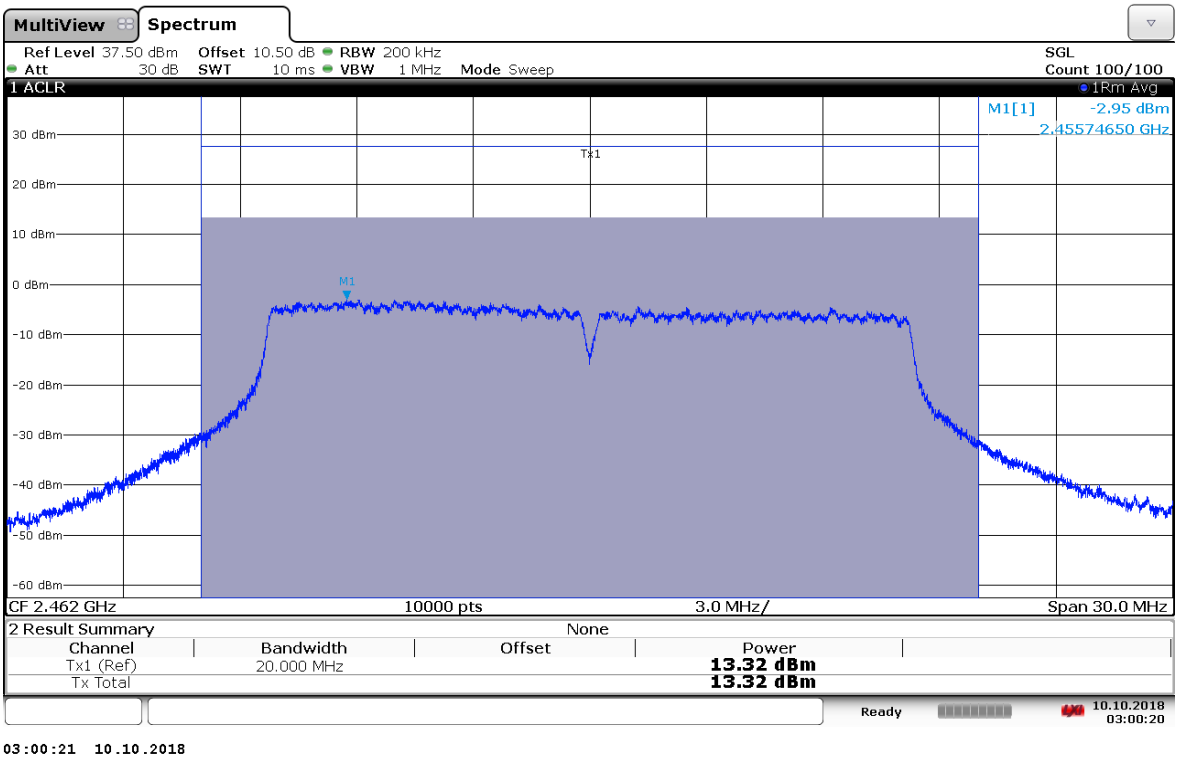
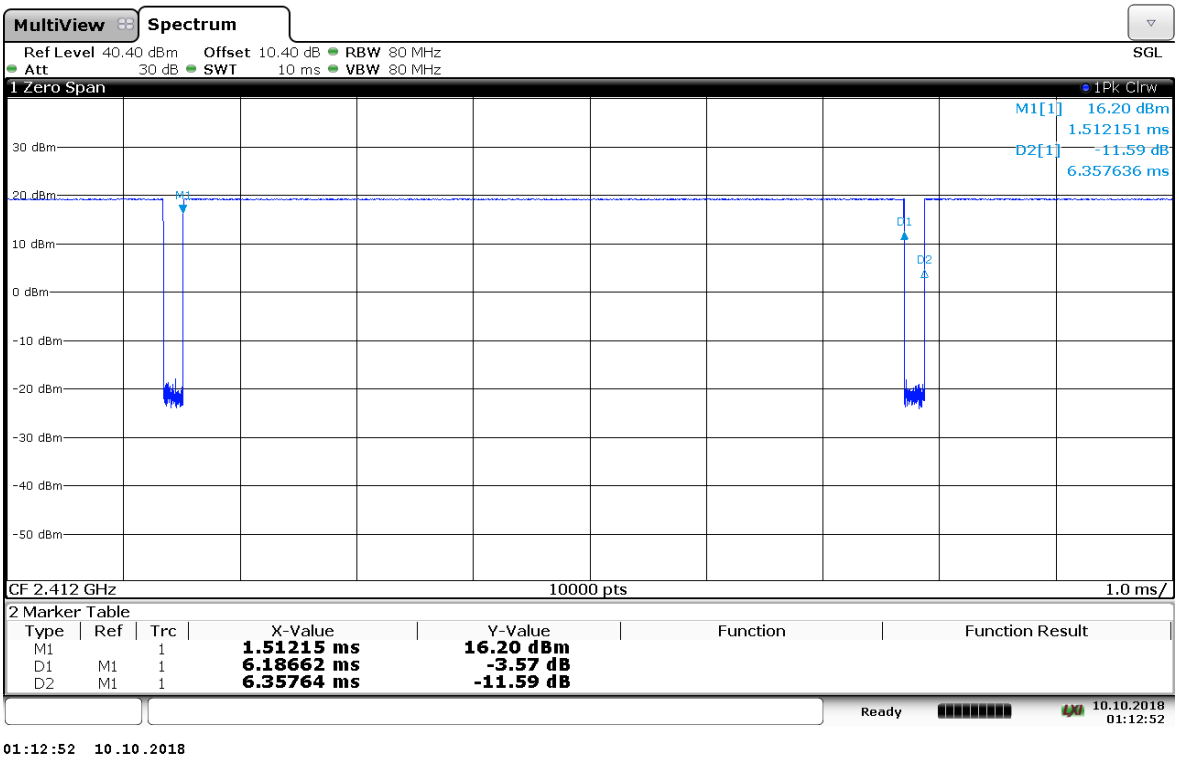


Figure 6: Power Spectral Density, 2462 MHz at 802.11g Mode

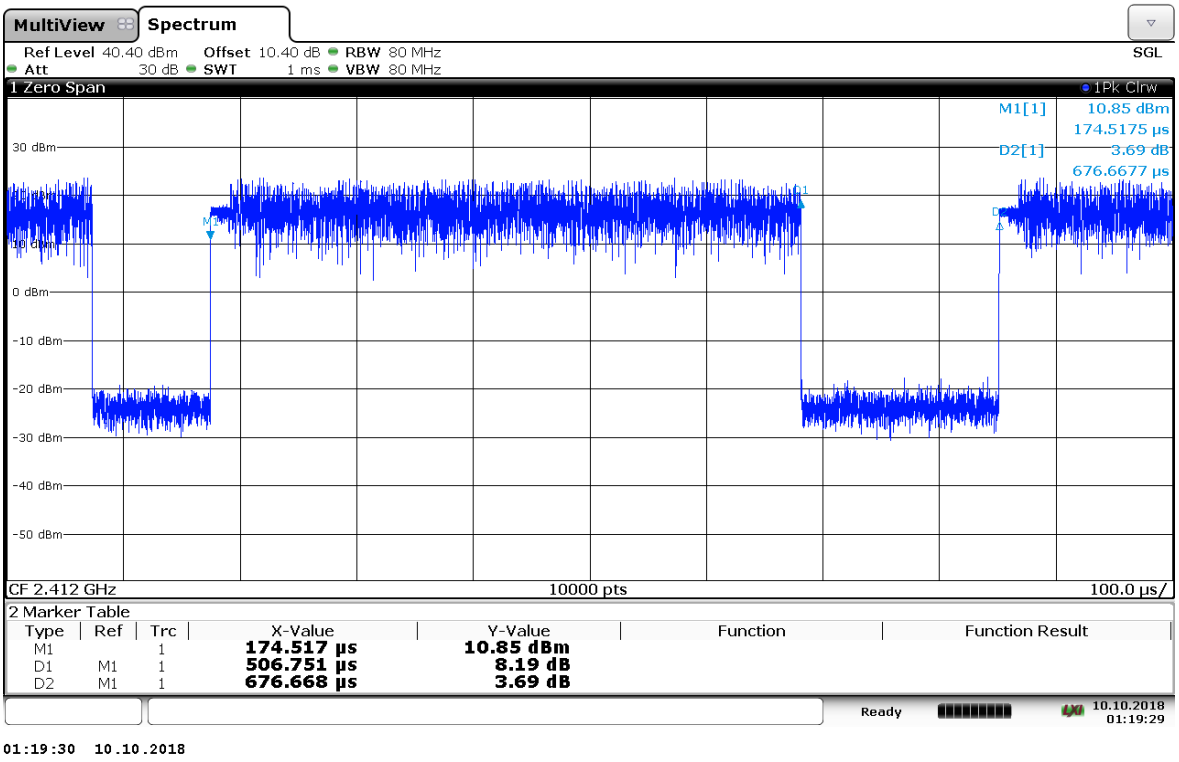
4.1.3.2 Duty Cycle Plots and Duty Cycle Correction Factor

Mode	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b CCK 2_S Mbps	97.3	0.1
802.11g NoHT 24 Mbps	74.9	1.3

CCK Mode



NoHT Mode


MultiView
Spectrum
Ref Level 40.40 dBm Offset 10.40 dB RBW 80 MHz
Att 30 dB SWT 1 ms VBW 80 MHz
SGL
1 Zero Span
1Pk Clrw
M1[1] 10.85 dBm
174.5175 µs
D2[1] 3.69 dB
676.6677 µs
30 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
CF 2.412 GHz
10000 pts
100.0 µs/
2 Marker Table
Type Ref Trc X-Value Y-Value Function Function Result
M1 1 174.517 µs 10.85 dBm
D1 M1 1 506.751 µs 8.19 dB
D2 M1 1 676.668 µs 3.69 dB
Ready
10.10.2018
01:19:29
01:19:30 10.10.2018

4.2 DTS Bandwidth (6dB) and Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

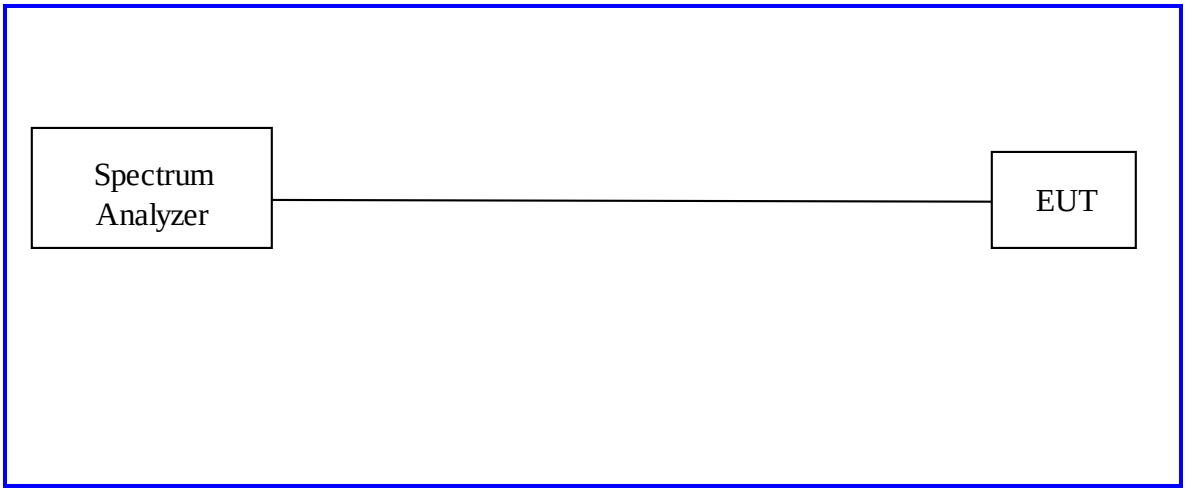
The minimum 6 dB bandwidth shall be at least 500 kHz.

4.2.1 Test Method

The conducted method was used to measure the occupied bandwidth according to ANSI C63.10:2013 Section 11.8. The measurement was performed with modulation per CFR47 15.247 (a) (2) 2016 and RSS Gen Sect. 6.6 2014. If necessary, measurements were performed on the low, middle and high channels of the operating frequency range; 2400 MHz to 2483.5 MHz.

Test reduction are based on margins to limits as specified in ANSI C63.10-2013 Section 5.6.2.1.

Test Setup:



4.2.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 3: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature		
Antenna Type: PCB type F dual band antenna		**Power Setting:** 16 (CCK), 15 (NoHT)
Max. Antenna Gain: 3.1 dBi		
Signal State: See Section 4.1.2.2		
Ambient Temp.: 23° C		**Relative Humidity:** 37%
Bandwidth (MHz) for 802.11b (CCK)		
Freq. (MHz)	**99% Bandwidth (MHz)**	**6dB Bandwidth (MHz)**
2412	N/A (See Note 2)	N/A (See Note 2)
2437	13.8	8.1
2462	N/A (See Note 2)	N/A (See Note 2)
Note: 1. The bandwidth was measured at 2_S Mbps. 2. Not required per ANS C63.10 5.6.2.1.		
Bandwidth (MHz) for 802.11g		
Freq. (MHz)	**99% Bandwidth (MHz)**	**6dB Bandwidth (MHz)**
2412	N/A (See Note 2)	N/A (See Note 2)
2437	16.6	16.5
2462	N/A (See Note 2)	N/A (See Note 2)
Note: 1. The bandwidth was measured at NoHT 24 Mbps, 1 Data Streams. 2. Not required per ANS C63.10 5.6.2.1.		

4.2.3 Measurement Plots

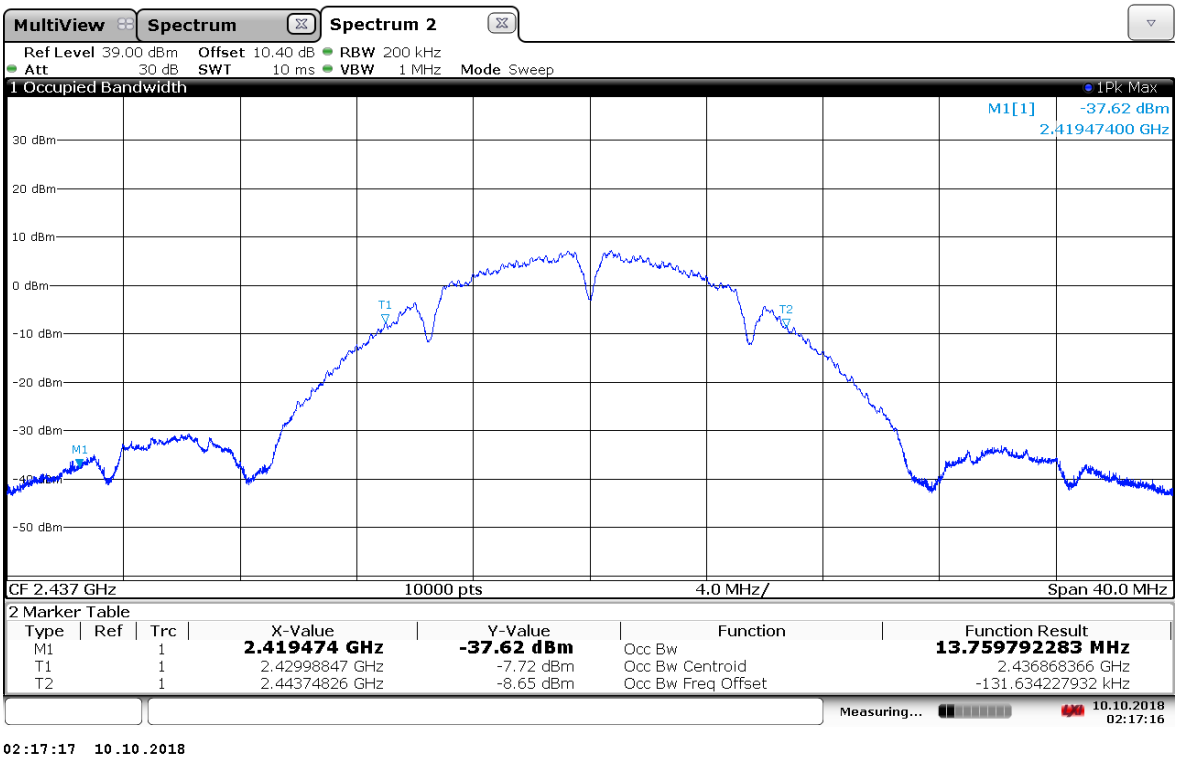


Figure 7: 99% Bandwidth, 2437 MHz at 802.11b

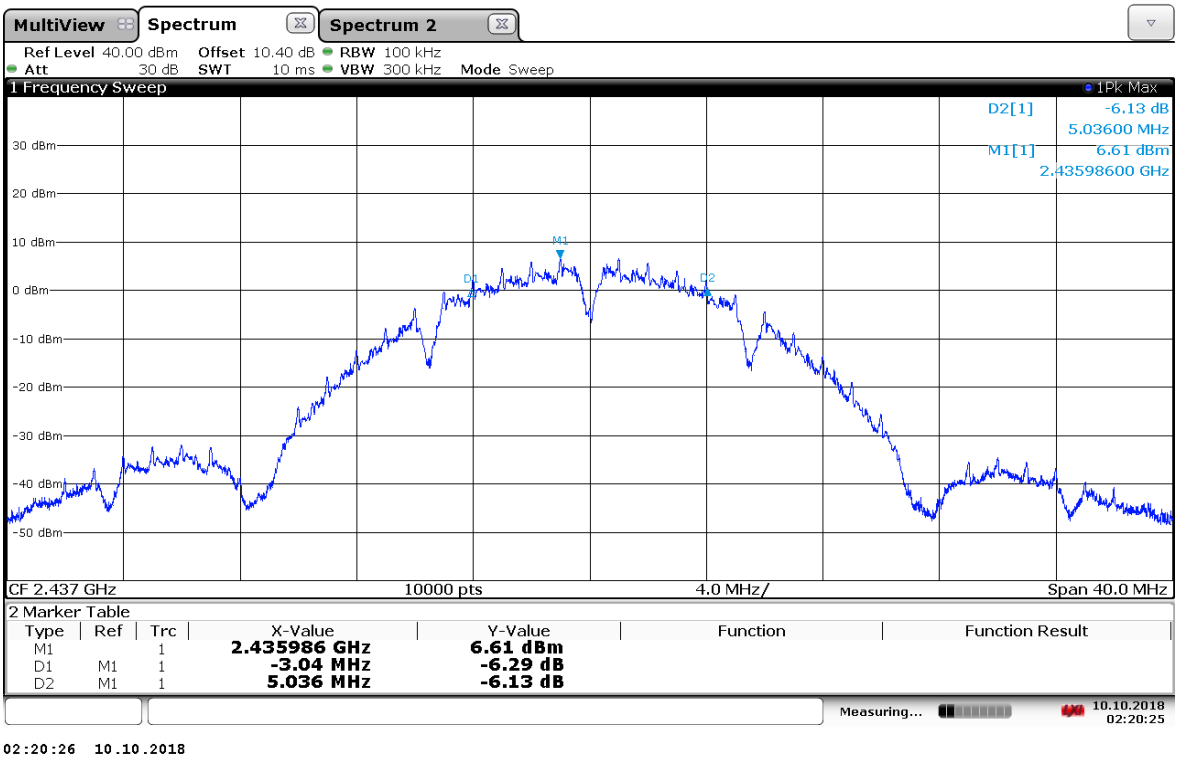


Figure 8: 6dB Bandwidth, 2437 MHz at 802.11b

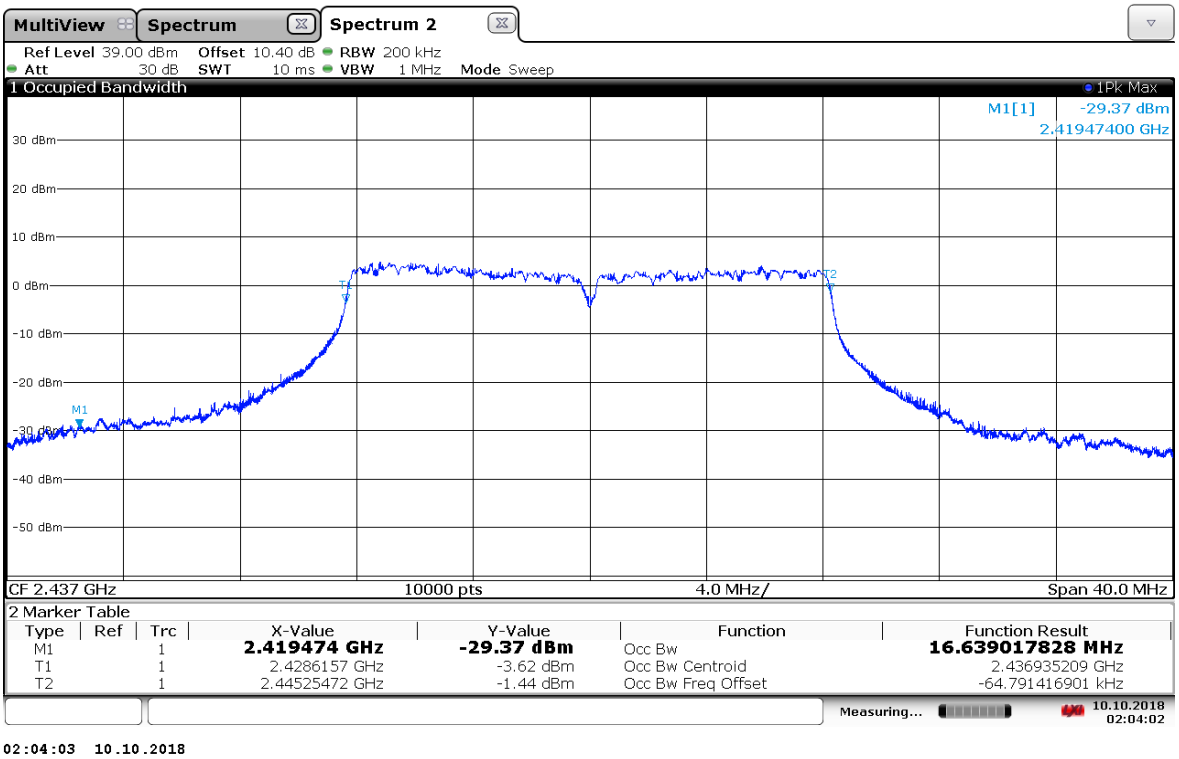


Figure 9: 99% Bandwidth, 2437 MHz at 802.11g

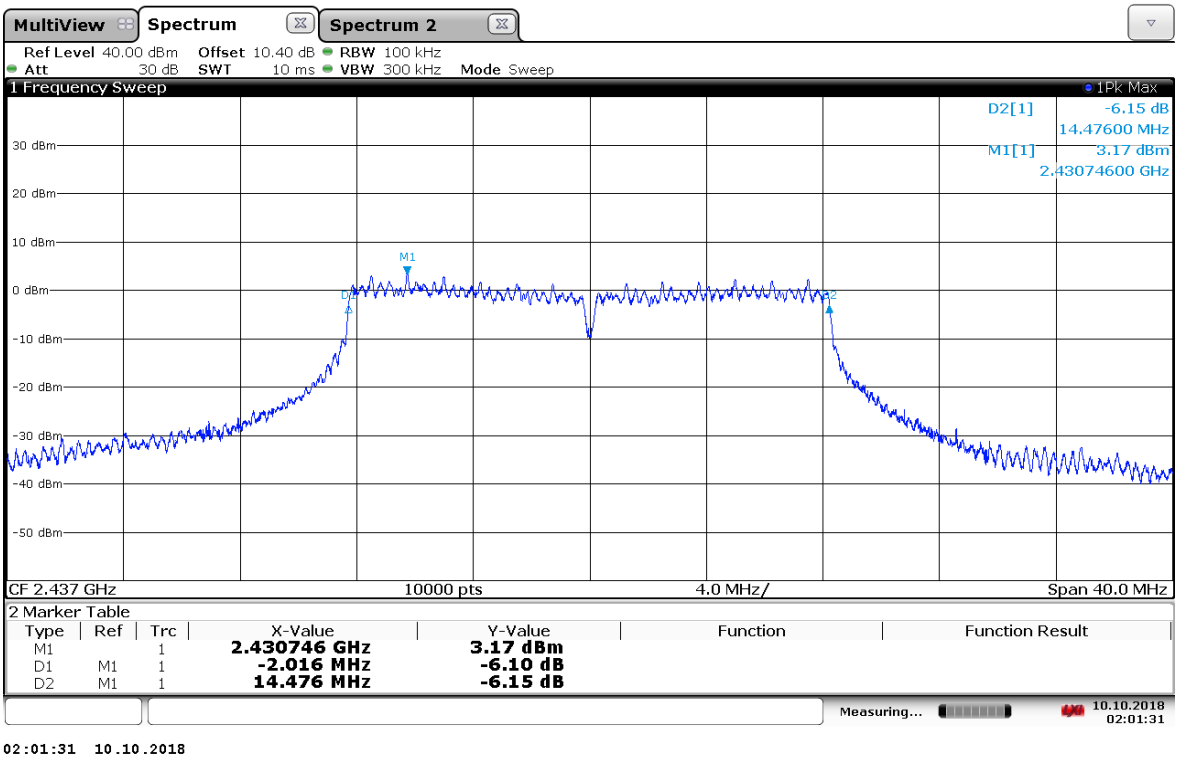


Figure 10: 6dB Bandwidth, 2437 MHz at 802.11g

4.3 Peak Power Spectral Density

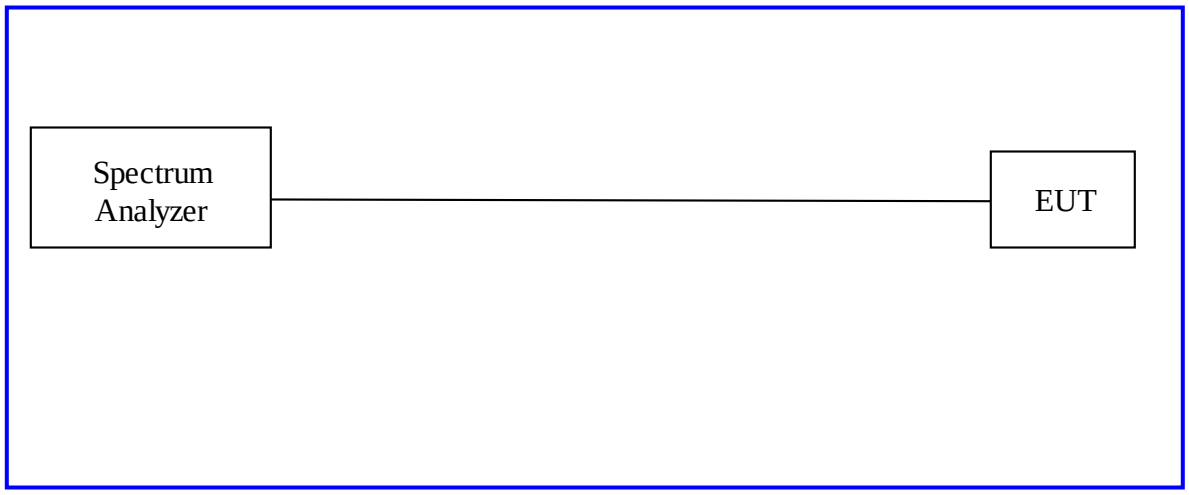
According to the CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b), the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.1 Test Method

The conducted method was used to measure the channel power output per ANSI C63.10-2013 11.10.5 Method AVGPSD-2. The measurement was performed with modulation per CFR47 Part 15.247 (e) and RSS 247 Sect.5.2 (b). A pre-evaluation was performed to find the worst case modes (Section 3.5.1). The worst findings were conducted on 3 channels in each operating frequency range of 2400 MHz to 2483.5 MHz. The worst sample result indicated below.

Measurement were made with a resolution bandwidth of 200KHz, which shows a more worse case result than the 100KHz specified in ANC63.10-2013 11.10.5 Method AVGPSD-2.

Test Setup:



4.3.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Peak Power Spectral Density – Test Results

Test Conditions: Conducted Measurement, Normal Temperature				
Antenna Type: PCB type F dual band antenna		**Power Setting:** 16 (CCK), 15 (NoHT)		
Max. Antenna Gain: 3.1 dBi				
Signal State: See Section 4.1.2.2				
Ambient Temp.: 23° C		**Relative Humidity:** 37%		
Peak Power Spectral Density (PPSD)				
802.11b CCK				
Freq. (MHz)	**Measured PPSD [dBm/200KHz]**	**Corrected PPSD [dBm/3KHz]**	**Limit [dBm/3KHz]**	**Margin [dB]**
2412	4.1	-14.1	8.0	-22.1
2437	1.9	-16.3	8.0	-24.3
2462	2.1	-16.1	8.0	-24.1
Note: 1. The highest peak output power was observed at 802.11b 2_S Mbps				
802.11g NoHT				
Freq. (MHz)	**Measured PPSD [dBm/200KHz]**	**Corrected PPSD [dBm/3KHz]**	**Limit [dBm/3KHz]**	**Margin [dB]**
2412	-1.2	-19.4	8.0	-27.4
2437	-2.0	-20.2	8.0	-28.2
2462	-0.7	-18.9	8.0	-26.9
Note: 1. The highest peak output power was observed at NoHT 24 Mbps				

Note: PSD measured at 200KHz RBW is corrected to 3KHz RBW using a factor of $10*\log(RBW_{200MHz}/RBW_{3KHz})= -18.2$ dB.

4.3.3 Measurement Plots

See Section 4.1.3.1

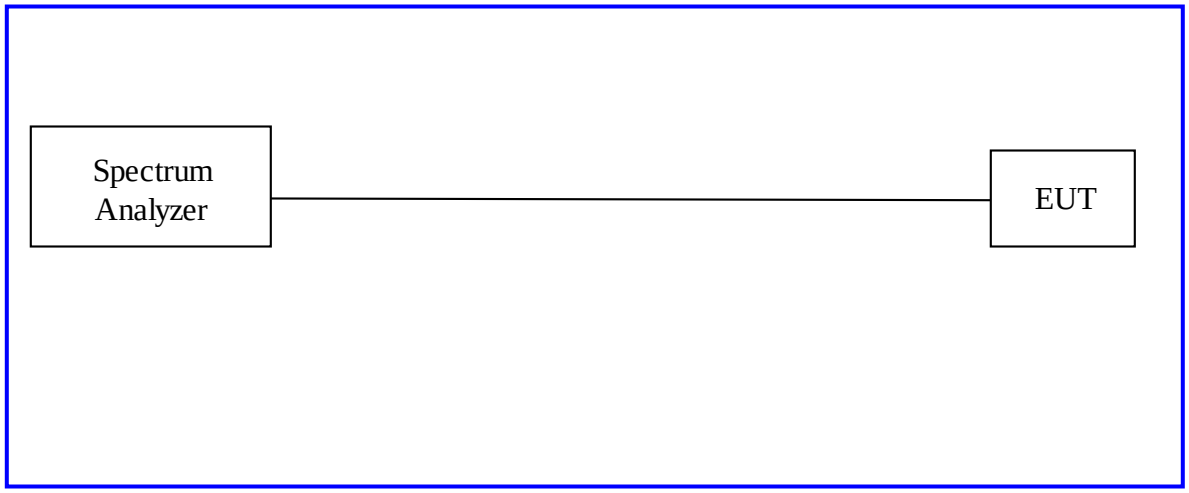
4.4 Out of Band Emissions: Non-Restricted Bands

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmitting mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS-247 Sect. 5.5, RSS-GEN Sect. 8.9 and 8.10.

4.4.1 Test Method

Conducted measurements per ANSI C63.10-2013 Sections 6.10, 11.11, 14.3.3 were used to measure the undesirable emission requirement in non-restricted bands. The measurement was performed with modulation. This test was conducted on 3 channels in each mode on the EUT. The worst case measurement of each channel is recorded in this report.

Test Setup:



4.4.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 5: Emissions at the Band-Edge – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only					
Antenna Type: PCB type F dual band antenna			**Power Setting:** 16 (CCK), 15 (NoHT)		
Max. Antenna Gain: 3.1 dBi					
Signal State: See Section 4.1.2.2					
Ambient Temp.: 23° C			**Relative Humidity:** 37%		
Non-Restricted Frequency Band Emissions					
Freq. (MHz)	**Mode**	**Measured (dBc)**	**Limit (dBc)**	**Worst Case Channel**	**Results**
2399	802.11b CCK 2_S Mbps	-43.1	30	1	Pass
2400	802.11g NoHT 24 Mbps	-30.9	30	1	Pass
Note: -					

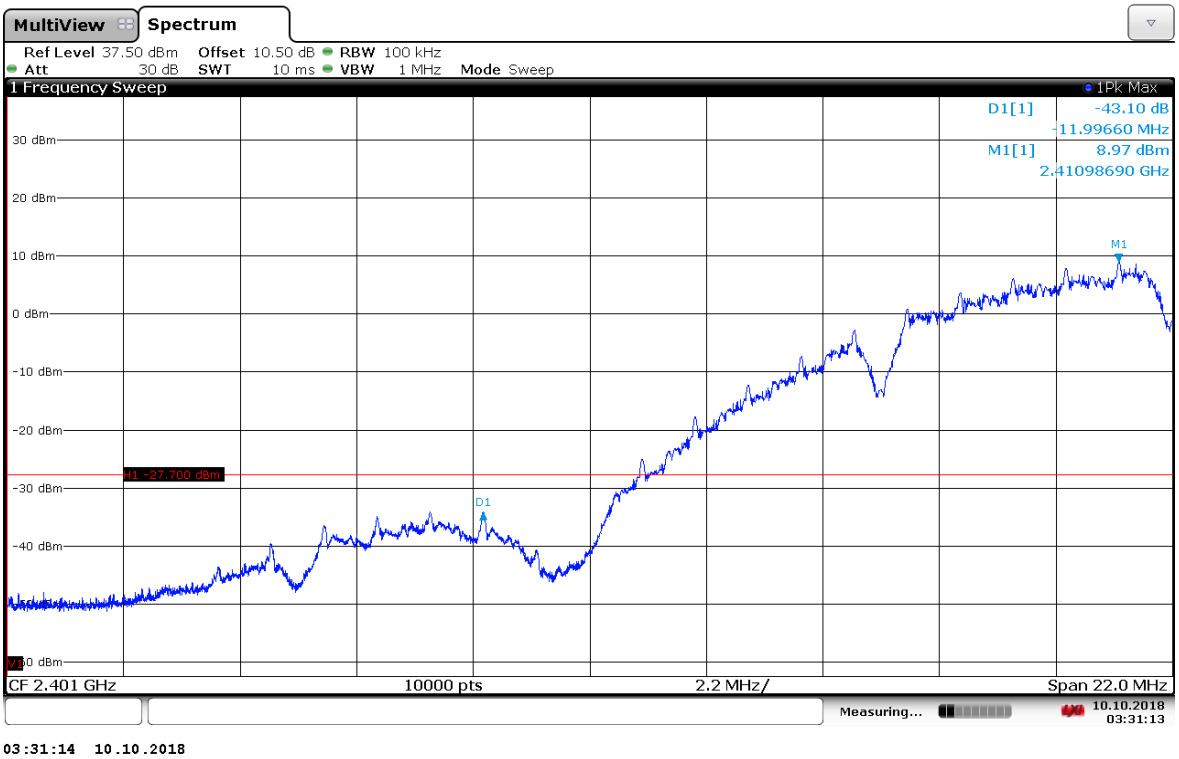


Figure 11: Low Bandedge(non-restricted) for 802.11b

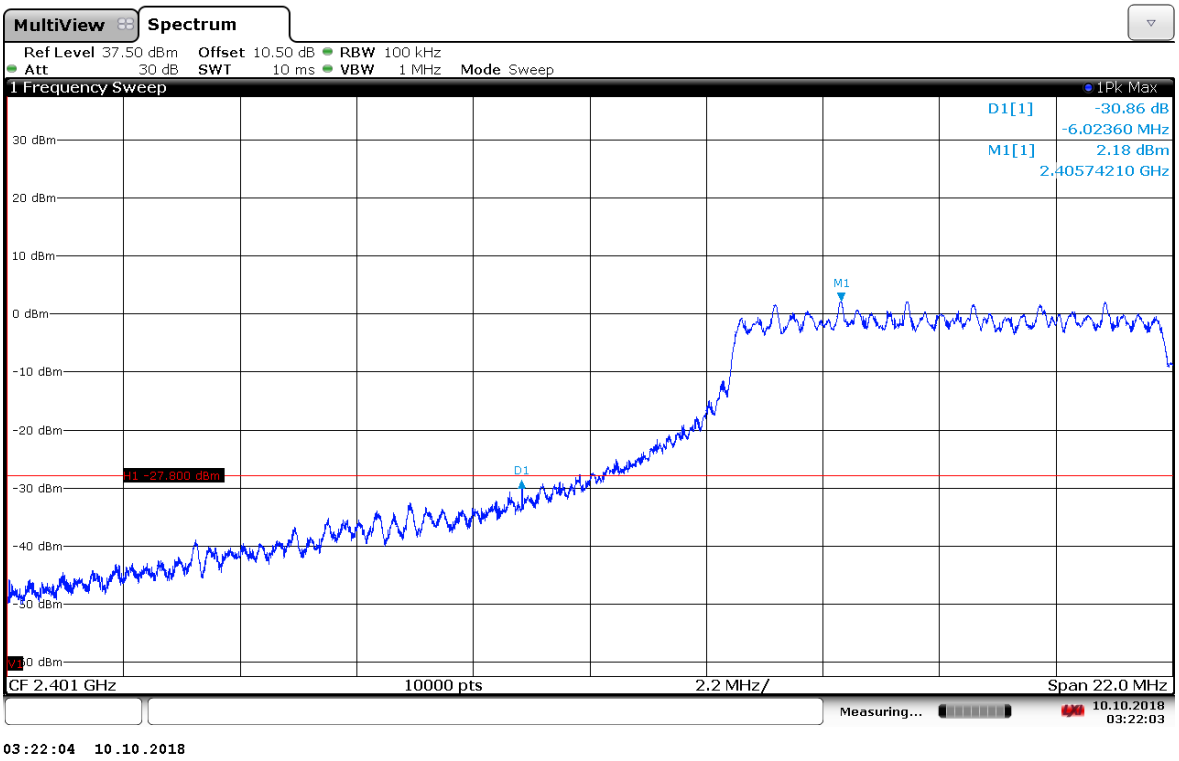


Figure 12: Low Bandedge(non-restricted) for 802.11g

4.5 Out of Band Emissions: Restricted Band Edge

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmitting mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS-247 Sect. 5.5, RSS-GEN Sect. 8.9 and 8.10.

4.5.1 Test Method

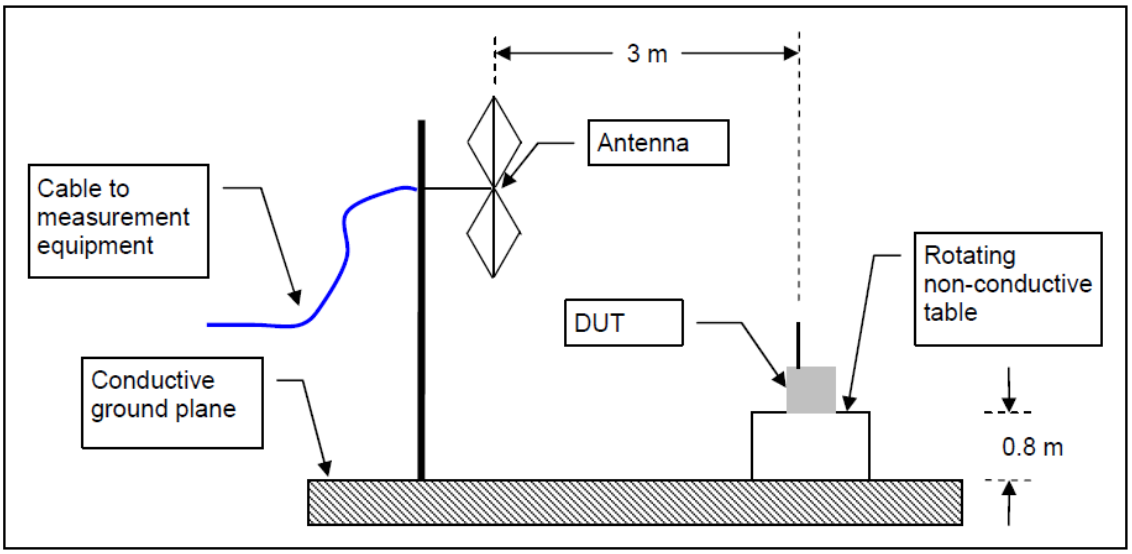
Radiated measurements per ANSI C63.10-2013 Section 6.10.5 were used to measure the undesirable emission requirement in restricted bands. The measurement was performed with modulation. This test was conducted on 3 channels in each mode on the EUT. The worst case measurement of each channel is recorded in this report.

Spectrum Analyzer Settings

	Peak Measurement	Average Measurement
Detector	Peak	Peak
Trace	Max Hold	Max Hold
RBW	1 MHz	1 MHz
VBW	3 MHz	See Section 4.5.2
Sweep Points	501	501
Sweep Time	Coupled	Coupled
Span	See Plots	See Plots, (Maximum of RBW/2 per sweep point)

The average measurement used video bandwidth averaging per ANSI C63.10-2013 Section 11.12.2.5.3.

4.5.2 Test Setup



The DUT was stimulated by manufacturer provided test software that is not available to the end user.

4.5.3 Transmission duration

Mode	Transmission Duration (us)	Video Bandwidth (Hz)
802.11b	6186.6	200
802.11n HT20	506.8	3000

See Section 4.1.3.2 for measurement plots.

4.5.4 Test Results

Table 6: Emissions at the Band-Edge – Test Results

Test Conditions: Radiated Measurement, Normal Temperature and Voltage							
Antenna Type: PCB type F dual band antenna			**Power Setting:** 16 (CCK), 15 (NoHT)				
Max. Antenna Gain: 3.1 dBi							
Signal State: See Section 4.1.2.2							
Ambient Temp.: 23° C			**Relative Humidity:** 37%				
Lower Restricted Band Edge							
Freq. (MHz)	**Mode**	**Channel**	**Detector (Average/ Peak)**	**Measured (dBuV/m)**	**Limit (dBuV/m)**	**Margin**	**Results**
2390	802.11b CCK 2_S Mbps	1	Average	43.0	54	11.0	Pass
2390	802.11b CCK 2_S Mbps	1	Peak	56.3	74	17.7	Pass
2390	802.11g NoHT 24 Mbps	1	Average	49.2	54	4.8	Pass
2390	802.11g NoHT 24 Mbps	1	Peak	65.5	74	8.5	Pass
Upper Restricted Band Edge							
Freq. (MHz)	**Mode**	**Channel**	**Detector (Average/ Peak)**	**Measured (dBuV/m)**	**Limit (dBuV/m)**	**Margin**	**Results**
2483.5	802.11b CCK 2_S Mbps	11	Average	46.2	54	7.8	Pass
2483.5	802.11b CCK 2_S Mbps	11	Peak	59.5	74	14.5	Pass
2483.5	802.11g NoHT 24 Mbps	11	Average	51.1	54	2.9	Pass
2483.5	802.11g NoHT 24 Mbps	11	Peak	71.0	74	3.0	Pass
Note: -							

4.5.4.1 Measurement Plots

Note: Plots depict worse case antenna polarization and EUT orientation.

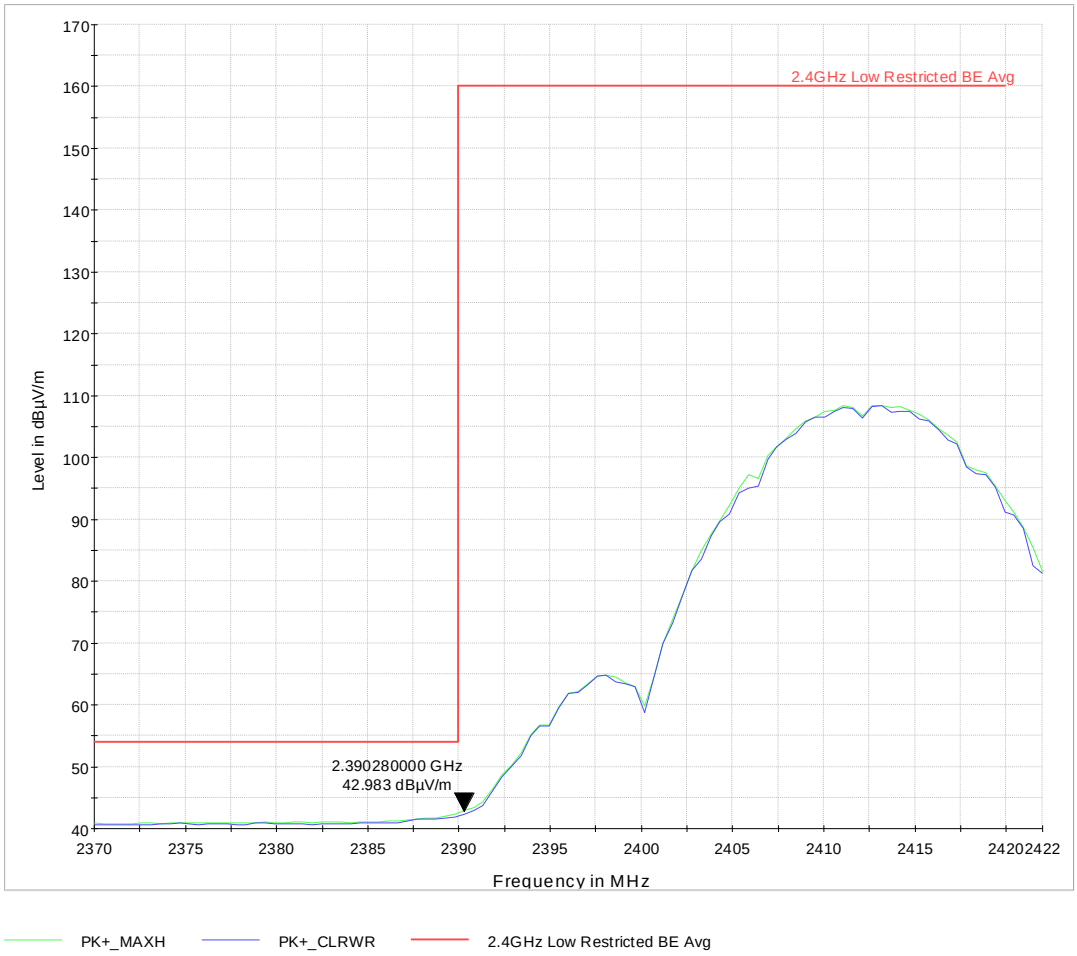


Figure 13: Low Band Edge (restricted) for 802.11b CCK at 2412 MHz-Average

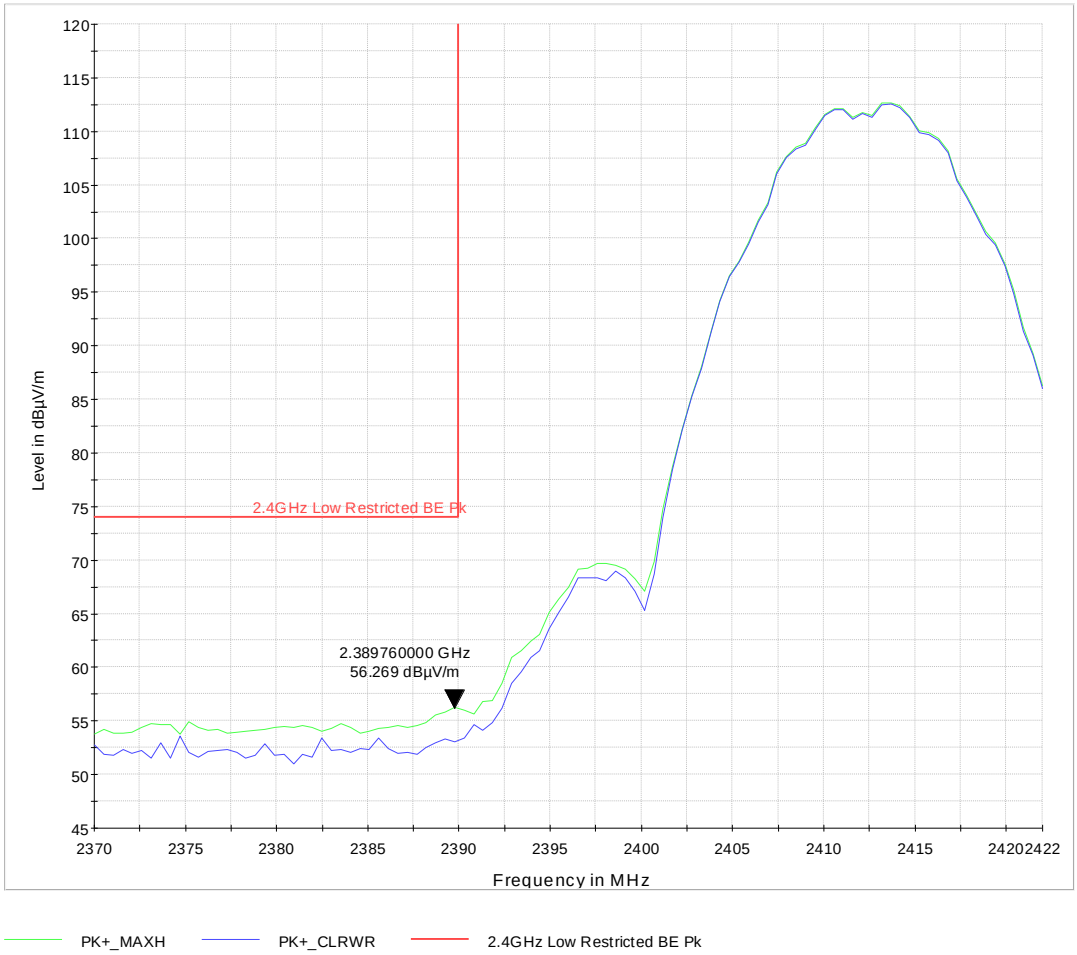


Figure 14: Low Band Edge (restricted) for 802.11b CCK at 2412 MHz-Peak

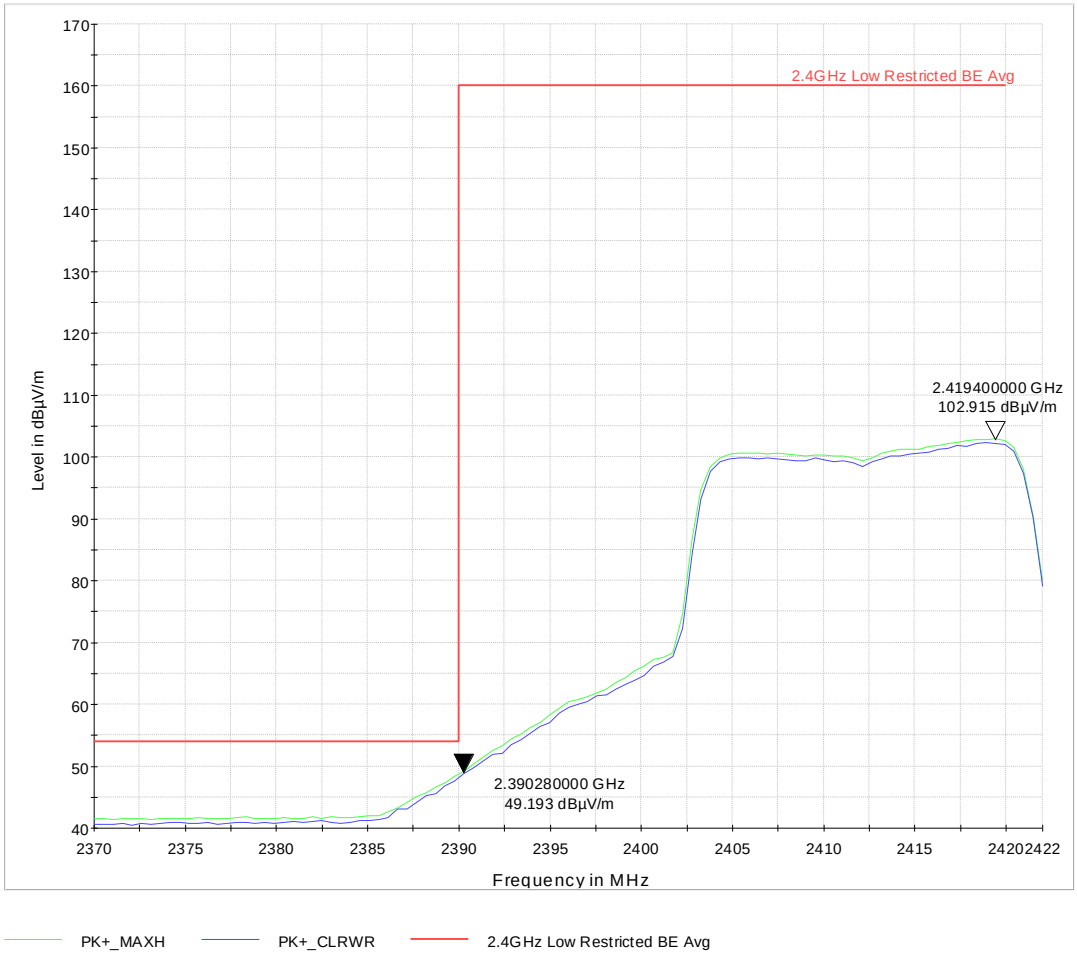


Figure 15: Low Band Edge (restricted) for 802.11g NoHT at 2412 MHz-Average

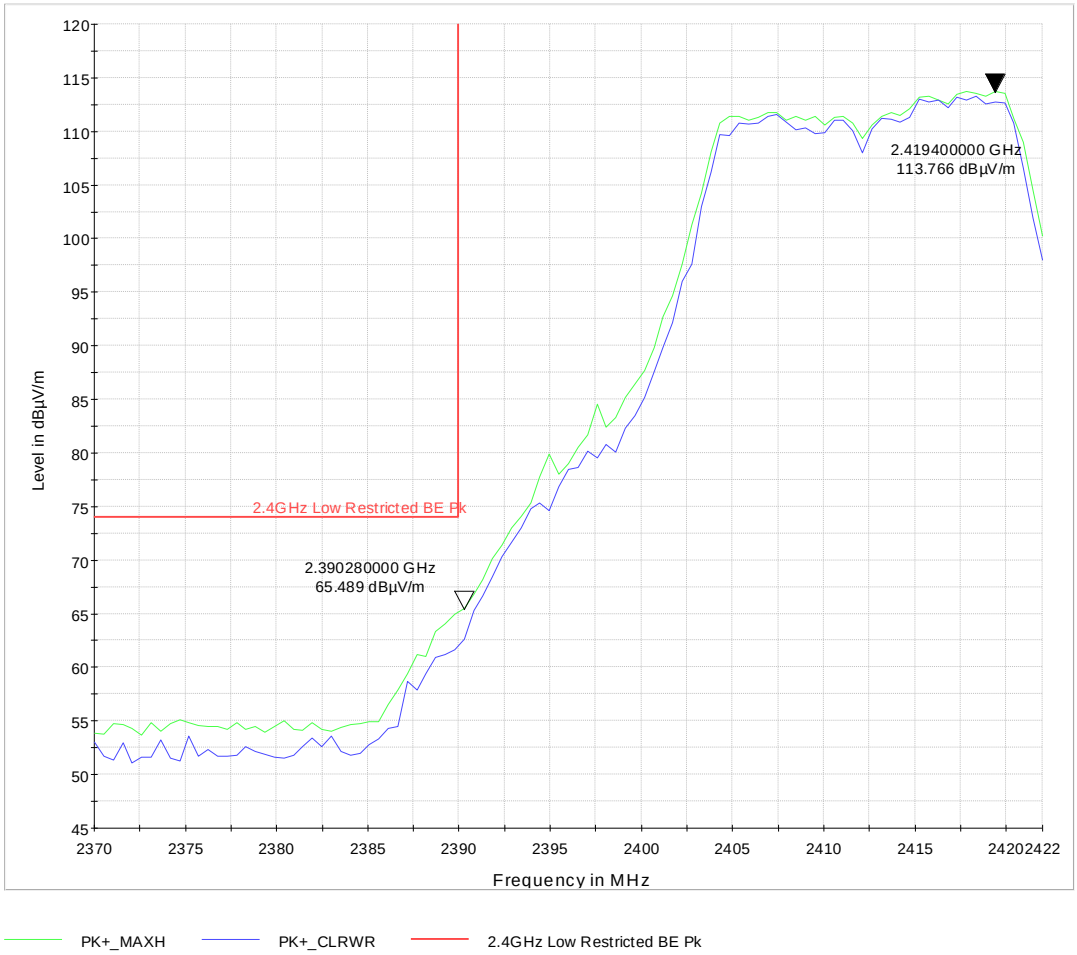


Figure 16: Low Band Edge (restricted) for 802.11g NoHT at 2412 MHz-Peak

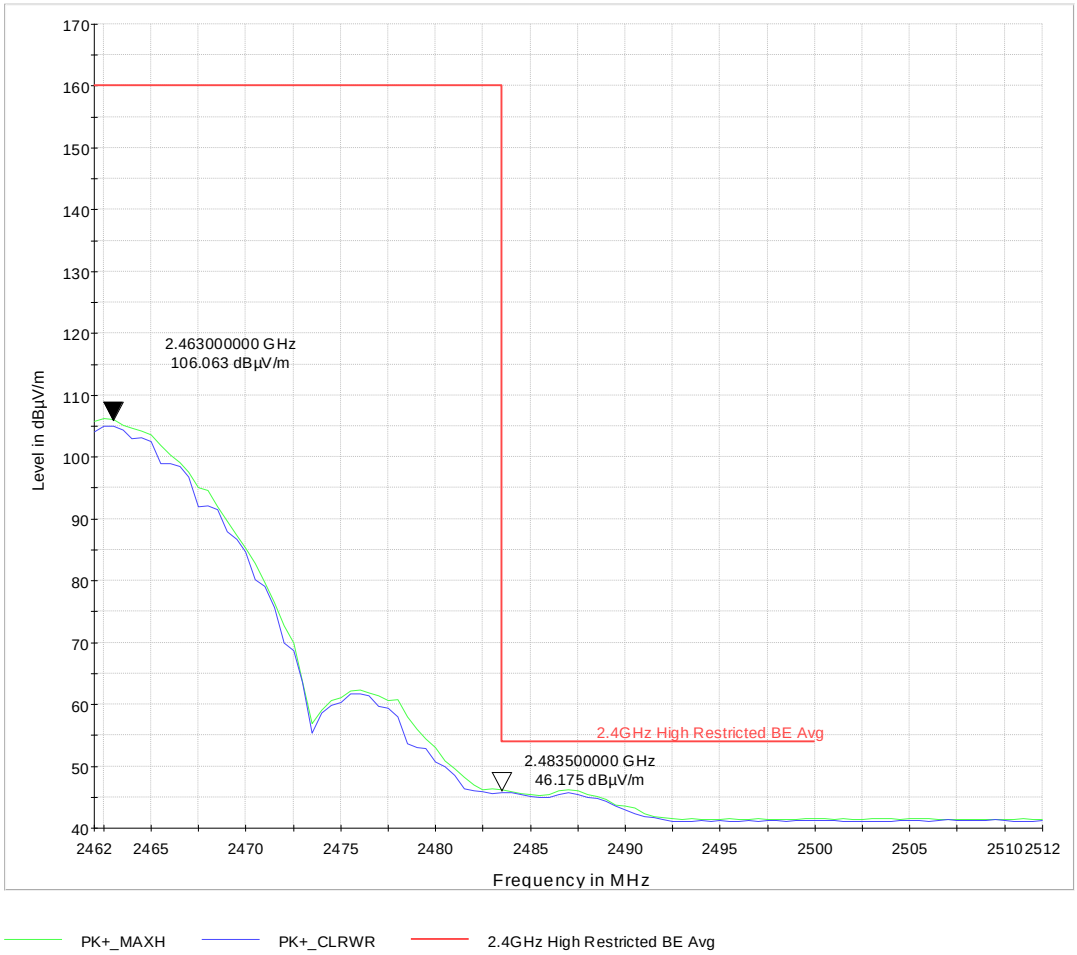


Figure 17: High Band Edge (restricted) for 802.11b CCK at 2462 MHz-Average

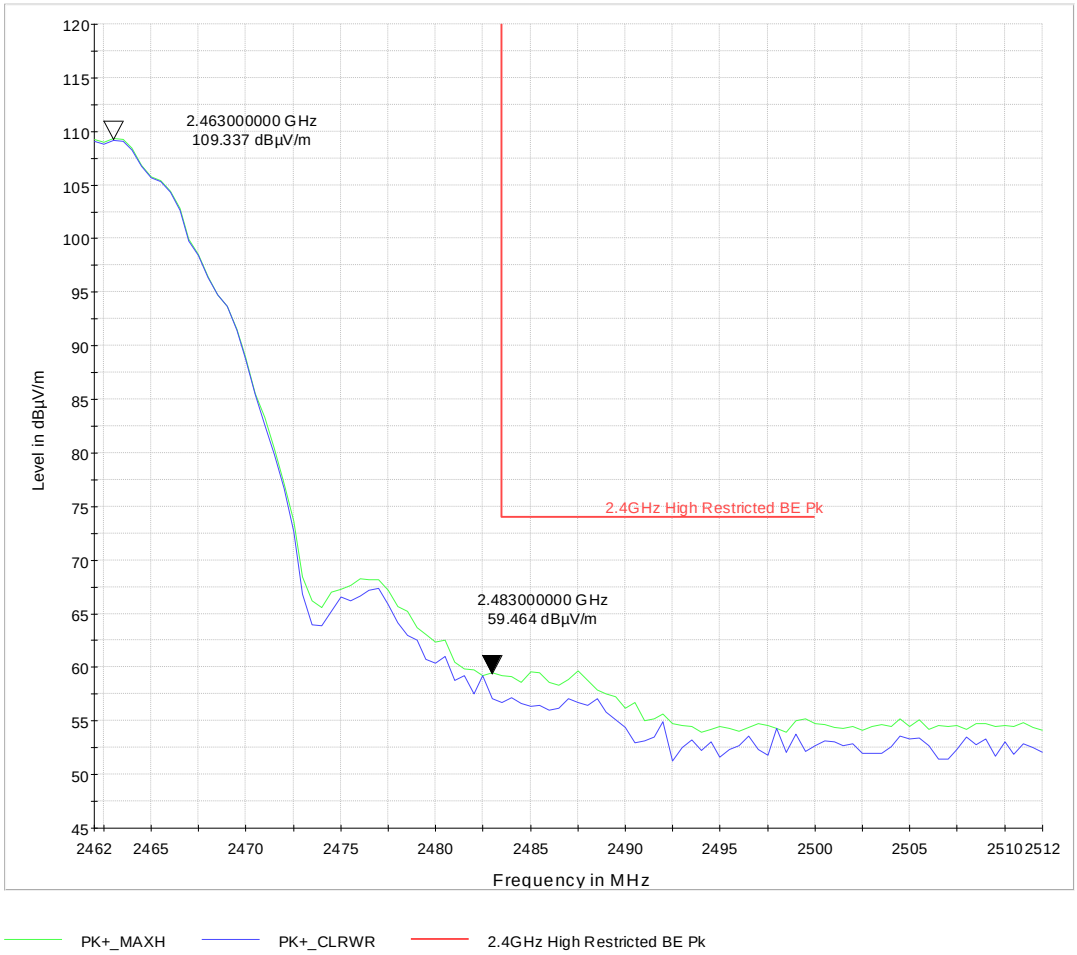


Figure 18: High Band Edge (restricted) for 802.11b CCK at 2462 MHz-Peak

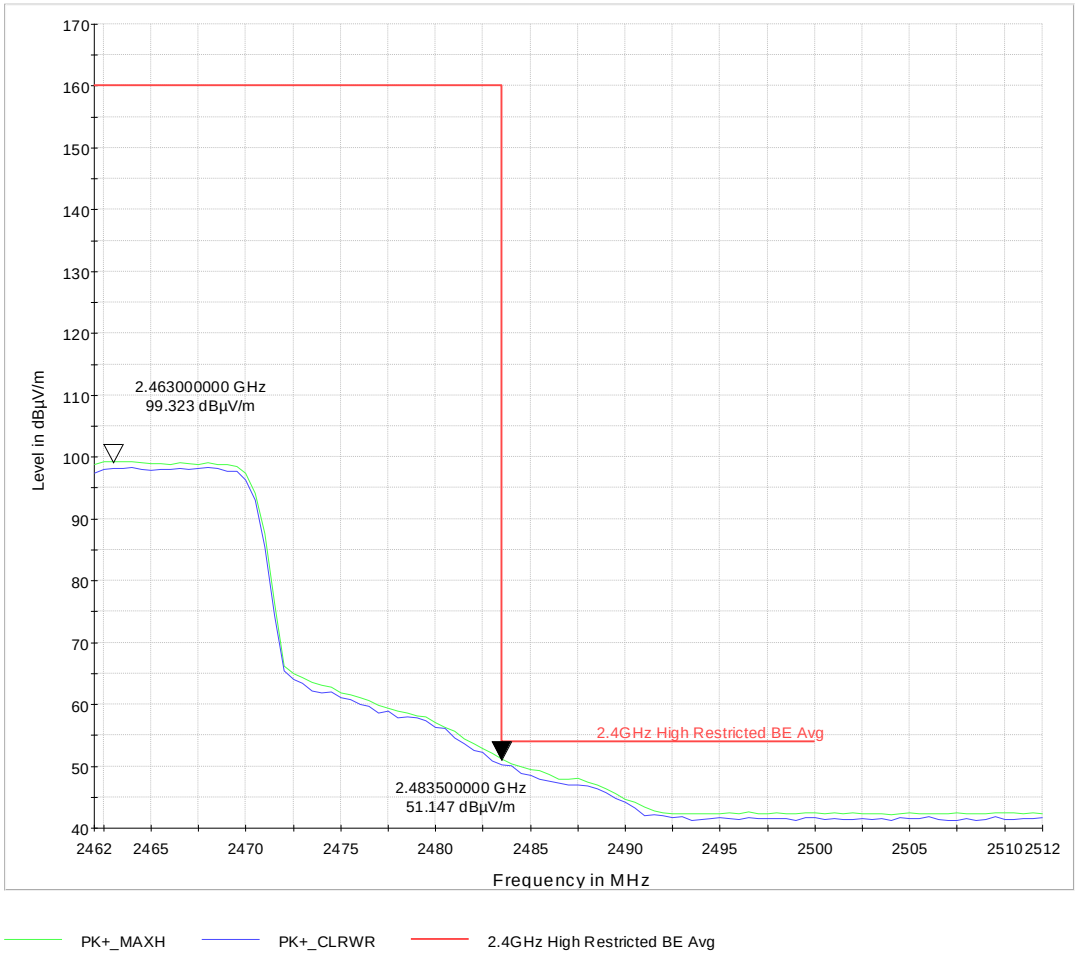


Figure 19: High Band Edge (restricted) for 802.11g NoHT at 2462 MHz-Average

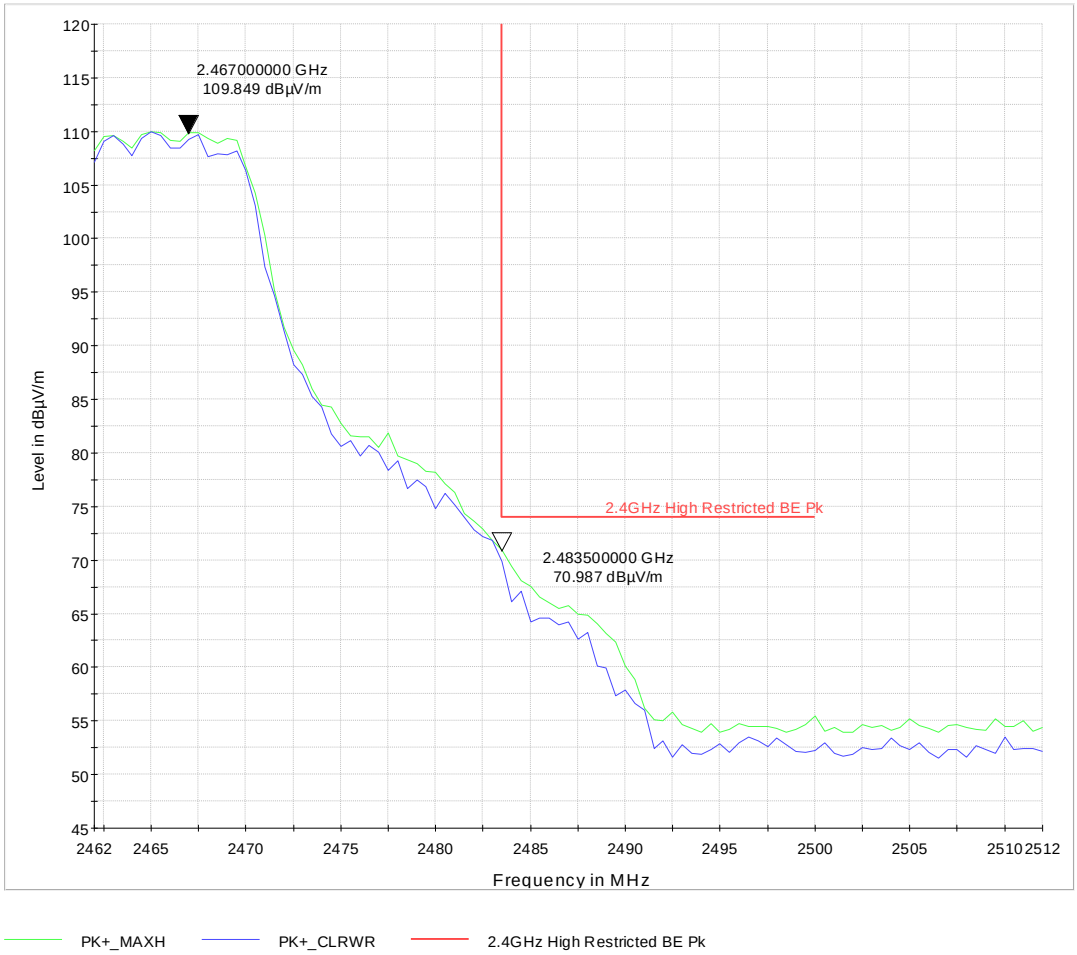


Figure 20: High Band Edge (restricted) for 802.11g NoHT at 2462 MHz-Peak

4.6 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS 247 Sect.5.5, RSS-GEN Sect. 8.9 and 8.10.

4.6.1 Test Methodology

4.6.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 90° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

Pre-scans were performed to determine the worst data rate.

4.6.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

4.6.1.3 Deviations

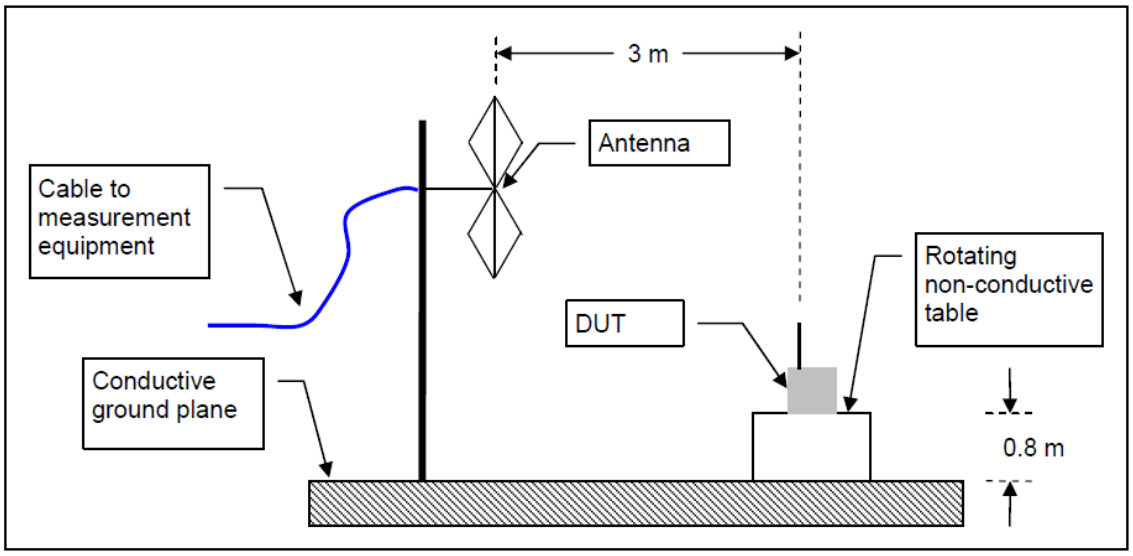
None.

4.6.2 Test Setup:

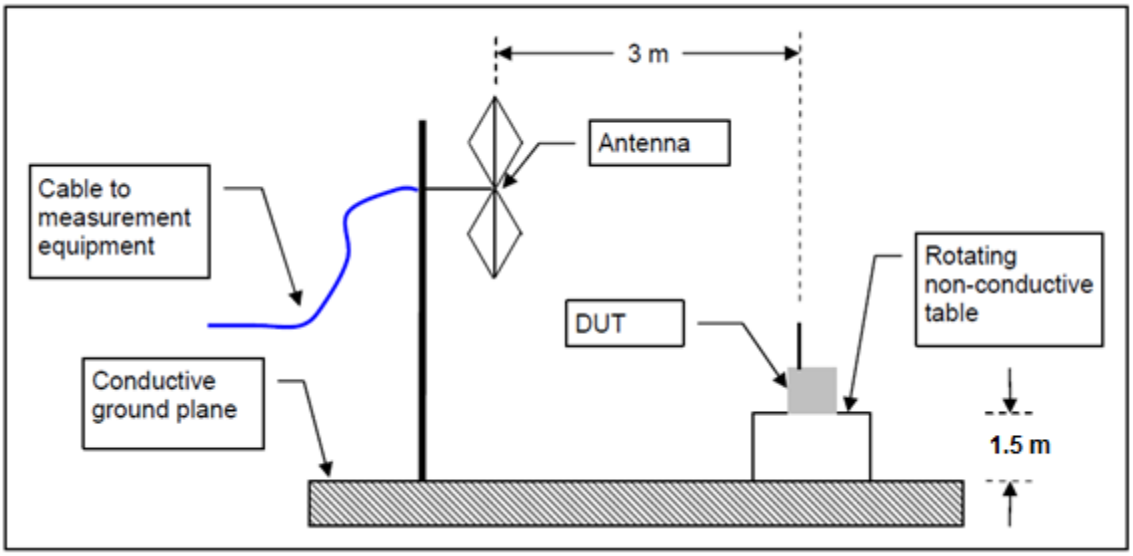
Worse case modes found in section 3.5.1 were used.

The DUT was stimulated by manufacturer provided test software that is not available to the end user.

9KHz-1GHz



1-25GHz



4.6.3 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2015 and RSS Gen Sect. 8.9 and 8.10: 2014.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490.....	2400/F(kHz)	300
0.490-1.705.....	24000/F(kHz)	30
1.705-30.0.....	30	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

.

4.6.4 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and test plan.

During measurements the EUT's LTE radio was also activated. LTE band 4 was active during all measurements.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.6.4.1 Measurement Plots

Note: Plots depict worse case antenna polarization and EUT orientation.

4.6.4.1.1 802.11b Mode

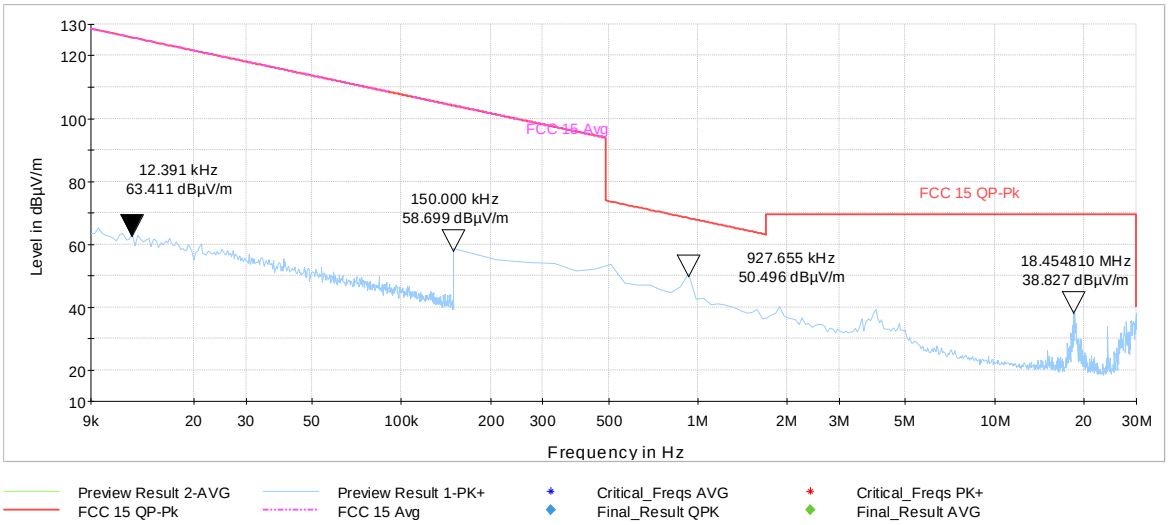


Figure 21: 9KHz-30MHz 802.11b Mode Channel 6

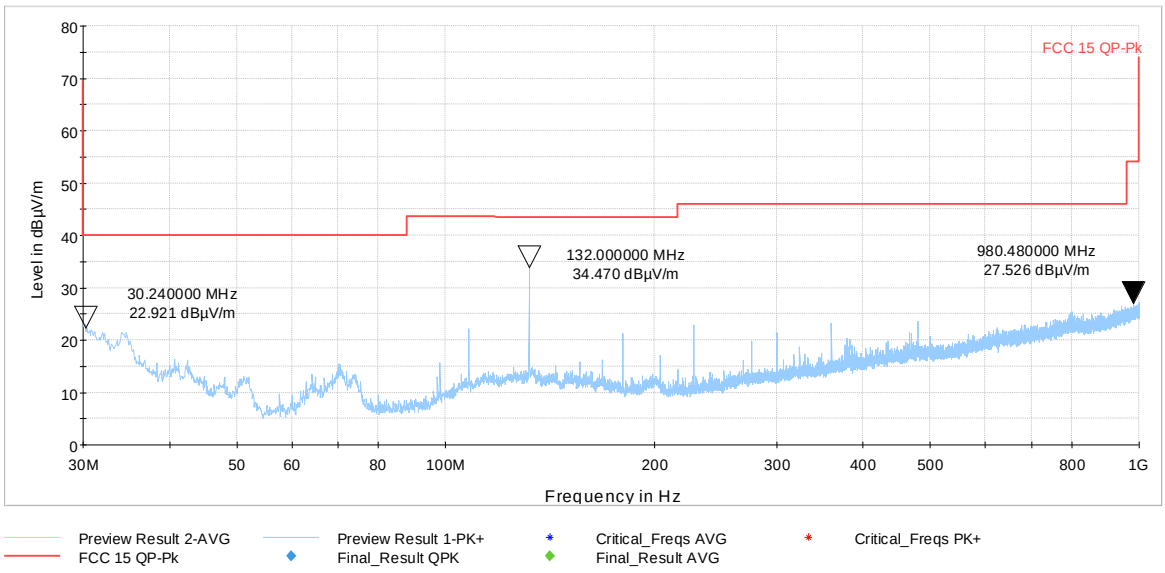


Figure 22: 30MHz-1GHz 802.11b Mode Channel 1

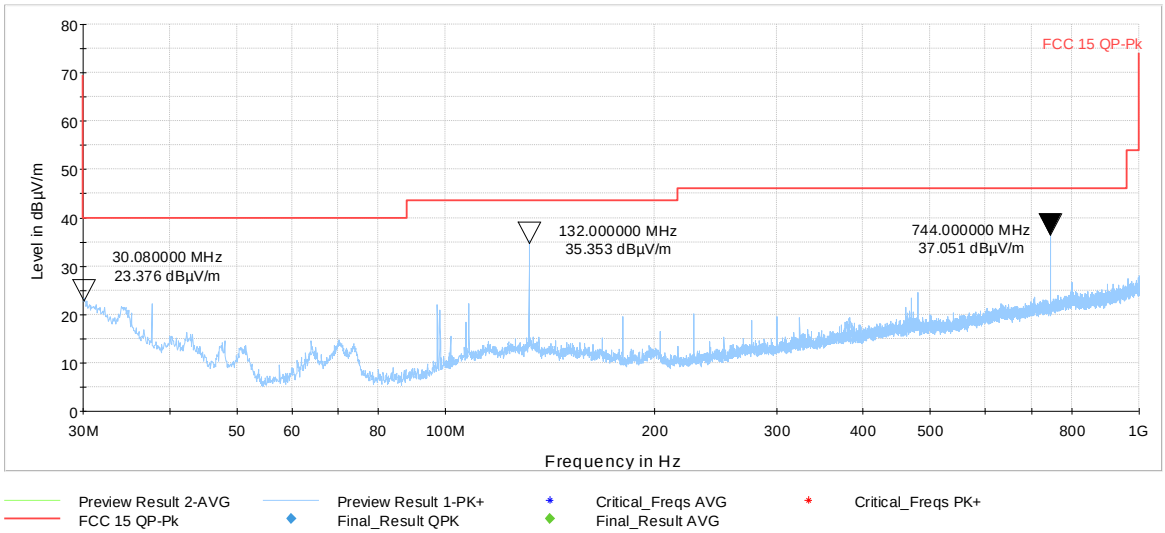


Figure 23: 30MHz-1GHz 802.11b Mode Channel 6

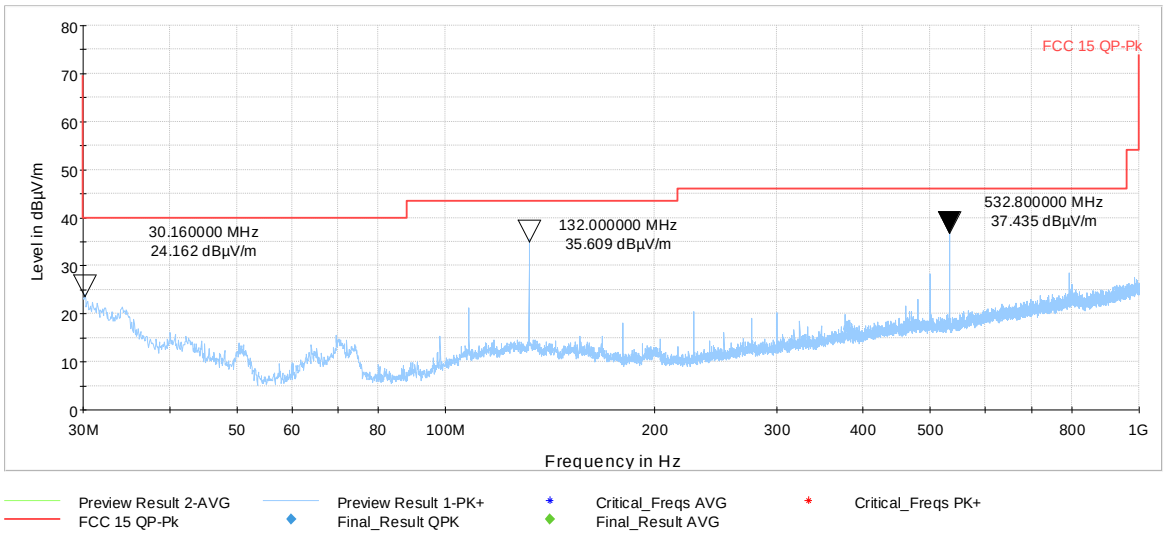
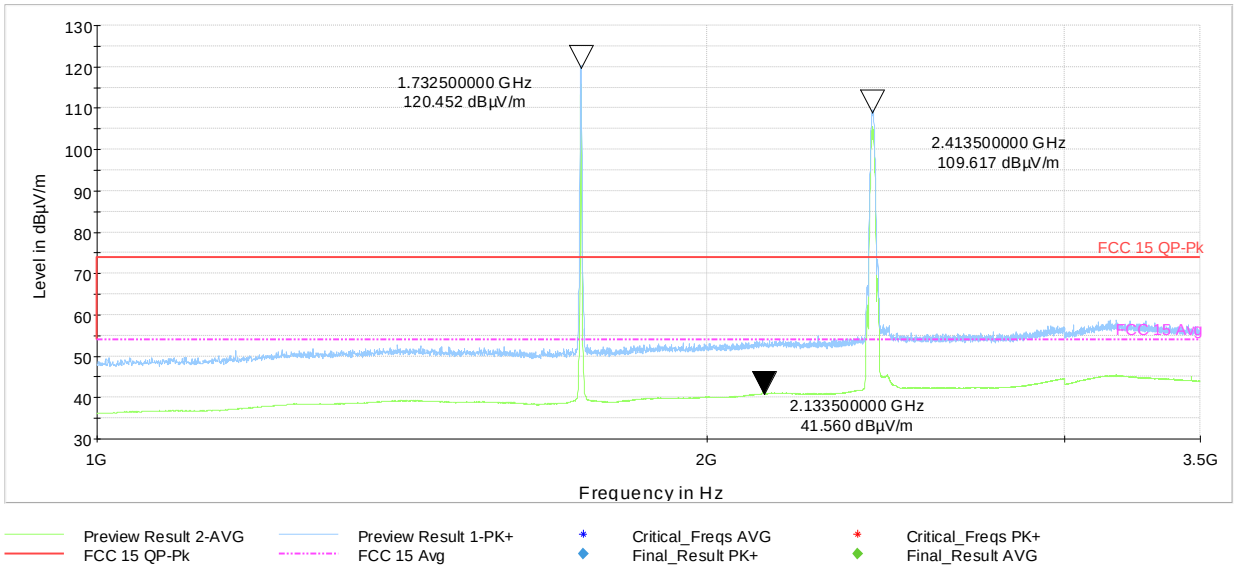
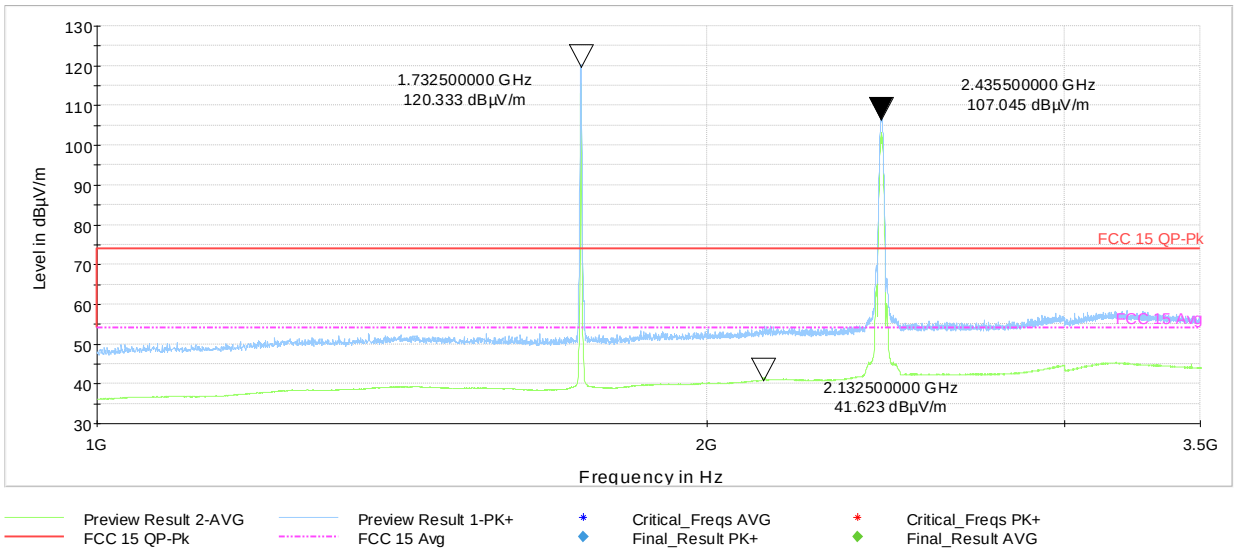


Figure 24: 30MHz-1GHz 802.11b Mode Channel 11



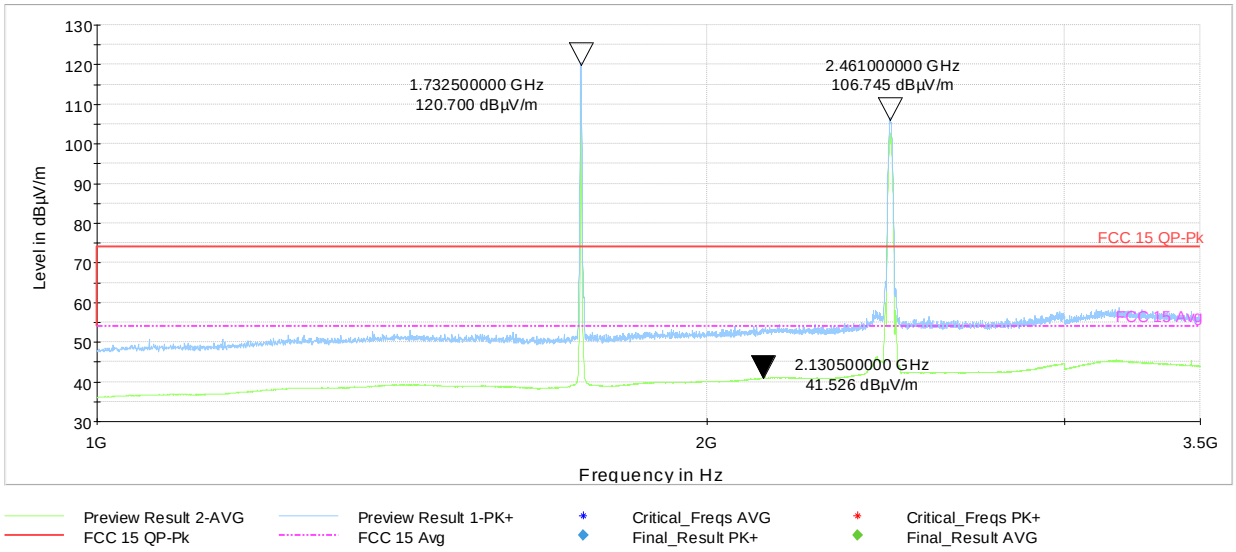
Note: Emissions above limit are the fundamental transmissions of the 2.4GHz and LTE Band 4 Radios

Figure 25: 1-3.5GHz 802.11b Mode Channel 1



Note: Emissions above limit are the fundamental transmissions of the 2.4GHz and LTE Band 4 Radios

Figure 26: 1-3.5GHz 802.11b Mode Channel 6



Note: Emissions above limit are the fundamental transmissions of the 2.4GHz and LTE Band 4 Radios

Figure 27: 1-3.5GHz 802.11b Mode Channel 11

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
4823.850000	---	51.75	54.00	2.25	500.0	1000.000	159.8	H	96.0	93.0
9647.870000	---	51.88	54.00	2.12	500.0	1000.000	179.1	H	111.0	53.1

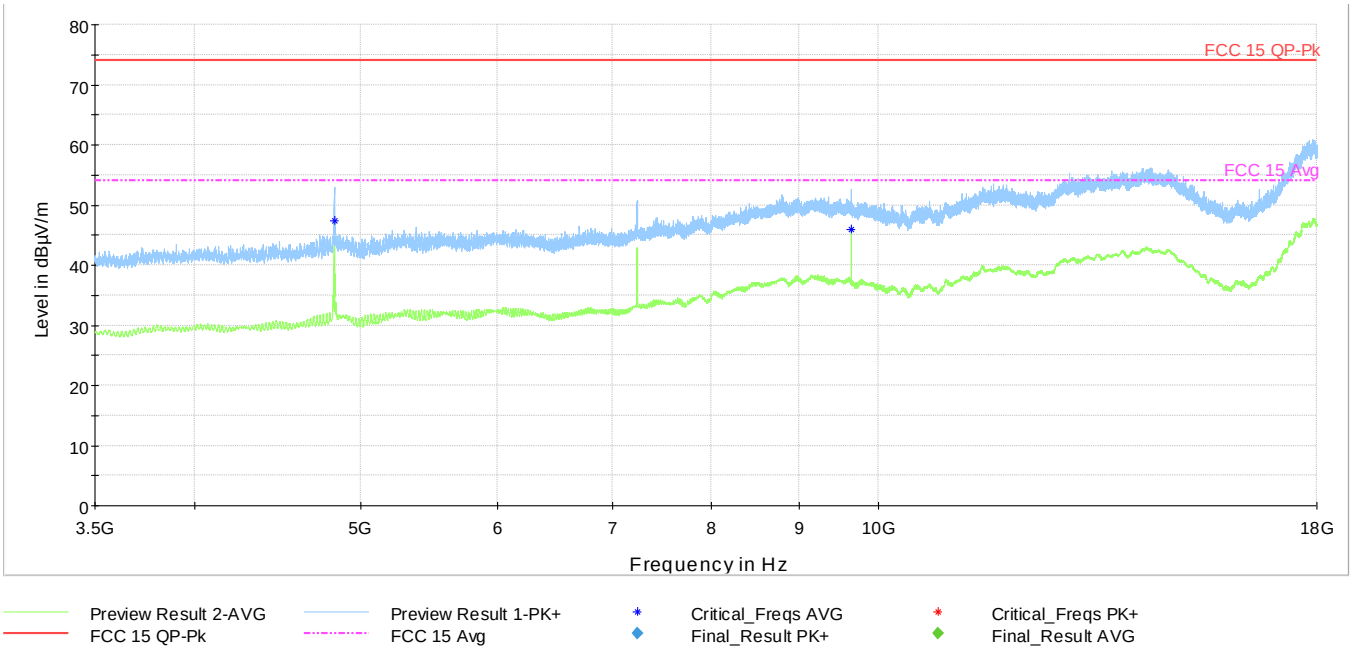


Figure 28: 3.5-18GHz 802.11b Mode Channel 1

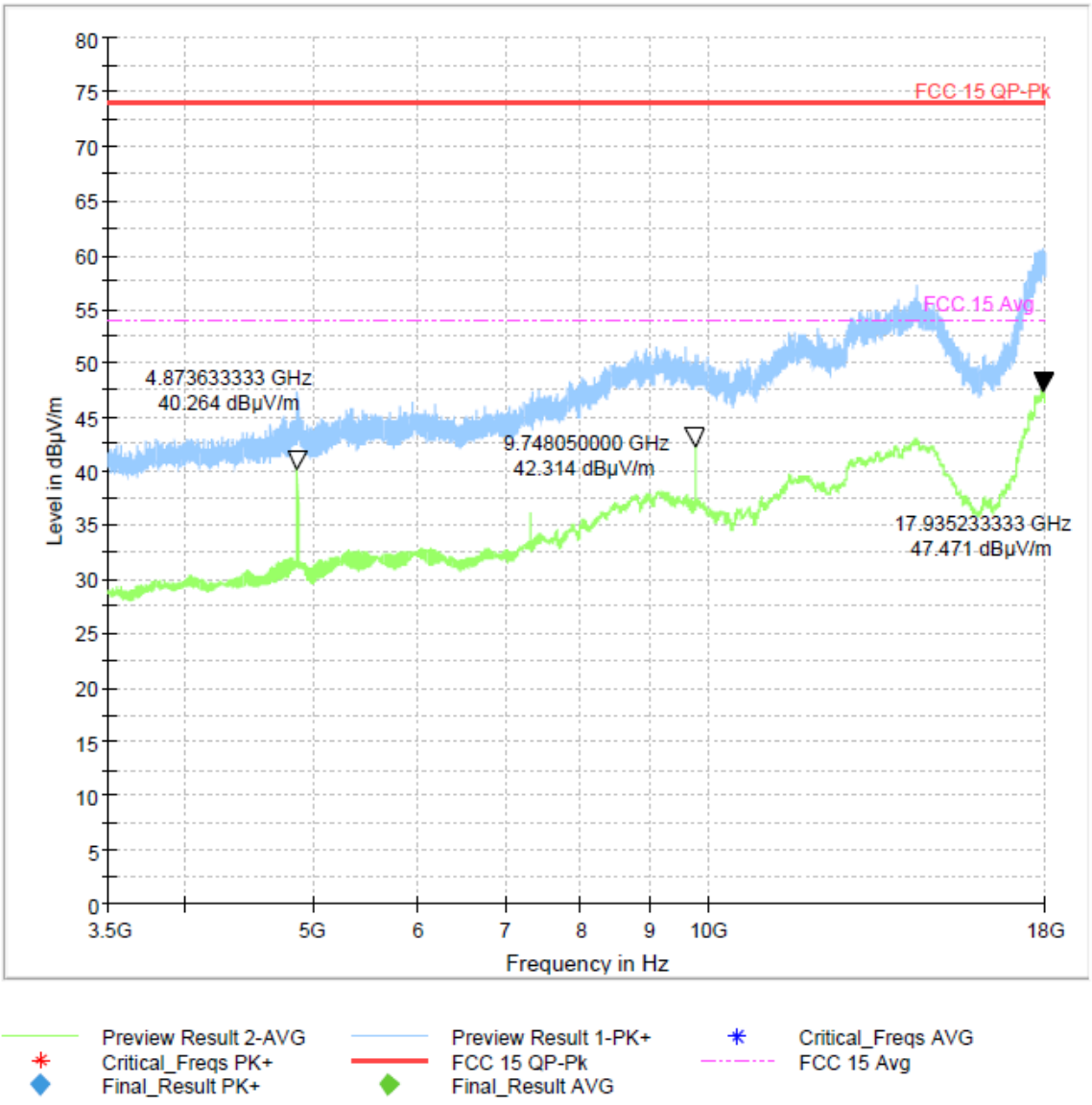


Figure 29: 3.5-18GHz 802.11b Mode Channel 6

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)
9847.920000	---	50.67	54.00	3.33	500.0	1000.000	148.2	H	60.0	83.1

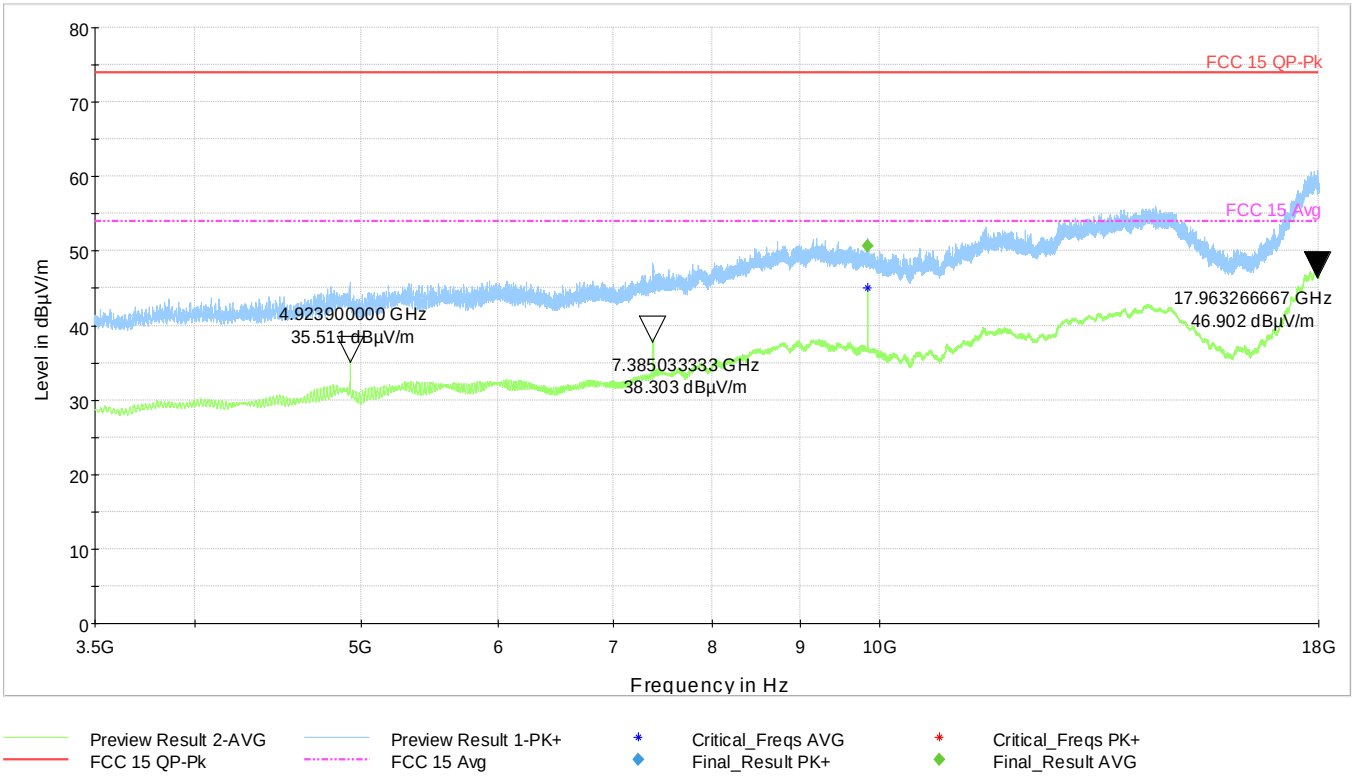


Figure 30: 3.5-18GHz 802.11b Mode Channel 11

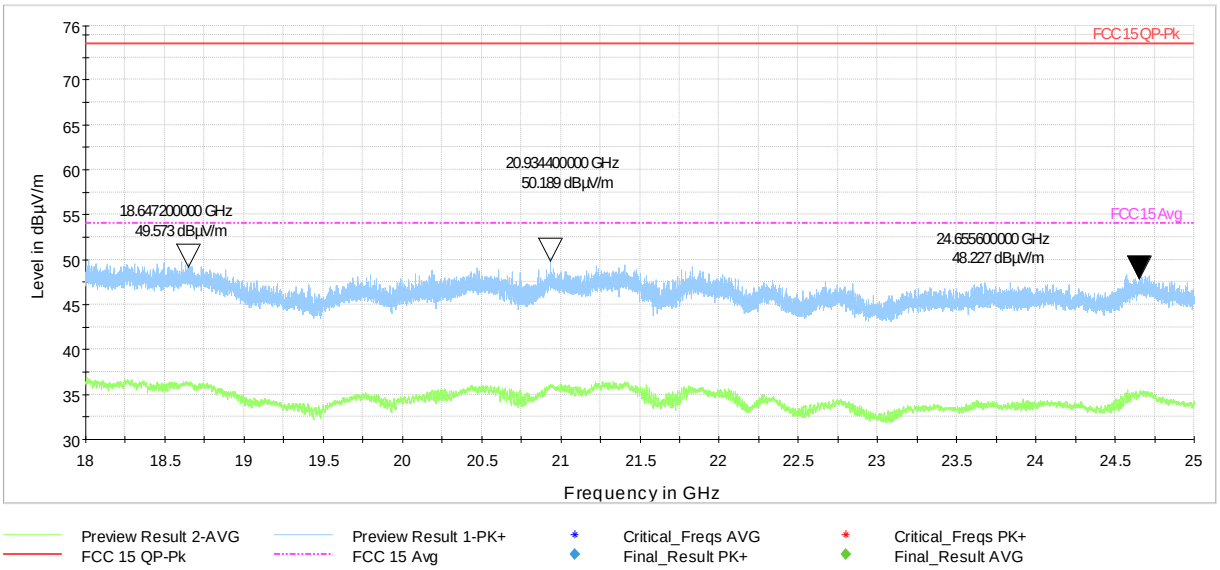


Figure 31: 18-25GHz 802.11b Mode Channel 6

4.6.4.1.2 802.11g NoHT Mode

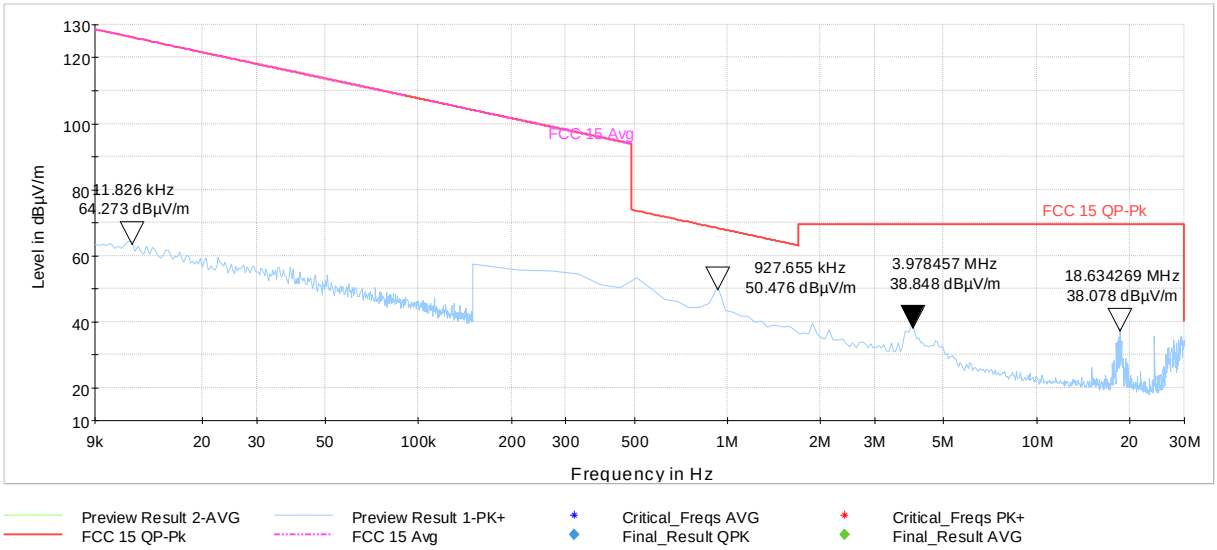


Figure 32: 9KHz-30MHz 802.11g Mode Channel 6

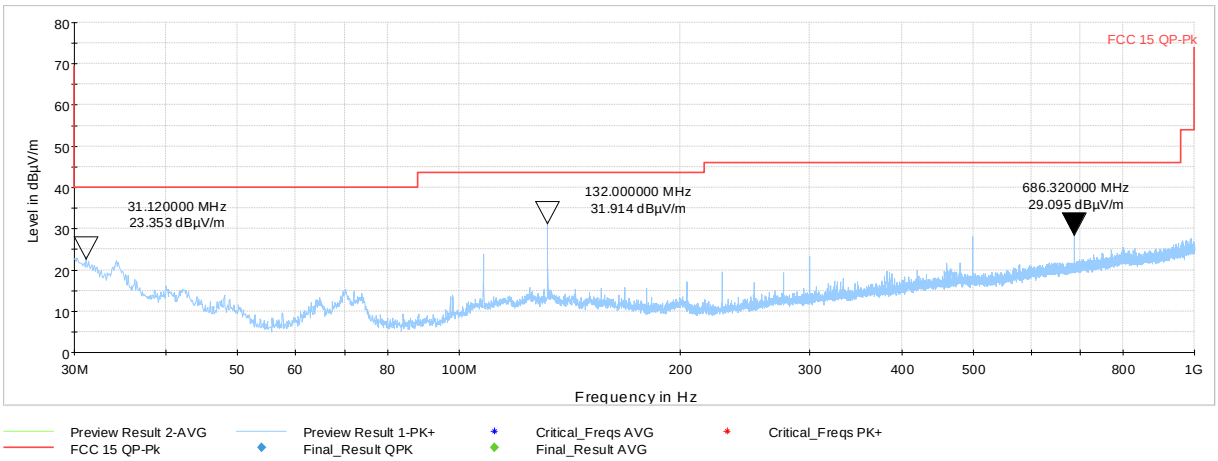


Figure 33: 30MHz-1GHz 802.11g Mode Channel 1

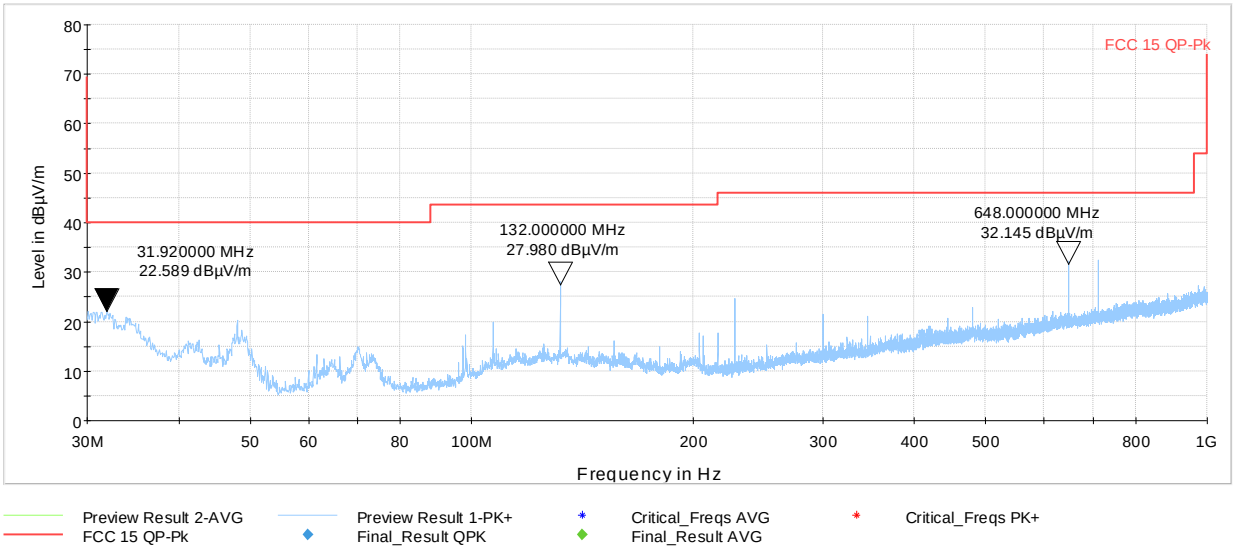


Figure 34: 30MHz-1GHz 802.11g Mode Channel 6

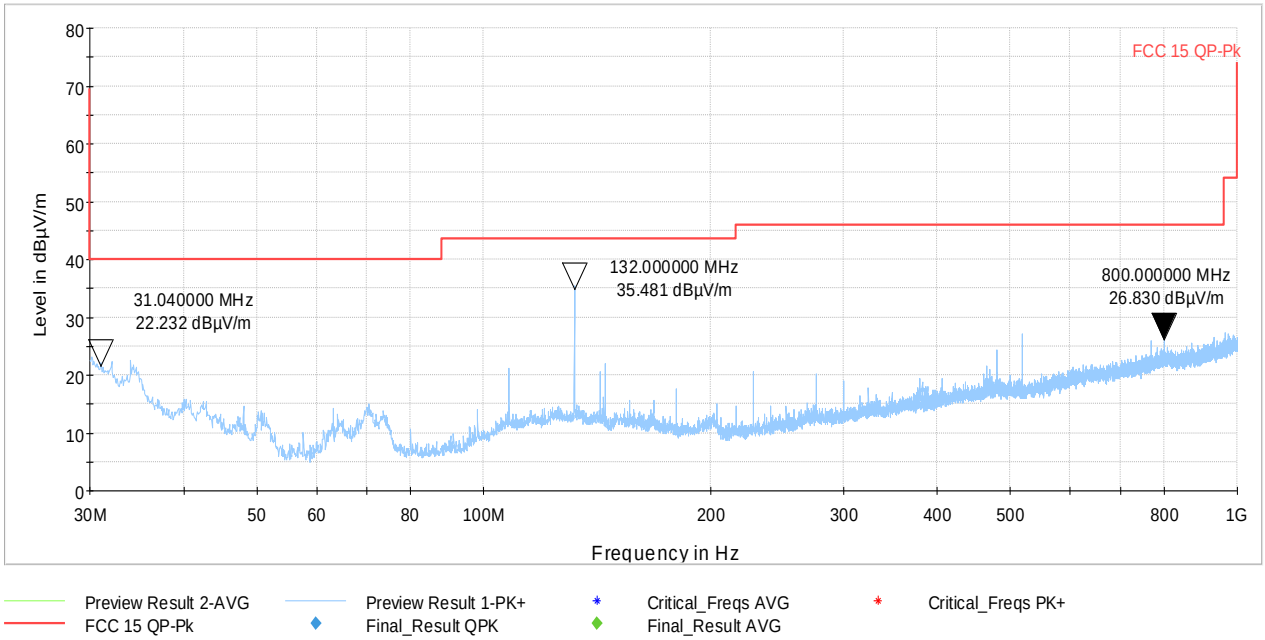
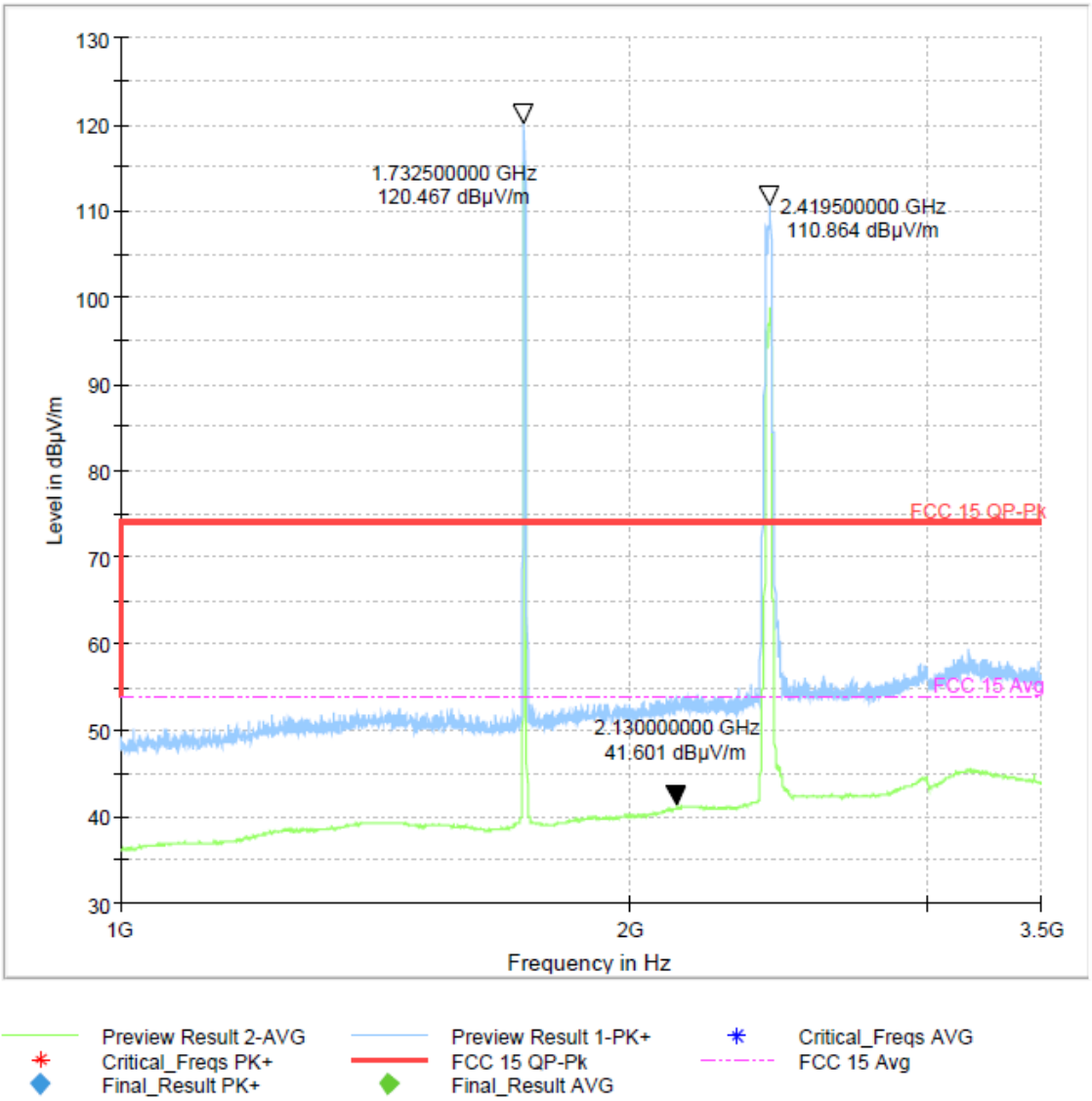
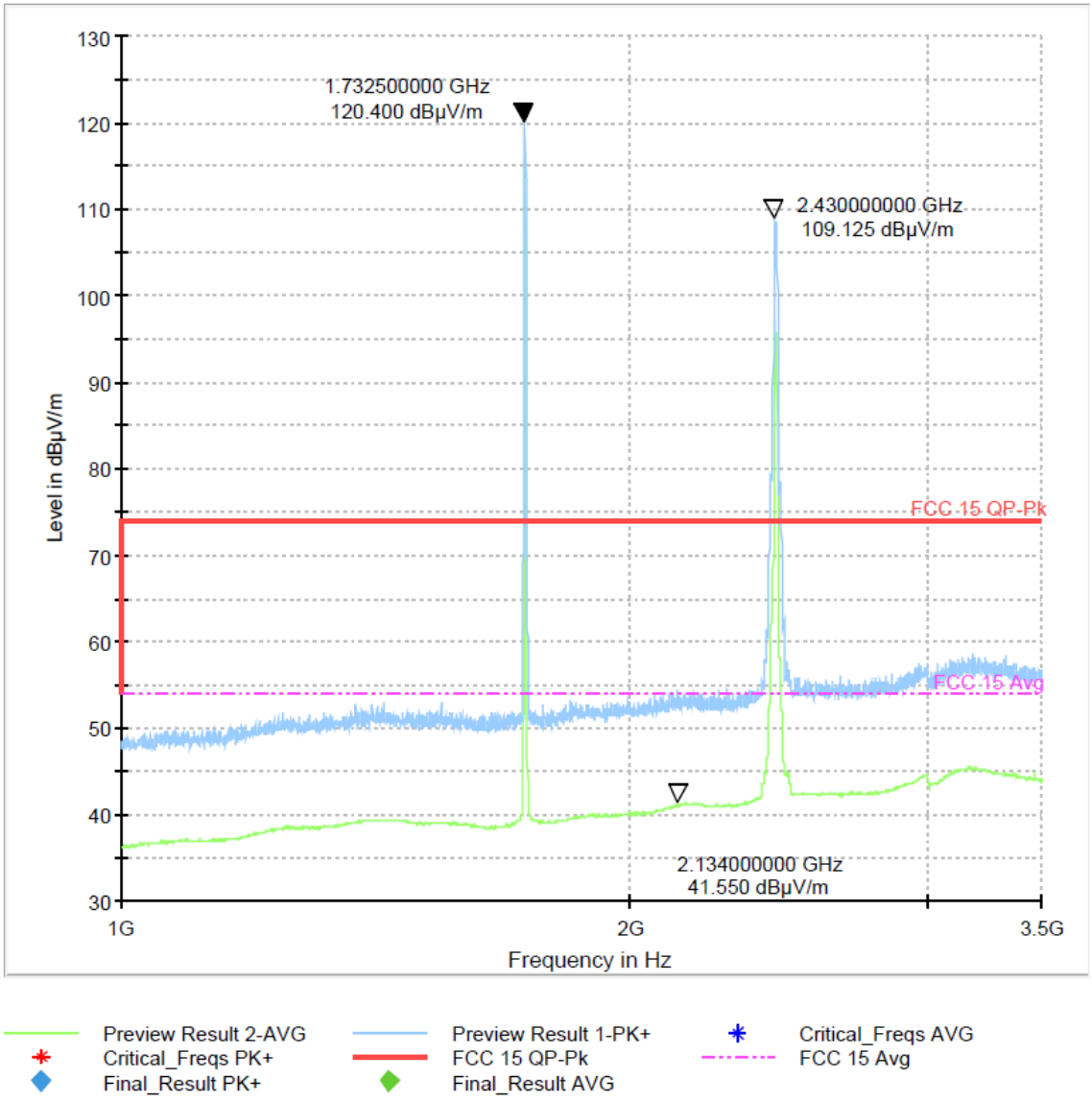


Figure 35: 30MHz-1GHz 802.11g Mode Channel 11



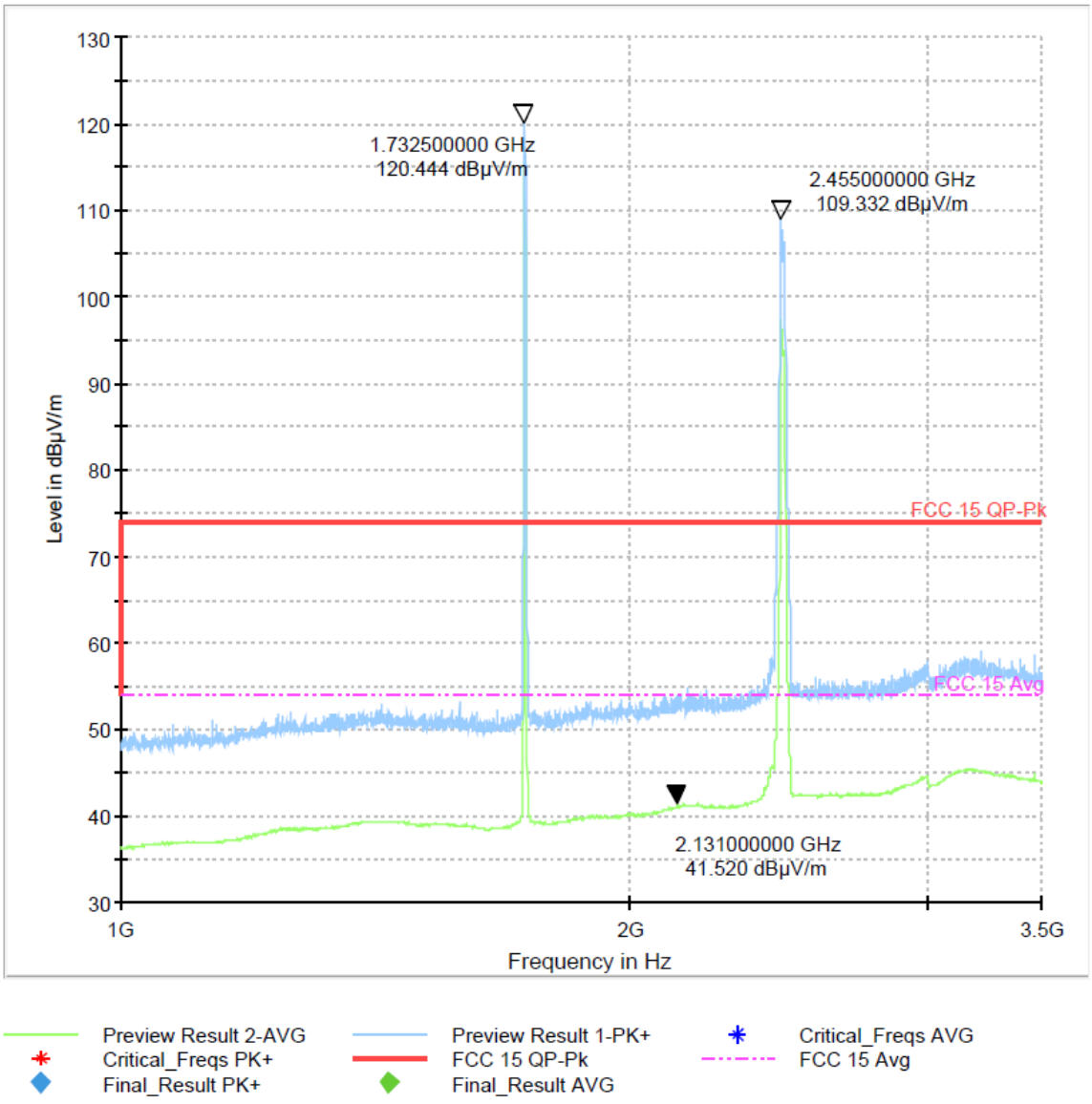
Note: Emissions above limit are the fundamental transmissions of the 2.4GHz and LTE Band 4 Radios

Figure 36: 1-3.5GHz 802.11g Mode Channel 1



Note: Emissions above limit are the fundamental transmissions of the 2.4GHz and LTE Band 4 Radios

Figure 37: 1-3.5GHz 802.11g Mode Channel 6



Note: Emissions above limit are the fundamental transmissions of the 2.4GHz and LTE Band 4 Radios

Figure 38: 1-3.5GHz 802.11g Mode Channel 11

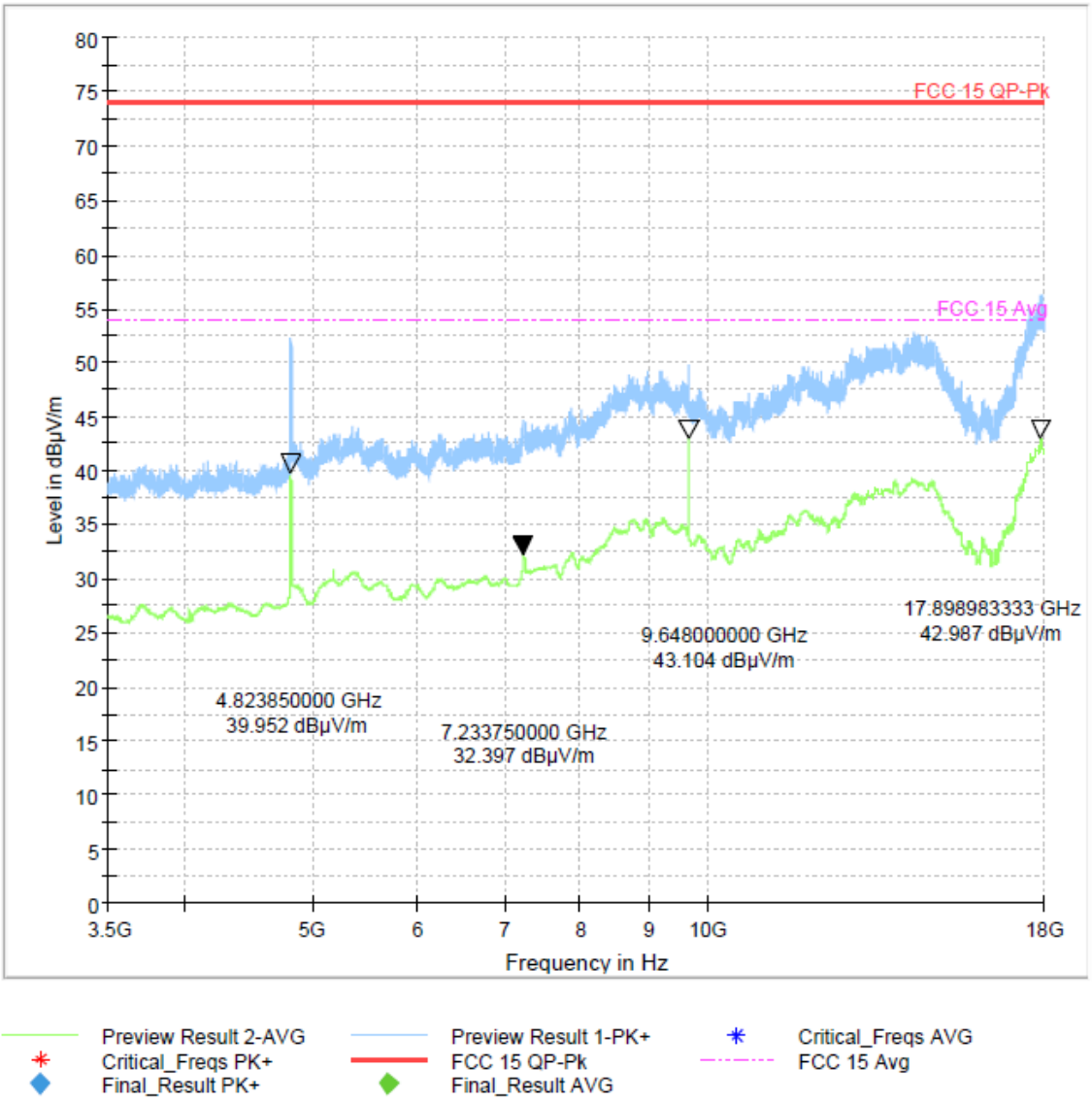


Figure 39: 3.5-18GHz 802.11g Mode Channel 1

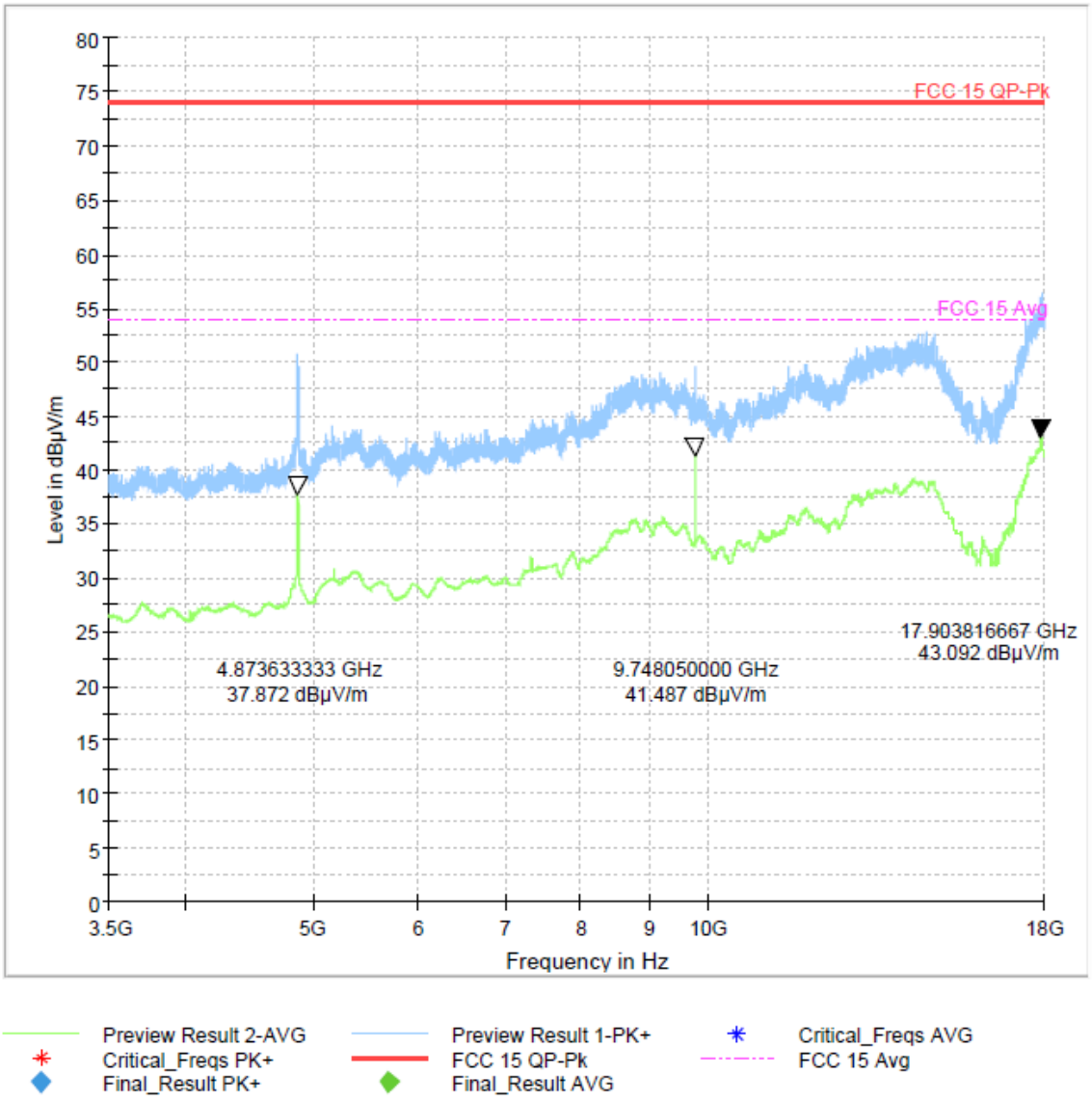


Figure 40: 3.5-18GHz 802.11g Mode Channel 6

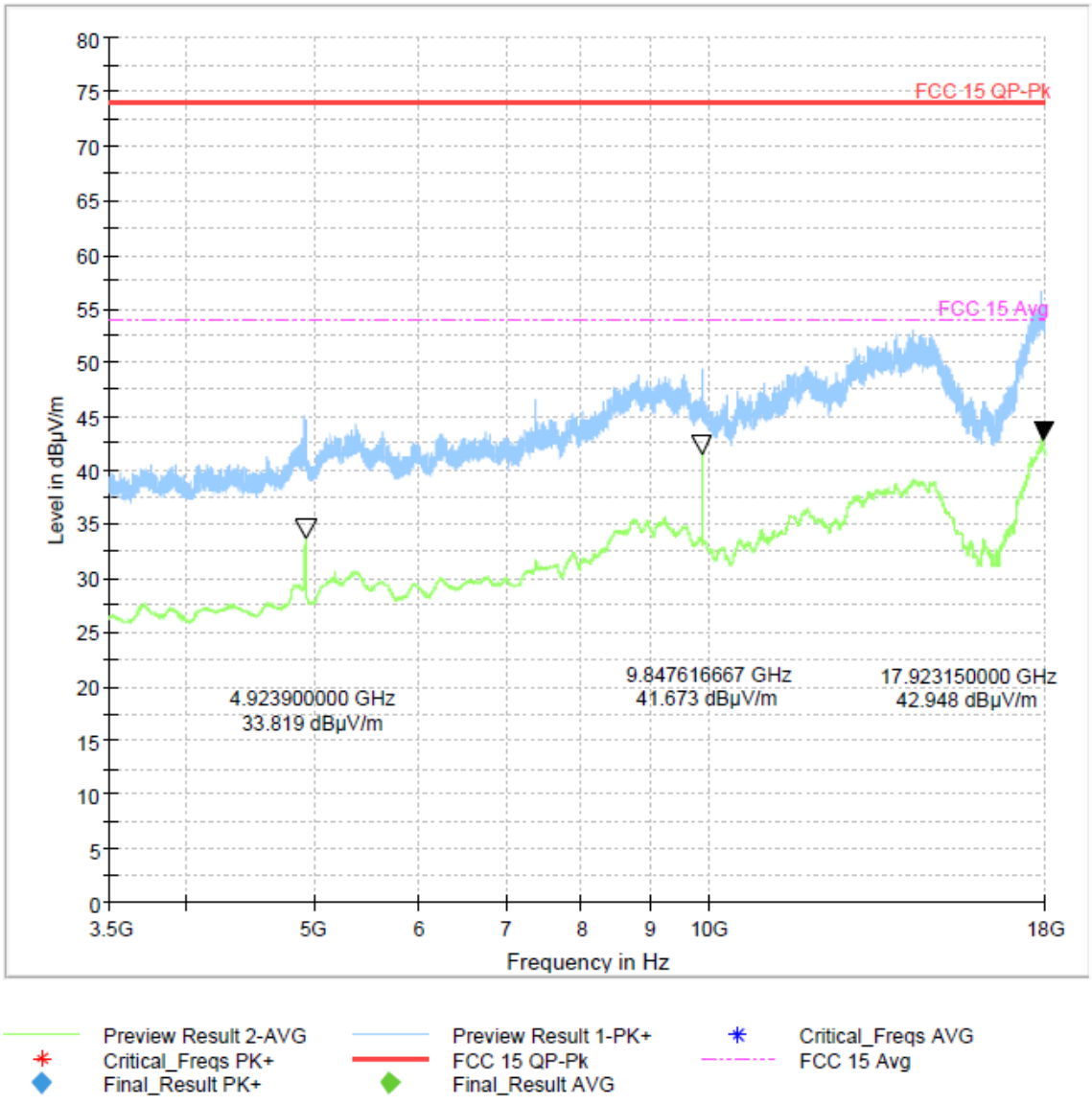


Figure 41: 3.5-18GHz 802.11g Mode Channel 11

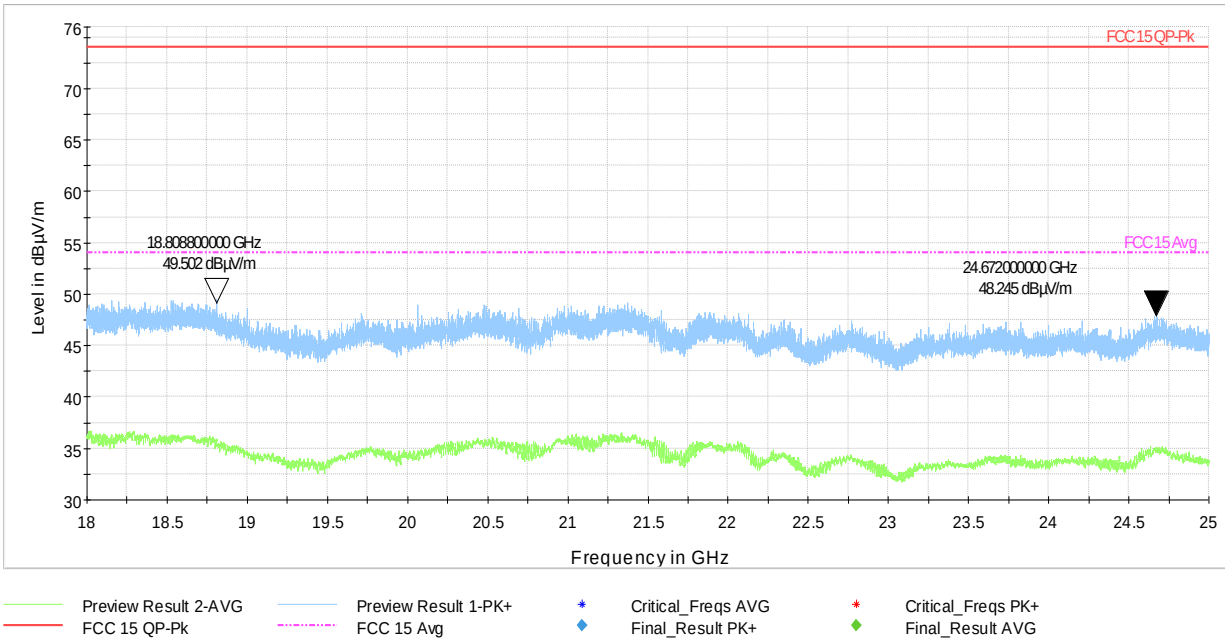


Figure 42: 18-25GHz 802.11g Mode Channel 6

5 Test Equipment List

5.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal mm/dd/yyyy	Next Cal mm/dd/yyyy
Bilog Antenna	Sunol Sciences	JB3	A102606	08/01/2018	08/01/2020
Horn Antenna	EMCO	3115	9211-3969	05/16/2017	05/16/2019
Active Horn Antenna	Com-Power	AHA-840	105005	05/26/2017	05/26/2019
Active Loop Antenna	EMCO	6502	00062531	05/17/2017	05/17/2019
Spectrum Analyzer	Agilent	N9038A	MY51210195	01/24/2018	01/24/2019
Spectrum Analyzer	Rohde & Schwarz	FSL6	100169	01/13/2018	01/13/2019
Spectrum Analyzer	Rohde & Schwarz	FSW67	104088	6/11/2018	6/11//2019
EMI Receiver	Rohde & Schwarz	ESIB40	832427/002	01/22/2018	01/22/2019
Thermometer	Extech	SD700	Q774118	05/03/2018	05/03/2020
Power Sensors	Rohde & Schwarz	OSP-B157	26160467	01/18/2018	01/18/2019
Vector Signal Generator	Rohde & Schwarz	SMBV100A	257744	9/16/2016	9/16/2019
Base Station Simulator	Rohde & Schwarz	CMW500	103915	12/20/2017	12/20/2018
DC Power Supply	Agilent	E3634A	MY40004331	01/25/2018	01/25/2019
Multimeter	Fluke	177	92780314	01/22/2018	01/22/2019
Amplifier	Sonoma	310N	185516	N/A (See Note)	
Amplifier	Miteq	AMF-7D-01001800-30-10P-L	2074297	N/A (See Note)	
Test Software	Rohde & Schwarz	EMC32 v.10.20.01	N/A	N/A (See Note)	
1.6 GHz Low Pass Filter	K&L Microwave	8L120-X1600-0/09135-0249	UA691-35	N/A (See Note)	
3.5 GHz High Pass Filter	Hewlett Packard	84300-80038	820004	N/A (See Note)	
DC Power Supply	HP	E3634A	3003A-06779	N/A (See Note)	
Signaling Antenna	A.H. Systems, Inc	SAS-571	752	N/A (See Note)	
Signaling Antenna	Commscope	CELLMAX-D-CPUSE	L011504152918	N/A (See Note)	
Maturo Control Unit	Maturo	SCU	246/20571216	N/A	
Maturo EUT Positioner	Maturo	TD1.5-10kg	087/20571216	N/A	

Note: Equipment is characterized before use.

6 EMC Test Plan

6.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

6.2 Customer

Table 7: Customer Information

Company Name	Continental Automotive
Address	21440 West Lake Cook Road
City, State, Zip	Deer Park, Illinois 60010, USA
Country	USA

6.3 Equipment Under Test (EUT)

The information provided in the following table should be listed as it should appear in the final report. For those products that have only a model name, list the model number as *non-applicable* and vice-versa.

Table 8: EUT Designation

Product Name	FB40-ND1
Model Number	FB40-ND1
System Name	NA
Product Description	Embedded communication device for automotive.

6.4 Product Specifications

Table 9: EUT Specifications

EUT Specifications	
Voltage Input	9-16 VDC
Environment	Indoor
Operating Temperature Range:	-40° C to 75° C
Multiple Feeds:	☐ Yes and how many ☒ No
Product Marketing Name (PMN)	FB40-ND1
Hardware Version Identification Number (HVIN)	FB40-ND1
Firmware Version Identification Number (FVIN)	4.7.1.3
RF Test Software Version	QRCT QMSL – QLIB V6.1.173,QPST
Operating Modes	802.11b 802.11g 802.11n HT20
Transmitter Frequency Band	2.4 GHz – 2.4835 GHz
Max. Power Output (RMS, Conducted)	17.3 dBm (802.11b)
Power Setting @ Operating Channel	See section 4.1.2.
Modulation	CCK (802.11b) and OFDM (802.11g/n/ac)
TX/RX Chain (s)	1
Directional Gain Type	☐ Correlated (CDD) ☐ Beam-Forming ☒ Other describe: N/A
Type of Equipment	☒ Table Top ☐ Wall-mount ☐ Floor standing cabinet ☐ Other:

Table 10: Antenna Information

Number	Antenna Type	Description	Max Gain (dBi)
Antenna 0	Internal, PCB type F dual band antenna	2.4GHz WLAN	3.1

Table 11: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
N/A	N/A	☐ Yes	☐ Metric:	☐ M

Table 12: Accessory Equipment

Equipment	Manufacturer	Model	Serial	Comment
N/A	N/A	N/A	N/A	N/A
Note: None.				

Table 13: Ancillary Equipment (used for test purposes only)

Equipment	Manufacturer	Model	Serial	Used for
Laptop	HP	Elitebook 8540w	N/A	Stimulating Radios
Note: None.				

Table 14: Description of Sample used for Testing

Sample Number	Device	Serial Number	Configuration	Used For
1	FB40-ND1	U87U050R	Radiated Sample	TX Spurious Emissions
2	FB40-ND1	U87U054G	Conducted Sample	Conducted measurements
Note: -				

Table 15: Description of Test Configuration used for Radiated Measurement.

Device	Antenna	Mode	Setup (X-Axis)	Setup (Y-Axis)	Setup Photo (Z-Axis)
FB40-ND1	PCB type F dual band antenna	Transmit	EUT upright	EUT Side	N/A
Note:					

6.5 Test Specifications

Table 16: Test Specifications

Emissions and Immunity	
Standard	**Requirement**
CFR 47 Part 15.247: 2018	All
RSS 247 Issue 2, 2017	All

END OF REPORT