



FCC / ISED Test Report

For:
Garmin International, Inc.

Model Name:
A03804

Product Description:
Portable Wireless Transceiver

FCC ID: IPH-03804
IC ID: 1792A-03804

Applied Rules and Standards:
47 CFR Part 15.247 (DTS)
RSS-247 Issue 2 (DTSS) & RSS-Gen Issue 5

REPORT #: EMC_GARMI-080-20001_15.247_WLAN

DATE: 2021-07-02



A2LA Accredited

IC recognized #
3462B-1

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Garmin International Inc.	Portable wireless transceiver	A03804

Responsible for Testing Laboratory:

2021-07-02	Compliance	Kevin Wang (EMC Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2021-07-02	Compliance	Yuchan Lu (EMC Engineer)	
Date	Section	Name	Signature

The test results of this test report relate exclusively to the test item specified in Section 3. CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
EMC Lab Manager:	Kevin Wang
Responsible Project Leader:	Sangeetha Sivaraman

2.2 Identification of the Client

Client's Name:	Garmin International, Inc.
Street Address:	1200 East 151st Street
City/Zip Code	Olathe, KS 66062
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	Garmin Corporation
Manufacturers Address:	No. 68, Zhangshu 2nd Rd., Xizhi Dist.,
City/Zip Code	New Taipei City 221,
Country	TAIWAN, R.O.C.

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	A03804
HW Version :	1
SW Version :	0.31
FCC-ID :	IPH-03804
IC-ID:	1792A-03804
FWIN:	N/A
HVIN:	A03804
PMN:	N/A
Product Description:	Portable wireless transceiver
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz; Center to center: 2412 MHz (ch 1) – 2462 MHz (ch 11), 11 channels
Radio Information:	<u>WLAN (WiFi):</u> <ul style="list-style-type: none"> • Module Number: ATWILC1000B • Modes of Operation: 802.11b,g,n
Antenna Information as declared:	Maximum Gain: 1.6 dBi
Max. Conducted Output Power:	Average measurement: 14.86 dBm
Power Supply/ Rated Operating Voltage Range:	Vmin: 4.5 VDC/ Vnom: 5.0 VDC / Vmax: 5.5 VDC
Operating Temperature Range	0°C to +60°C
Other Radios included in the device:	Cellular; GPS; BTLE; ANT
Sample Revision	<input type="checkbox"/> Prototype Unit; <input checked="" type="checkbox"/> Production Unit; <input type="checkbox"/> Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	6K2000505	1	0.31	Conducted Sample
2	6K2000331	1	0.31	Radiated Sample

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	USB Cable	-----	Garmin	-----

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. The measurement equipment was connected to the 50 ohm RF port of the EUT.
2	EUT#2 + AE#1	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. The internal antenna was connected.
3	EUT#2 + AE#1	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user. The internal antenna was connected. The EUT was connected to the AC mains through a USB charger.

3.5 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels, and highest possible duty cycle. For radiated measurements, all data in this report show the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

The channels and modulation schemes of the EUT were set with highest Duty Cycle possible using diagnostic software (not available to the end user).



4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

This test report is to support a request for new equipment authorization under the FCC ID: IPH-03804 IC ID: 1792A-03804

Testing procedures are based on 558074 D01 15.247 Meas Guidance v05r02 – “GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES” - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(a)(1) RSS-247 5.2(a)	Emission Bandwidth	Nominal	802.11b,g,n	■	□	□	Complies
§15.247(e) RSS-247 5.2(b)	Power Spectral Density	Nominal	802.11b,g,n	■	□	□	Complies
§15.247(b)(1) RSS-247 5.4(d)	Maximum Conducted Output Power and EIRP	Nominal	802.11b,g,n	■	□	□	Complies
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	802.11b,g,n	■	□	□	Complies
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	802.11b,g,n	■	□	□	Complies
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions- Radiated	Nominal	802.11g	■	□	□	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	802.11g	■	□	□	Complies

Note: NA= Not Applicable; NP= Not Performed.

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor $k=1$.

Radiated measurement

9 kHz to 30 MHz	± 2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	± 2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	± 2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	± 0.7 dB (LISN)
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RF conducted measurement	± 0.5 dB
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According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: <http://physics.nist.gov/cuu/Uncertainty/typeb.html>. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

6.1 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

6.2 Dates of Testing:

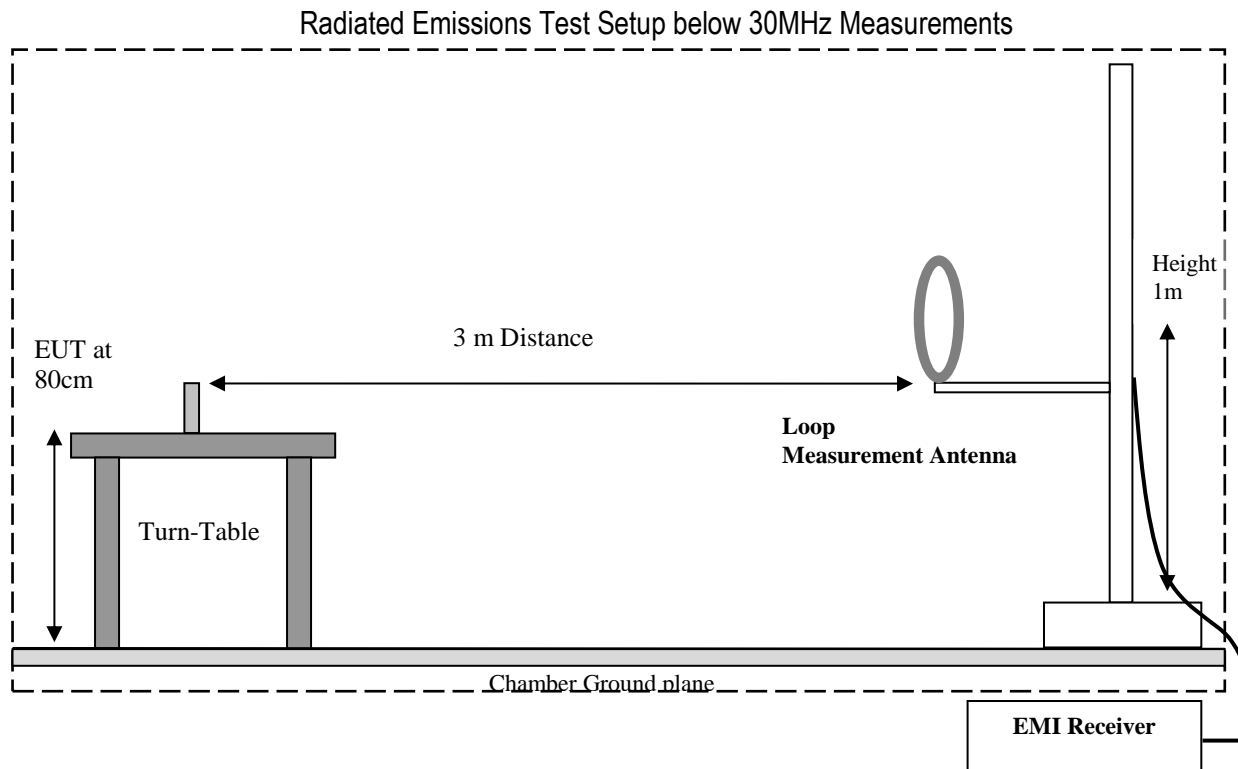
11/23/2020 – 11/29/2020

7 Measurement Procedures

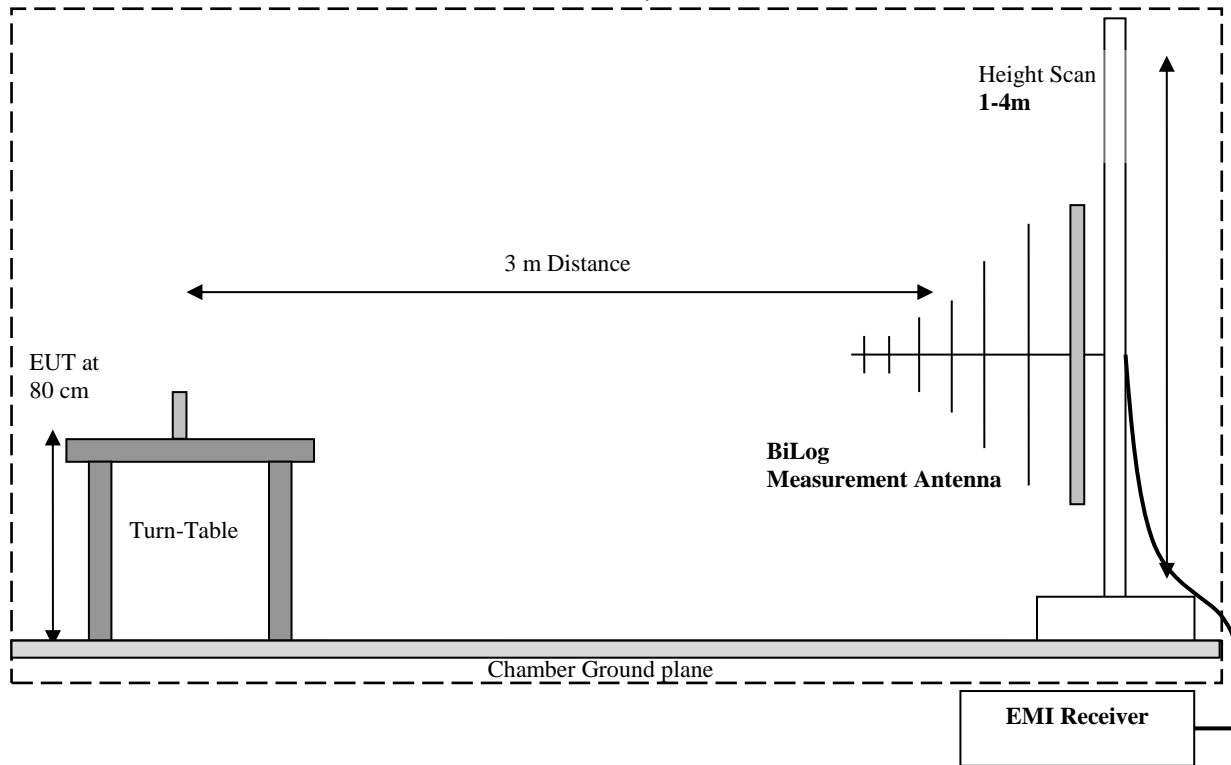
7.1 Radiated Measurement

The radiated measurement is performed according to ANSI C63.10 (2013)

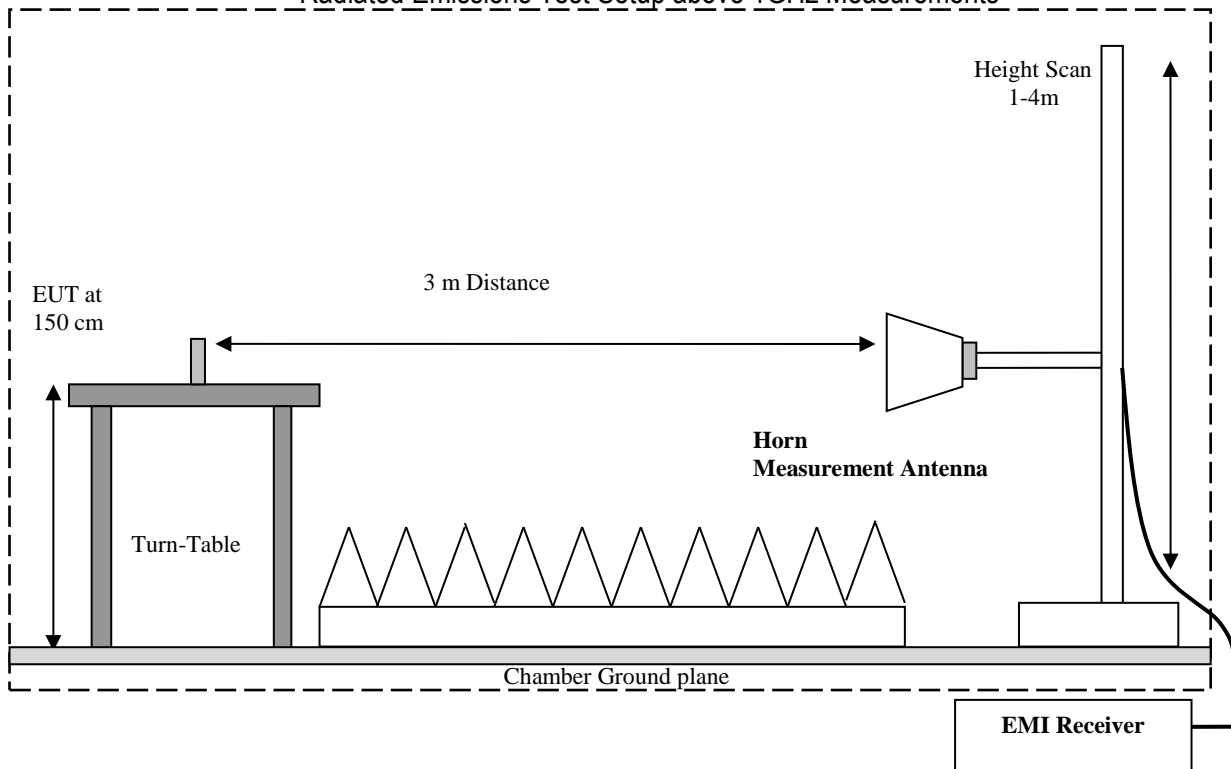
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBμV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

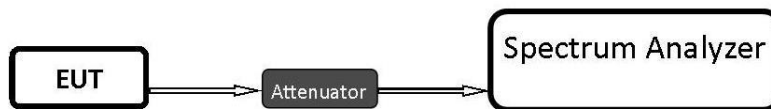
Frequency (MHz)	Measured SA (dBμV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBμV/m)
1000	80.5	3.5	14	98.0

7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

7.3 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 15.247 Meas Guidance v05r02 – “GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES” - April 2, 2019, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

8 Test Result Data

8.1 Maximum Conducted (Average) Output Power

8.1.1 Measurement according to FCC 558074 D01 15.247 Meas Guidance v05r02

Spectrum Analyzer settings:

- RBW = 1% to 5% of the OBW, not to exceed 1 MHz
- VBW $\geq 3 \times$ RBW
- Span = at least 1.5 times the OBW
- Sweep = Auto couple
- Detector function = RMS
- Trace = Average (at least 100 traces in power averaging (rms) mode)
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges
- Add $[10 \log (1 / D)]$, where D is the duty cycle, to the measured power to compute the average power during the actual transmission times

8.1.2 Limits:

Maximum Output Power:

- FCC §15.247 (b)(1): 1 W
- IC RSS-247: 1 W

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	802.11b,g,n	5 VDC	1.6 dBi

8.1.4 Measurement result:

Plot #	Mode	Data Rate	Channel/Frequency (MHz)			Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
			Low	Mid	High				
1	802.11b	1Mbps	Low	1	2412	13.52	15.12	30 (Pk) / 36 (EIRP)	Pass
2			Mid	6	2437	13.59	15.19	30 (Pk) / 36 (EIRP)	Pass
3			High	11	2462	13.29	14.89	30 (Pk) / 36 (EIRP)	Pass
4	802.11g	6Mbps	Low	1	2412	14.86	16.46	30 (Pk) / 36 (EIRP)	Pass
5			Mid	6	2437	14.59	16.19	30 (Pk) / 36 (EIRP)	Pass
6			High	11	2462	14.36	15.96	30 (Pk) / 36 (EIRP)	Pass
7	802.11n20	MCS0	Low	1	2412	14.33	15.93	30 (Pk) / 36 (EIRP)	Pass
8			Mid	6	2437	14.45	16.05	30 (Pk) / 36 (EIRP)	Pass
9			High	11	2462	14.08	15.68	30 (Pk) / 36 (EIRP)	Pass

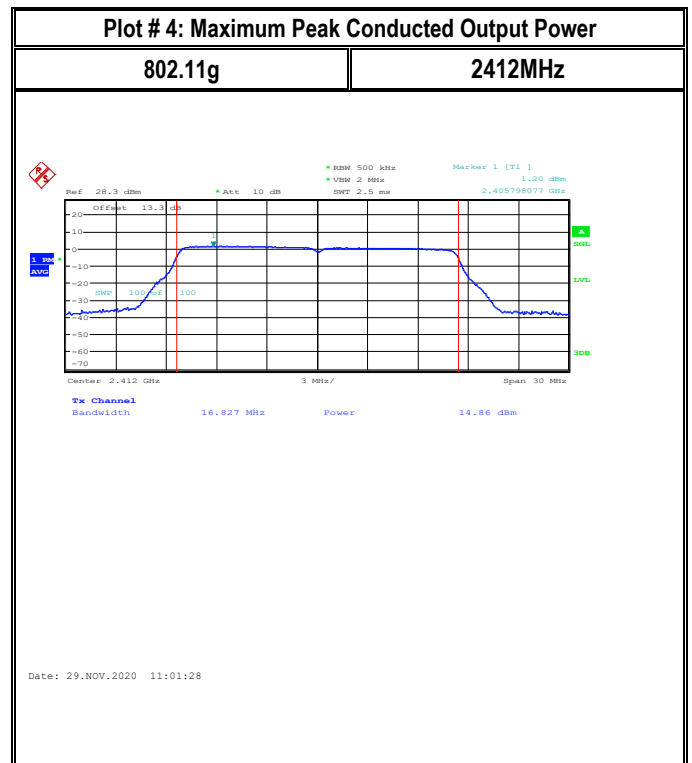
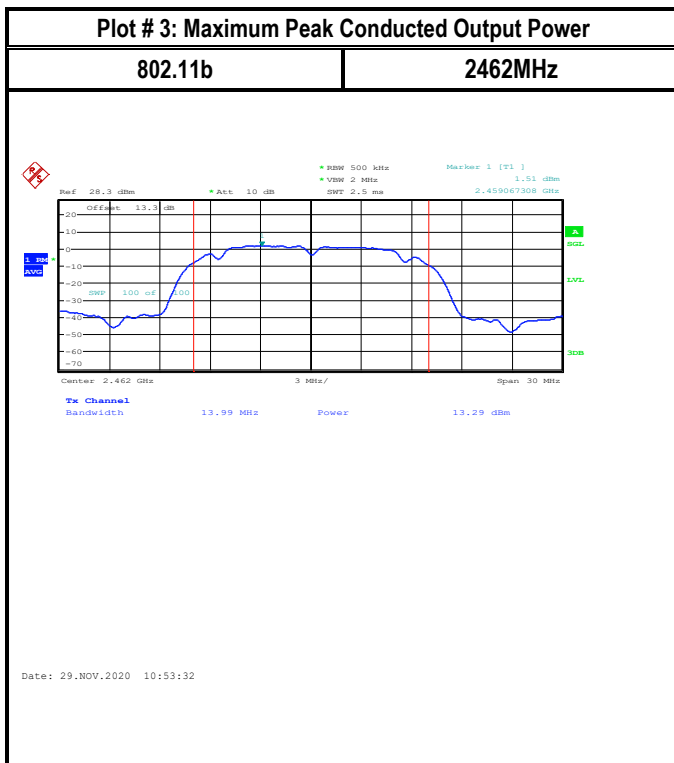
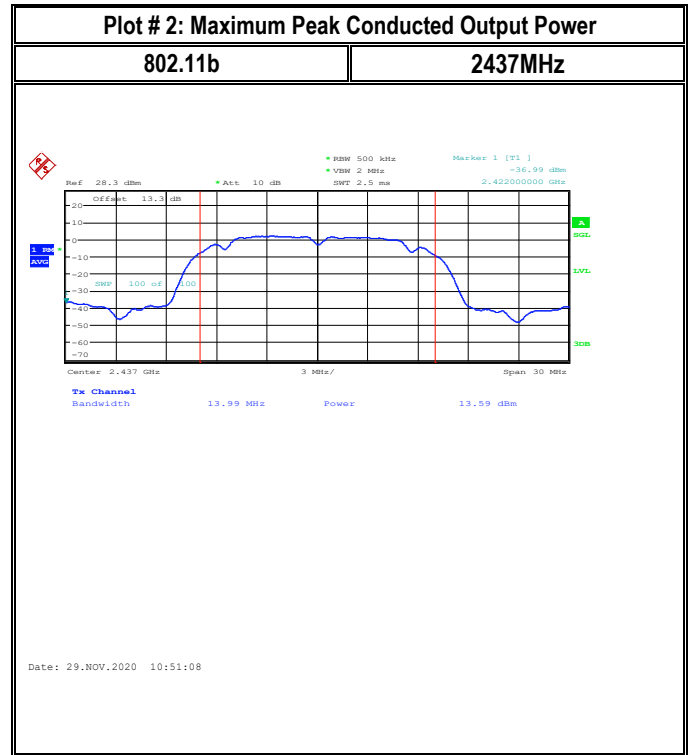
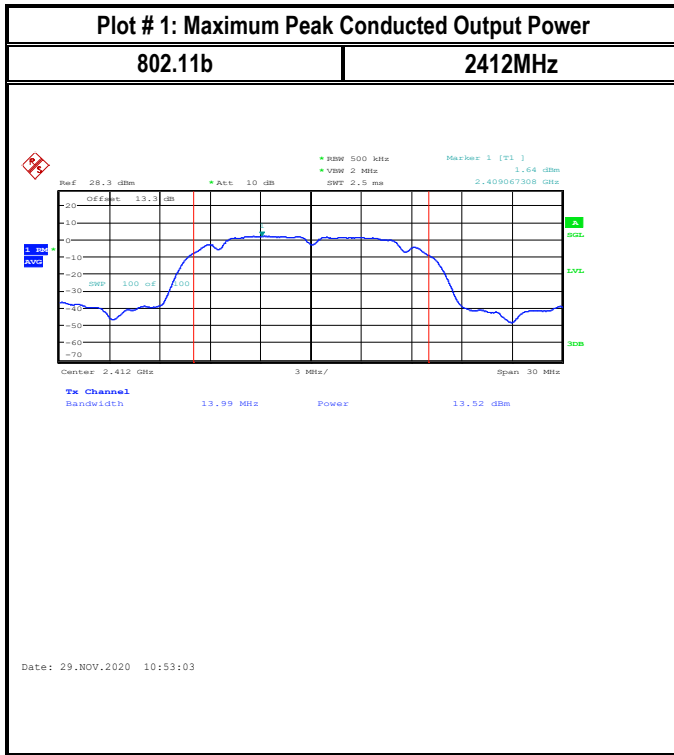
* Duty cycle correction factor was applied to conducted output power for each operating mode:

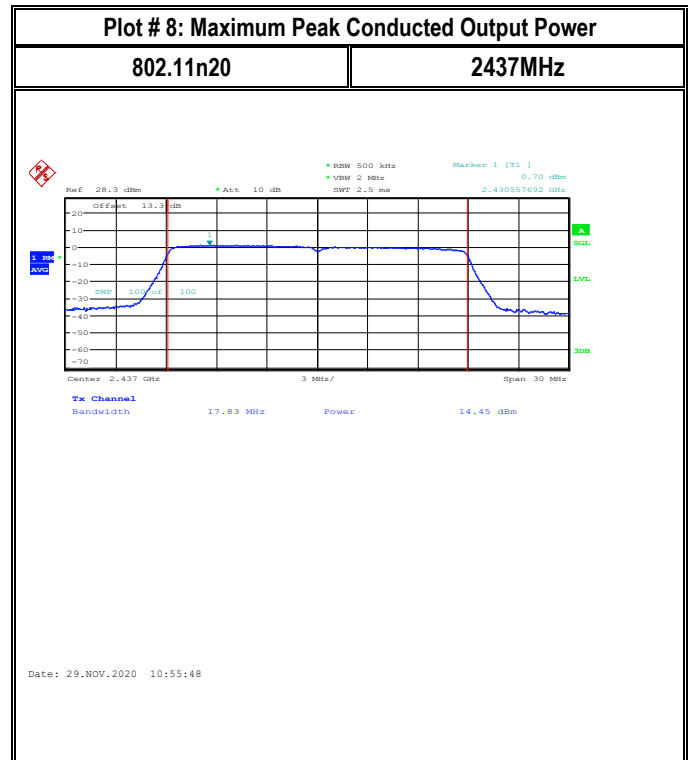
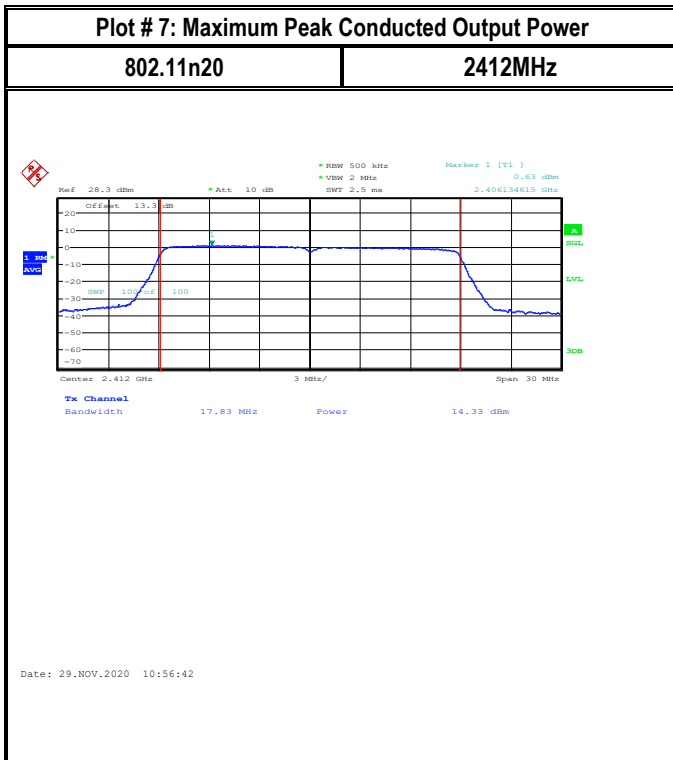
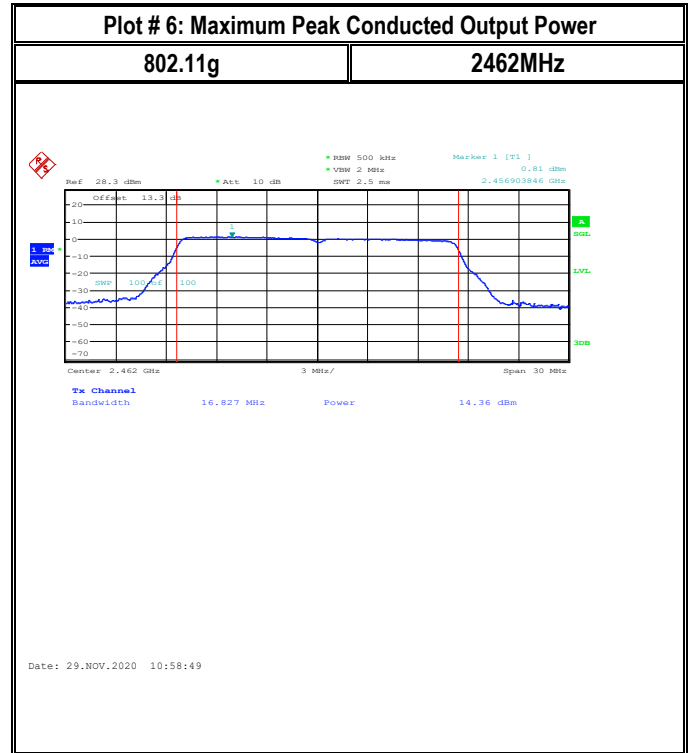
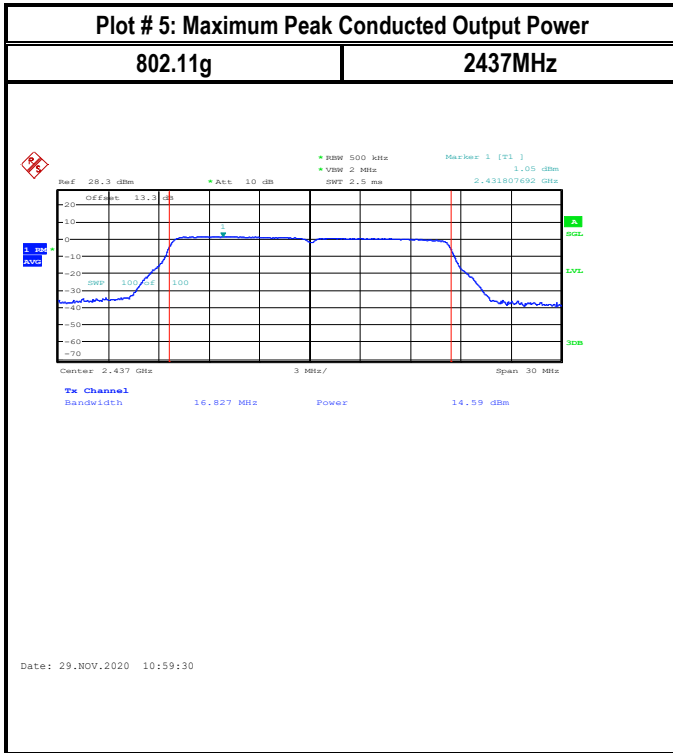
- 802.11b: 0dB
- 802.11g: 0 dB
- 802.11n HT20: 0 dB

** For all operating modes, 1.6 dBi antenna gain was added



8.1.5 Measurement Plots:



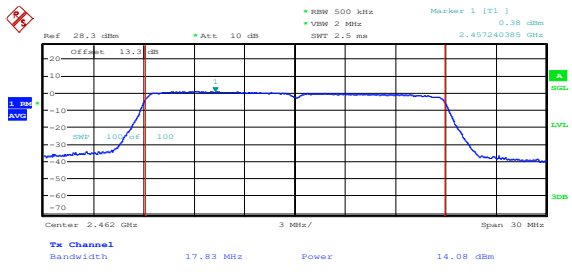




Plot # 9: Maximum Peak Conducted Output Power

802.11n20

2462MHz



Date: 29.NOV.2020 10:55:11

8.2 Power Spectral Density

8.2.1 Measurement according to FCC 558074 D01 15.247 Meas Guidance v05r02

Spectrum Analyzer settings for Peak PSD method:

- Set analyzer center frequency to DTS channel center frequency
- Set the span to 1.5 x DTS bandwidth
- Set RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
- Set the VBW $\geq 3 \times \text{RBW}$
- Detector = Peak
- Sweep time = Auto couple
- Trace mode = Max hold
- Allow trace to fully stabilize
- 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

8.2.2 Limits:

FCC §15.247(e) & RSS-247 5.2(b):

- For digitally modulated systems, the peak 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.

8.2.3 Test conditions and setup:

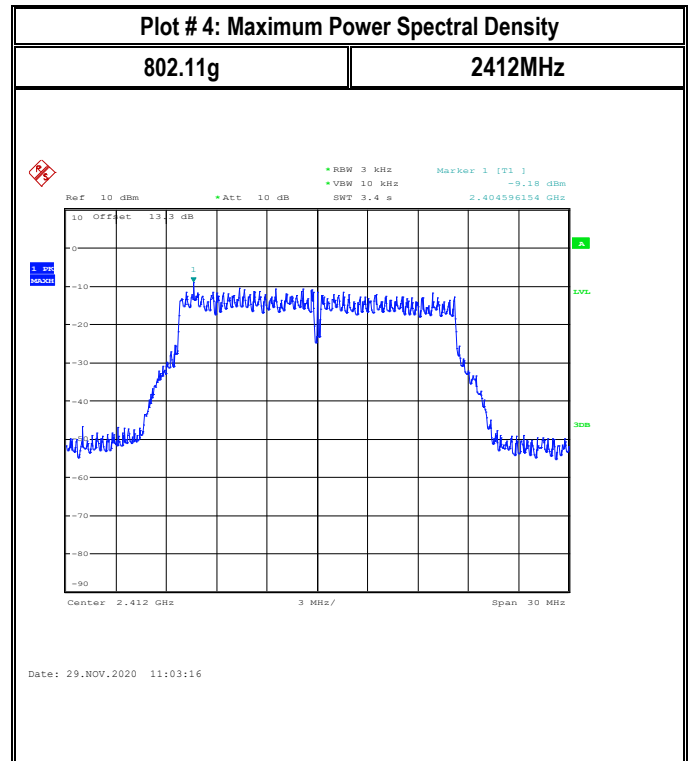
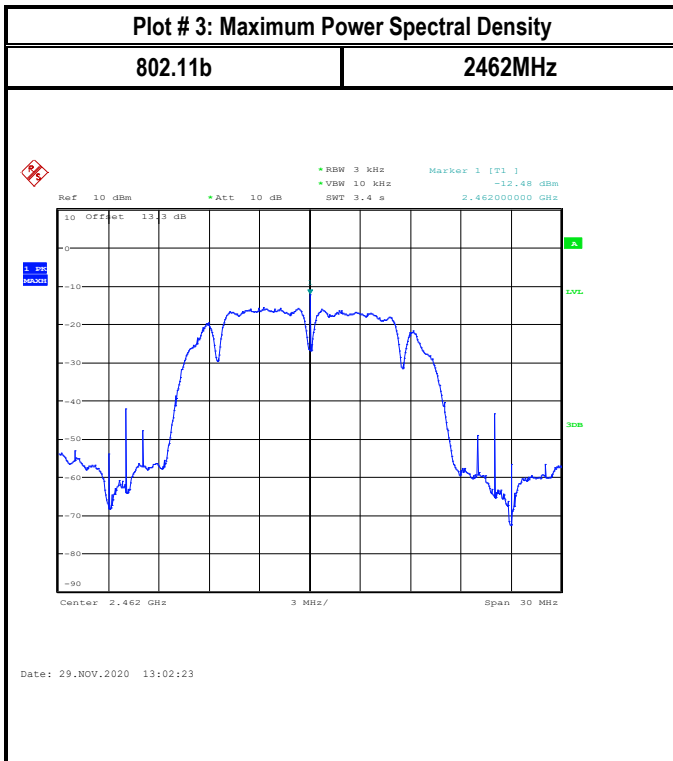
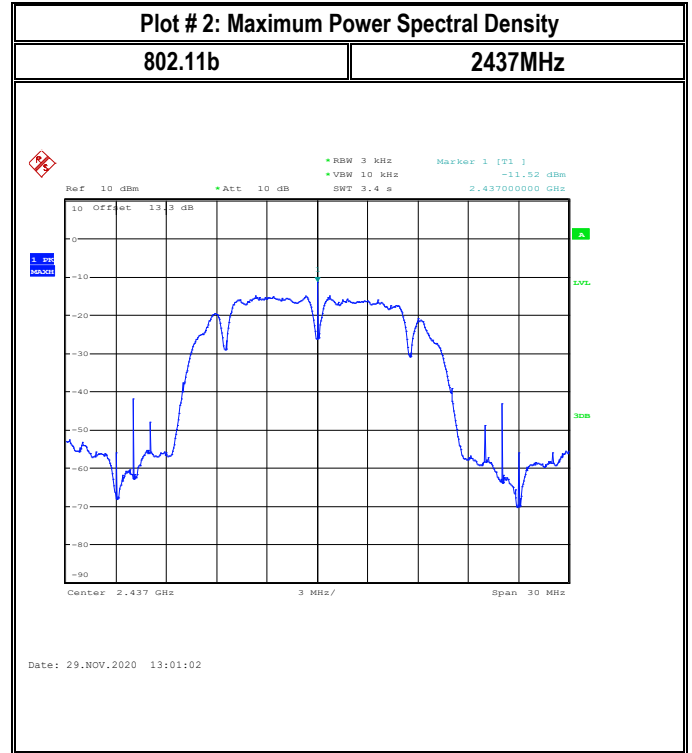
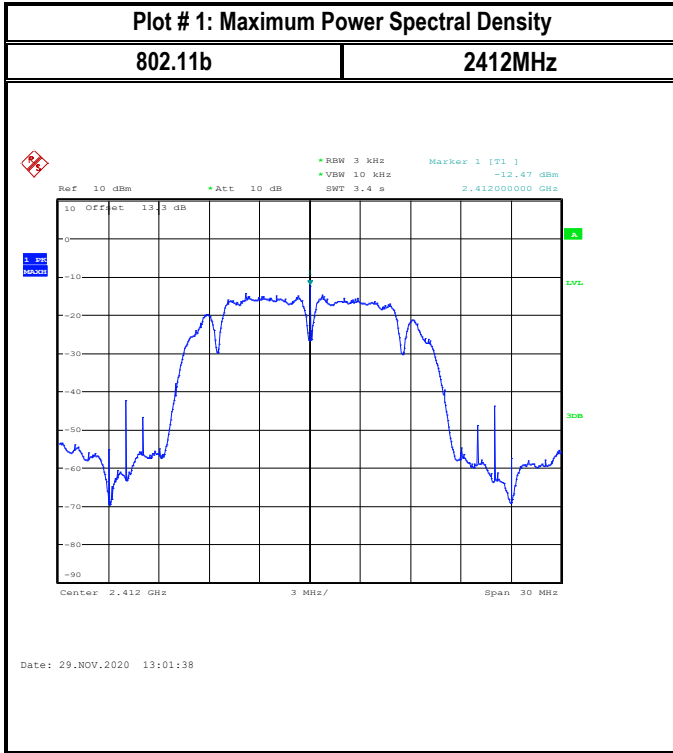
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	802.11b,g,n	5 VDC	1.6 dBi

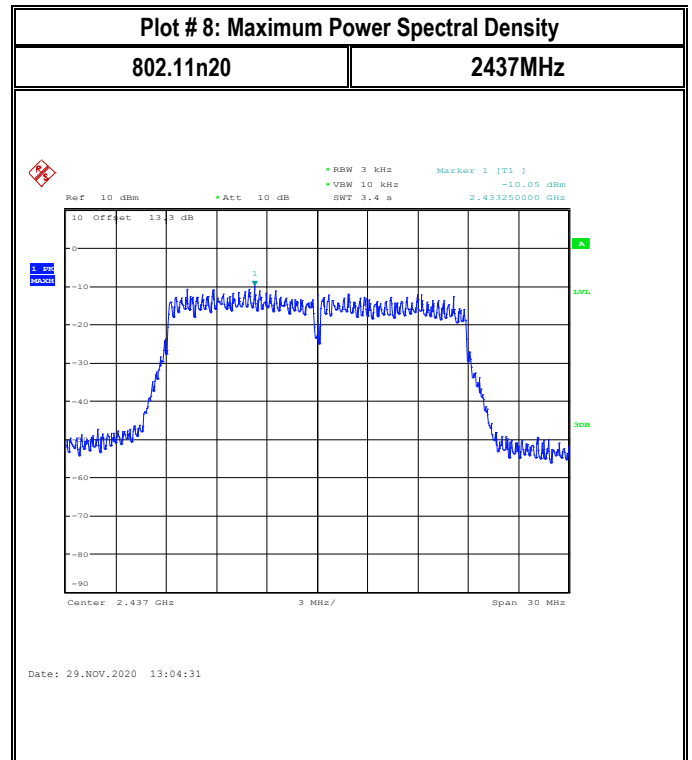
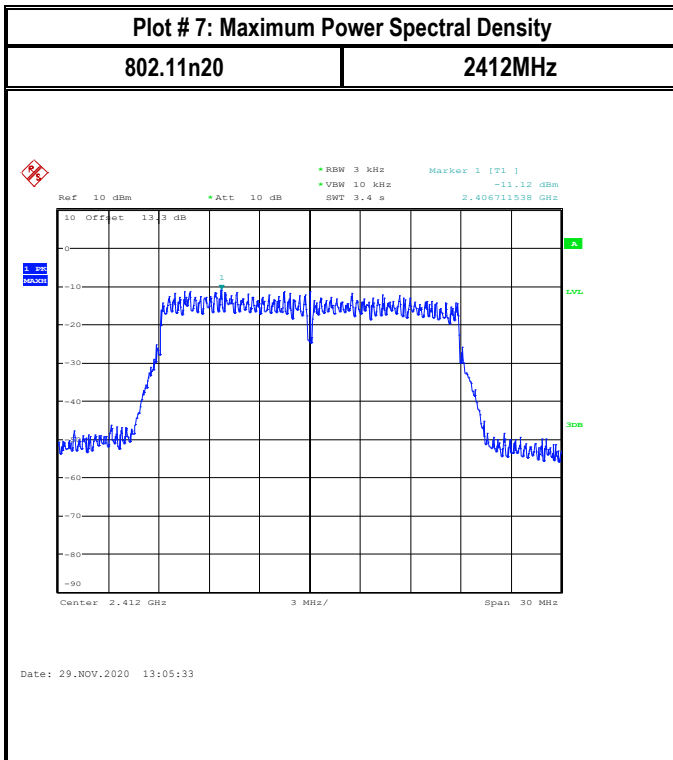
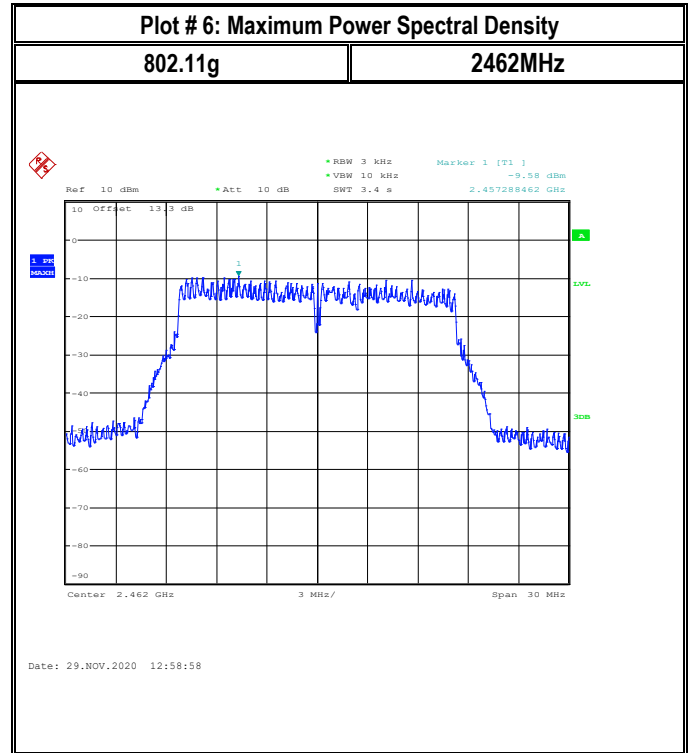
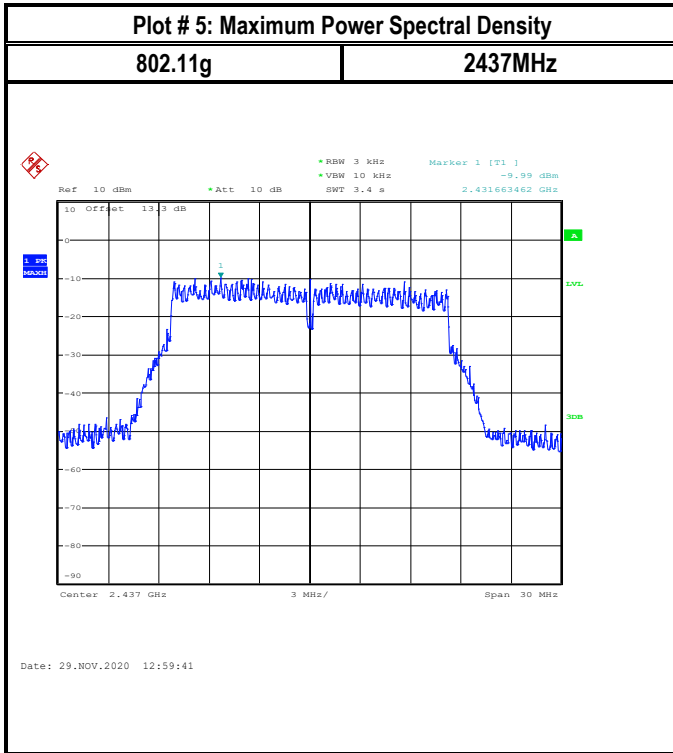
8.2.4 Measurement result:

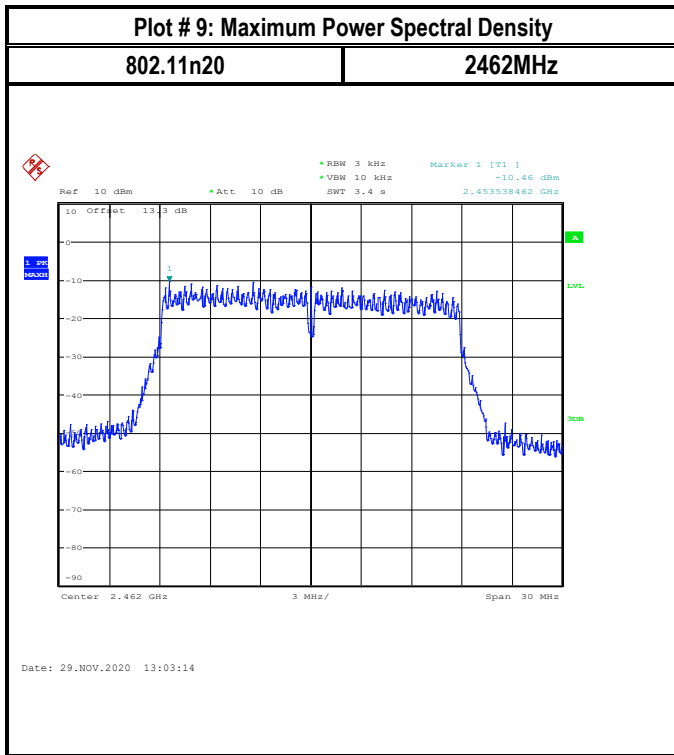
Plot #	Mode	Data Rate	Channel/Frequency (MHz)			Maximum Power Spectral Density (dBm/3 kHz)	Limit (dBm / 3 kHz)	Result
			Low	Mid	High			
1	802.11b	1Mbps	Low	1	2412	-12.47	8	Pass
2			Mid	6	2437	-11.52	8	Pass
3			High	11	2462	-12.48	8	Pass
4	802.11g	6Mbps	Low	1	2412	-9.18	8	Pass
5			Mid	6	2437	-9.99	8	Pass
6			High	11	2462	-9.58	8	Pass
7	802.11n20	MCS0	Low	1	2412	-11.12	8	Pass
8			Mid	6	2437	-10.05	8	Pass
9			High	11	2462	-10.46	8	Pass



8.2.5 Measurement Plots:







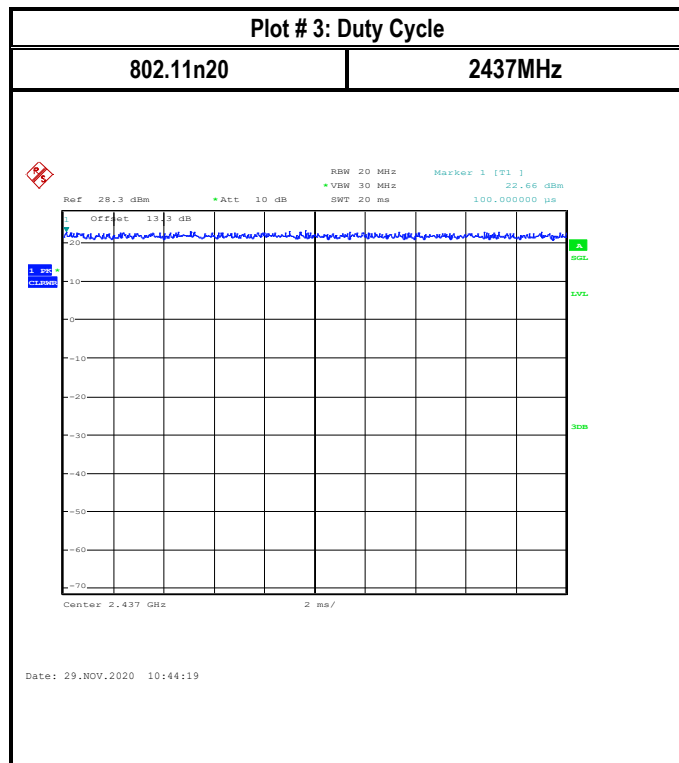
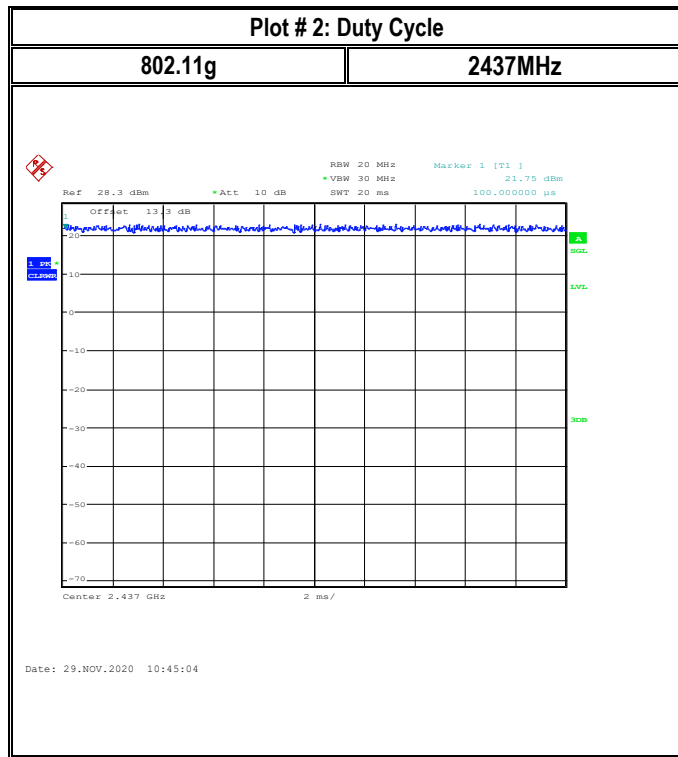
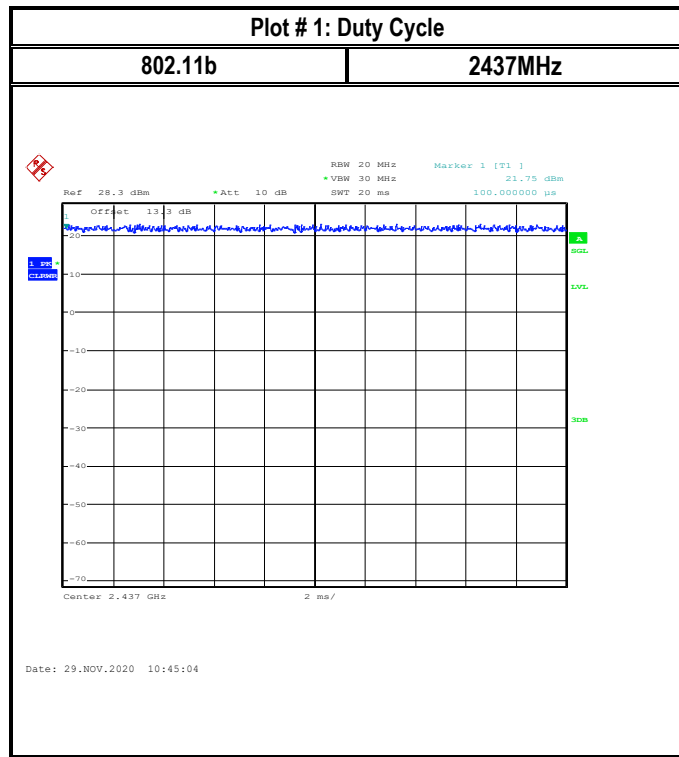
8.3 Duty cycle

8.3.1 Measurement according to FCC 558074 D01 15.247 Meas Guidance v05r02

Spectrum Analyzer settings:

- Set the center frequency and of the instrument to the center frequency of the transmission
- Zero span
- Set RBW \geq OBW if possible; otherwise, set RBW to the largest available value
- Detector = Peak or average

8.3.2 Measurement result



Duty cycle = 100%

Duty cycle correction factor = $10 \cdot \log(1/1) = 0$ dB

8.4 Band Edge Compliance

8.4.1 Measurement according to FCC 558074 D01 15.247 Meas Guidance v05r02

Spectrum Analyzer settings for band edge:

- Set the center frequency and span to encompass frequency range to be measured
- RBW = 100 kHz
- VBW $\geq 3 \times$ RBW
- Sweep Time: Auto couple
- Detector = Peak
- Trace = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level
- Set the marker 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

8.4.2 Limits non restricted band:

FCC§15.247 (d)

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

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- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB.

Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz



8.4.3 Limits restricted band §15.247/15.209/15.205 and RSS-Gen 8.9/8.10

- *PEAK LIMIT= 74 dBµV/m @3m =-21.23 dBm
- *AVG. LIMIT= 54 dBµV/m @3m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205 & RSS-Gen 8.10
- Measurements with a peak detector were used to show compliance to average limits, thus showing compliance to both peak and average limits.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

8.4.4 Test conditions and setup:

Non-Restricted Band:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	802.11b,g,n	120 VAC	1.6 dBi

Restricted Band:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
23.8°C	1	802.11b,g,n	120 VAC	1.6 dBi

8.4.5 Measurement result:

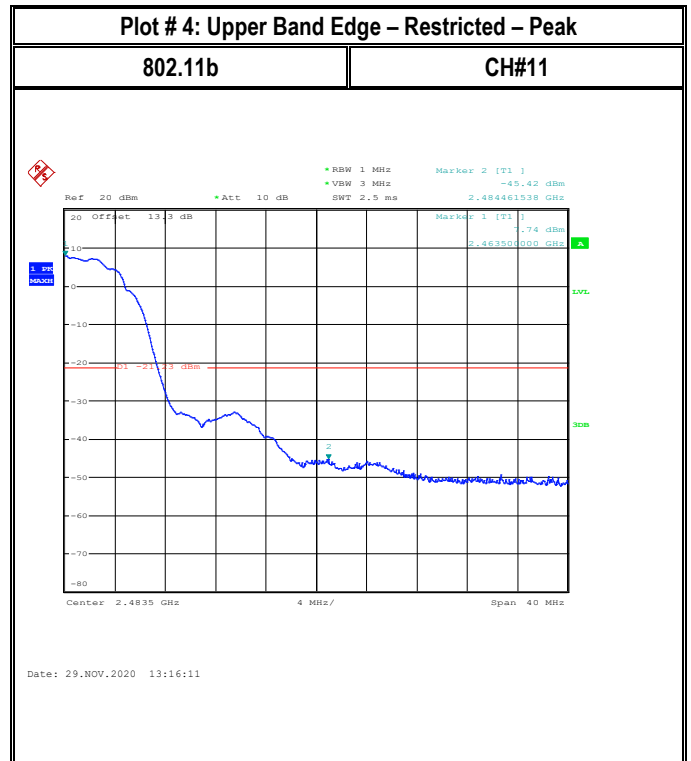
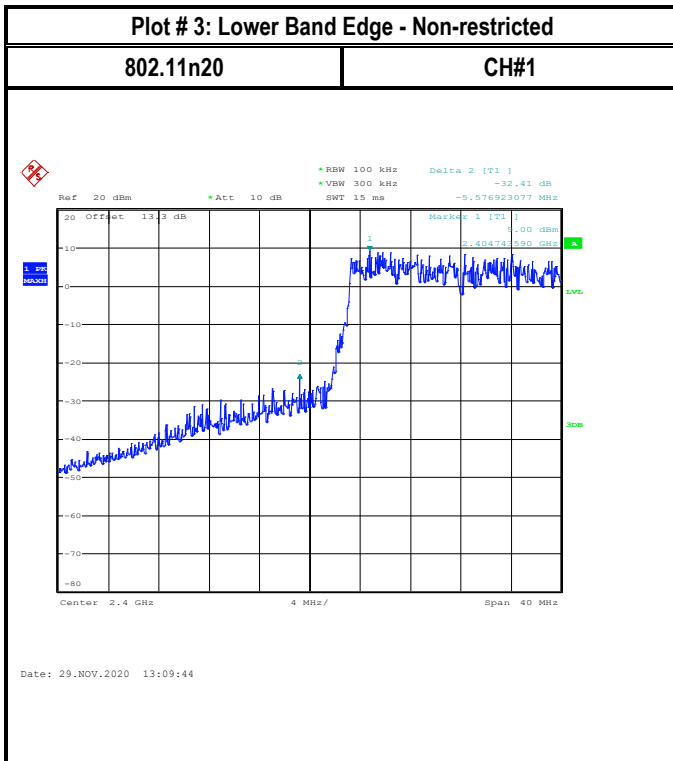
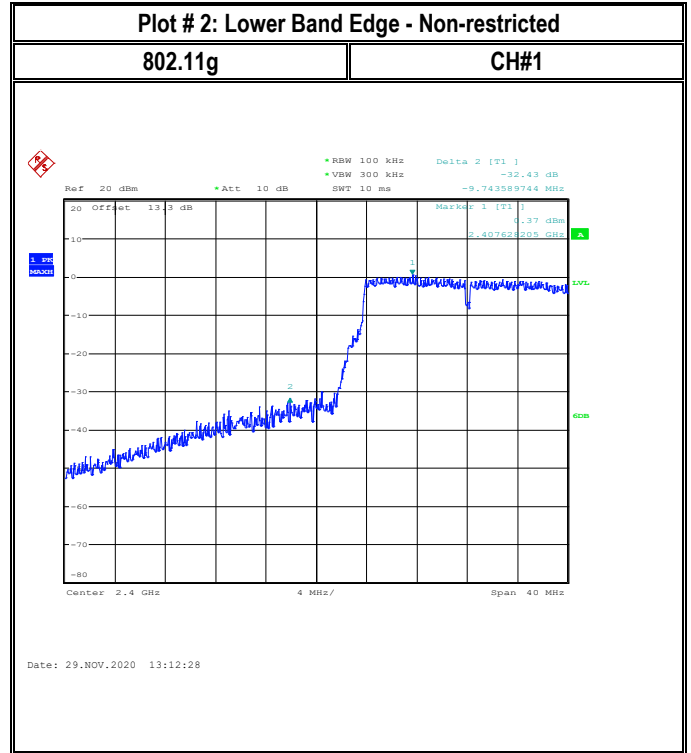
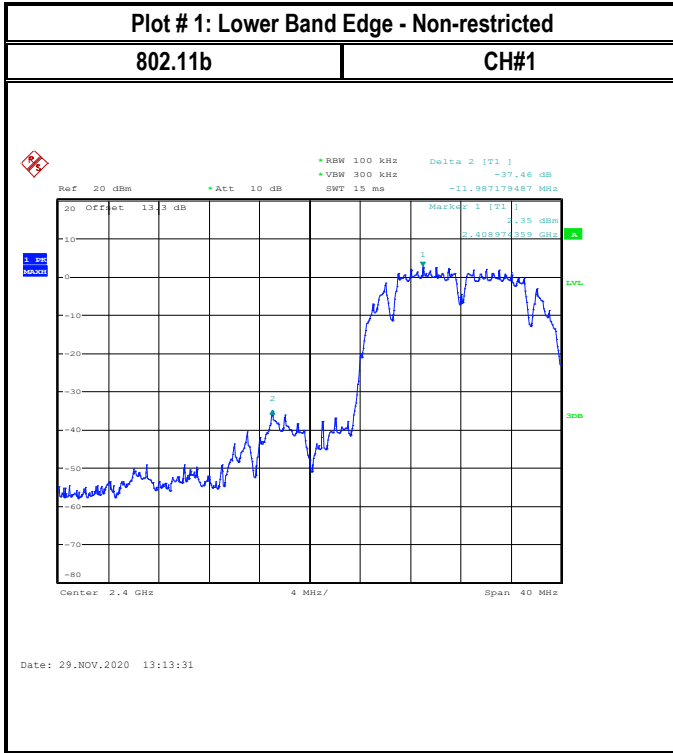
Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	b	Lower, Non-restricted	-37.46	30	Pass
2	g	Lower, Non-restricted	-32.43	30	Pass
3	n20	Lower, Non-restricted	-32.41	30	Pass

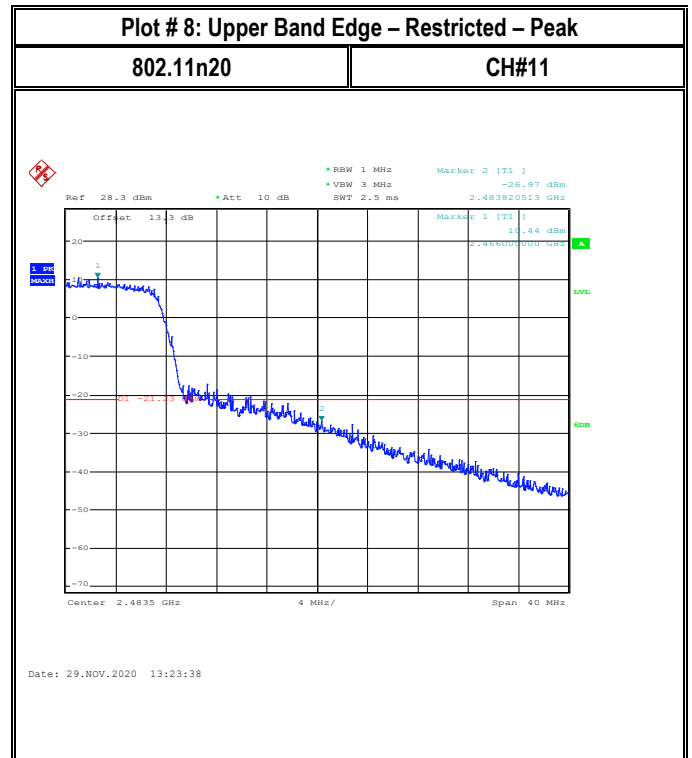
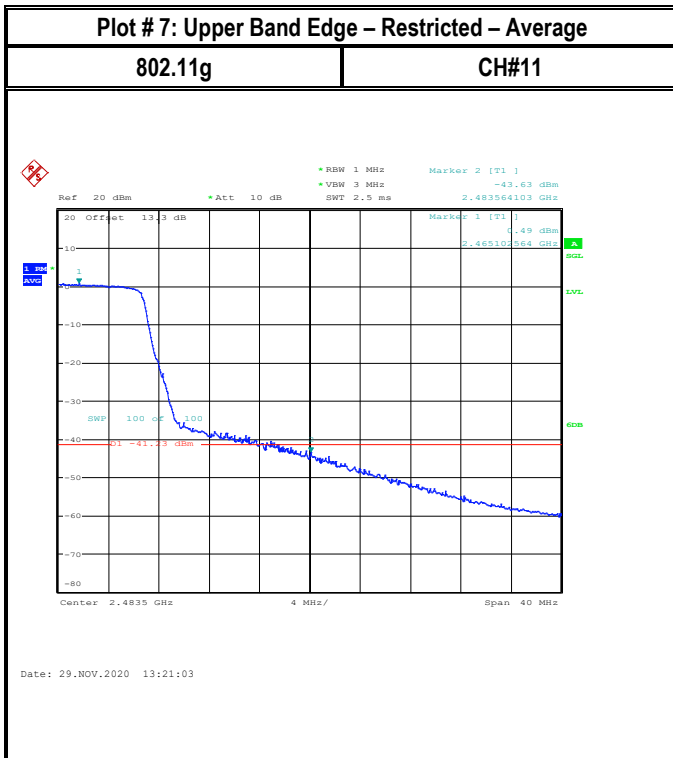
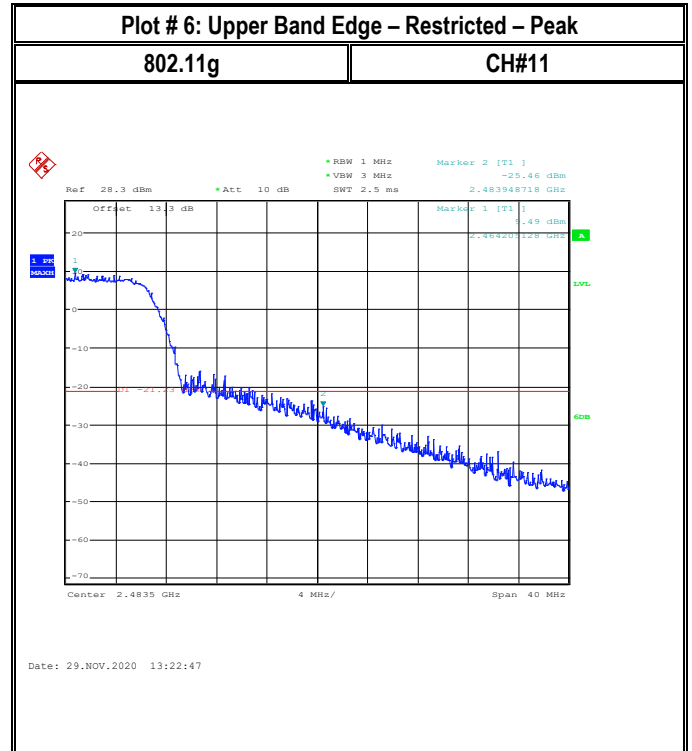
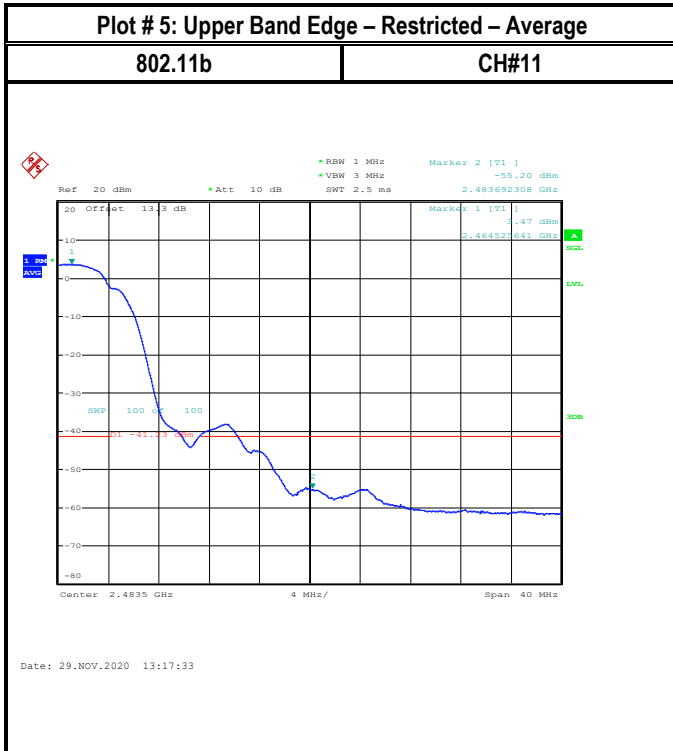
Plot #	EUT operating mode	Band Edge	Measured Peak Value (dBm)	Corrected by duty cycle	Corrected by Antenna Gain (dBm)	Limit (dBm)	Result
4	b	Upper Restricted Peak	-45.42	NA due to peak detector, and trace max hold	-43.82	-21.23 Peak	Pass
5		Upper Restricted AVG	-55.2	-55.2	-53.6	-41.23 AVG	Pass
6	g	Upper Restricted Peak	-25.46	NA due to peak detector, and trace max hold	-23.86	-21.23 Peak	Pass
7		Upper Restricted AVG	-43.63	-43.63	-42.03	-41.23 AVG	Pass
8	n20	Upper Restricted Peak	-26.97	NA due to peak detector, and trace max hold	-25.37	-21.23 Peak	Pass
9		Upper Restricted AVG	-42.97	-42.97	-41.37	-41.23 AVG	Pass

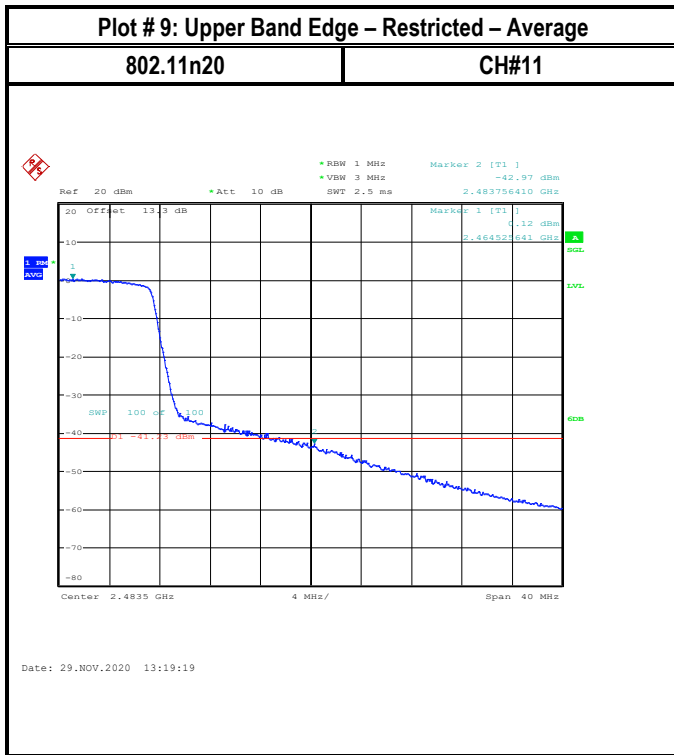
Note: for b, g, n20 mode, the Duty Cycle Correction Factor is 0.



8.4.6 Measurement Plots:







8.5 Emission Bandwidth 6dB and 99% Occupied Bandwidth

8.5.1 Measurement according to FCC 558074 D01 15.247 Meas Guidance v05r02

Spectrum Analyzer settings:

6dB (DTS) Bandwidth:

- Set RBW = 100 kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

99% Occupied Bandwidth:

- Set frequency = nominal EUT channel center frequency
- Set Span = 1.5 x to 5.0 x OBW
- Set RBW = 1% to 5% of OBW
- Set the video bandwidth (VBW) $\approx 3 \times$ RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth
- If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

8.5.2 Limits:

FCC §15.247(a)(2) and RSS-247 5.2(a)

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

8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23.8°C	1	802.11b,g,n	5 VDC

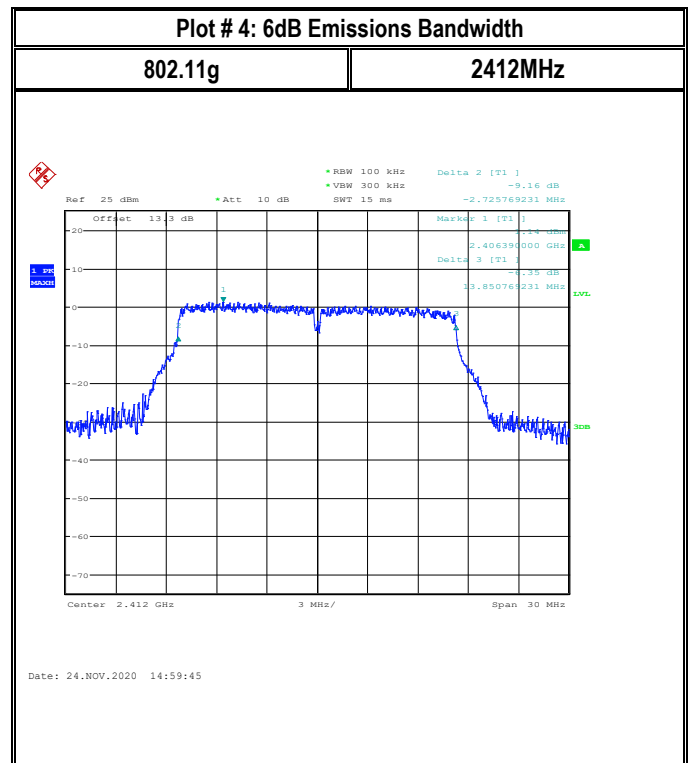
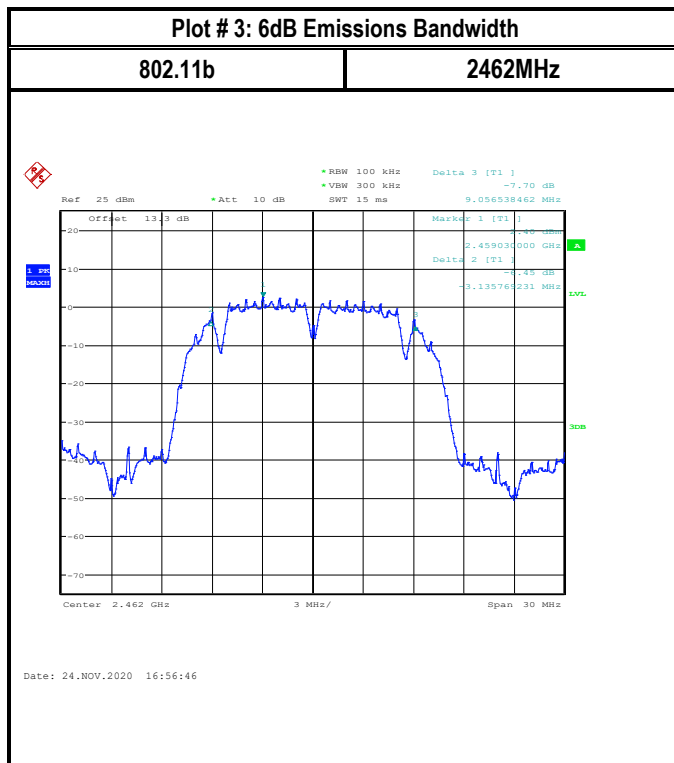
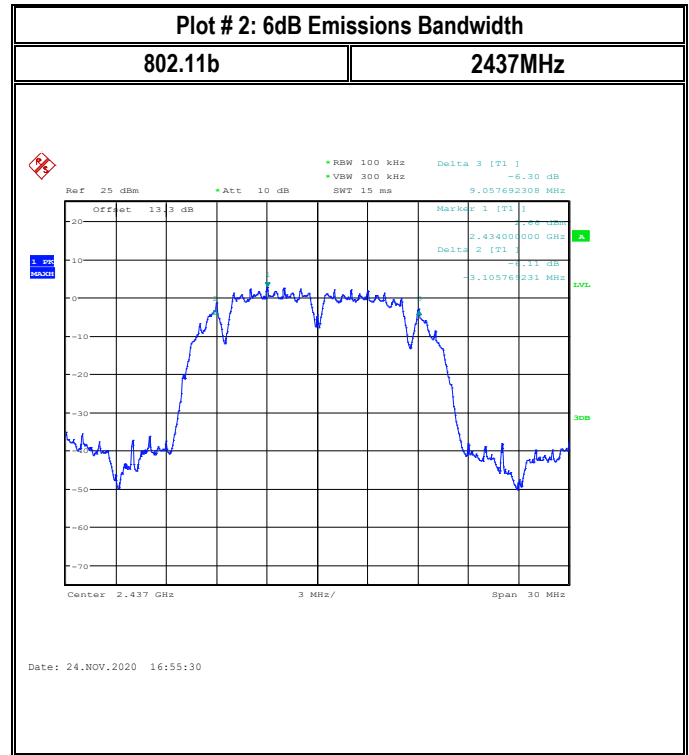
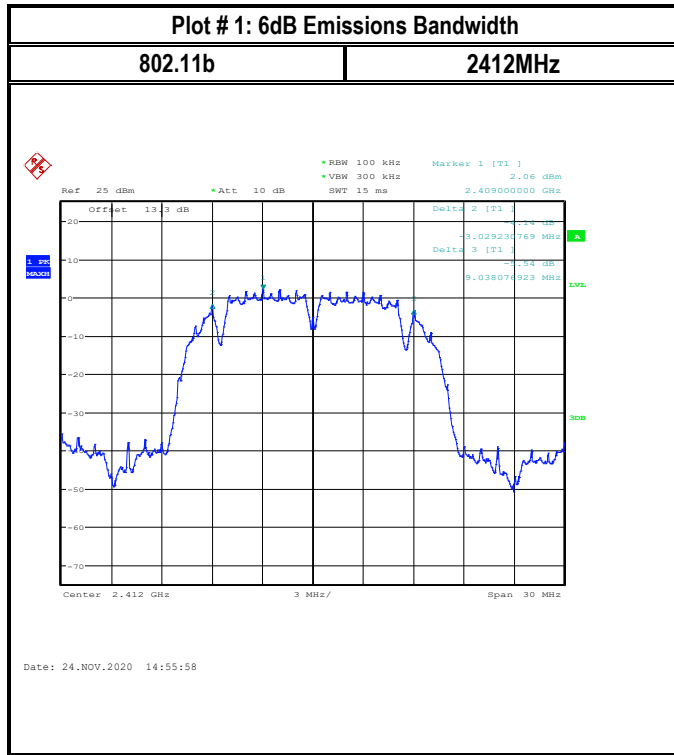
8.5.4 Measurement result:

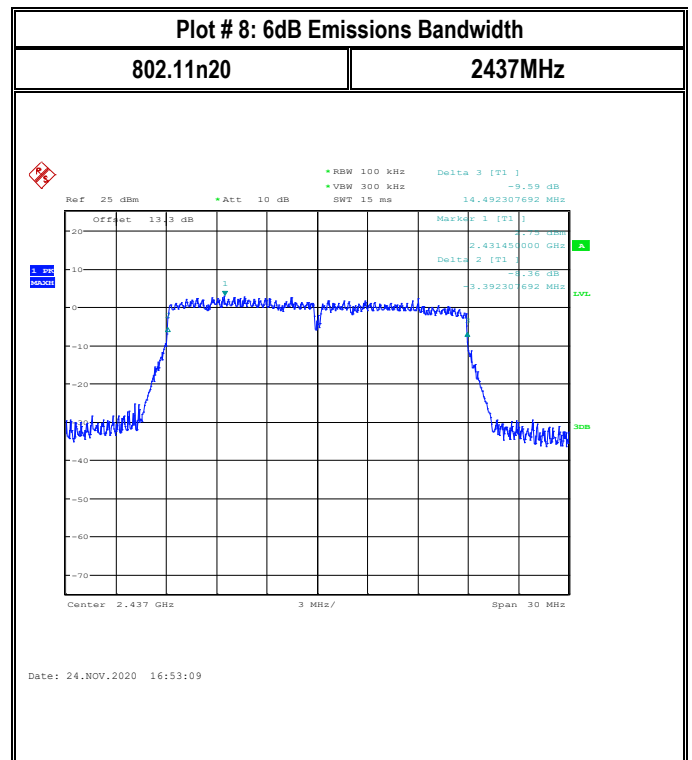
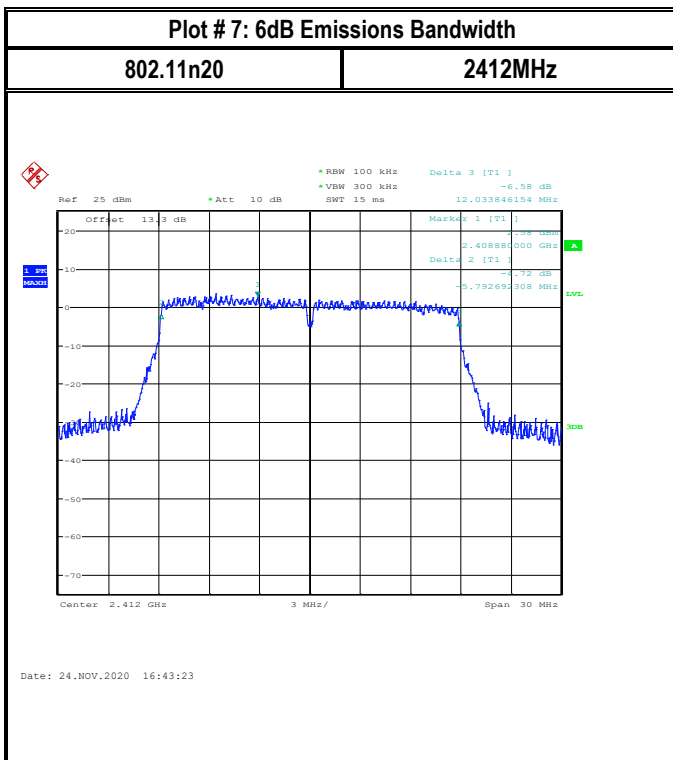
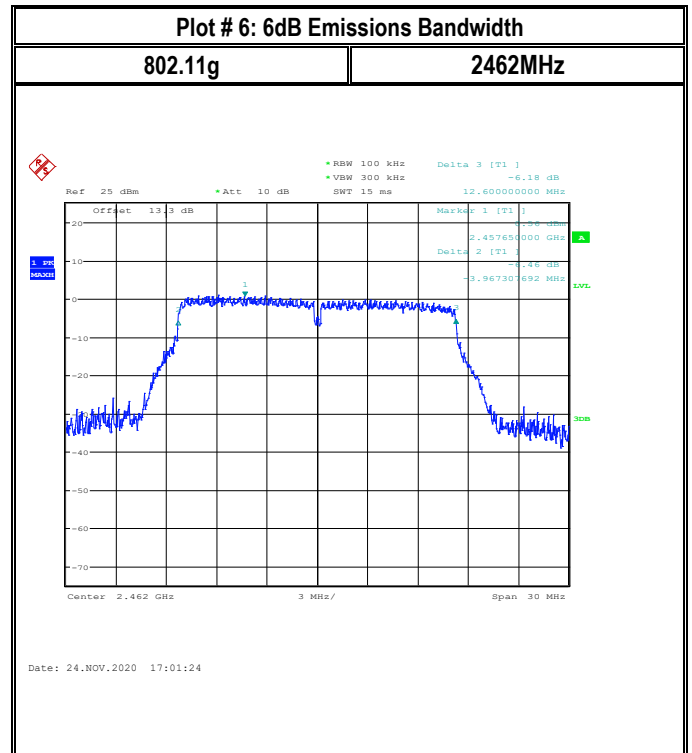
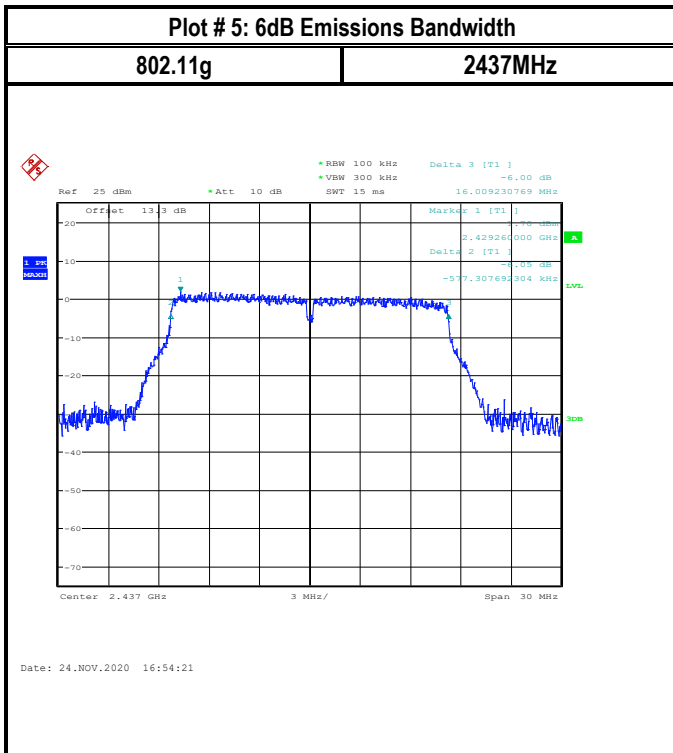
Plot #	Frequency (MHz)	EUT Operating Mode	6dB Emission Bandwidth (MHz)	Limit (MHz)	Result
1	2412	802.11b	12.067	> 0.5	Pass
2	2437	802.11b	12.162	> 0.5	Pass
3	2462	802.11b	12.191	> 0.5	Pass
4	2412	802.11g	16.577	> 0.5	Pass
5	2437	802.11g	16.586	> 0.5	Pass
6	2462	802.11g	16.567	> 0.5	Pass
7	2412	802.11n HT20	17.825	> 0.5	Pass
8	2437	802.11n HT20	17.884	> 0.5	Pass
9	2462	802.11n HT20	17.817	> 0.5	Pass

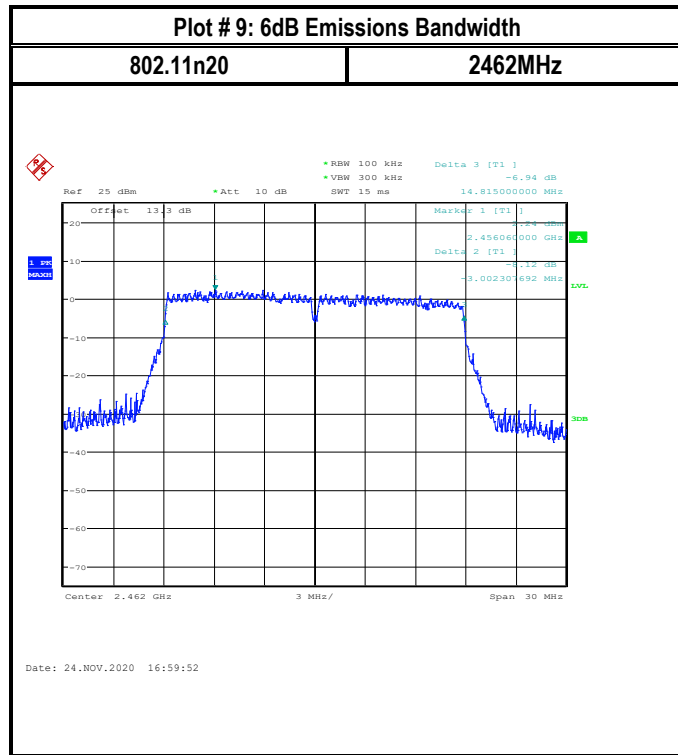
Plot #	Frequency (MHz)	EUT Operating Mode	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
10	2412	802.11b	13.99	> 0.5	Pass
11	2437	802.11b	13.894	> 0.5	Pass
12	2462	802.11b	13.942	> 0.5	Pass
13	2412	802.11g	16.827	> 0.5	Pass
14	2437	802.11g	16.827	> 0.5	Pass
15	2462	802.11g	16.827	> 0.5	Pass
16	2412	802.11n HT20	17.83	> 0.5	Pass
17	2437	802.11n HT20	17.788	> 0.5	Pass
18	2462	802.11n HT20	17.788	> 0.5	Pass

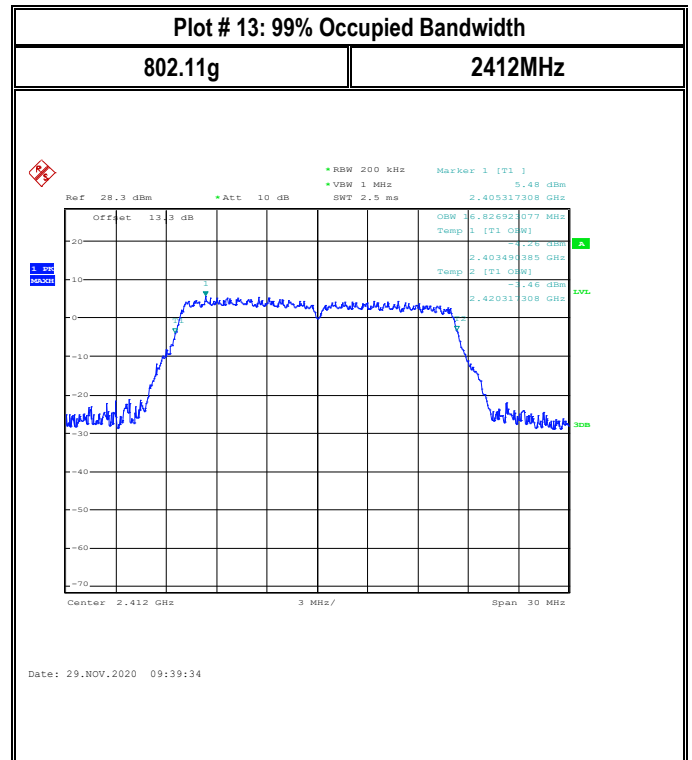
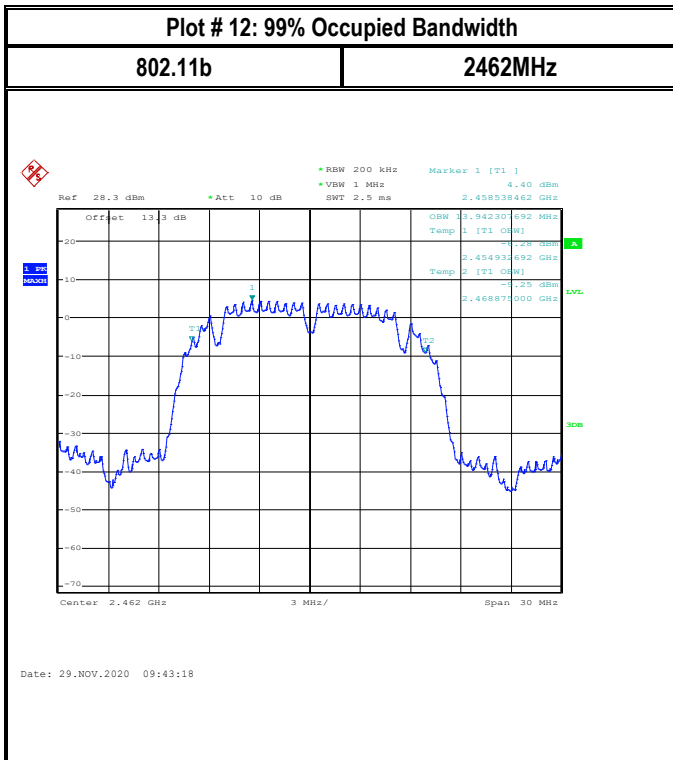
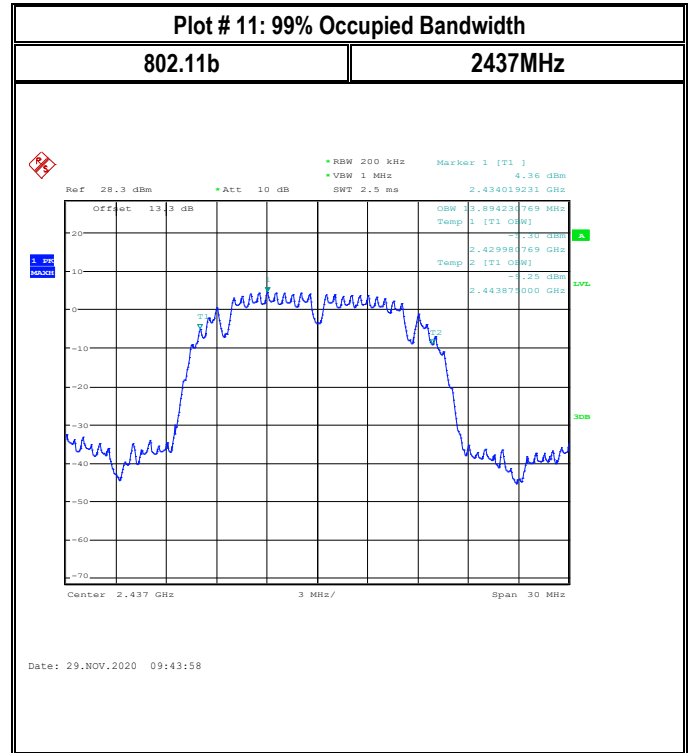
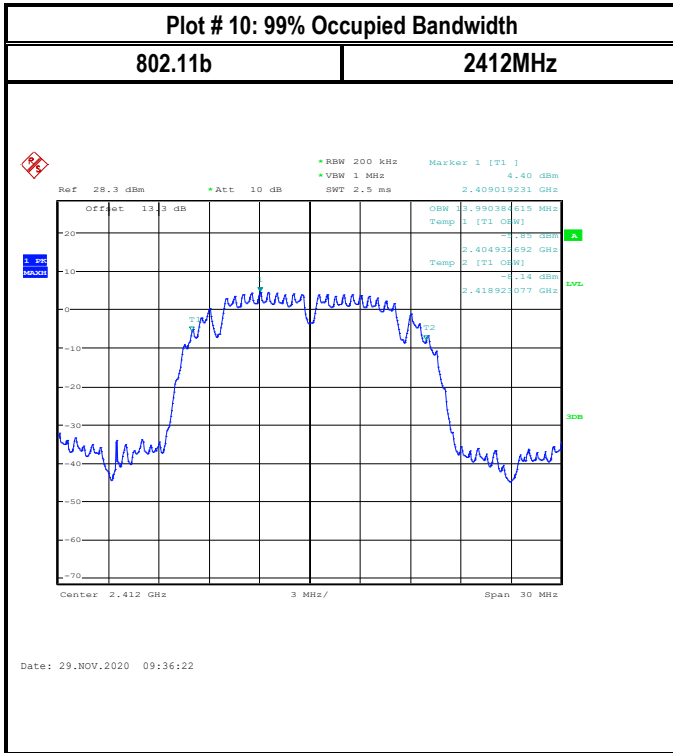


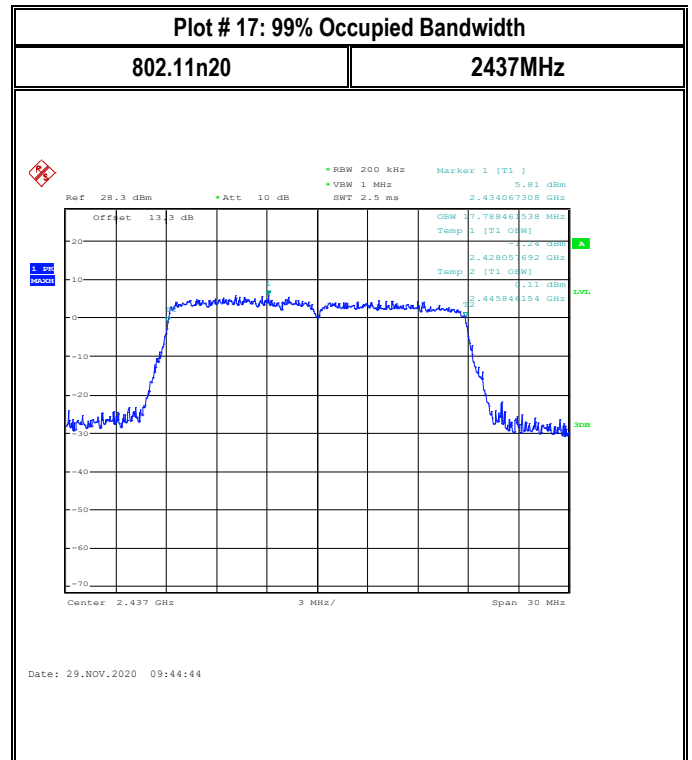
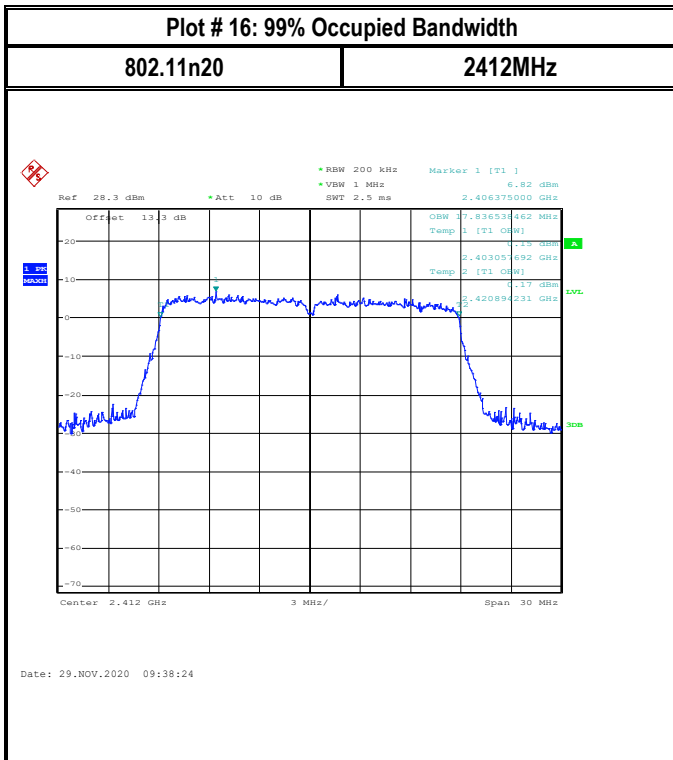
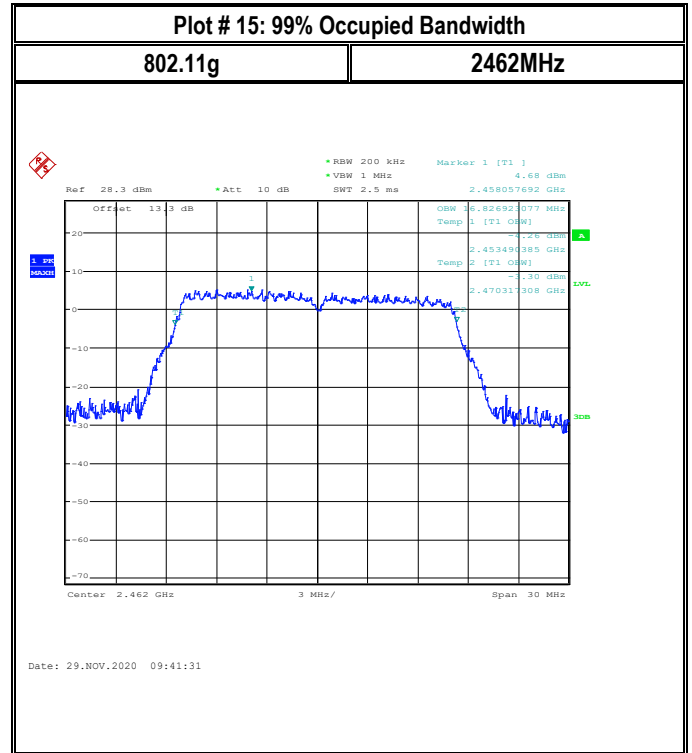
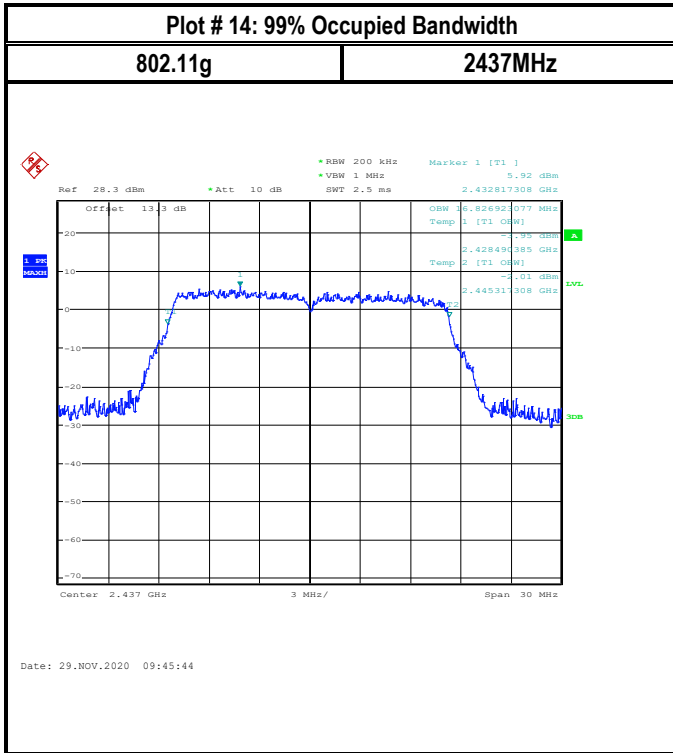
8.5.5 Measurement Plots:

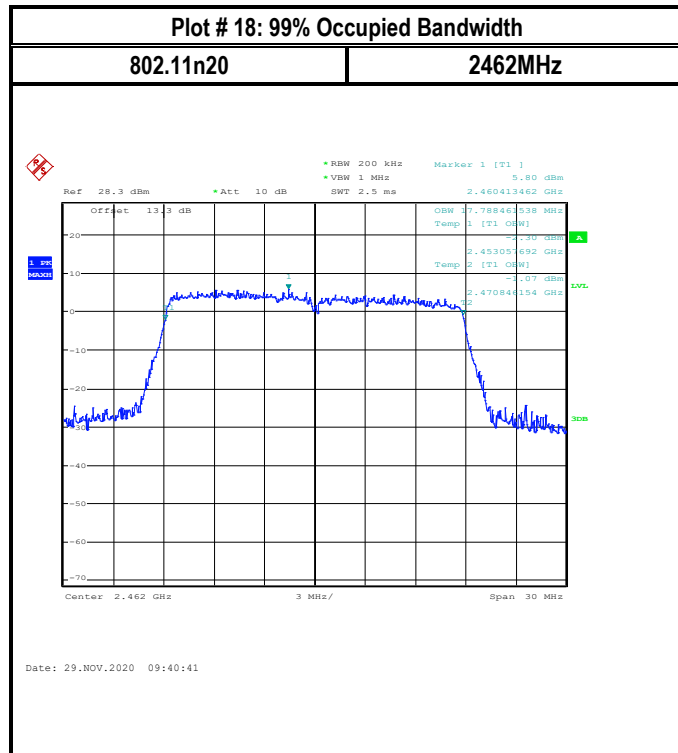












8.6 Radiated Transmitter Spurious Emissions and Restricted Bands

8.6.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector: Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 KHz (<1GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1 MHz

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing frequencies below 30 MHz at distance other than the specified in the standard, the limit conversion is calculated by using the FCC materials for the ANSI 63 committee issued on January, 27 1991.

8.6.2 Limits:

FCC §15.247

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



FCC §15.209 & RSS-Gen 8.9

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength @ 3m (dBµV/m)
0.009–0.490	2400/F(kHz) / -----	300	-
0.490–1.705	24000/F(kHz) / -----	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBµV/m
88–216	150	3	43.5 dBµV/m
216–960	200	3	46 dBµV/m
Above 960	500	3	54 dBµV/m

FCC §15.205 & RSS-Gen 8.10

- Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
 *PEAK LIMIT= 74 dBµV/m
 *AVG. LIMIT= 54 dBµV/m

8.6.3 Test conditions and setup:

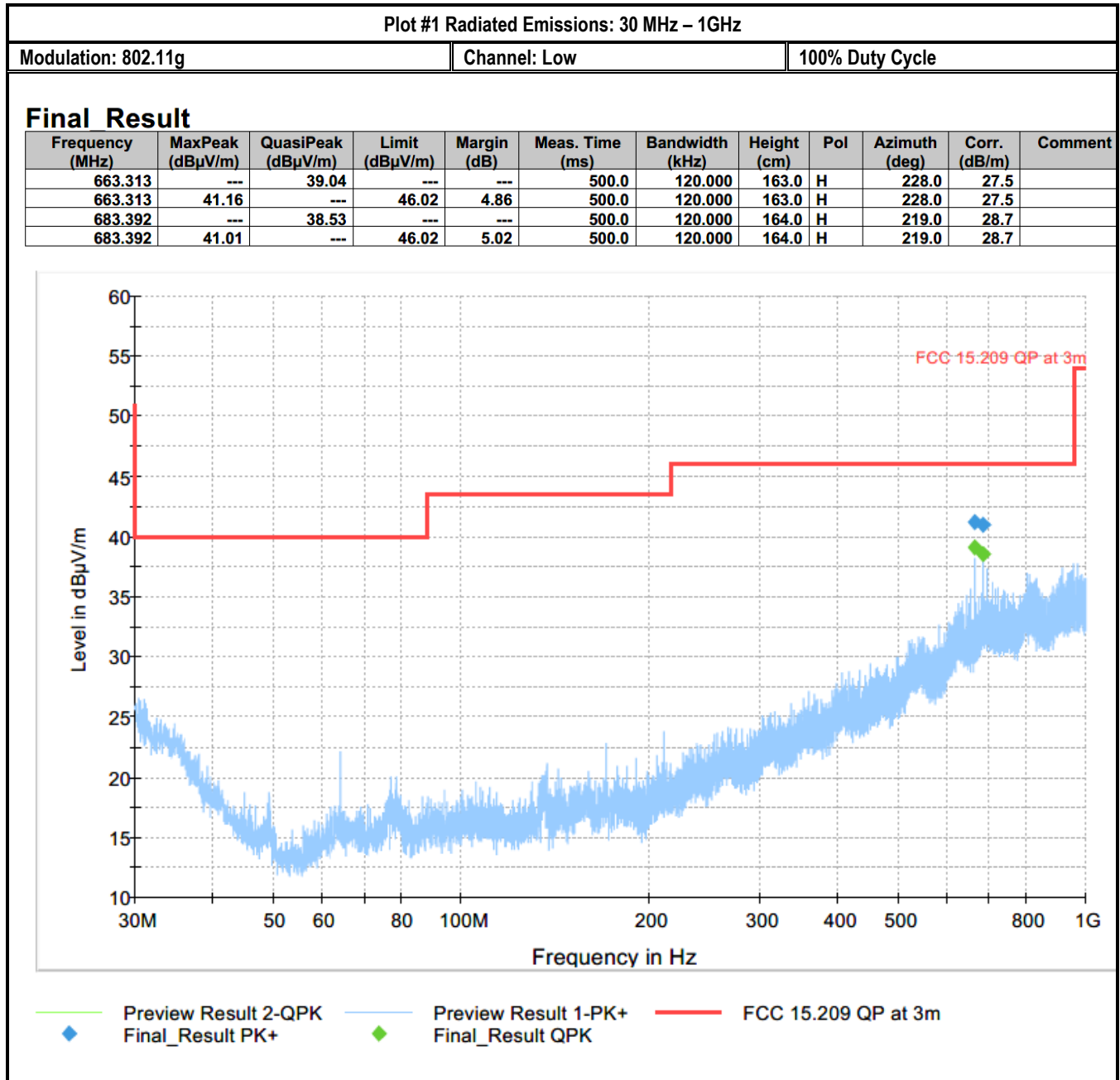
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22.0° C	2	802.11g	5 VDC

8.6.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.6.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.6.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.6.2	Pass

Note: Tested co-transmission with LTE B2

8.6.5 Measurement Plots:

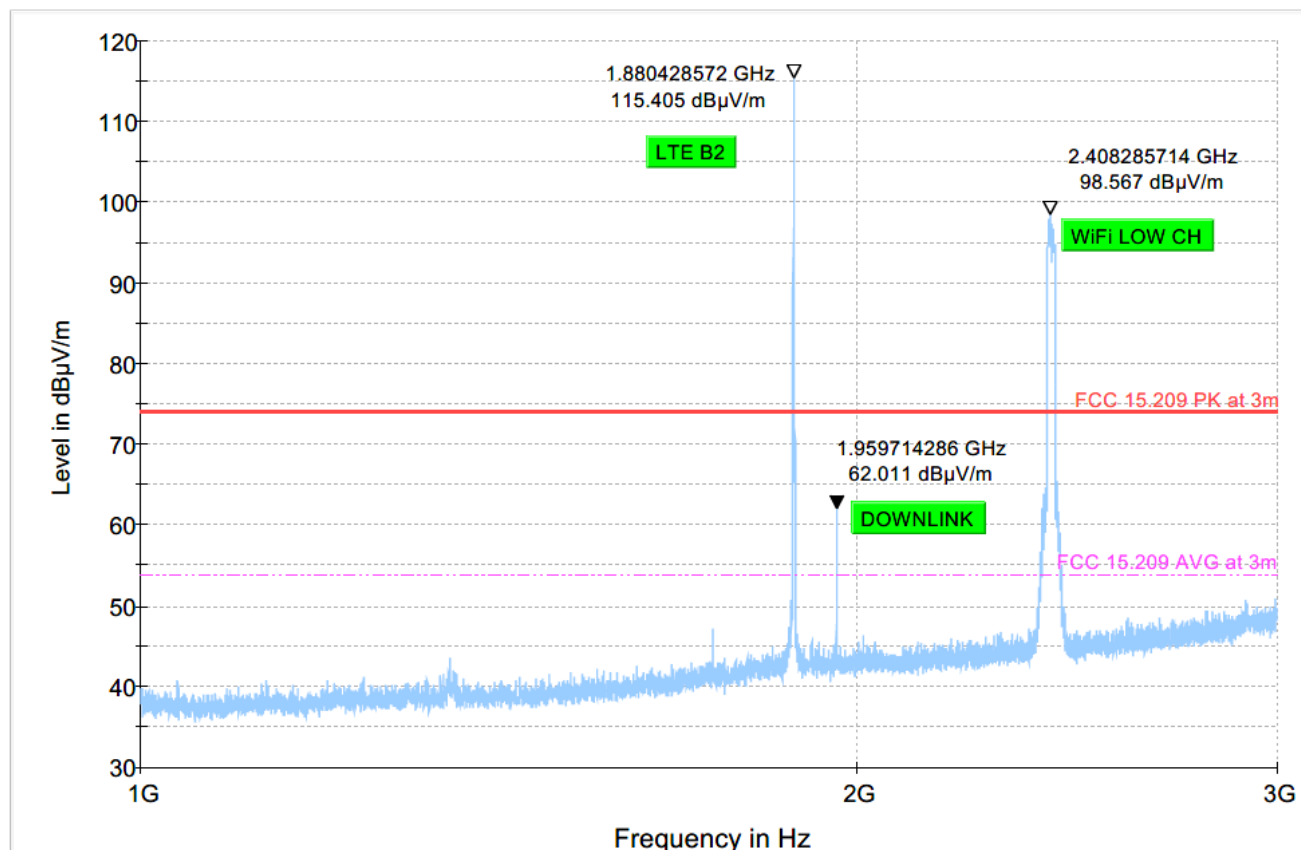


Plot #2 Radiated Emissions: 1-3 GHz

Modulation: 802.11g

Channel: Low

100% Duty Cycle



- ◆ Preview Result 1-PK+ Final_Result PK+
- ◆ FCC 15.209 PK at 3m Final_Result CAV
- ◆ FCC 15.209 AVG at 3m

Plot #3 Radiated Emissions: 3-18 GHz

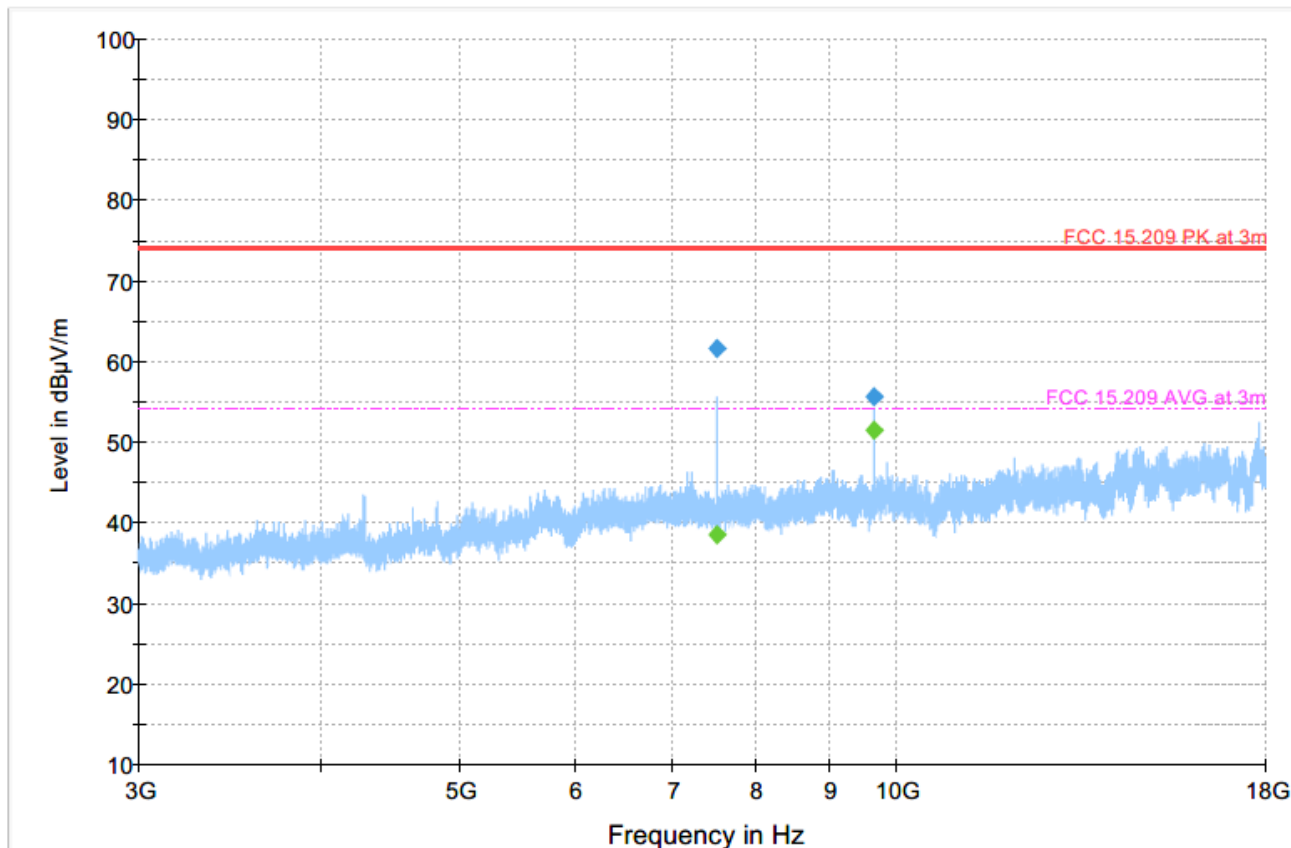
Modulation: 802.11g

Channel: Low

100% Duty Cycle

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
7521.750	---	38.38	53.98	15.60	500.0	1000.000	107.0	V	2.0	0.2	
7521.750	61.57	---	73.98	12.41	500.0	1000.000	107.0	V	2.0	0.2	
9647.750	---	51.33	53.98	2.65	500.0	1000.000	142.0	V	180.0	1.6	
9647.750	55.50	---	73.98	18.48	500.0	1000.000	142.0	V	180.0	1.6	



◆ Preview Result 1-PK+ Final_Result PK+
 — FCC 15.209 PK at 3m
 - - - FCC 15.209 AVG at 3m
 ◆ Final_Result CAV

Plot #4 Radiated Emissions: 9 KHz – 30 MHz

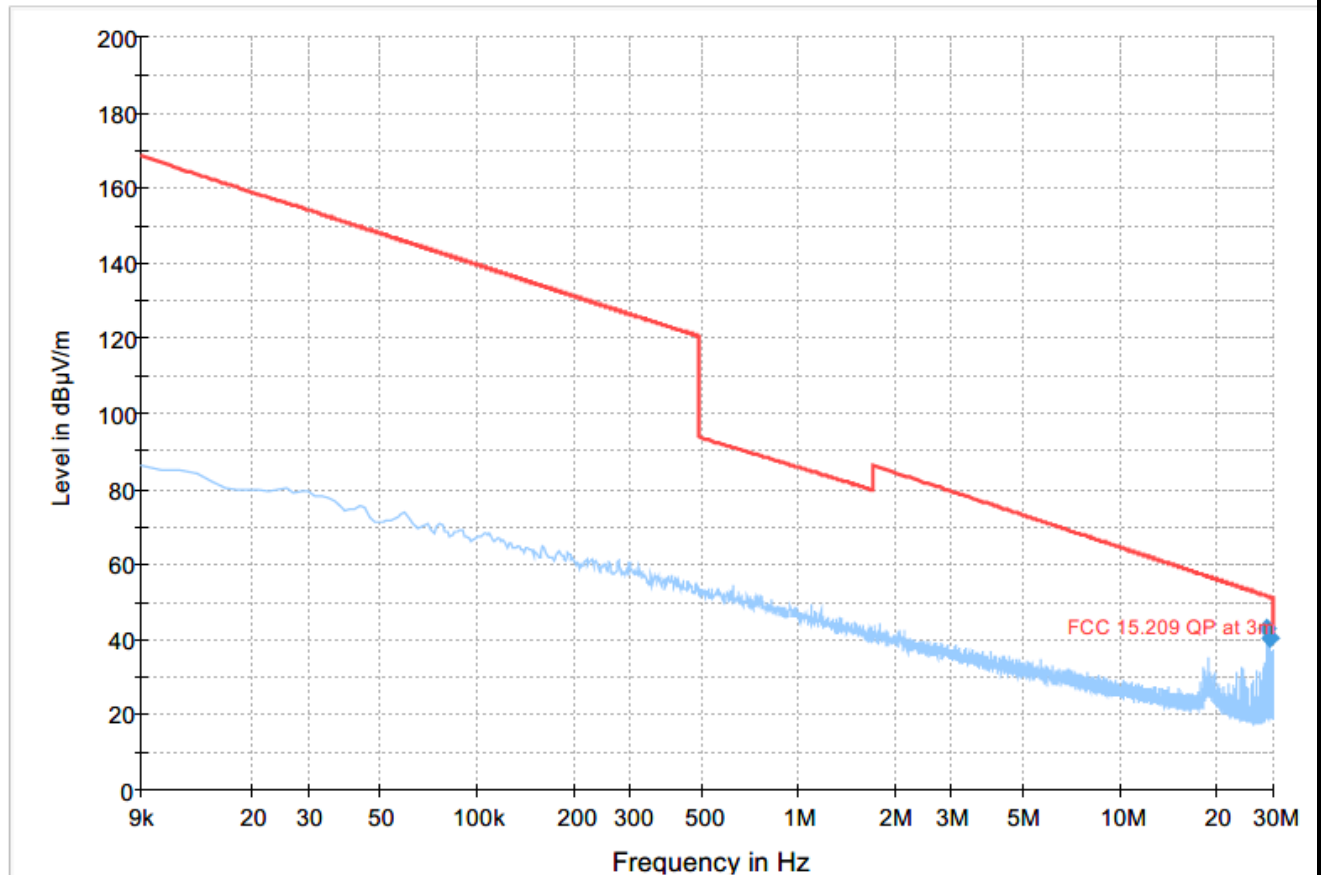
Modulation: 802.11g

Channel: Mid

100% Duty Cycle

Final Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
28.688	43.10	51.59	8.49	500.0	9.000	107.0	H	117.0	16.3	
29.237	40.30	51.36	11.06	500.0	9.000	107.0	H	79.0	16.3	



— Preview Result 1-PK+ — FCC 15.209 QP at 3m ◆ Final_Result QPK

Plot #5 Radiated Emissions: 30 MHz – 1GHz

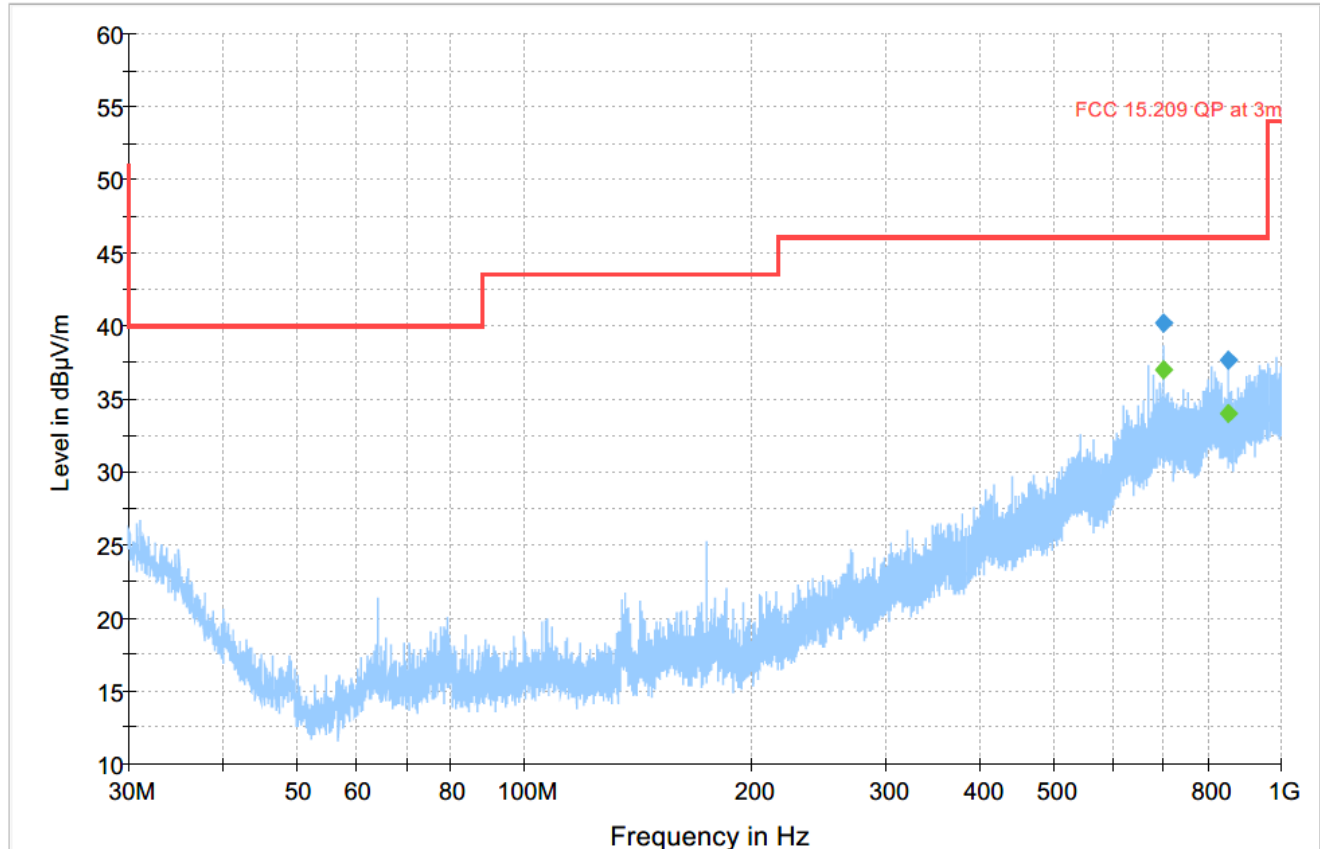
Modulation: 802.11g

Channel: Mid

100% Duty Cycle

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
697.554	40.19	---	46.02	5.83	500.0	120.000	164.0	H	226.0	29.1	
697.554	---	36.95	---	---	500.0	120.000	164.0	H	226.0	29.1	
851.461	37.64	---	46.02	8.38	500.0	120.000	195.0	H	217.0	29.1	
851.461	---	34.05	---	---	500.0	120.000	195.0	H	217.0	29.1	



◆ Preview Result 2-QPK Final_Result PK+
 ◆ Preview Result 1-PK+ Final_Result QPK
 — FCC 15.209 QP at 3m

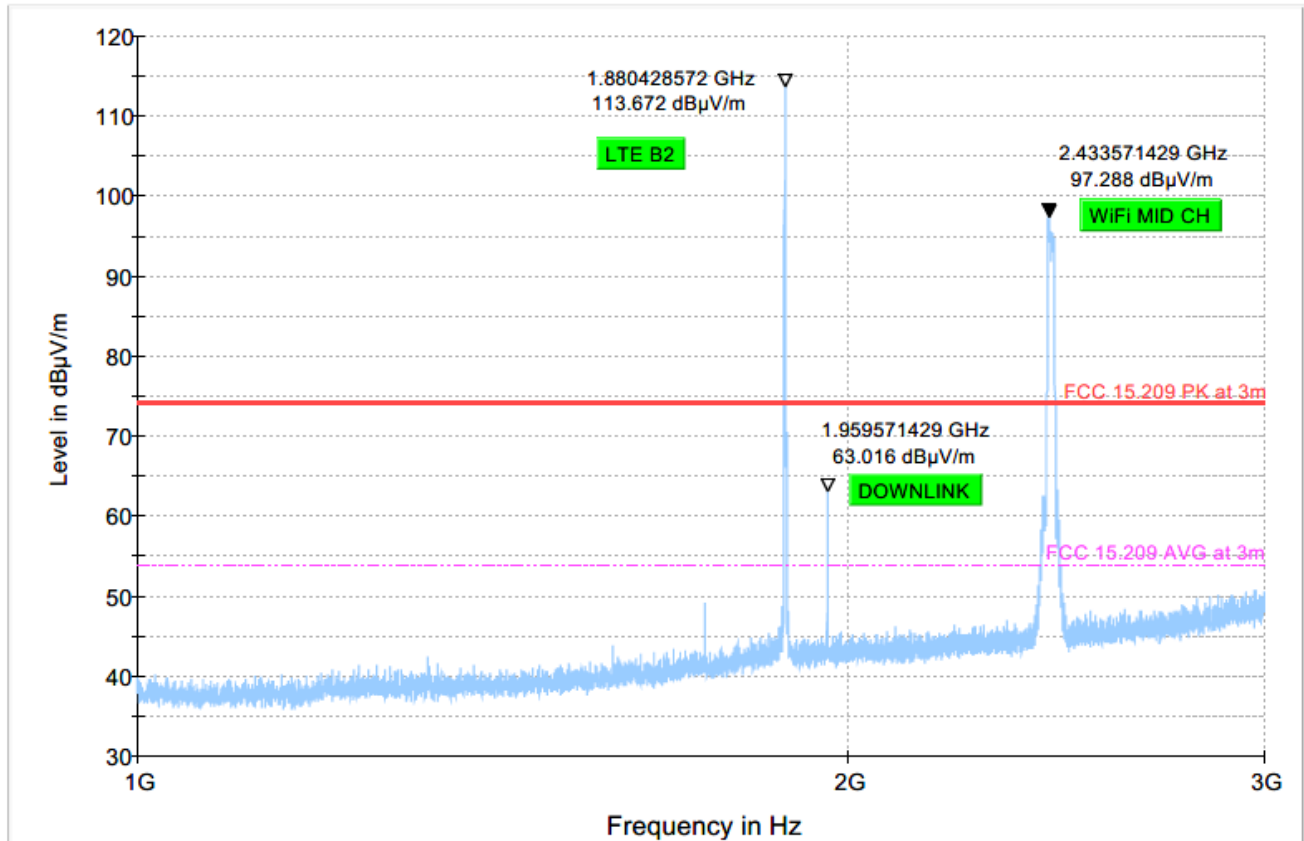


Plot #6 Radiated Emissions: 1-3 GHz

Modulation: 802.11g

Channel: Mid

100% Duty Cycle



- ◆ Preview Result 1-PK+ Final_Result PK+
- ◆ FCC 15.209 PK at 3m Final_Result CAV
- ◆ FCC 15.209 AVG at 3m

Plot #7 Radiated Emissions: 3-18 GHz

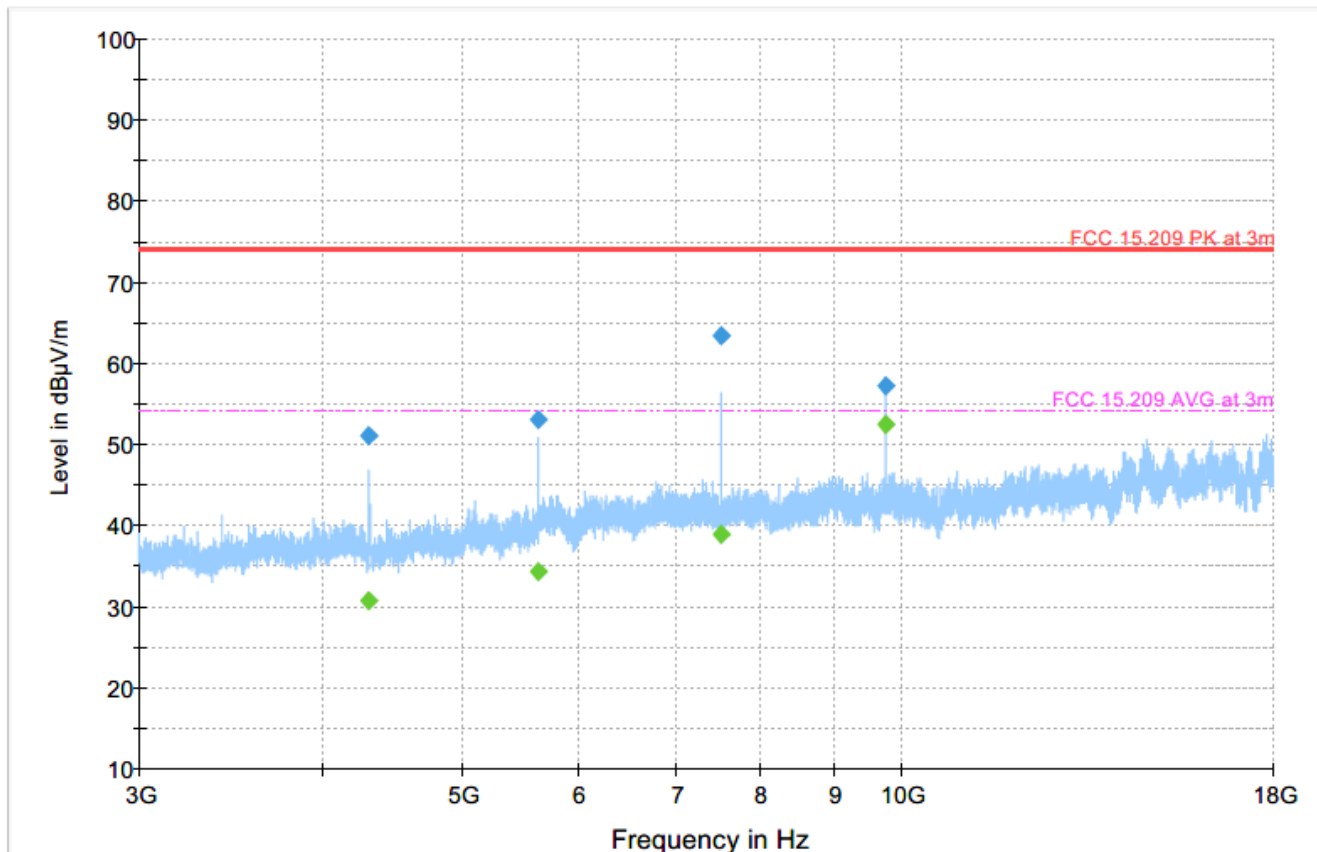
Modulation: 802.11g

Channel: Mid

100% Duty Cycle

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
4313.750	50.99	---	73.98	22.99	500.0	1000.000	142.0	H	156.0	-4.6	
4313.750	---	30.69	53.98	23.29	500.0	1000.000	142.0	H	156.0	-4.6	
5641.000	53.04	---	73.98	20.94	500.0	1000.000	151.0	H	142.0	-1.1	
5641.000	---	34.20	53.98	19.78	500.0	1000.000	151.0	H	142.0	-1.1	
7521.500	---	38.90	53.98	15.07	500.0	1000.000	116.0	H	44.0	0.2	
7521.500	63.44	---	73.98	10.54	500.0	1000.000	116.0	H	44.0	0.2	
9747.750	---	52.36	53.98	1.62	500.0	1000.000	147.0	V	127.0	2.0	
9747.750	57.12	---	73.98	16.86	500.0	1000.000	147.0	V	127.0	2.0	



◆ Preview Result 1-PK+ Final_Result PK+
 — FCC 15.209 PK at 3m
 - - - FCC 15.209 AVG at 3m
 ◆ Final_Result CAV

Plot #8 Radiated Emissions: 18-26 GHz

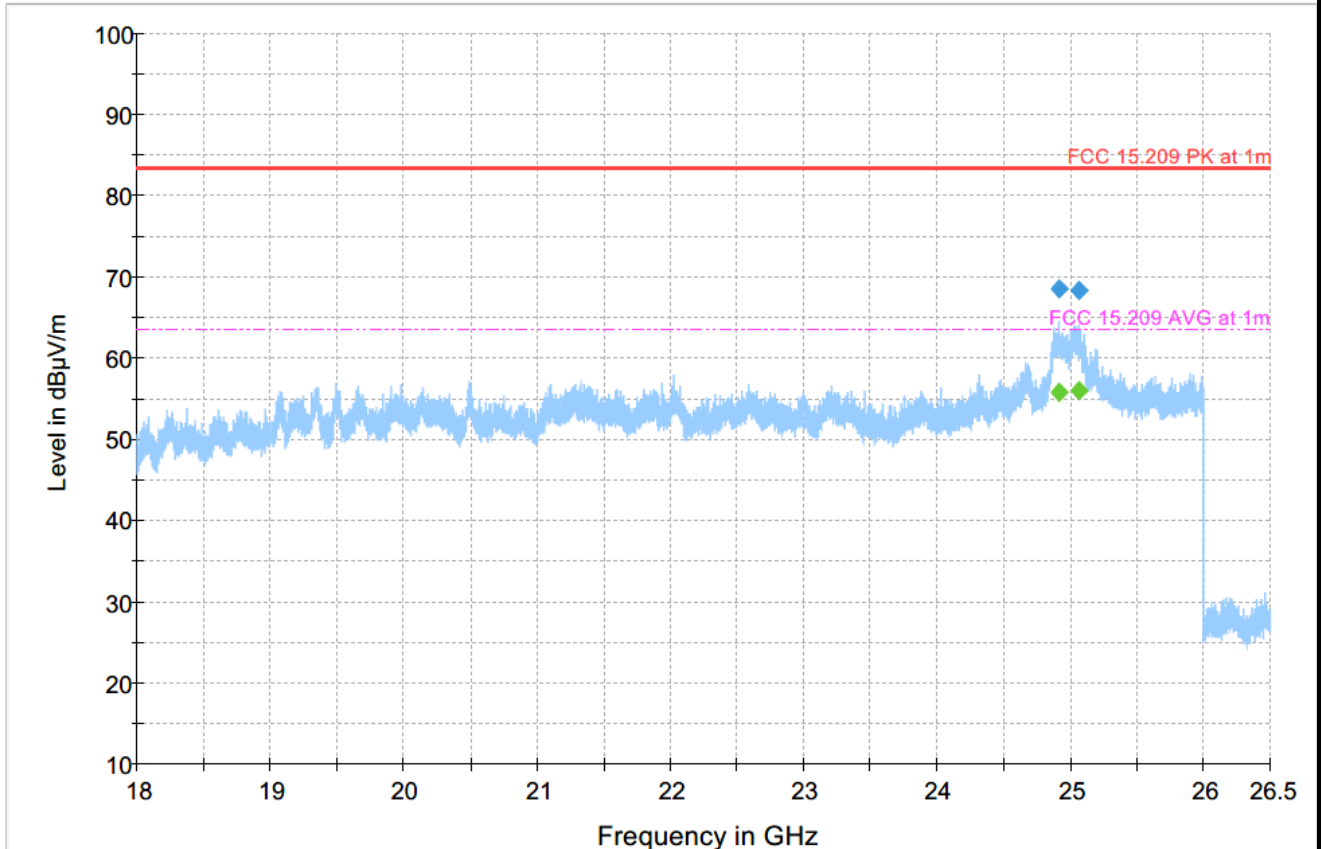
Modulation: 802.11g

Channel: Mid

100% Duty Cycle

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
24920.063	68.51	---	83.50	14.99	500.0	1000.000	150.0	V	282.0	30.2	
24920.063	---	55.74	63.50	7.76	500.0	1000.000	150.0	V	282.0	30.2	
25061.109	68.29	---	83.50	15.21	500.0	1000.000	150.0	V	23.0	30.3	
25061.109	---	55.95	63.50	7.55	500.0	1000.000	150.0	V	23.0	30.3	



— Preview Result 2-QPK
 — Preview Result 1-PK+
 — FCC 15.209 PK at 1m
- - - FCC 15.209 AVG at 1m
 ◆ Final_Result PK+
 ◆ Final_Result CAV

Plot #9 Radiated Emissions: 30 MHz – 1GHz

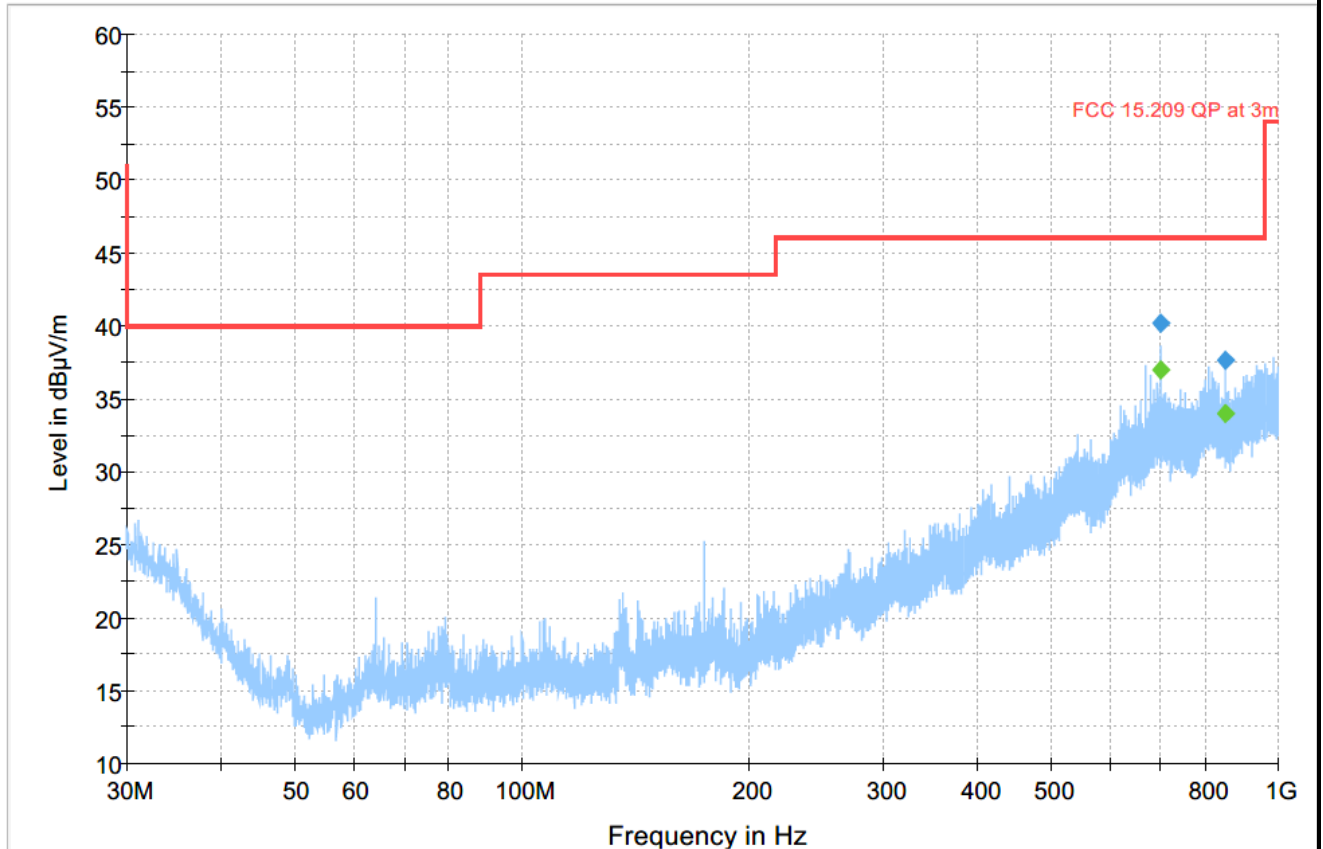
Modulation: 802.11g

Channel: High

100% Duty Cycle

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
697.554	40.19	---	46.02	5.83	500.0	120.000	164.0	H	226.0	29.1	
697.554	---	36.95	---	---	500.0	120.000	164.0	H	226.0	29.1	
851.461	37.64	---	46.02	8.38	500.0	120.000	195.0	H	217.0	29.1	
851.461	---	34.05	---	---	500.0	120.000	195.0	H	217.0	29.1	



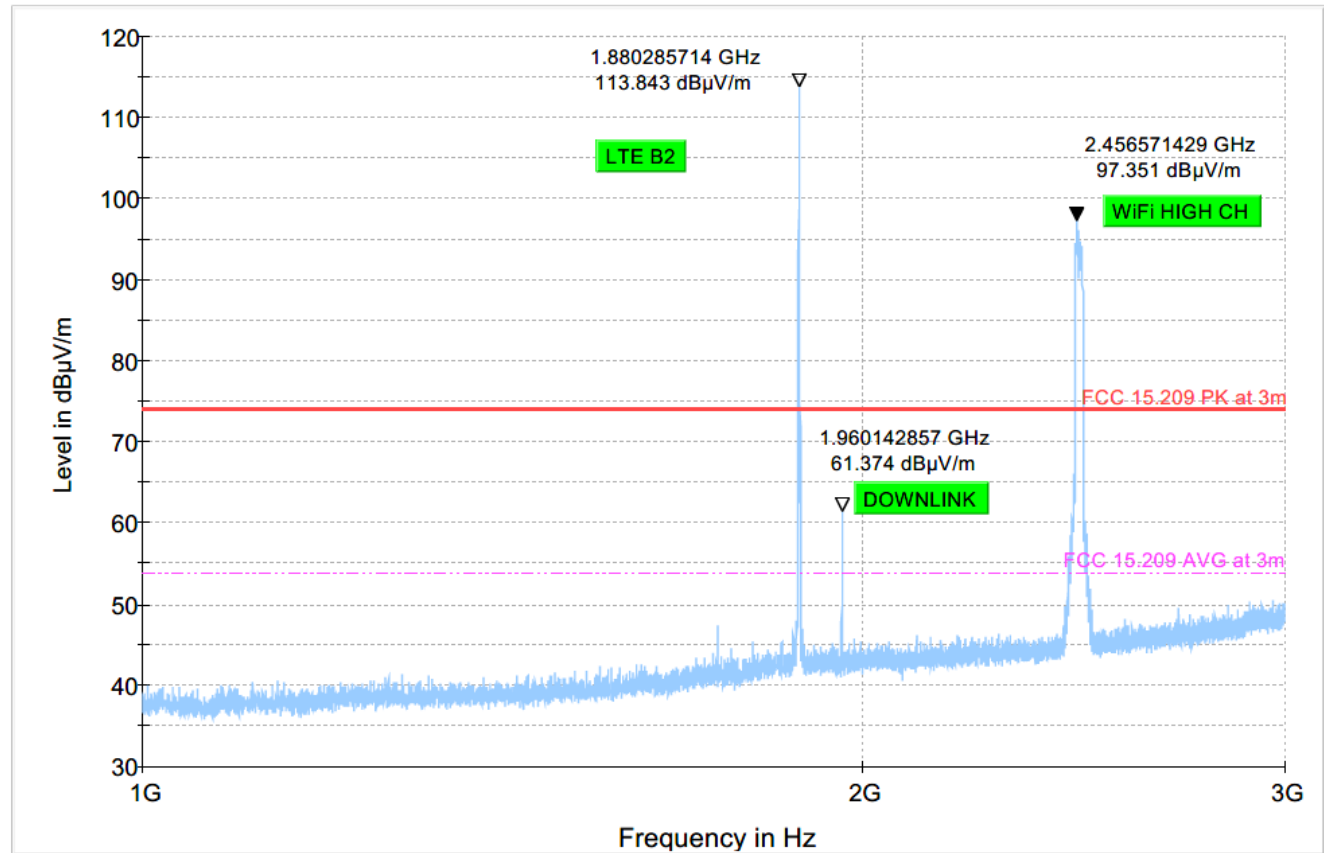
- ◆ Preview Result 2-QPK Final_Result PK+
- ◆ Preview Result 1-PK+
- ◆ Preview Result QPK Final_Result QPK
- FCC 15.209 QP at 3m

Plot #10 Radiated Emissions: 1-3 GHz

Modulation: 802.11g

Channel: High

100% Duty Cycle



- Preview Result 1-PK+ (blue line)
- Final_Result PK+ (blue diamond)
- FCC 15.209 PK at 3m (red line)
- Final_Result CAV (green diamond)
- FCC 15.209 AVG at 3m (magenta dashed line)



Plot #11 Radiated Emissions: 3-18 GHz

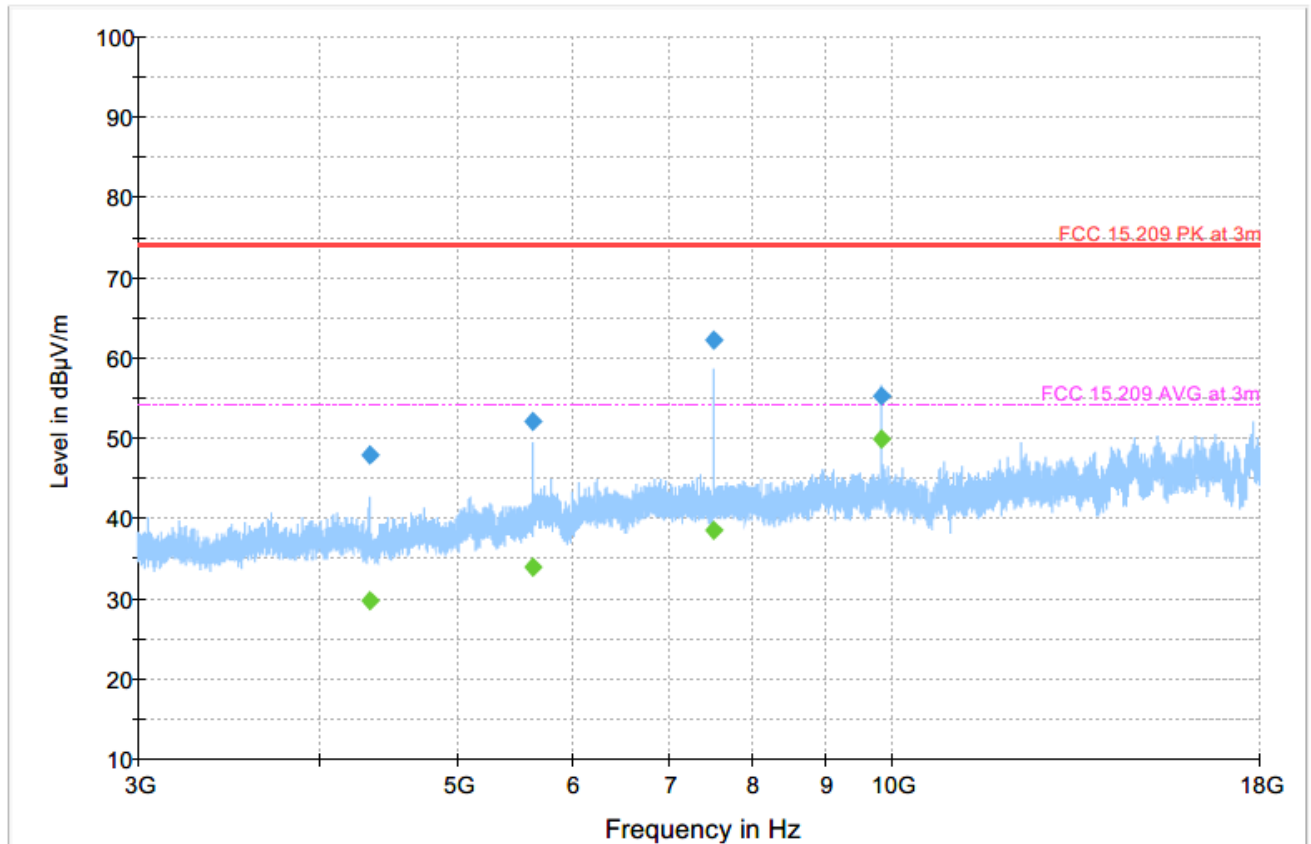
Modulation: 802.11g

Channel: High

100% Duty Cycle

Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
4340.250	47.76	---	73.98	26.22	500.0	1000.000	100.0	V	139.0	-4.7	
4340.250	---	29.68	53.98	24.30	500.0	1000.000	100.0	V	139.0	-4.7	
5641.000	---	33.96	53.98	20.02	500.0	1000.000	240.0	H	135.0	-1.1	
5641.000	51.96	---	73.98	22.02	500.0	1000.000	240.0	H	135.0	-1.1	
7521.500	62.10	---	73.98	11.88	500.0	1000.000	117.0	H	36.0	0.2	
7521.500	---	38.47	53.98	15.51	500.0	1000.000	117.0	H	36.0	0.2	
9847.750	---	49.90	53.98	4.08	500.0	1000.000	271.0	V	280.0	2.4	
9847.750	55.12	---	73.98	18.86	500.0	1000.000	271.0	V	280.0	2.4	



◆ Preview Result 1-PK+ Final_Result PK+
 — FCC 15.209 PK at 3m
 - - - FCC 15.209 AVG at 3m
 ◆ Final_Result CAV

8.7 AC Power Line Conducted Emissions

8.7.1 Measurement according to ANSI C63.4

Analyzer Settings:

- RBW = 9 KHz (CISPR Bandwidth)
- Detector: Peak / Average for Pre-scan
- Quasi-Peak/Average for Final Measurements

8.7.2 Limits: §15.207 & RSS-Gen 8.8

FCC §15.207(a) & RSS-Gen 8.8

- Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

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

*Decreases with the logarithm of the frequency.

8.7.3 Test conditions and setup:

Ambient Temperature $^{\circ}$ C	EUT Set-Up #	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22 $^{\circ}$ C	3	802.11g	Line & Neutral	110V / 60Hz

8.7.4 Measurement Result:

Plot #	Port	EUT Set-Up #:	EUT operating mode	Scan Frequency	Limit	Result
1, 2	AC Mains	3	802.11g	150 kHz – 30 MHz	See section 8.7.2	Pass

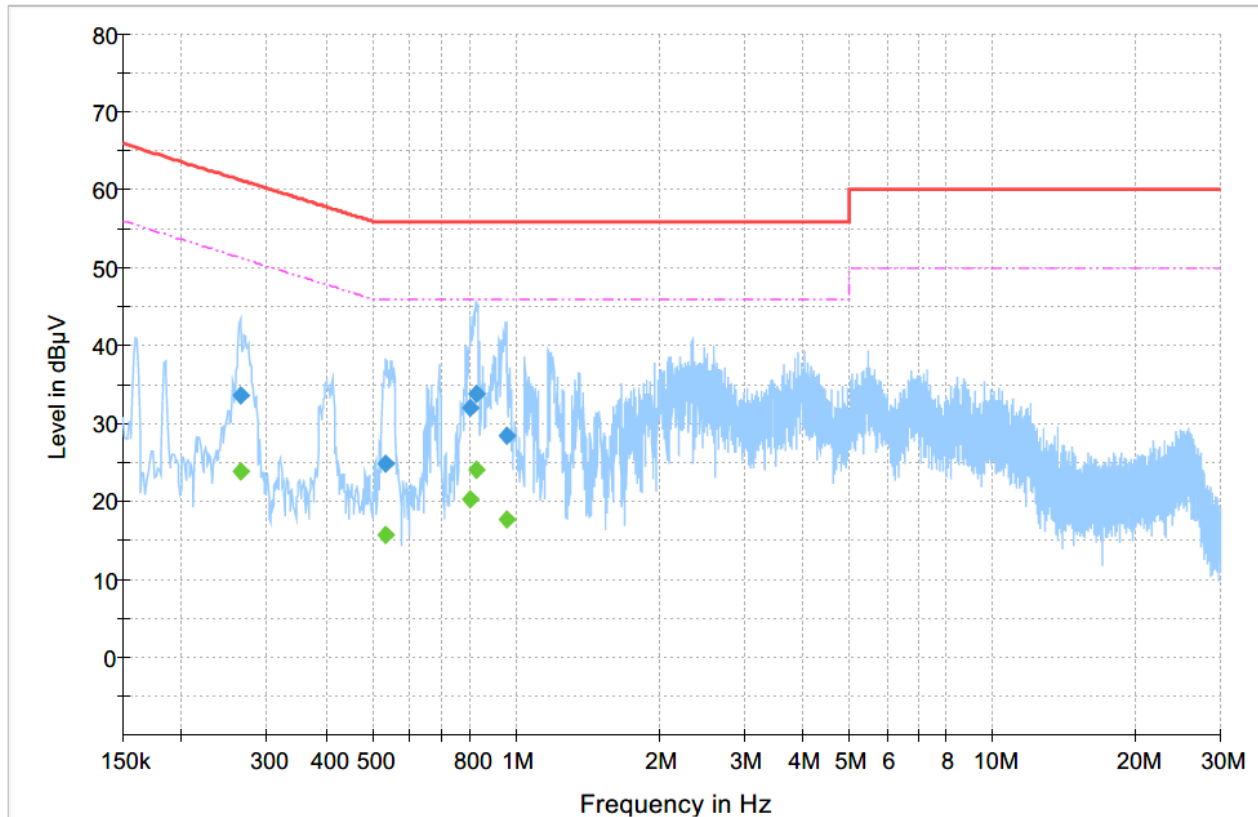
8.7.5 Measurement Plots:

Plot # 1 – Line

Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)	Comment
0.264	---	23.82	51.30	27.48	500.0	9.000	N	GND	10.1	
0.264	33.55	---	61.30	27.75	500.0	9.000	N	GND	10.1	
0.535	---	15.64	46.00	30.36	500.0	9.000	N	GND	10.0	
0.535	24.81	---	56.00	31.19	500.0	9.000	N	GND	10.0	
0.801	---	20.35	46.00	25.65	500.0	9.000	N	GND	10.0	
0.801	32.11	---	56.00	23.89	500.0	9.000	N	GND	10.0	
0.826	---	24.06	46.00	21.94	500.0	9.000	N	GND	10.0	
0.826	33.83	---	56.00	22.17	500.0	9.000	N	GND	10.0	
0.954	---	17.64	46.00	28.36	500.0	9.000	N	GND	10.1	
0.954	28.38	---	56.00	27.62	500.0	9.000	N	GND	10.1	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



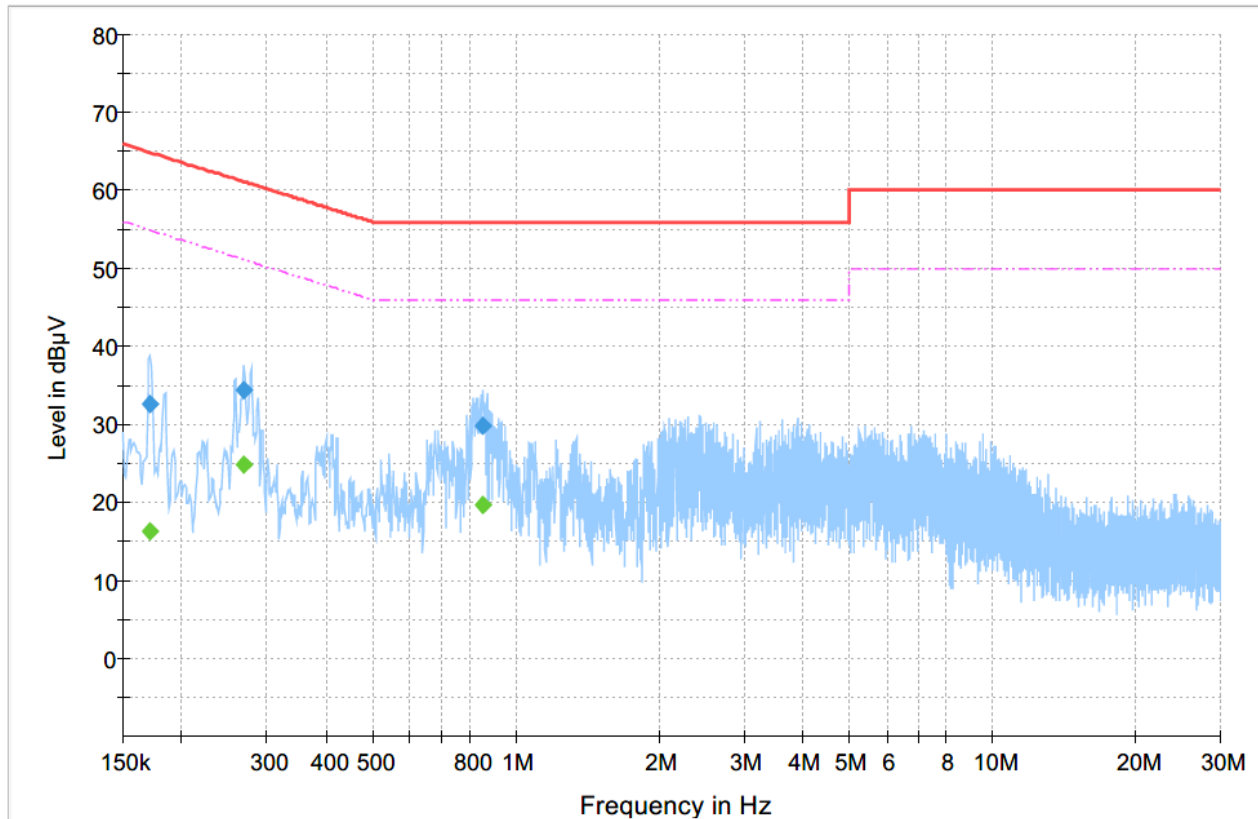
- ◆ Preview Result 1-PK+ Final_Result QPK
- ◆ EN 55032 Voltage on Mains QP Final_Result CAV
- - - EN 55032 Voltage on Mains A1

Plot # 2 – Neutral

Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)	Comment
0.171	---	16.36	54.90	38.54	500.0	9.000	L1	GND	10.6	
0.171	32.67	---	64.90	32.23	500.0	9.000	L1	GND	10.6	
0.269	---	24.76	51.14	26.38	500.0	9.000	L1	GND	10.1	
0.269	34.34	---	61.14	26.79	500.0	9.000	L1	GND	10.1	
0.856	---	19.64	46.00	26.36	500.0	9.000	L1	GND	10.0	
0.856	29.81	---	56.00	26.19	500.0	9.000	L1	GND	10.0	

Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.



- ◆ Preview Result 1-PK+ Final_Result QPK
- EN 55032 Voltage on Mains QP
- - - EN 55032 Voltage on Mains A1
- ◆ Final_Result CAV

9 Test setup photos

Setup photos are included in supporting file name: "EMC_GARMI-080-20001_FCC_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	03/12/2020
Magnetic Loop Antenna	Loop Antenna	ETS Lindgren	6507	161344	3 years	10/30/2020
Antenna Horn 3115 SN 35111	Horn Antenna	EMCO	3115	35111	3 years	04/17/2019
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	11/23/2020
Antenna Horn 3117	Horn Antenna	ETS Lindgren	3117-PA	169547	3 years	09/01/2020
FSU26	Spectrum Analyzer	R&S	FSU26	200302	3 years	7/16/2019
EMI Receiver	EMI Receiver	R&S	ESU40	100251	3 years	07/16/2019
LISN	Line Impedance Stabilization Network	FCC	FCC-LISN-50-25-2-08	8014	3 Year	7/19/2019
Thermometer Humidity	Thermometer Humidity	Control Company	36934-164	191871994	2 Year	1/10/2019

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.



11 History

Date	Report Name	Changes to report	Report prepared by
2021-07-02	EMC_GARMI-080-20001_15.247_WLAN	Initial Version	Yuchan Lu

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