FCC / ISED Test Report

FOR:

Astronautics

Model Name:

AFS6460

Product Description:

Connectivity Module

FCC ID: 2AVRR-AGCS-AFS6460
ISED ID: 25923-AFS6460

Applied Rules and Standards:
47 CFR Part 15.407 (NII) & 5 GHz (UNII)
RSS-247 Issue 2 (DTSs) & (LE-LAN), and RSS-Gen Issue 5

REPORT #: EMC_ASTRO-001-20001_15.407

DATE: 2020-04-02

A2LA Accredited

IC recognized # 3462B-1

***CETECOM* Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
Phone: + 1 (408) 586 6200 ◆ Fax: + 1 (408) 586 6299 ◆ E-mail: info@cetecom.com ◆ http://www.cetecom.com
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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.407 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Astronautics	Connectivity Module	AFS6460

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2020-04-02	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I am approving this document Location: Date: 2020-04-02 14:50:40

Responsible for the Report:

Date	Section	Name	Signature
2020-04-02	Compliance	Kris Lazarov (Senior EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov Date: 2020.04.02 14:13:45 -07'00'

The test results of this test report relate exclusively to the test item specified in Section3.
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:	Cindy Li
Responsible Project Leader:	Kris Lazarov

2.2 Identification of the Client

Applicant's Name:	Astronautics
Street Address:	135 W Forest Hill Avenue
City/Zip Code	Oak Creek, WI 53154-0121
Country	United States

2.3 Identification of the Manufacturer

Manufacturer's Name:	Astronautics
Manufacturers Address:	1426 W National Ave
City/Zip Code	Milwaukee, WI 53204
Country	United States

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	AFS6460
HW Version :	278830-1
SW Version :	282306-0002
FCC-ID :	2AVRR-AGCS-AFS6460
ISED ID:	25923-AFS6460
FWIN:	N/A
HVIN:	AFS6460
PMN:	Connectivity Module
Product Description:	Connectivity Module
Radio Module:	Contains two Sparklan WPEQ-256ACNI; FCC ID: RYK-WPEQ256ACNI
Frequency Range / number of channels:	Frequency Range (MHz) / Channel Number 5150-5250 / 36-48 [4] 5725-5850 / 149-161 [4]
Modes of Operation	WiFi 802.11n/ac set as WAP and WLAN See Note 1
Type(s) of Modulation:	BPSK / QPSK / QAM
Antenna Information as declared:	WAP Max Gain 3.2dBi WLAN Max Gain 2.9dBi
Max. Output Power:	13dBm
Power Supply/ Rated Operating Voltage Range:	- 37V to - 57V – Nominal - 48V
Operating Temperature Range	-40 ºC to 65 ºC
Other Radios included in the device:	UMTS / LTE / 802.11b/g/n
Sample Revision	☐Prototype Unit; ■Production Unit; ☐Pre-Production

Note 1: This devise incorporates two identical Sparklan certified modules model number: WPEQ-256ACNI. One module is configured to operate as Access Point (WAP), and the other operates as WLAN station.

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	112190984	278830-1	282306-0002	

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Remote Media Device	AFS6480	Astronautics	110191019
2	Airborne Communication Server	AFS6400	Astronautics	110190246

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1 +AE#2	

3.5 Mode of Operation details

Mode of Operation	Description of Operating modes	Additional Information
1	WAP	The device was configured to operate as a wireless access point, and linked to a laptop PC in 802.11n mode. Iperf3 traffic was established between the AP and the laptop PC.
2	WLAN	The device was configured to operate as a station, and linked to an access point in 802.11n mode. Iperf3 traffic was established between the AP and the device.

3.6 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 power in 802.11n mode. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

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 15.407 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: 2AVRR-AGCS-AFS6460, and ISED ID: 25923-AFS6460

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.407(e) RSS-247 6.2.4.1	Emission Bandwidth	Nominal	802.11n	☐	☐	■	Complies See Note 2
§15.407(a) RSS-247 6	Power Spectral Density	Nominal	802.11n	☐	☐	■	Complies See Note 2
§15.407(a) RSS-247 6	Maximum Output Power	Nominal	802.11n	☐	☐	■	Complies See Note 2
§15.407; 15.205 RSS-247 6; RSS-Gen 8.10	Band Edge Compliance	Nominal	802.11n	☐	☐	■	Complies See Note 2
§15.407(b); §15.209; 15.205 RSS-247 6; RSS-Gen 8.9; 8.10	Radiated TX Spurious Emissions	Nominal	802.11n	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	802.11n	☐	■	☐	Complies See Note 3

Note 1: NA= Not Applicable; NP= Not Performed.

Note 2: This devise incorporates two identical Sparklan certified modules model number: WPEQ-256ACNI. One module is configured to operate as Access Point (WAP), and the other operates as WLAN station. Only radiated spurious emissions were tested for both modules

Note 3: This devise does not connect to AC mains network

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)

RF conducted measurement	±0.5 dB

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:

03/09/2020 - 03/20/2020

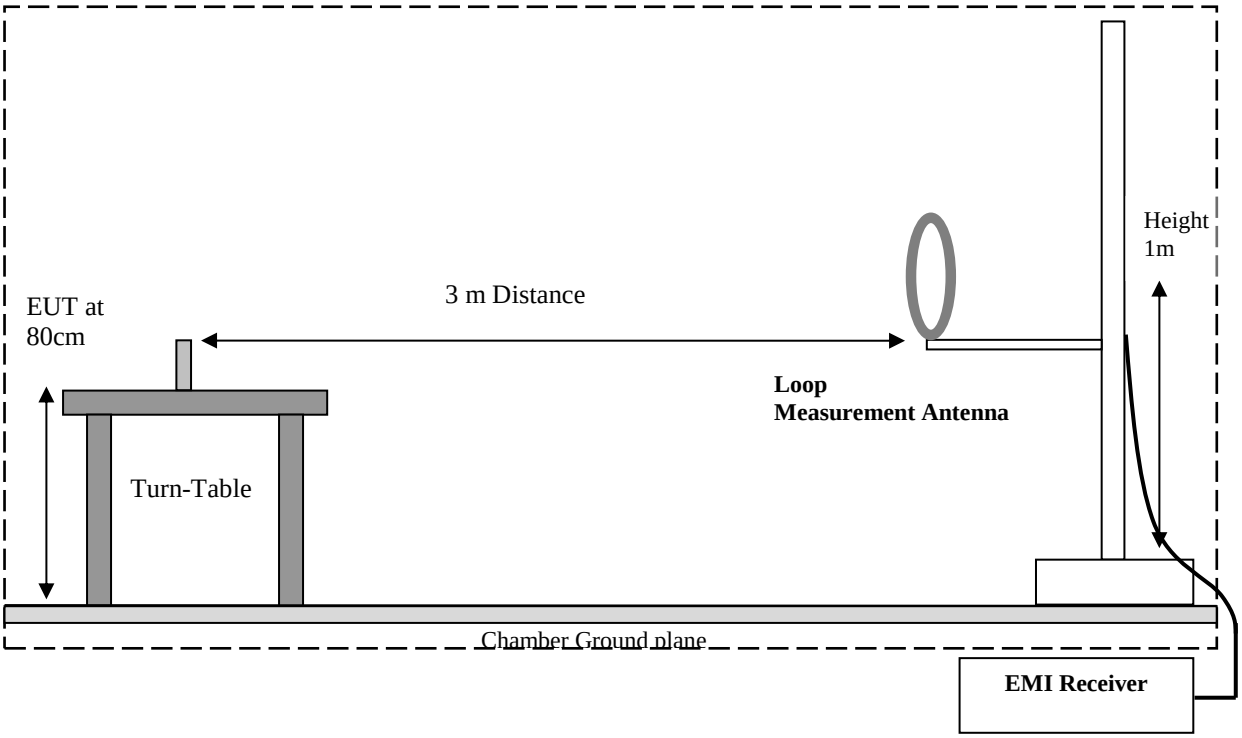
7 Measurement Procedures

7.1 Radiated Measurement

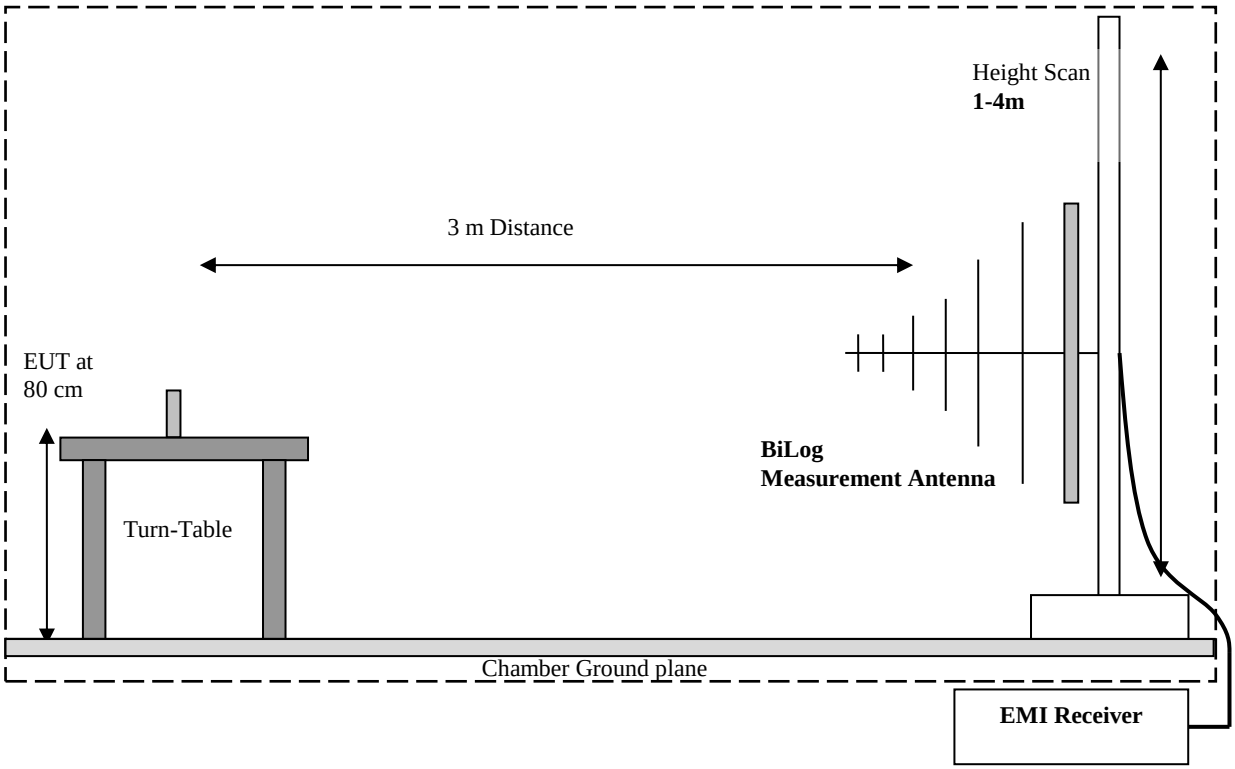
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

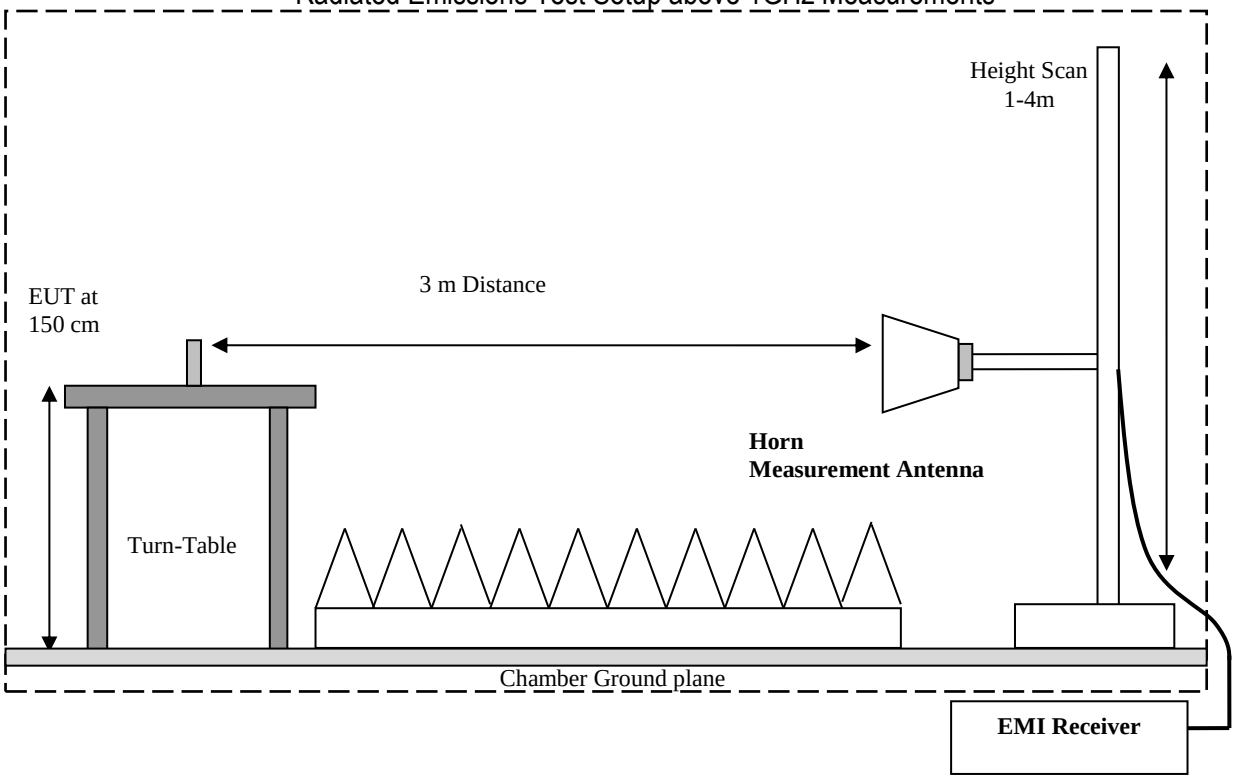
Radiated Emissions Test Setup below 30MHz Measurements



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 (dBµV/m) = Measured Value on SA (dBµV)+ Cable Loss (dB)+ 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

8 Test Result Data

8.1 Radiated Transmitter Spurious Emissions

8.1.1 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 at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

8.1.2 Limits:

FCC §15.407

- Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209.
- The provisions of §15.205 apply to intentional radiators operating under this section.

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
[1]0.495-0.505	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)).

8.1.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	1 and 2	29 VDC

8.1.4 Testing notes:

In order to exercise the EUT the support equipment needed to be placed in close proximity on top of the turn table. The emissions from the support equipment were evaluated with a base line scan where the EUT was powered off. This base line scan identified the following frequencies, which were excluded from the evaluation of the EUT performance:

Frequency (MHz)
31.067
133.208
212.457
249.996
315.115
499.997
687.531
750.031
875.064
1000.000
1250.000
5000.000

8.1.5 Measurement result:

Plot #	EUT Operating Mode	Channel #	Scan Frequency	Limit	Result
1-4	1 (WAP)	Low (36)	30 MHz – 26 GHz	See section 8.1.2	Pass
5-10	1 (WAP)	Mid (40)	9 kHz – 40 GHz	See section 8.1.2	Pass
11-14	1 (WAP)	High (48)	30 MHz – 26 GHz	See section 8.1.2	Pass
15-18	1 (WAP)	Low (149)	30 MHz – 26 GHz	See section 8.1.2	Pass
19-24	1 (WAP)	Mid (153)	9 kHz – 40 GHz	See section 8.1.2	Pass
25-28	1 (WAP)	High (161)	30 MHz – 26 GHz	See section 8.1.2	Pass

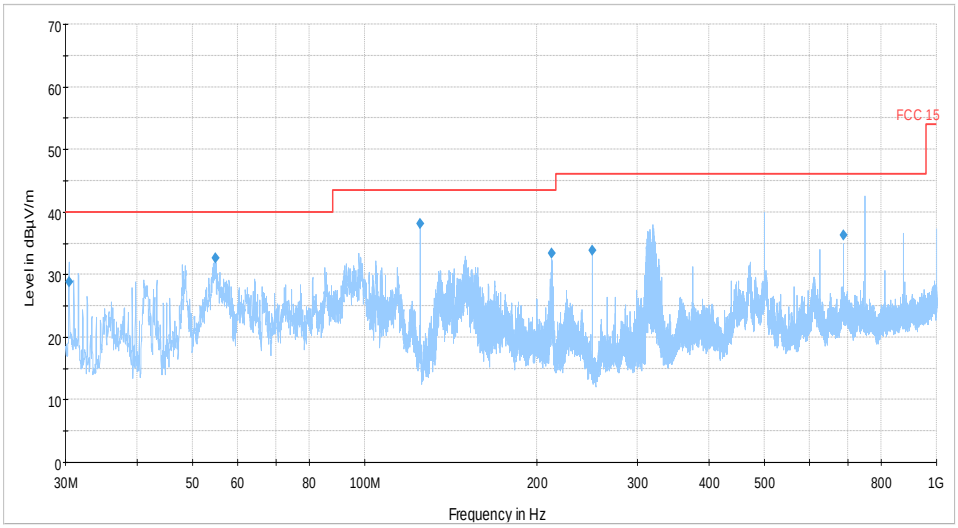
Plot #	EUT Operating Mode	Channel #	Scan Frequency	Limit	Result
29-32	2 (WLAN)	Low (36)	30 MHz – 26 GHz	See section 8.1.2	Pass
33-38	2 (WLAN)	Mid (40)	9 kHz – 40 GHz	See section 8.1.2	Pass
39-41	2 (WLAN)	High (48)	30 MHz – 26 GHz	See section 8.1.2	Pass
42-45	2 (WLAN)	Low (149)	30 MHz – 26 GHz	See section 8.1.2	Pass
46-51	2 (WLAN)	Mid (153)	9 kHz – 40 GHz	See section 8.1.2	Pass
52-55	2 (WLAN)	High (161)	30 MHz – 26 GHz	See section 8.1.2	Pass

8.1.6 WAP Measurement Plots:

Plot #1 Radiated Emissions: 30 MHz – 1GHz

Mode: WAP 802.11/n | Low (36)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.466	28.86	40.00	11.14	200.0	120.000	158.0	V	-2.0
54.801	32.59	40.00	7.41	200.0	120.000	181.0	V	269.0
125.011	38.07	43.52	5.45	200.0	120.000	300.0	H	97.0
212.636	33.39	43.52	10.13	200.0	120.000	166.0	V	123.0
250.010	33.80	46.02	12.22	200.0	120.000	140.0	V	110.0
687.510	36.36	46.02	9.66	200.0	120.000	140.0	V	-48.0

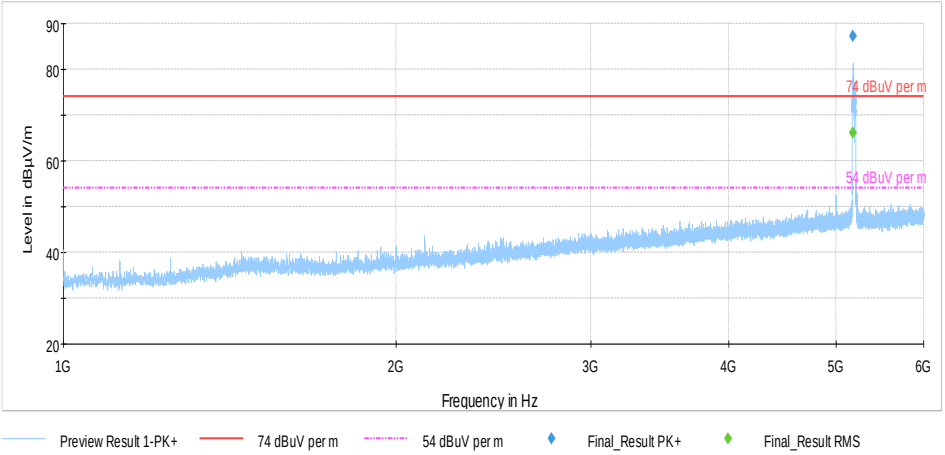


Preview Result 1-PK+ FCC 15 Final_Result QPK

Plot #2 Radiated Emissions: 1-6 GHz

Mode: WAP 802.11/n | Low (36)

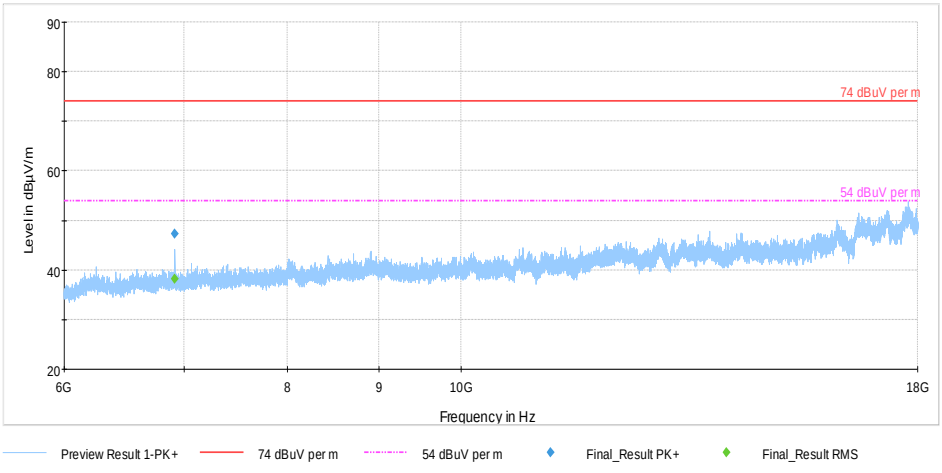
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
5181.250	---	66.03	54.00	-12.03	500.0	1000.000	140.0	H	264.0
5181.250	87.32	---	74.00	-13.32	500.0	1000.000	140.0	H	264.0



Plot #3 Radiated Emissions: 6-18 GHz

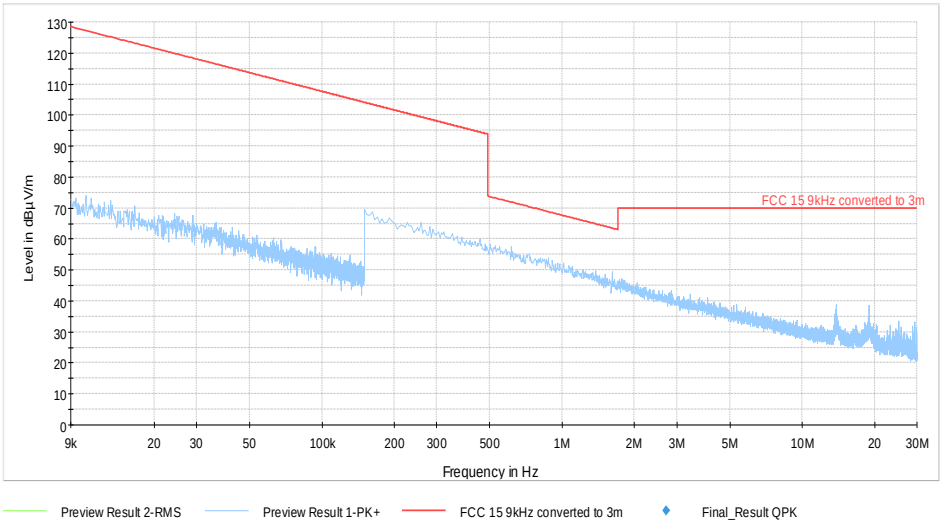
Mode: WAP 802.11/n | Low (36)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
6919.800	---	38.28	54.00	15.72	500.0	1000.000	184.0	H
6919.800	47.25	---	74.00	26.75	500.0	1000.000	184.0	H



Plot #4 Radiated Emissions: 18-26 GHz		
Mode: WAP 802.11/n	Low (36)	

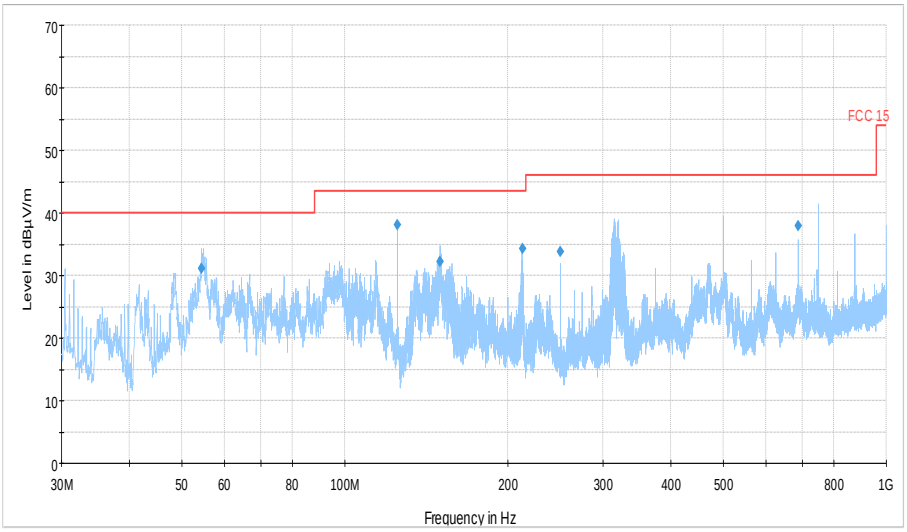
Plot # 5 Radiated Emissions: 9 KHz – 30 MHz		
Mode: WAP 802.11/n	Mid (40)	



Plot #6 Radiated Emissions: 30 MHz – 1GHz

Mode: WAP 802.11/n | Mid (40)

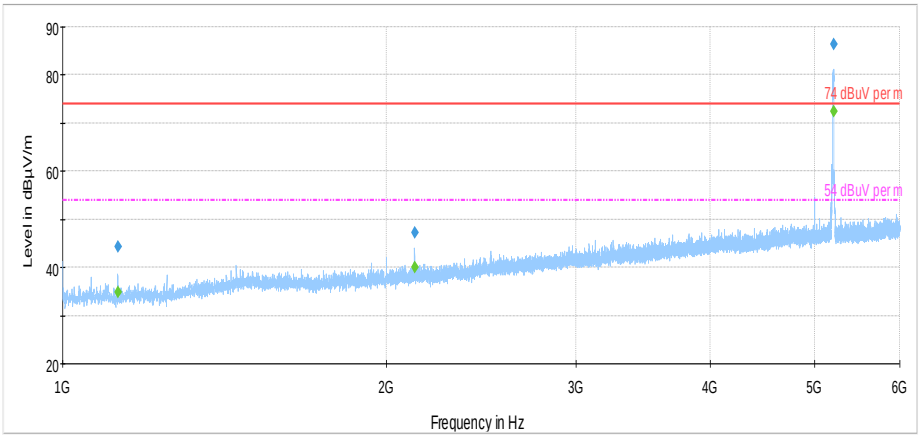
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
54.376	31.06	40.00	8.94	200.0	120.000	186.0	V	13.0
125.015	38.06	43.52	5.46	200.0	120.000	140.0	V	267.0
149.896	32.19	43.52	11.33	200.0	120.000	184.0	V	237.0
212.661	34.30	43.52	9.22	200.0	120.000	159.0	V	123.0
249.995	33.75	46.02	12.27	200.0	120.000	140.0	V	114.0
687.514	37.89	46.02	8.13	200.0	120.000	152.0	V	-15.0



Plot #7 Radiated Emissions: 1-6 GHz

Mode: WAP 802.11/n | Mid (40)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1125.050	---	34.88	54.00	19.12	500.0	1000.000	162.0	V	96.0
1125.050	44.27	---	74.00	29.73	500.0	1000.000	162.0	V	96.0
2123.550	---	39.98	54.00	14.02	500.0	1000.000	140.0	V	202.0
2123.550	47.20	---	74.00	26.80	500.0	1000.000	140.0	V	202.0
5206.500	---	72.39	54.00	-18.39	500.0	1000.000	173.0	H	205.0
5206.500	86.35	---	74.00	-12.35	500.0	1000.000	173.0	H	205.0

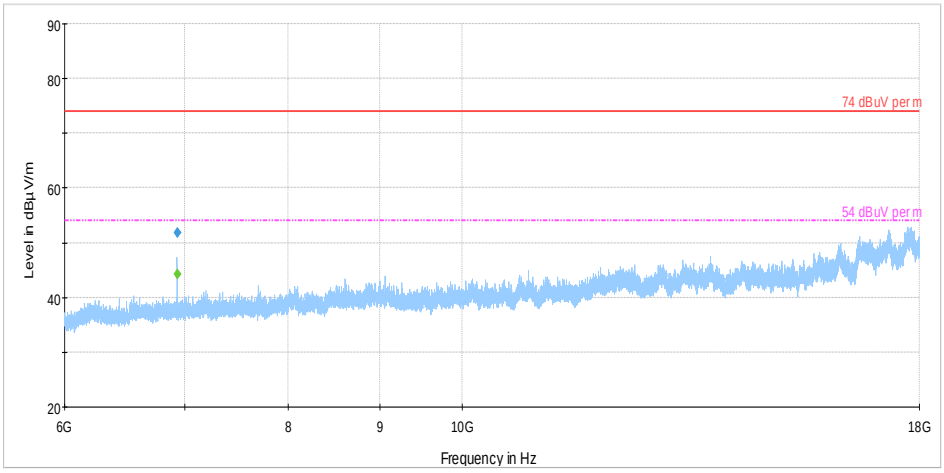


Preview Result 1-PK+ | 74 dBuV per m | 54 dBuV per m | Final_Result PK+ | Final_Result RMS

Plot #8 Radiated Emissions: 6-18 GHz

Mode: WAP 802.11/n | Mid (40)

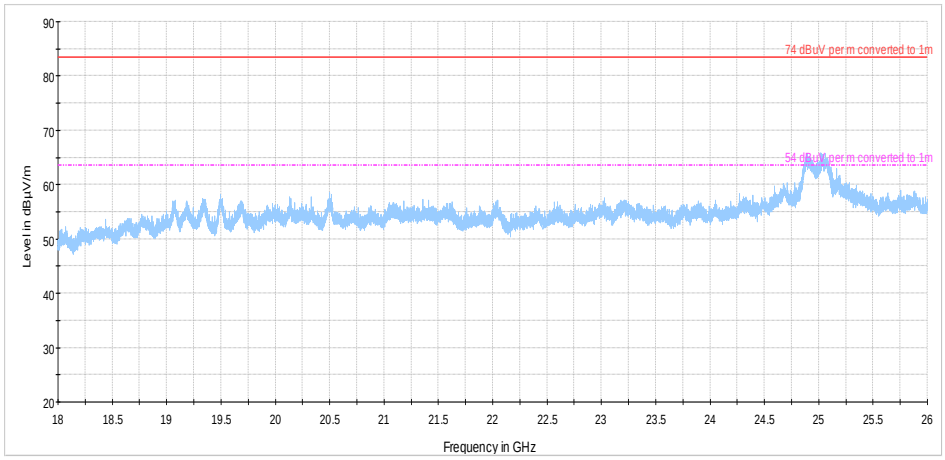
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
6933.400	---	44.22	54.00	9.78	500.0	1000.000	152.0	H	208.0
6933.400	51.81	---	74.00	22.19	500.0	1000.000	152.0	H	208.0



Preview Result 1-PK+ | 74 dBuV per m | 54 dBuV per m | Final_Result PK+ | Final_Result RMS

Plot #9 Radiated Emissions: 18-26 GHz

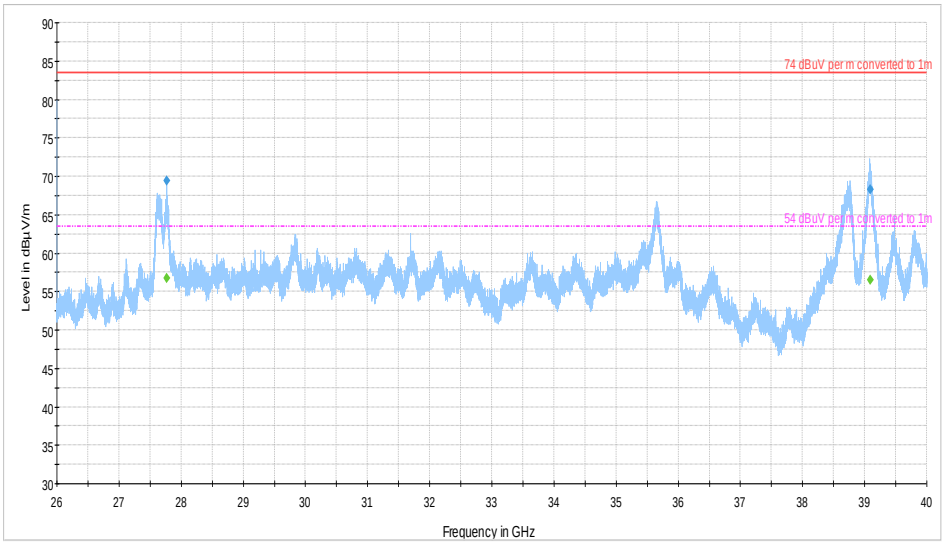
Mode: WAP 802.11/n | Mid (40)



Plot #10 Radiated Emissions: 26-40 GHz

Mode: WAP 802.11/n | Mid (40)

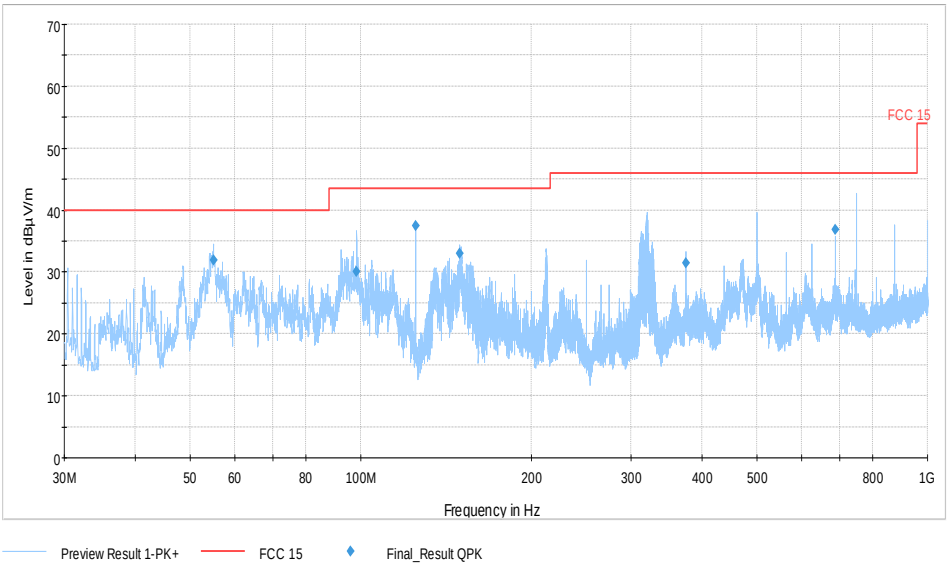
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
27771.804	---	56.75	63.50	6.75	100.0	1000.000	150.0	V	99.0
27771.804	69.43	---	83.50	14.07	100.0	1000.000	150.0	V	99.0
39087.708	---	56.52	63.50	6.98	100.0	1000.000	150.0	H	112.0
39087.708	68.32	---	83.50	15.18	100.0	1000.000	150.0	H	112.0



Plot #11 Radiated Emissions: 30 MHz – 1GHz

Mode: WAP 802.11/n | High (48)

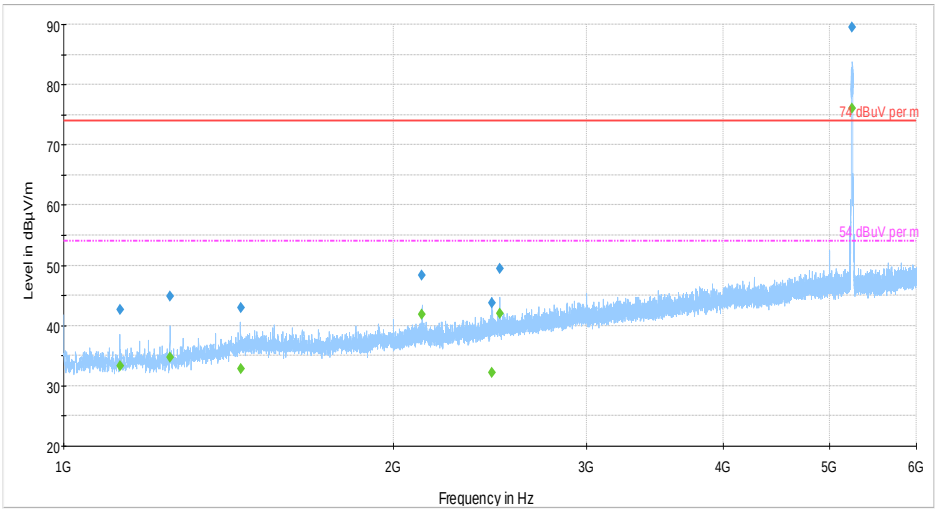
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
54.956	31.85	40.00	8.15	200.0	120.000	162.0	V	210.0
98.399	30.07	43.52	13.45	200.0	120.000	291.0	V	143.0
125.004	37.53	43.52	5.99	200.0	120.000	140.0	V	17.0
149.586	32.95	43.52	10.57	200.0	120.000	152.0	V	192.0
374.995	31.40	46.02	14.62	200.0	120.000	158.0	V	72.0
687.512	36.85	46.02	9.17	200.0	120.000	172.0	V	-19.0



Plot #12 Radiated Emissions: 1-6 GHz

Mode: WAP 802.11/n | High (48)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1125.050	---	33.25	54.00	20.75	500.0	1000.000	162.0	H	239.0
1125.050	42.58	---	74.00	31.42	500.0	1000.000	162.0	H	239.0
1250.050	---	34.74	54.00	19.26	500.0	1000.000	140.0	V	100.0
1250.050	44.89	---	74.00	29.11	500.0	1000.000	140.0	V	100.0
1450.050	---	32.85	54.00	21.16	500.0	1000.000	237.0	V	314.0
1450.050	42.96	---	74.00	31.04	500.0	1000.000	237.0	V	314.0
2123.400	---	41.80	54.00	12.20	500.0	1000.000	213.0	V	105.0
2123.400	48.35	---	74.00	25.65	500.0	1000.000	213.0	V	105.0
2458.650	---	32.25	54.00	21.75	500.0	1000.000	205.0	V	169.0
2458.650	43.73	---	74.00	30.27	500.0	1000.000	205.0	V	169.0
2500.050	---	42.01	54.00	11.99	500.0	1000.000	246.0	V	336.0
2500.050	49.45	---	74.00	24.55	500.0	1000.000	246.0	V	336.0
5242.250	---	76.06	54.00	-22.06	500.0	1000.000	227.0	H	211.0
5242.250	89.55	---	74.00	-15.55	500.0	1000.000	227.0	H	211.0

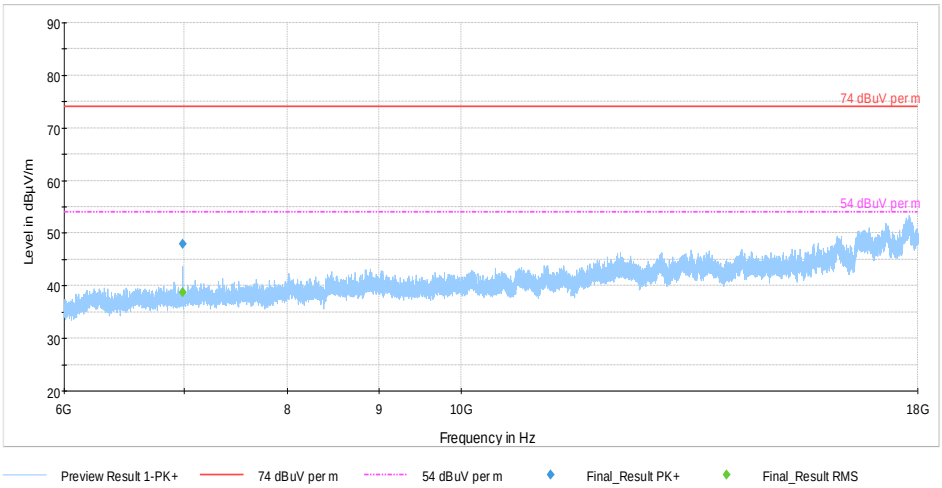


Preview Result 1-PK+ | 74 dBuV per m | 54 dBuV per m | Final_Result PK+ | Final_Result RMS

Plot #13 Radiated Emissions: 6-18 GHz

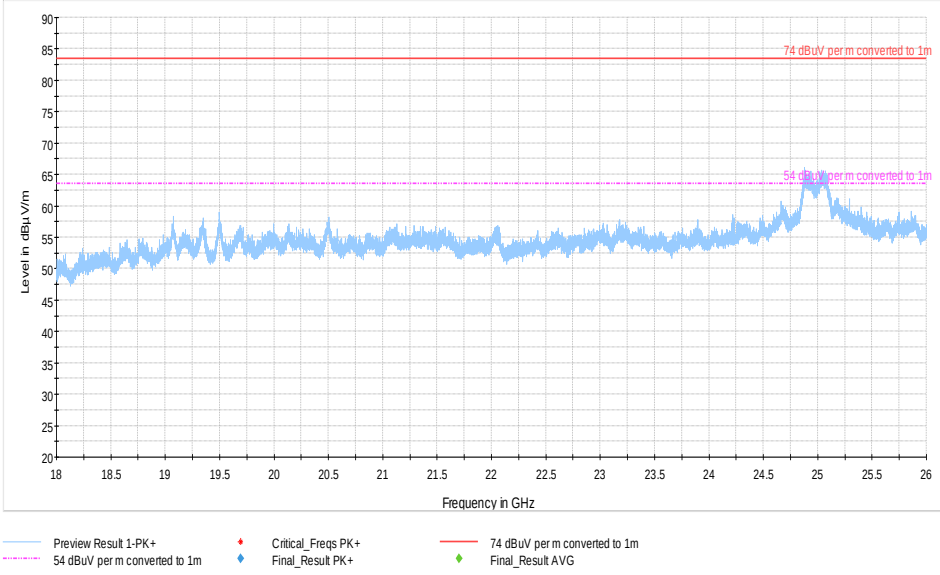
Mode: WAP 802.11/n | High (48)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
6986.600	---	38.79	54.00	15.21	500.0	1000.000	173.0	H	215.0
6986.600	47.98	---	74.00	26.02	500.0	1000.000	173.0	H	215.0



Plot #14 Radiated Emissions: 18-26 GHz

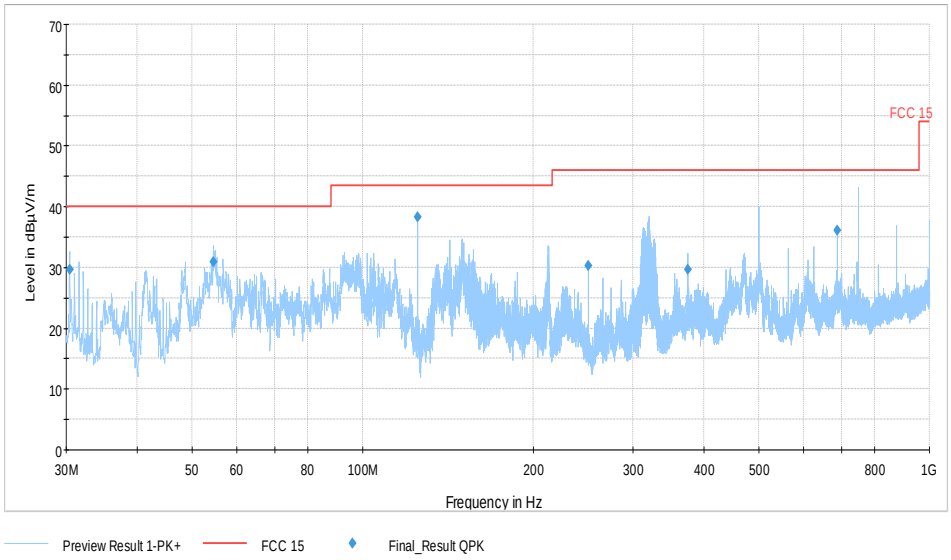
Mode: WAP 802.11/n | High (48)



Plot #15 Radiated Emissions: 30 MHz – 1GHz

Mode: WAP 802.11/n | Low (149)

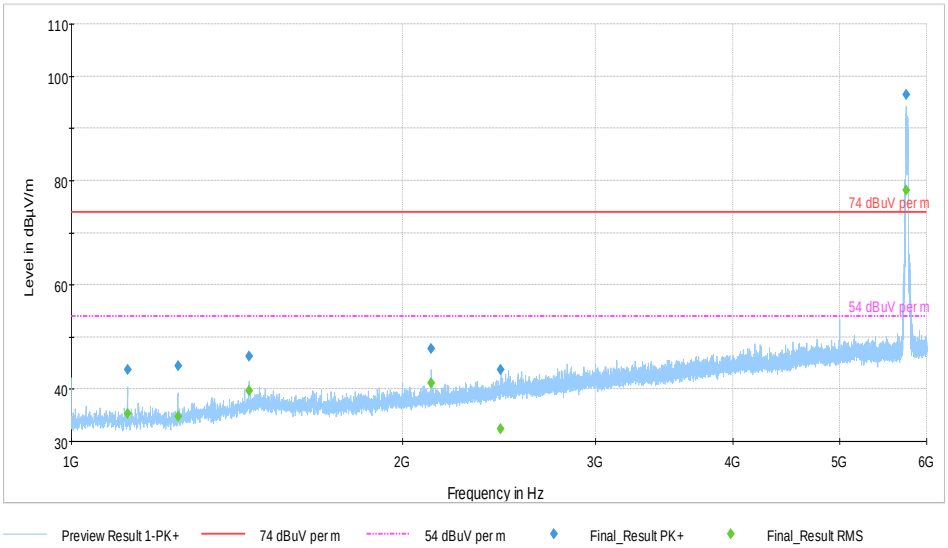
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.459	29.59	40.00	10.41	200.0	120.000	151.0	V	348.0
54.545	30.96	40.00	9.04	200.0	120.000	154.0	V	208.0
125.011	38.31	43.52	5.21	200.0	120.000	140.0	V	39.0
249.986	30.30	46.02	15.72	200.0	120.000	175.0	H	253.0
375.046	29.66	46.02	16.36	200.0	120.000	140.0	V	-23.0
687.509	36.15	46.02	9.87	200.0	120.000	151.0	V	-16.0



Plot #16 Radiated Emissions: 1-6 GHz

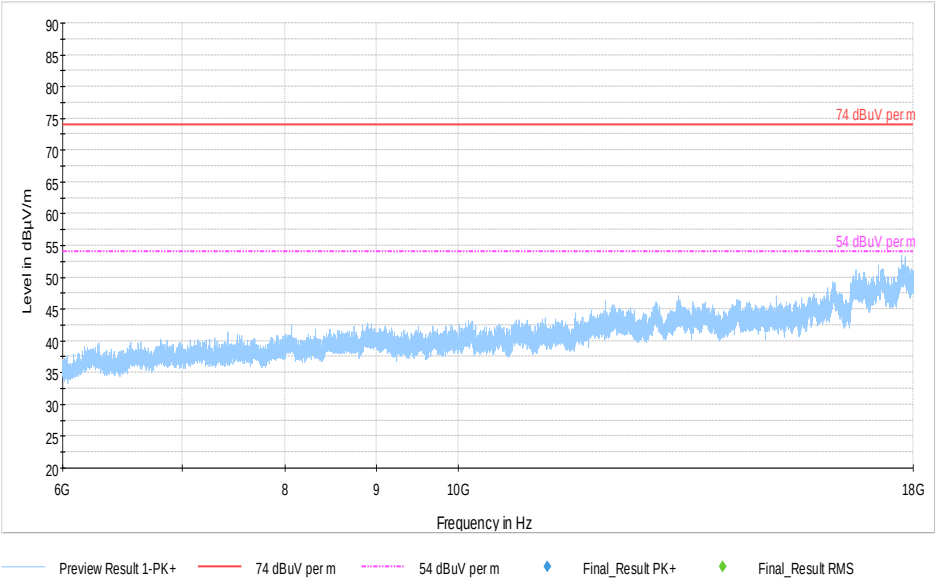
Mode: WAP 802.11/n | Low (149)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1125.050	---	35.35	54.00	18.65	500.0	1000.000	173.0	V	96.0
1125.050	43.81	---	74.00	30.19	500.0	1000.000	173.0	V	96.0
1250.050	---	34.85	54.00	19.15	500.0	1000.000	140.0	V	95.0
1250.050	44.38	---	74.00	29.62	500.0	1000.000	140.0	V	95.0
1450.050	---	39.67	54.00	14.33	500.0	1000.000	173.0	V	251.0
1450.050	46.22	---	74.00	27.78	500.0	1000.000	173.0	V	251.0
2123.550	---	41.14	54.00	12.86	500.0	1000.000	226.0	V	105.0
2123.550	47.74	---	74.00	26.26	500.0	1000.000	226.0	V	105.0
5749.350	---	78.14	54.00	-24.14	500.0	1000.000	265.0	H	313.0
5749.350	96.45	---	74.00	-22.45	500.0	1000.000	265.0	H	313.0



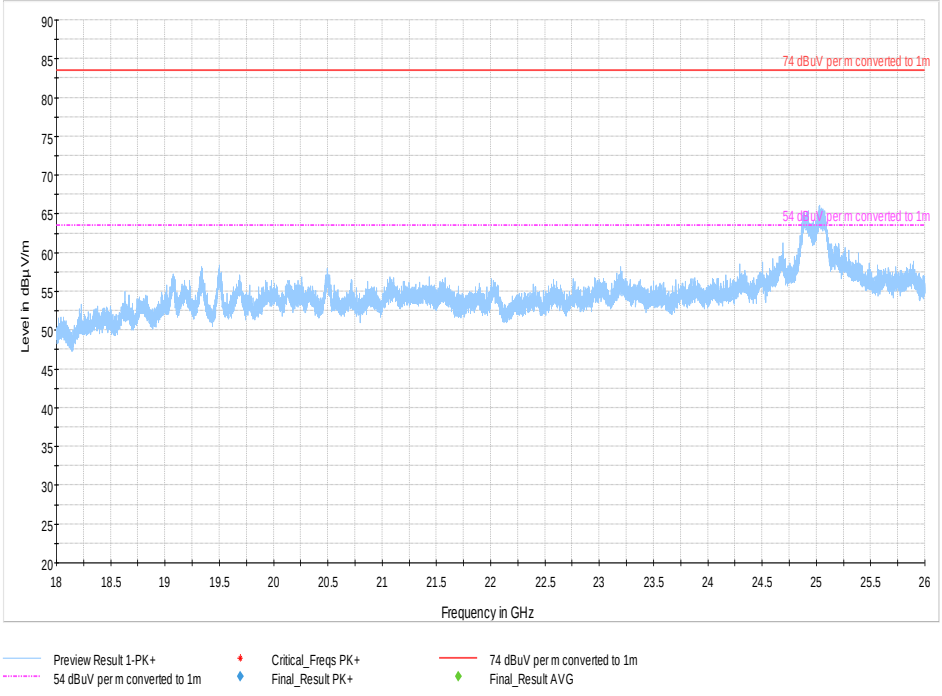
Plot #17 Radiated Emissions: 6-18 GHz

Mode: WAP 802.11/n	Low (149)	



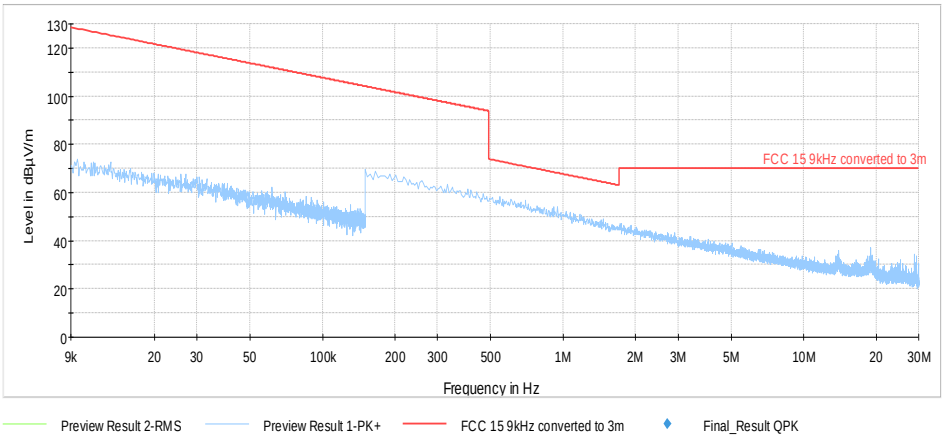
Plot #18 Radiated Emissions: 18-26 GHz

Mode: WAP 802.11/n	Low (149)	



Plot # 19 Radiated Emissions: 9 KHz – 30 MHz

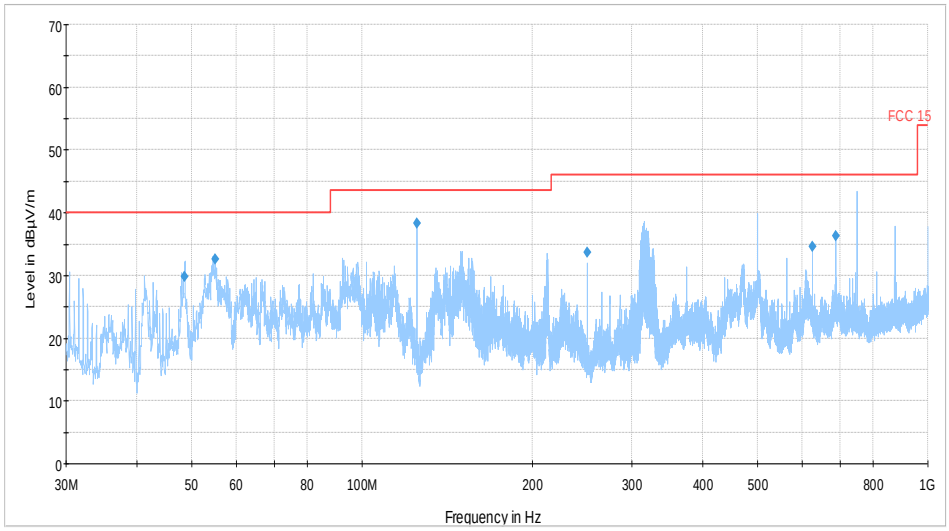
Mode: WAP 802.11/n	Mid (153)	



Plot #20 Radiated Emissions: 30 MHz – 1GHz

Mode: WAP 802.11/n	Mid (153)	

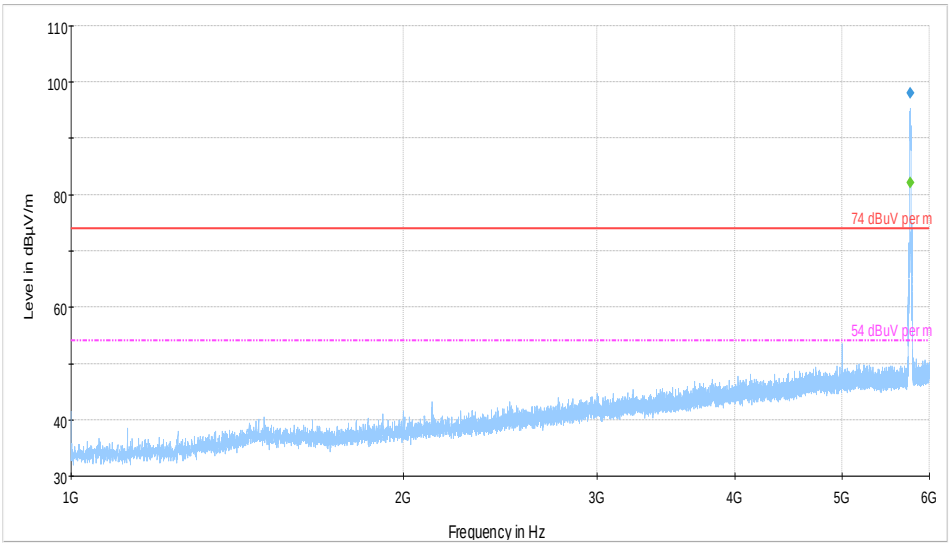
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
48.639	29.79	40.00	10.21	200.0	120.000	201.0	V	228.0
55.043	32.53	40.00	7.47	200.0	120.000	140.0	V	201.0
125.005	38.28	43.52	5.24	200.0	120.000	140.0	V	47.0
250.011	33.66	46.02	12.36	200.0	120.000	195.0	V	17.0
624.996	34.66	46.02	11.36	200.0	120.000	151.0	V	342.0
687.483	36.36	46.02	9.66	200.0	120.000	140.0	V	-15.0



Plot #21 Radiated Emissions: 1-6 GHz

Mode: WAP 802.11/n | Mid (153)

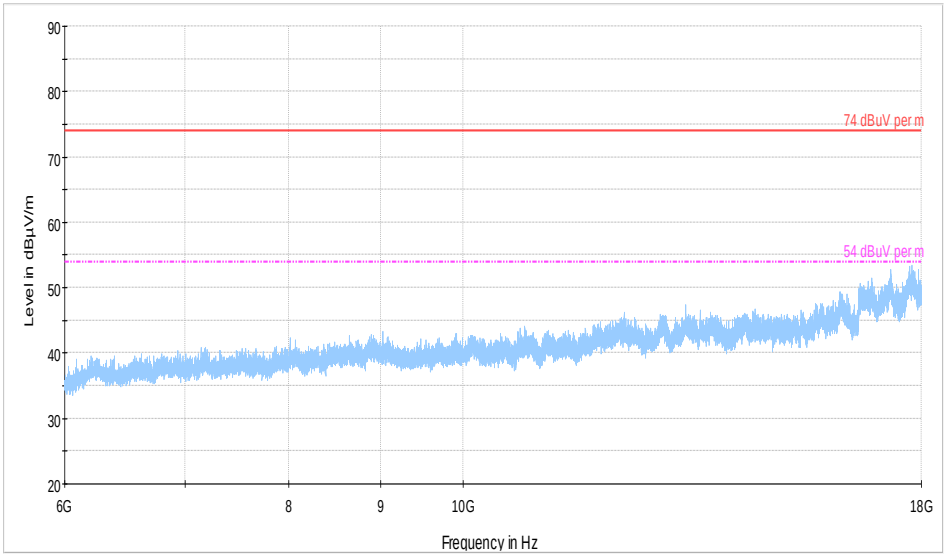
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
5765.900	---	82.13	54.00	-28.13	500.0	1000.000	140.0	H	309.0
5765.900	98.10	---	74.00	-24.10	500.0	1000.000	140.0	H	309.0



Preview Result 1-PK+ | 74 dBuV per m | 54 dBuV per m | Final_Result PK+ | Final_Result RMS

Plot #22 Radiated Emissions: 6-18 GHz

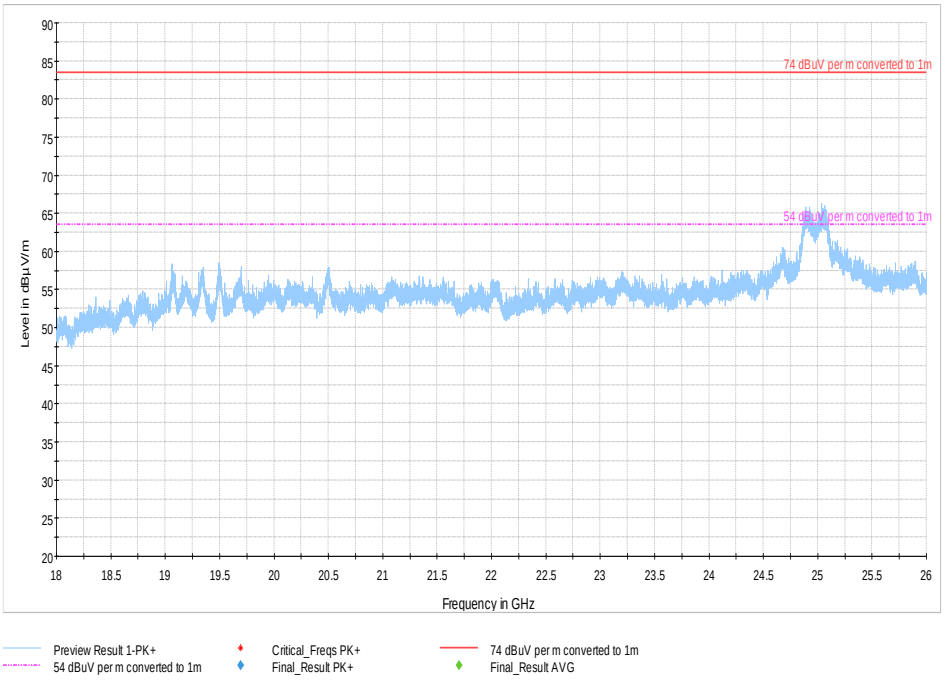
Mode: WAP 802.11/n | Mid (153)



Preview Result 1-PK+ | 74 dBuV per m | 54 dBuV per m | Final_Result PK+ | Final_Result RMS

Plot #23 Radiated Emissions: 18-26 GHz

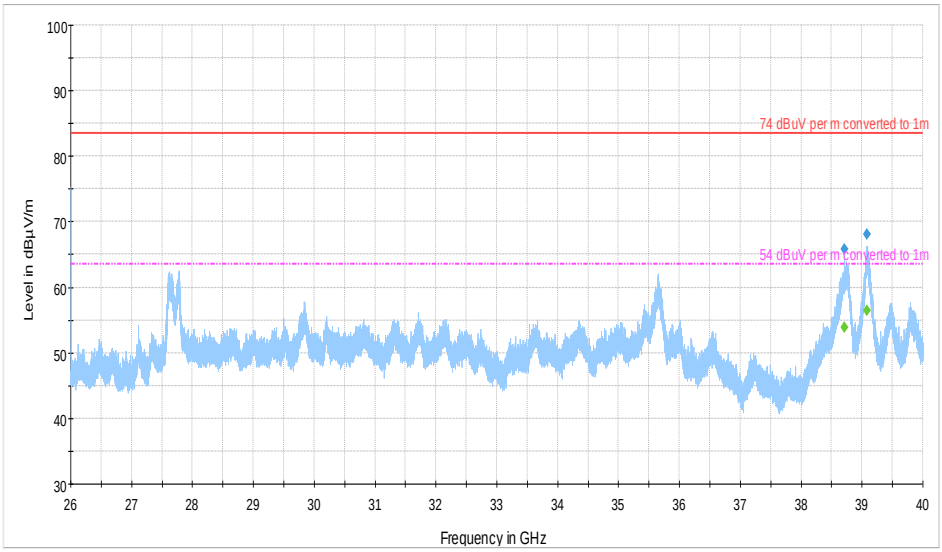
Mode: WAP 802.11/n	Mid (153)	



Plot #24 Radiated Emissions: 26-40 GHz

Mode: WAP 802.11/n	Mid (153)	

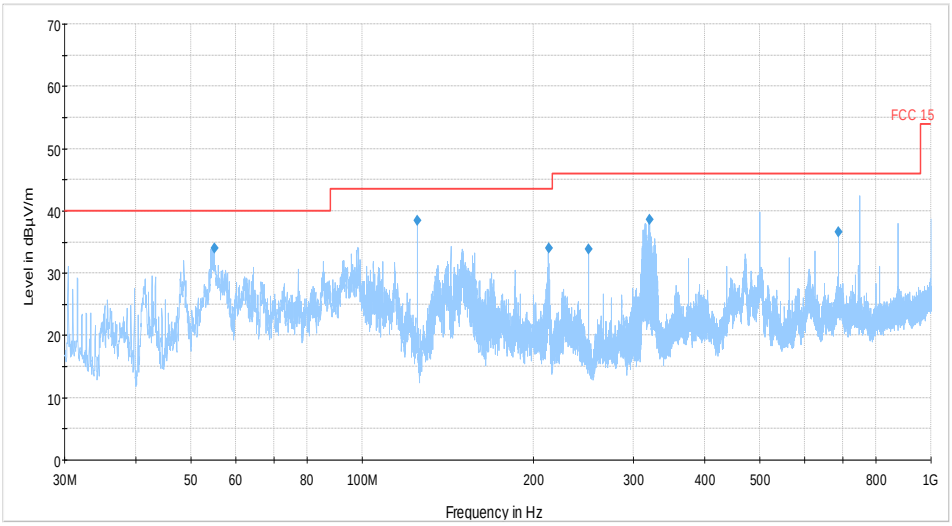
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
38708.114	---	53.82	63.50	9.68	100.0	1000.000	150.0	H	239.0
38708.114	65.88	---	83.50	17.62	100.0	1000.000	150.0	H	239.0
39080.782	---	56.39	63.50	7.11	100.0	1000.000	150.0	V	83.0
39080.782	68.16	---	83.50	15.34	100.0	1000.000	150.0	V	83.0



Plot #25 Radiated Emissions: 30 MHz – 1GHz

Mode: WAP 802.11/n | High (161)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
55.011	34.06	40.00	5.94	200.0	120.000	160.0	V	234.0
125.000	38.47	43.52	5.05	200.0	120.000	140.0	V	41.0
212.665	34.03	43.52	9.50	200.0	120.000	155.0	V	106.0
250.005	33.82	46.02	12.20	200.0	120.000	154.0	V	16.0
320.436	38.61	46.02	7.42	200.0	120.000	162.0	H	300.0
687.508	36.62	46.02	9.40	200.0	120.000	165.0	V	348.0

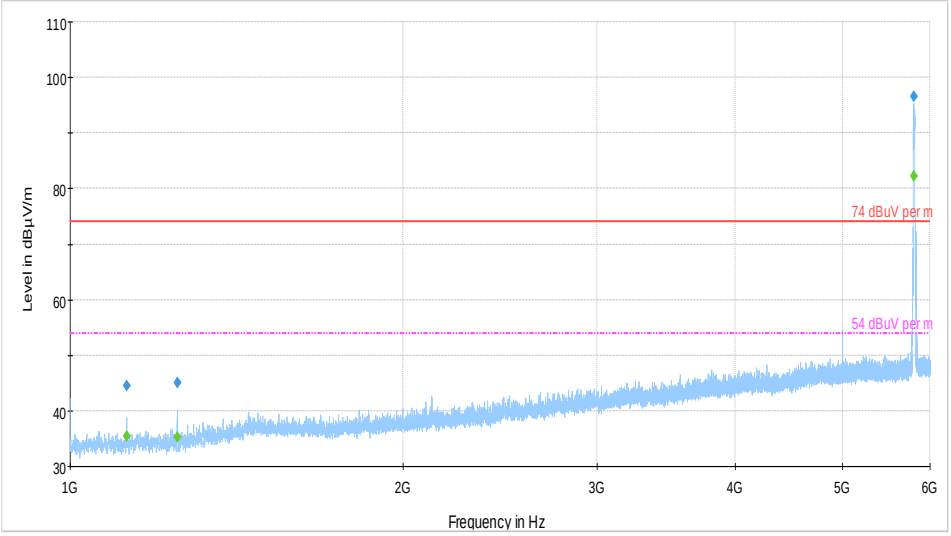


Preview Result 1-PK+ — FCC 15 — Final_Result QPK

Plot #26 Radiated Emissions: 1-6 GHz

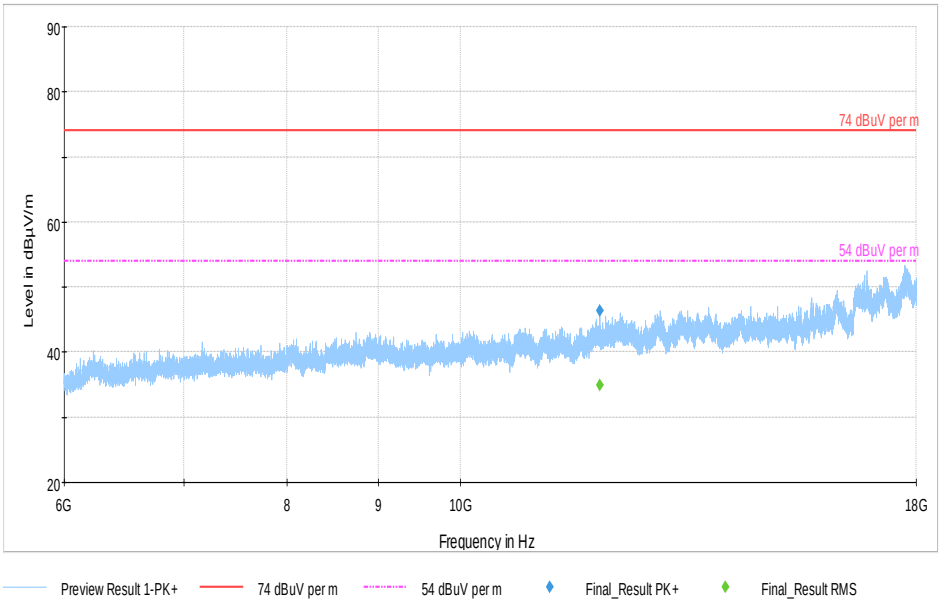
Mode: WAP 802.11/n | High (161)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1125.050	---	35.48	54.00	18.53	500.0	1000.000	151.0	V	97.0
1125.050	44.49	---	74.00	29.51	500.0	1000.000	151.0	V	97.0
1249.900	---	35.26	54.00	18.74	500.0	1000.000	140.0	V	100.0
1249.900	45.08	---	74.00	28.92	500.0	1000.000	140.0	V	100.0
5801.350	---	82.24	54.00	-28.24	500.0	1000.000	151.0	H	201.0
5801.350	96.58	---	74.00	-22.58	500.0	1000.000	151.0	H	201.0

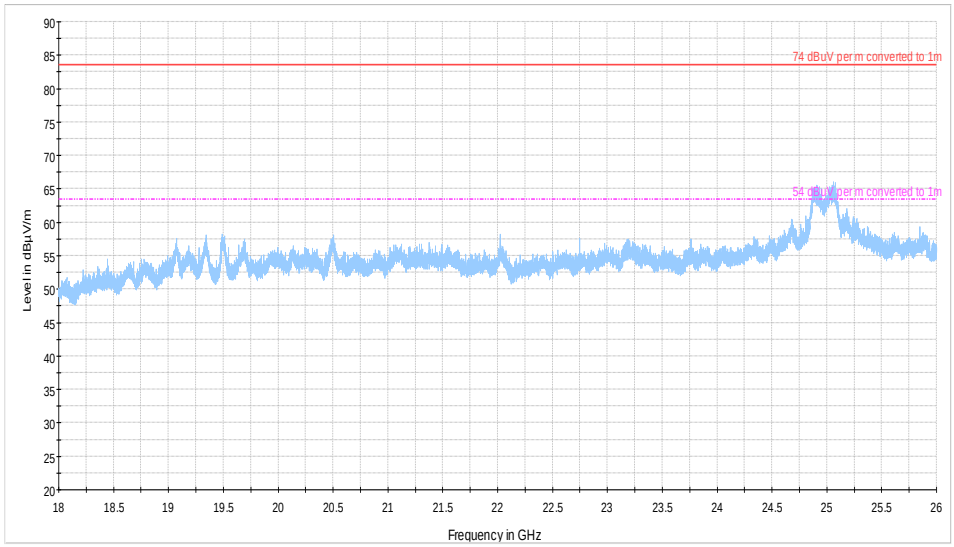


Plot #27 Radiated Emissions: 6-18 GHz

Mode: WAP 802.11/n | High (161)



Plot #28 Radiated Emissions: 18-26 GHz		
Mode: WAP 802.11/n	High (161)	

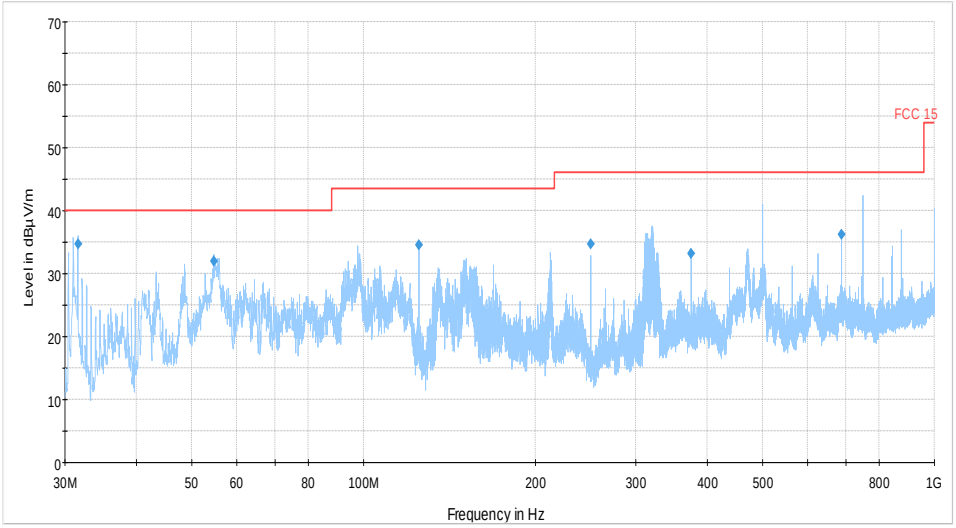


8.1.7 WLAN Measurement Plots:

Plot #29 Radiated Emissions: 30 MHz – 1GHz

Mode: WLAN 802.11/n | Low (36)

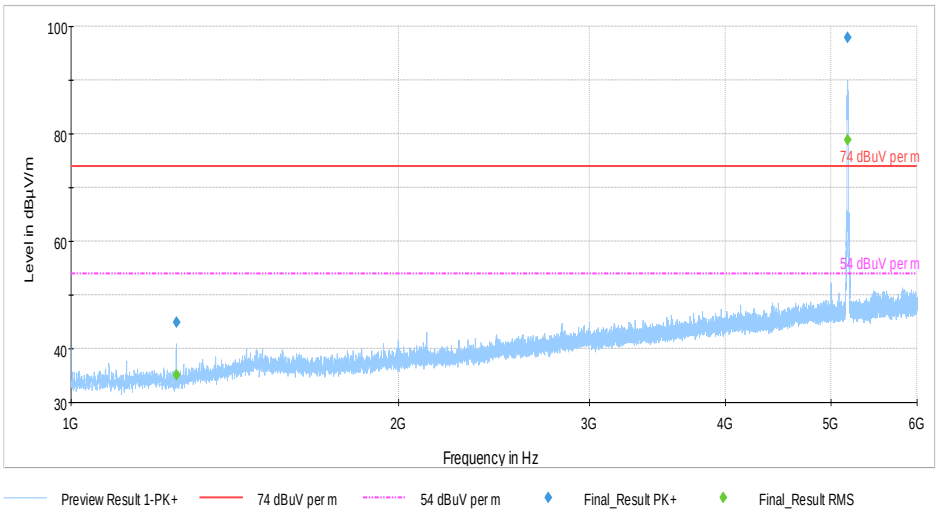
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
31.633	34.69	40.00	5.31	200.0	120.000	152.0	V	319.0
54.760	31.97	40.00	8.03	200.0	120.000	213.0	V	200.0
124.996	34.52	43.52	9.00	200.0	120.000	158.0	H	266.0
249.994	34.70	46.02	11.32	200.0	120.000	187.0	H	244.0
375.011	33.13	46.02	12.89	200.0	120.000	166.0	H	56.0
687.501	36.14	46.02	9.88	200.0	120.000	156.0	V	-2.0



Plot #30 Radiated Emissions: 1-6 GHz

Mode: WLAN 802.11/n | Low (36)

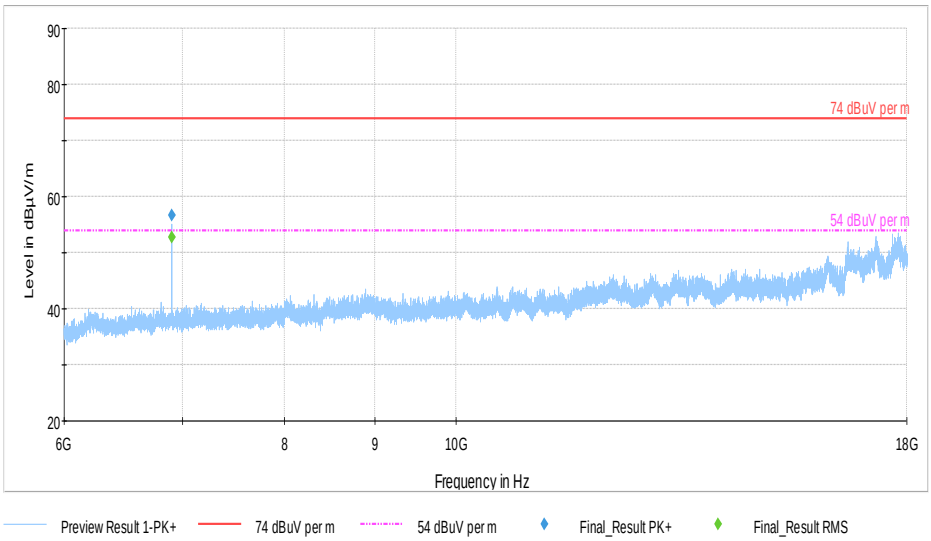
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1250.050	---	35.12	54.00	18.88	500.0	1000.000	140.0	V	103.0
1250.050	45.00	---	74.00	29.00	500.0	1000.000	140.0	V	103.0
5176.450	---	78.93	54.00	-24.93	500.0	1000.000	184.0	V	177.0
5176.450	97.93	---	74.00	-23.93	500.0	1000.000	184.0	V	177.0



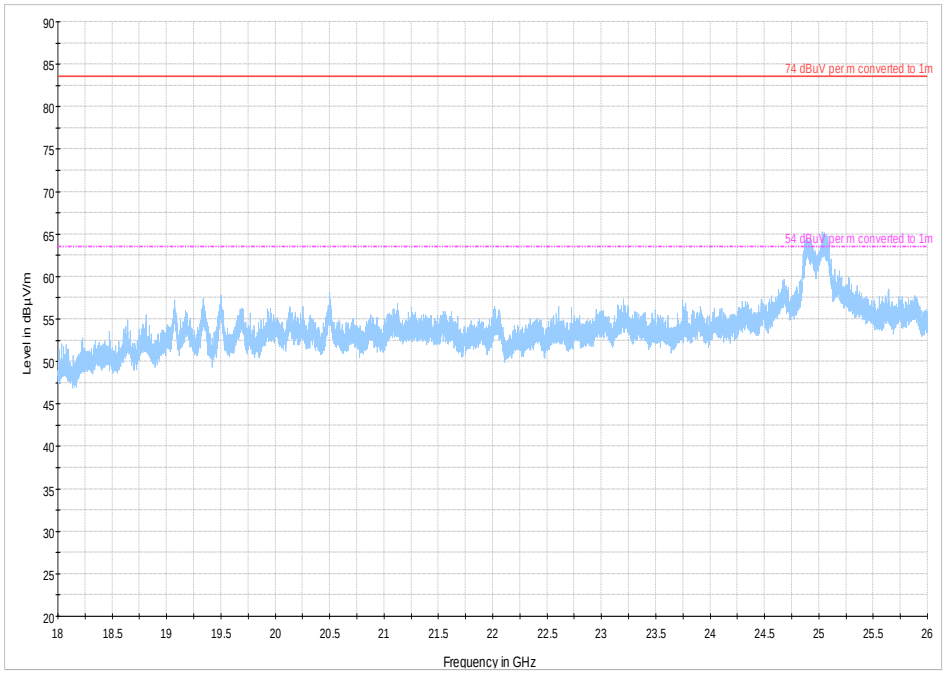
Plot #31 Radiated Emissions: 6-18 GHz

Mode: WLAN 802.11/n | Low (36)

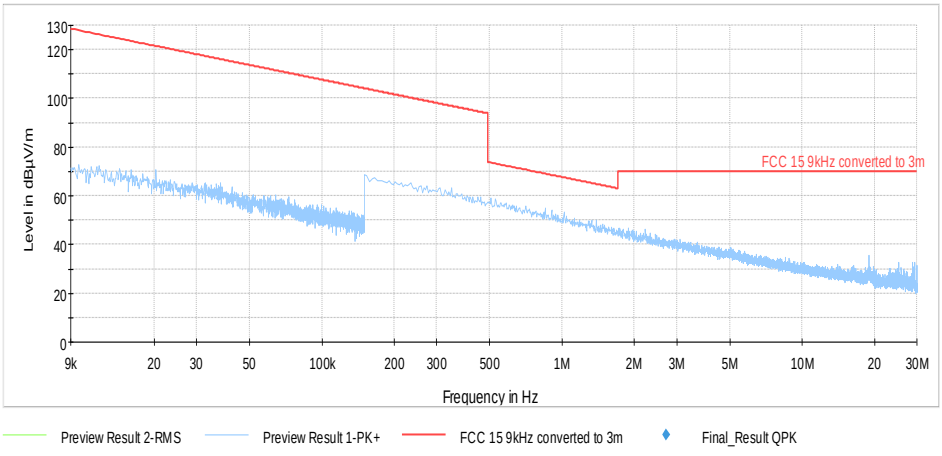
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
6906.600	---	52.81	54.00	1.19	500.0	1000.000	140.0	H	328.0
6906.600	56.73	---	74.00	17.27	500.0	1000.000	140.0	H	328.0



Plot #32 Radiated Emissions: 18-26 GHz		
Mode: WLAN 802.11/n	Low (36)	



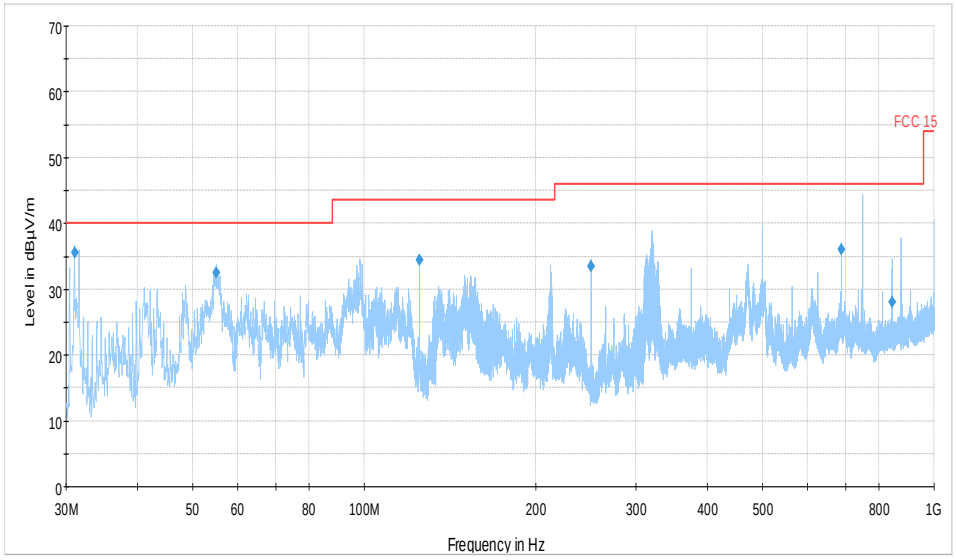
Plot # 33 Radiated Emissions: 9 KHz – 30 MHz		
Mode: WLAN 802.11/n	Mid (40)	



Plot #34 Radiated Emissions: 30 MHz – 1GHz

Mode: WLAN 802.11/n | Mid (40)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
31.047	35.53	40.00	4.47	200.0	120.000	151.0	V	270.0
55.044	32.52	40.00	7.48	200.0	120.000	158.0	V	46.0
125.003	34.43	43.52	9.09	200.0	120.000	174.0	H	271.0
249.999	33.54	46.02	12.48	200.0	120.000	140.0	V	-75.0
687.499	36.02	46.02	10.00	200.0	120.000	151.0	V	-12.0
843.720	28.00	46.02	18.02	200.0	120.000	151.0	H	307.0

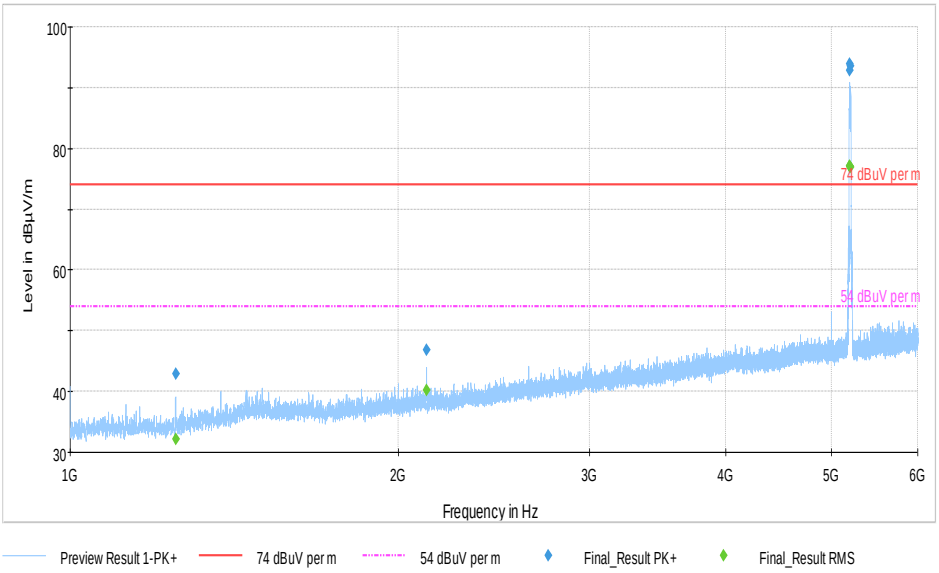


Preview Result 1-PK+ FCC 15 Final_Result QPK

Plot #35 Radiated Emissions: 1-6 GHz

Mode: WLAN 802.11/n | Mid (40)

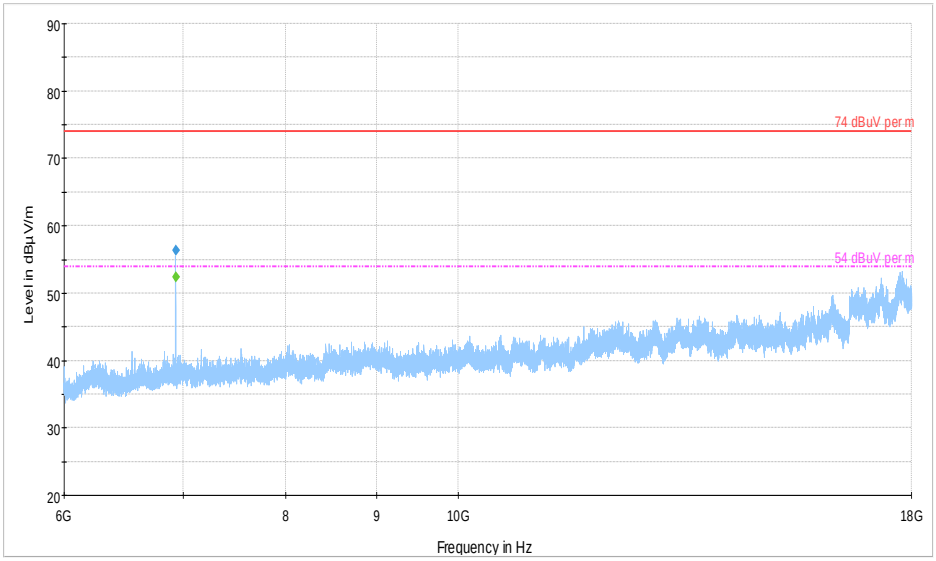
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1250.050	---	32.08	54.00	21.92	500.0	1000.000	257.0	V	308.0
1250.050	42.84	---	74.00	31.16	500.0	1000.000	257.0	V	308.0
2123.150	---	40.12	54.00	13.88	500.0	1000.000	140.0	V	32.0
2123.150	46.75	---	74.00	27.25	500.0	1000.000	140.0	V	32.0
5192.550	---	77.17	54.00	-23.17	500.0	1000.000	140.0	H	302.0
5192.550	92.76	---	74.00	-18.76	500.0	1000.000	140.0	H	302.0
5198.300	---	77.06	54.00	-23.06	500.0	1000.000	140.0	H	304.0
5198.300	93.89	---	74.00	-19.89	500.0	1000.000	140.0	H	304.0
5202.050	---	76.82	54.00	-22.82	500.0	1000.000	300.0	H	303.0
5202.050	93.59	---	74.00	-19.59	500.0	1000.000	300.0	H	303.0



Plot #36 Radiated Emissions: 6-18 GHz

Mode: WLAN 802.11/n | Mid (40)

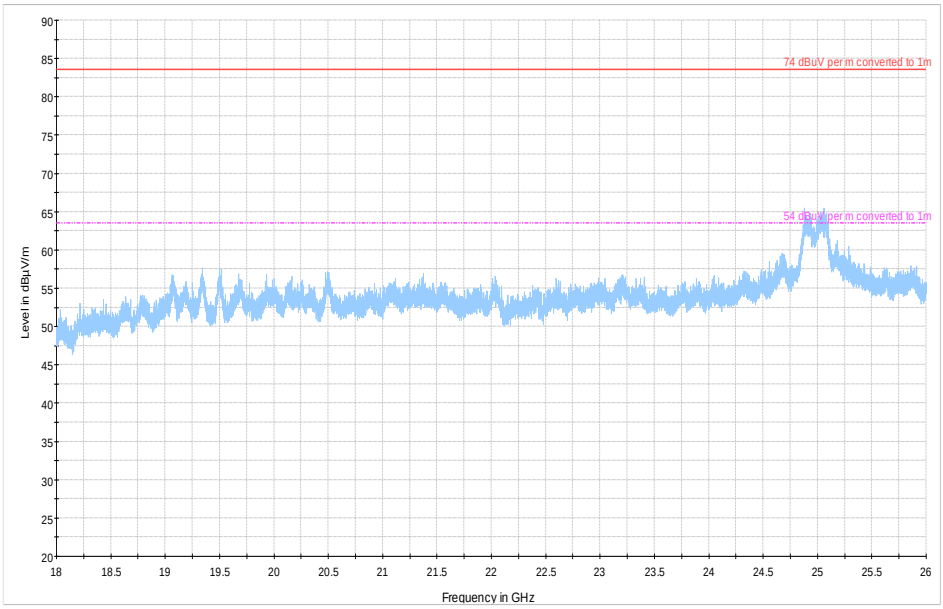
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
6933.400	---	52.41	54.00	1.59	500.0	1000.000	140.0	H	329.0
6933.400	56.36	---	74.00	17.64	500.0	1000.000	140.0	H	329.0



Preview Result 1-PK+ | 74 dBuV per m | 54 dBuV per m | Final_Result PK+ | Final_Result RMS

Plot #37 Radiated Emissions: 18-26 GHz

Mode: WLAN 802.11/n | Mid (40)

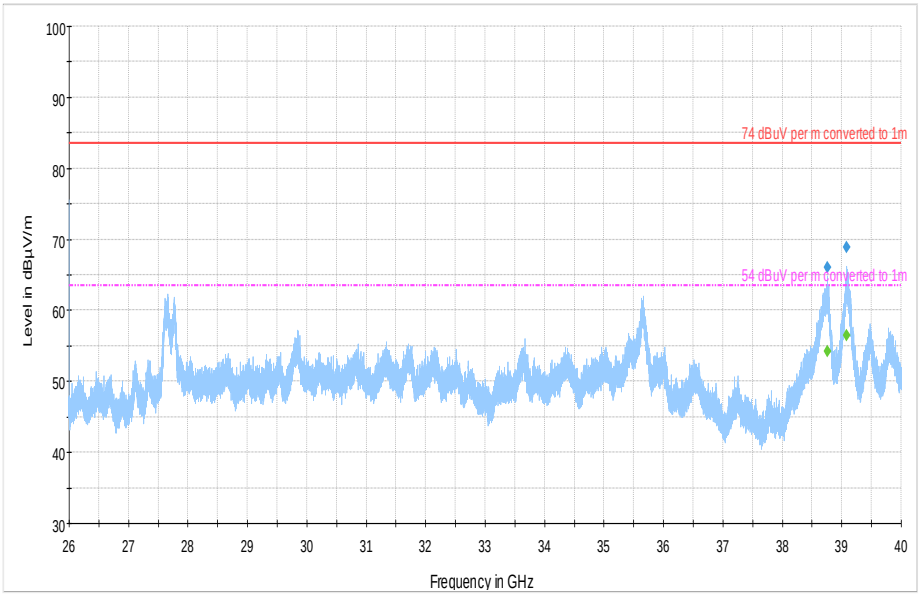


Preview Result 1-PK+ | Critical_Freqs PK+ | 74 dBuV per m converted to 1m
54 dBuV per m converted to 1m | Final_Result PK+ | Final_Result AVG

Plot #38 Radiated Emissions: 26-40 GHz

Mode: WLAN 802.11/n | Mid (40)

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
38759.908	---	54.18	63.50	9.32	100.0	1000.000	150.0	H	258.0
38759.908	66.10	---	83.50	17.40	100.0	1000.000	150.0	H	258.0
39082.488	---	56.49	63.50	7.01	100.0	1000.000	150.0	V	281.0
39082.488	68.90	---	83.50	14.60	100.0	1000.000	150.0	V	281.0

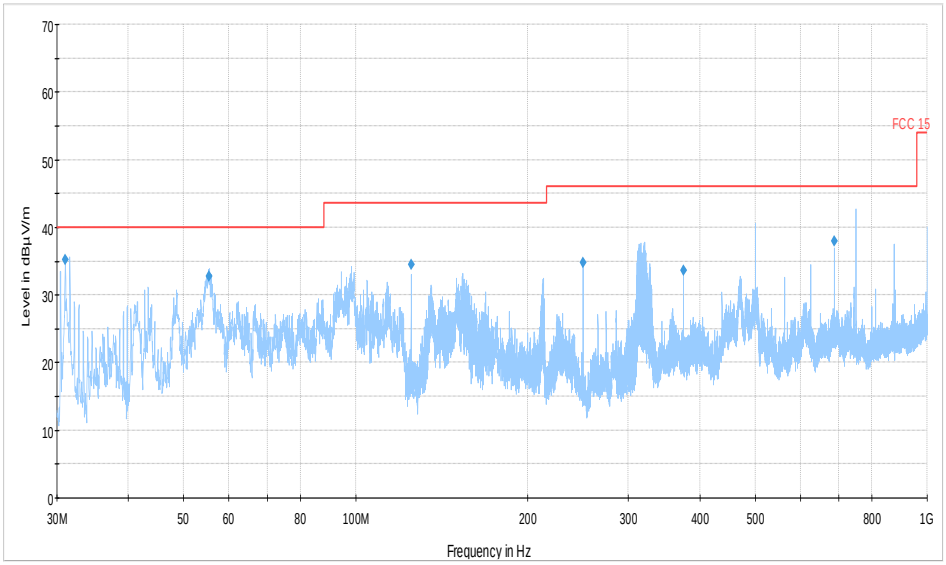


Preview Result 1-PK+
Final_Result PK+
74 dBuV per m converted to 1m
Final_Result AVG
54 dBuV per m converted to 1m

Plot #39 Radiated Emissions: 30 MHz – 1GHz

Mode: WLAN 802.11/n | High (48)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
31.055	35.28	40.00	4.72	200.0	120.000	166.0	V	268.0
55.396	32.75	40.00	7.25	200.0	120.000	198.0	V	40.0
124.996	34.53	43.52	8.99	200.0	120.000	272.0	H	281.0
249.993	34.73	46.02	11.29	200.0	120.000	158.0	H	240.0
374.994	33.68	46.02	12.34	200.0	120.000	166.0	H	57.0
687.510	37.98	46.02	8.04	200.0	120.000	181.0	V	-7.0

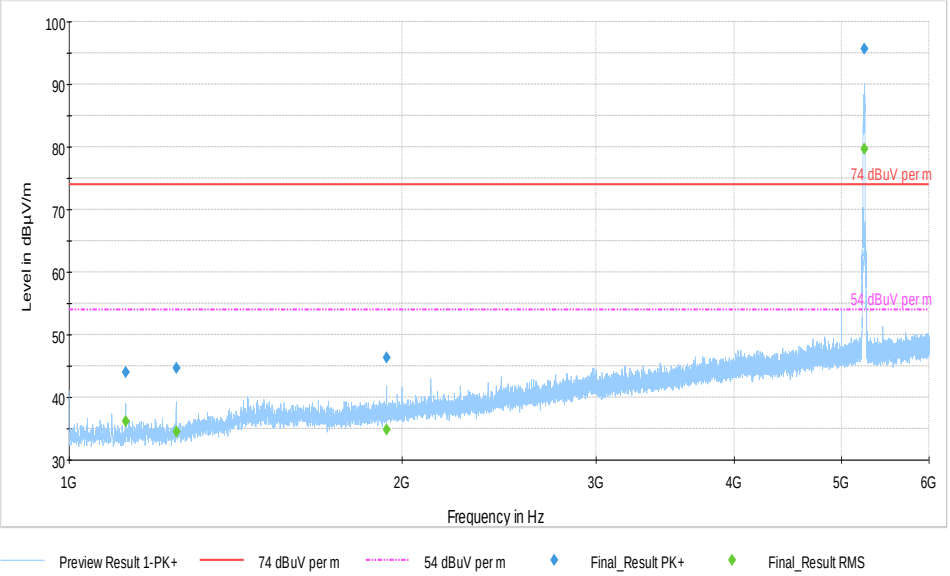


Preview Result 1-PK+ — FCC 15 — Final_Result QPK

Plot #40 Radiated Emissions: 1-6 GHz

Mode: WLAN 802.11/n | High (48)

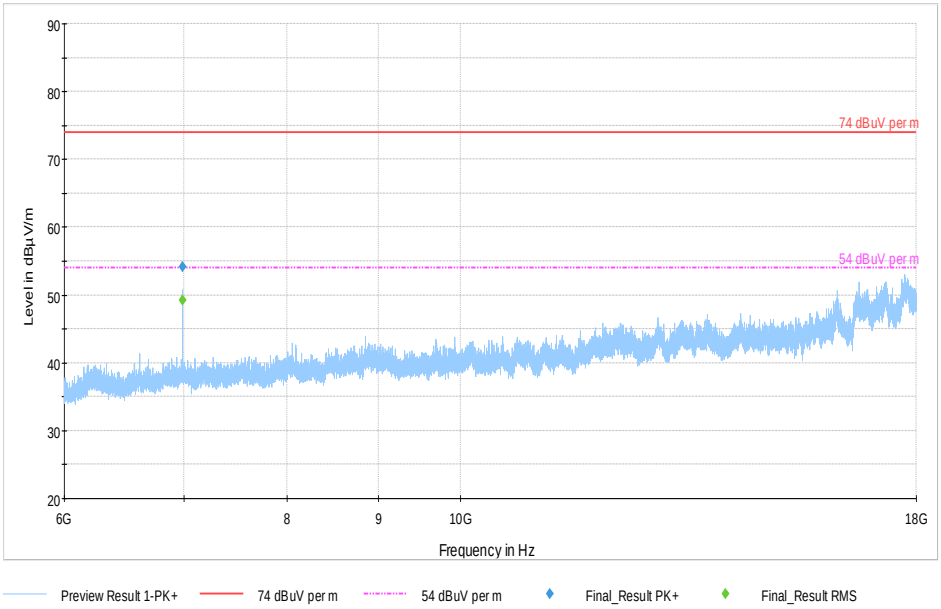
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1125.050	---	36.20	54.00	17.80	500.0	1000.000	151.0	V	99.0
1125.050	44.06	---	74.00	29.94	500.0	1000.000	151.0	V	99.0
1250.050	---	34.45	54.00	19.55	500.0	1000.000	140.0	V	87.0
1250.050	44.61	---	74.00	29.39	500.0	1000.000	140.0	V	87.0
1937.550	---	34.82	54.00	19.18	500.0	1000.000	256.0	V	-14.0
1937.550	46.27	---	74.00	27.73	500.0	1000.000	256.0	V	-14.0
5244.750	---	79.63	54.00	-25.63	500.0	1000.000	294.0	H	307.0
5244.750	95.69	---	74.00	-21.69	500.0	1000.000	294.0	H	307.0



Plot #41 Radiated Emissions: 6-18 GHz

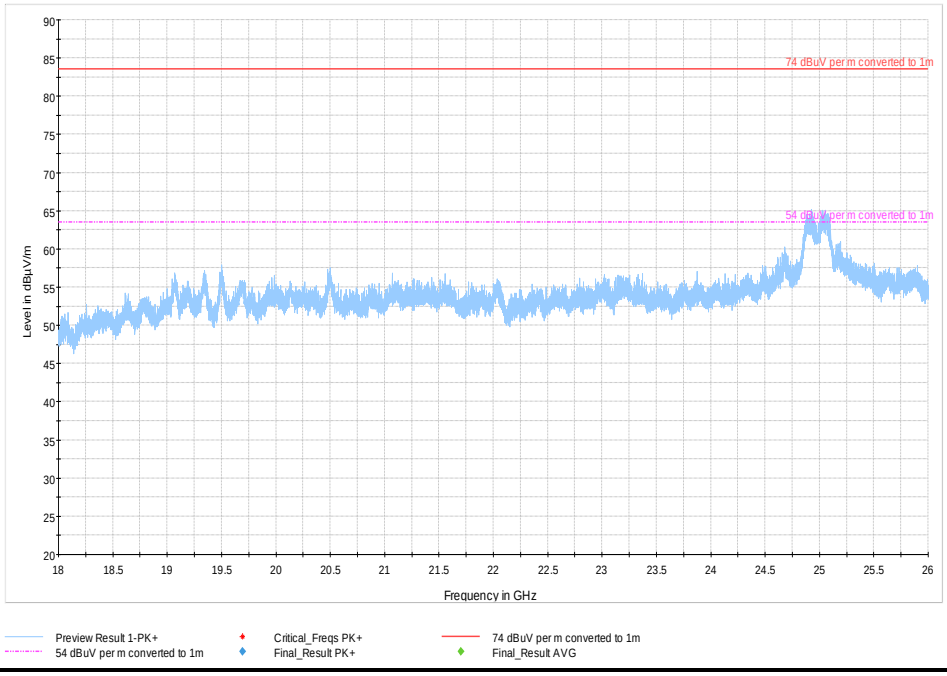
Mode: WLAN 802.11/n | High (48)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
6986.600	---	49.24	54.00	4.76	500.0	1000.000	152.0	H	325.0
6986.600	54.18	---	74.00	19.82	500.0	1000.000	152.0	H	325.0



Plot #41 Radiated Emissions: 18-26 GHz

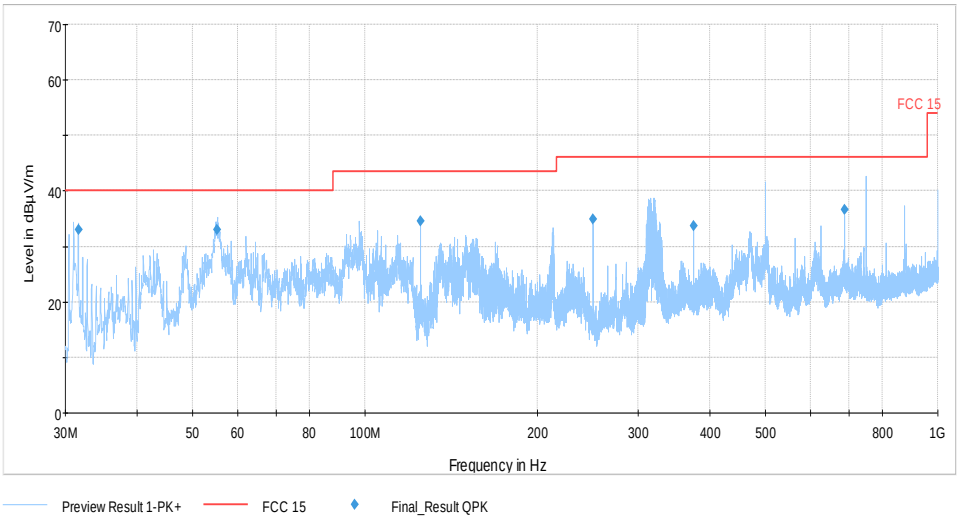
Mode: WLAN 802.11/n | High (48)



Plot #42 Radiated Emissions: 30 MHz – 1GHz

Mode: WLAN 802.11/n | Low (149)

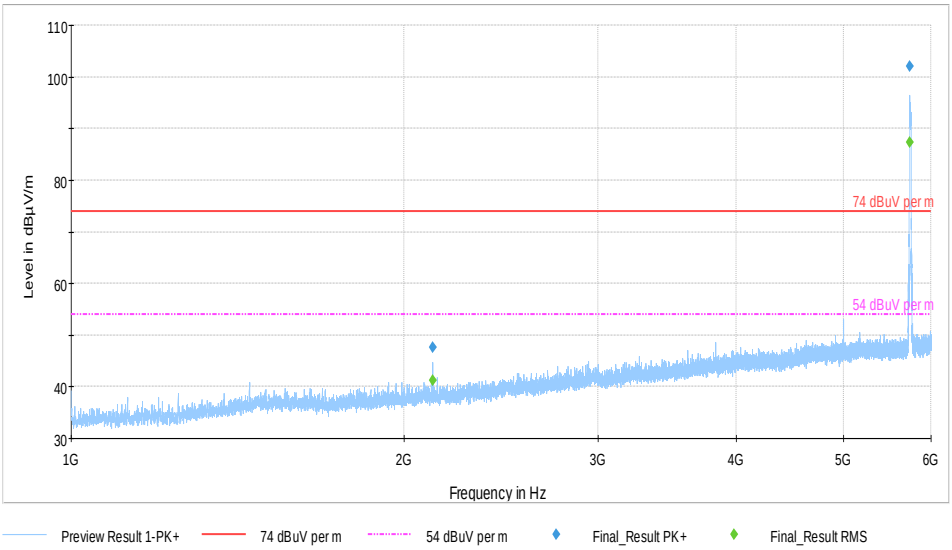
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
31.645	32.96	40.00	7.04	200.0	120.000	158.0	V	253.0
55.274	33.10	40.00	6.90	200.0	120.000	223.0	V	234.0
124.997	34.51	43.52	9.01	200.0	120.000	169.0	H	281.0
249.996	34.96	46.02	11.07	200.0	120.000	154.0	H	238.0
374.996	33.72	46.02	12.30	200.0	120.000	158.0	H	55.0
687.484	36.63	46.02	9.39	200.0	120.000	154.0	V	-12.0



Plot #43 Radiated Emissions: 1-6 GHz

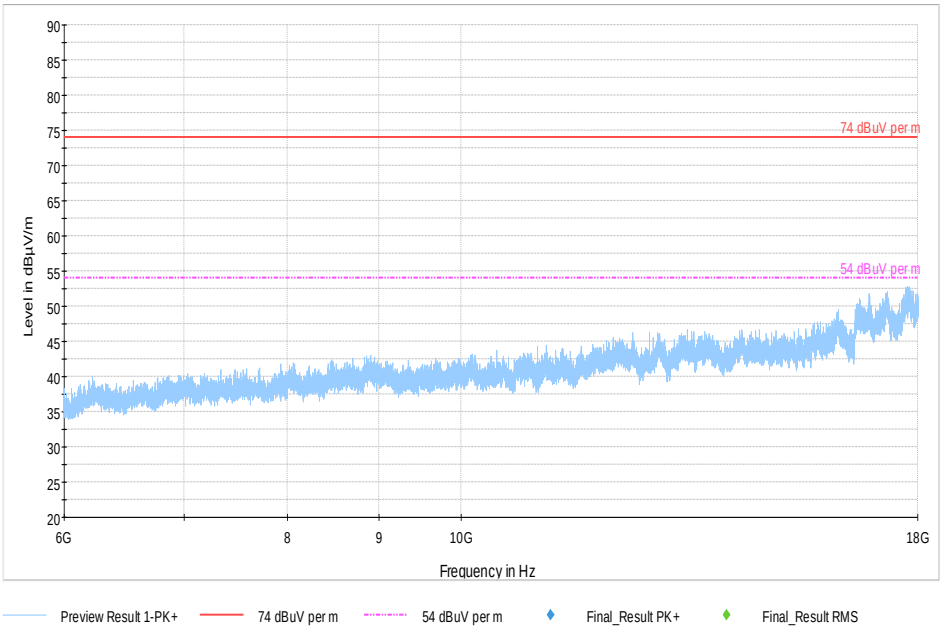
Mode: WLAN 802.11/n | Low (149)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2123.300	---	41.23	54.00	12.77	500.0	1000.000	140.0	V	338.0
2123.300	47.69	---	74.00	26.31	500.0	1000.000	140.0	V	338.0
5742.000	---	87.25	54.00	-33.25	500.0	1000.000	140.0	H	315.0
5742.000	102.07	---	74.00	-28.07	500.0	1000.000	140.0	H	315.0



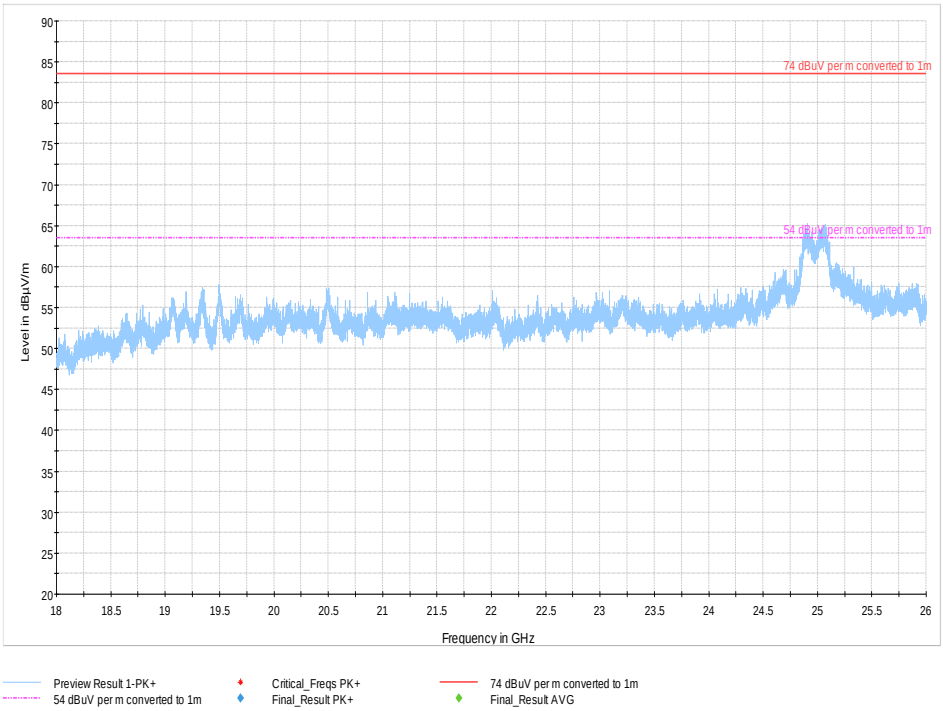
Plot #44 Radiated Emissions: 6-18 GHz

Mode: WLAN 802.11/n | Low (149)



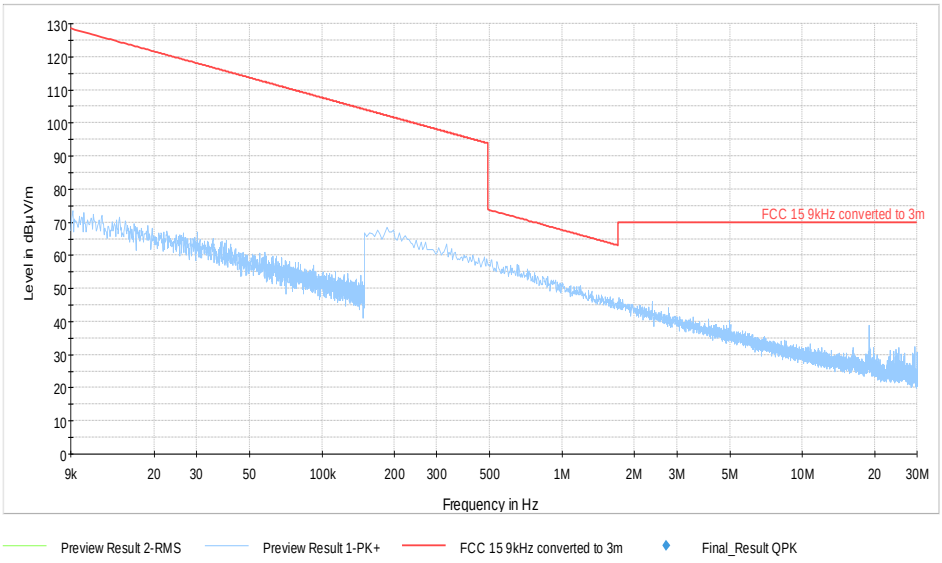
Plot #45 Radiated Emissions: 18-26 GHz

Mode: WLAN 802.11/n	Low (149)	



Plot # 46 Radiated Emissions: 9 KHz – 30 MHz

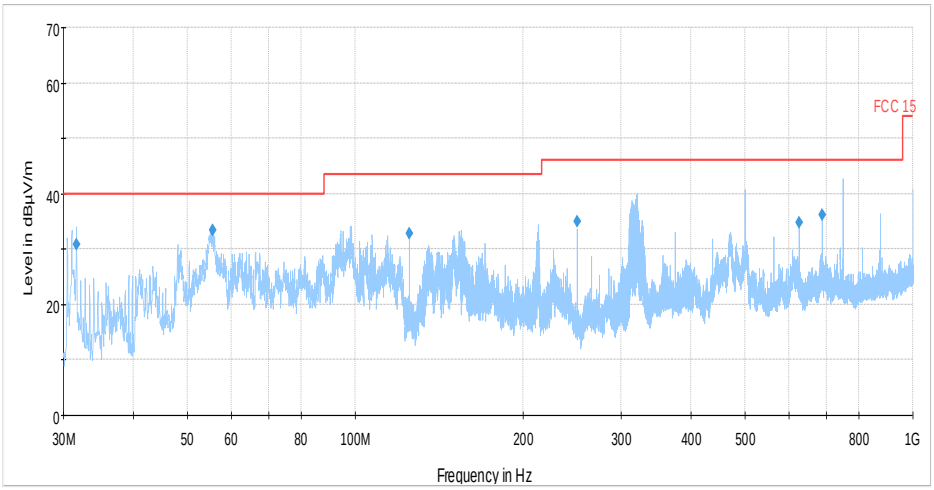
Mode: WLAN 802.11/n	Mid (153)	



Plot #47 Radiated Emissions: 30 MHz – 1GHz

Mode: WLAN 802.11/n | Mid (153)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
31.670	30.77	40.00	9.23	200.0	120.000	151.0	V	269.0
55.590	33.33	40.00	6.67	200.0	120.000	169.0	V	260.0
125.007	32.76	43.52	10.76	200.0	120.000	151.0	V	235.0
249.992	34.96	46.02	11.06	200.0	120.000	158.0	H	235.0
625.000	34.88	46.02	11.14	200.0	120.000	158.0	V	347.0
687.515	36.12	46.02	9.90	200.0	120.000	154.0	V	185.0

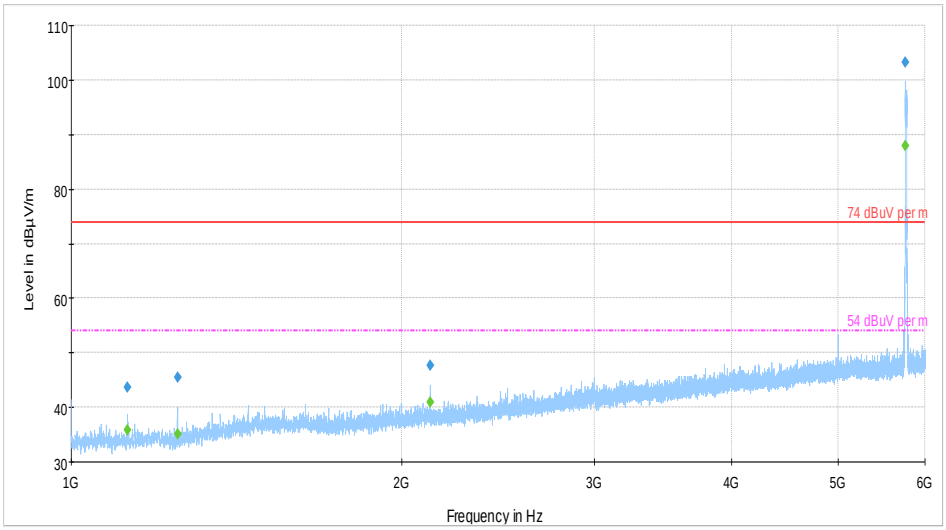


Preview Result 1-PK+ | FCC 15 | Final_Result QPK

Plot #48 Radiated Emissions: 1-6 GHz

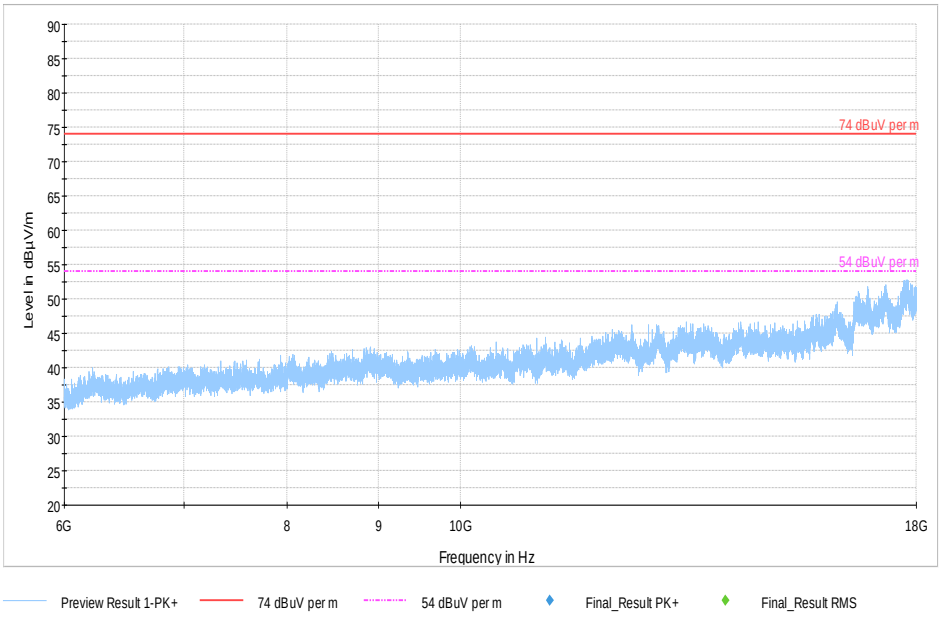
Mode: WLAN 802.11/n | Mid (153)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1124.900	---	35.82	54.00	18.18	500.0	1000.000	152.0	V	97.0
1124.900	43.69	---	74.00	30.31	500.0	1000.000	152.0	V	97.0
1250.050	---	35.12	54.00	18.88	500.0	1000.000	140.0	V	94.0
1250.050	45.43	---	74.00	28.57	500.0	1000.000	140.0	V	94.0
2123.150	---	40.98	54.00	13.02	500.0	1000.000	140.0	V	340.0
2123.150	47.60	---	74.00	26.40	500.0	1000.000	140.0	V	340.0
5758.250	---	87.95	54.00	-33.95	500.0	1000.000	261.0	H	216.0
5758.250	103.24	---	74.00	-29.24	500.0	1000.000	261.0	H	216.0

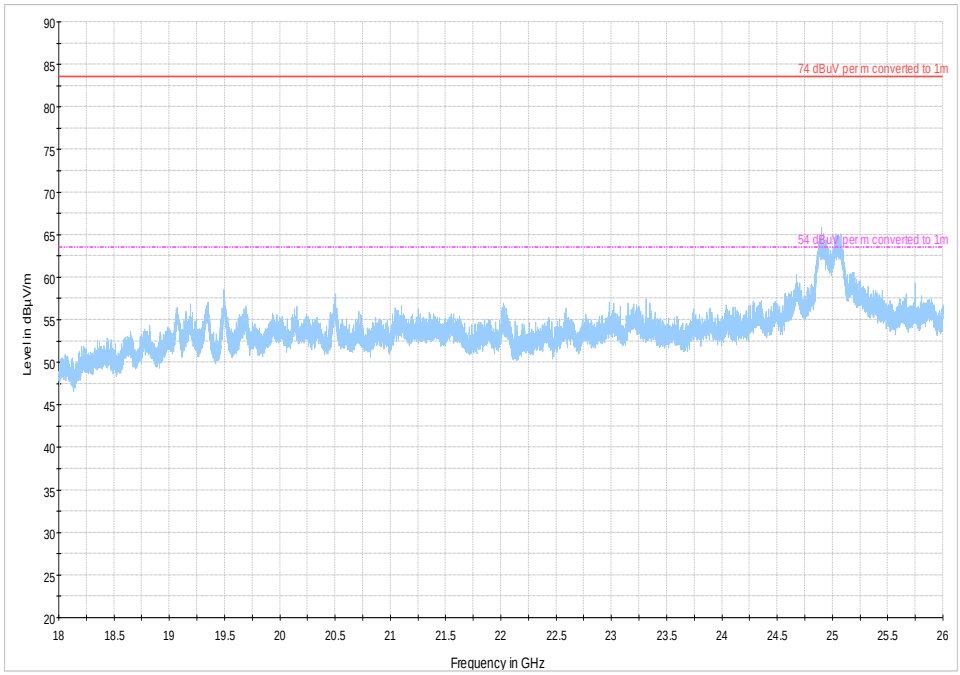


Plot #49 Radiated Emissions: 6-18 GHz

Mode: WLAN 802.11/n | Mid (153)



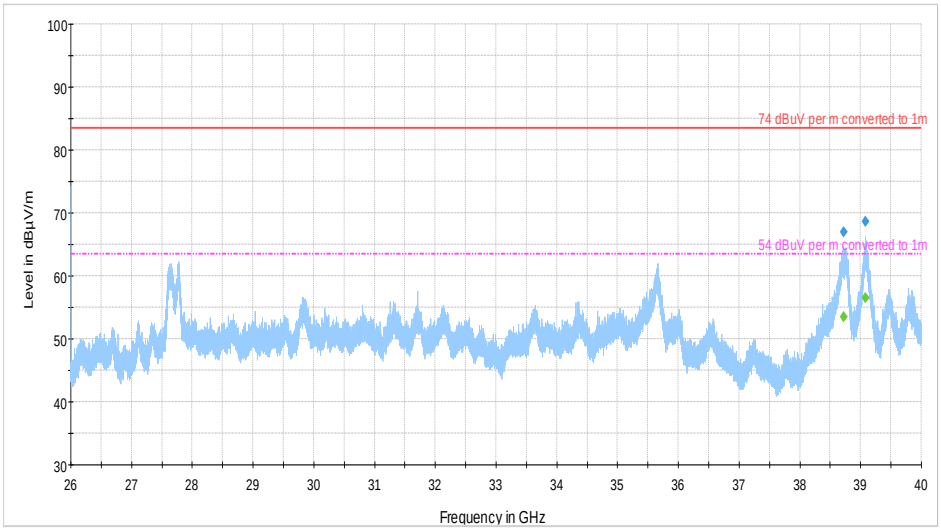
Plot #50 Radiated Emissions: 18-26 GHz		
Mode: WLAN 802.11/n	Mid (153)	



Plot #51 Radiated Emissions: 26-40 GHz

Mode: WLAN 802.11/n | Mid (153)

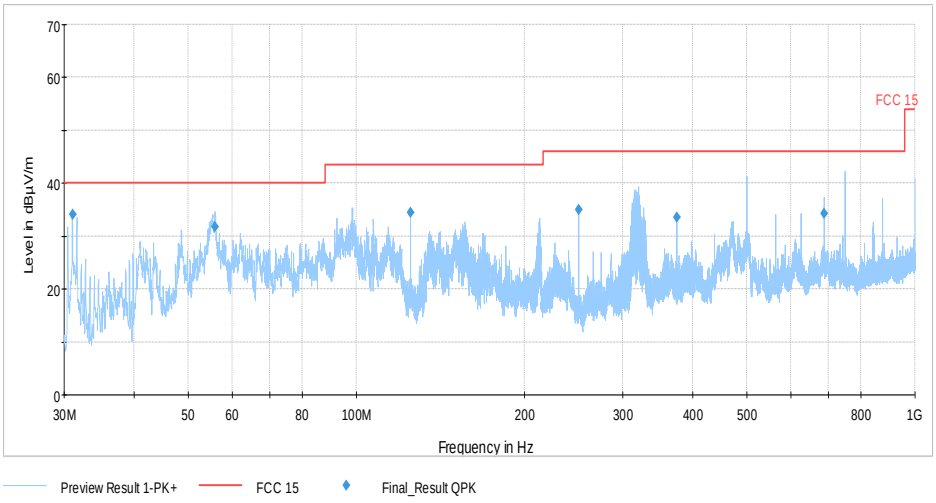
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
38725.299	66.94	---	83.50	16.56	100.0	1000.000	150.0	V	50.0
38725.299	---	53.48	63.50	10.02	100.0	1000.000	150.0	V	50.0
39084.936	68.60	---	83.50	14.90	100.0	1000.000	150.0	H	196.0
39084.936	---	56.49	63.50	7.01	100.0	1000.000	150.0	H	196.0



Plot #52 Radiated Emissions: 30 MHz – 1GHz

Mode: WLAN 802.11/n | High (161)

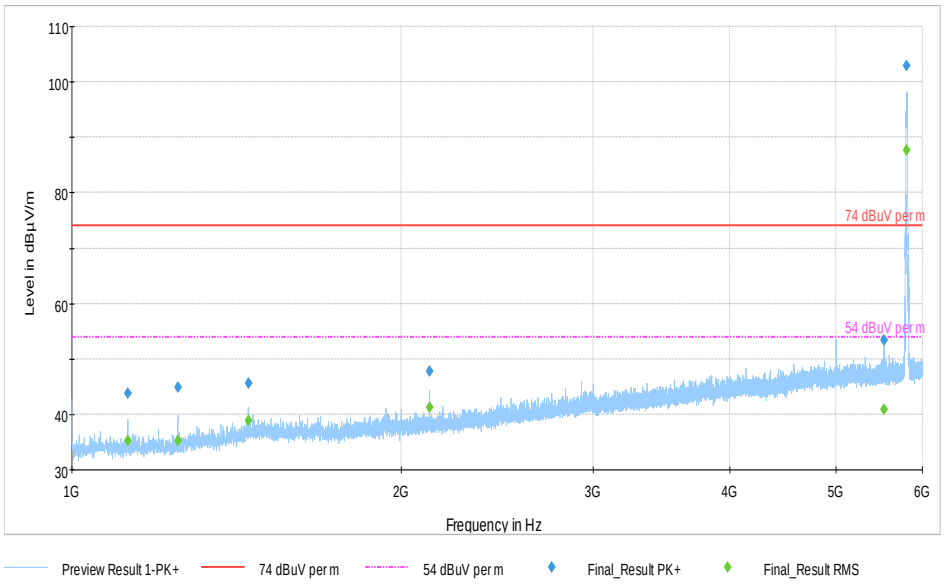
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
31.065	34.08	40.00	5.92	200.0	120.000	152.0	V	258.0
55.817	31.82	40.00	8.18	200.0	120.000	196.0	V	48.0
124.996	34.51	43.52	9.01	200.0	120.000	285.0	H	279.0
249.992	34.98	46.02	11.04	200.0	120.000	177.0	H	238.0
374.997	33.60	46.02	12.42	200.0	120.000	196.0	H	61.0
687.523	34.20	46.02	11.82	200.0	120.000	140.0	V	116.0



Plot #53 Radiated Emissions: 1-6 GHz

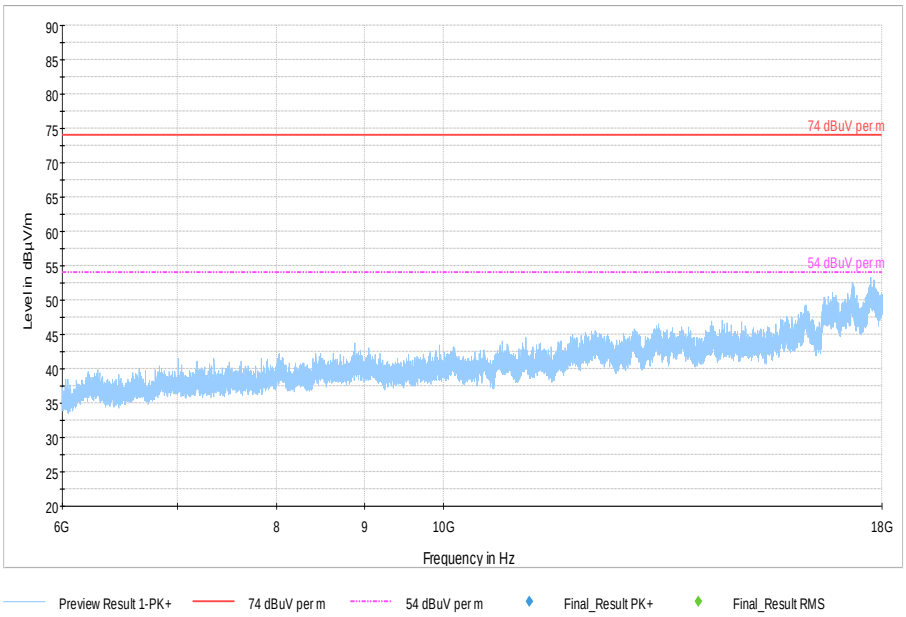
Mode: WLAN 802.11/n | High (161)

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1125.050	---	35.19	54.00	18.81	500.0	1000.000	182.0	V	96.0
1125.050	43.71	---	74.00	30.29	500.0	1000.000	182.0	V	96.0
1249.900	---	35.27	54.00	18.73	500.0	1000.000	140.0	V	97.0
1249.900	44.90	---	74.00	29.10	500.0	1000.000	140.0	V	97.0
1450.050	---	38.88	54.00	15.12	500.0	1000.000	248.0	V	257.0
1450.050	45.58	---	74.00	28.42	500.0	1000.000	248.0	V	257.0
2123.550	---	41.20	54.00	12.80	500.0	1000.000	140.0	V	36.0
2123.550	47.79	---	74.00	26.21	500.0	1000.000	140.0	V	36.0
5531.350	---	40.87	54.00	13.13	500.0	1000.000	216.0	H	232.0
5531.350	53.44	---	74.00	20.56	500.0	1000.000	216.0	H	232.0
5800.600	---	87.61	54.00	-33.61	500.0	1000.000	261.0	H	214.0
5800.600	102.94	---	74.00	-28.94	500.0	1000.000	261.0	H	214.0



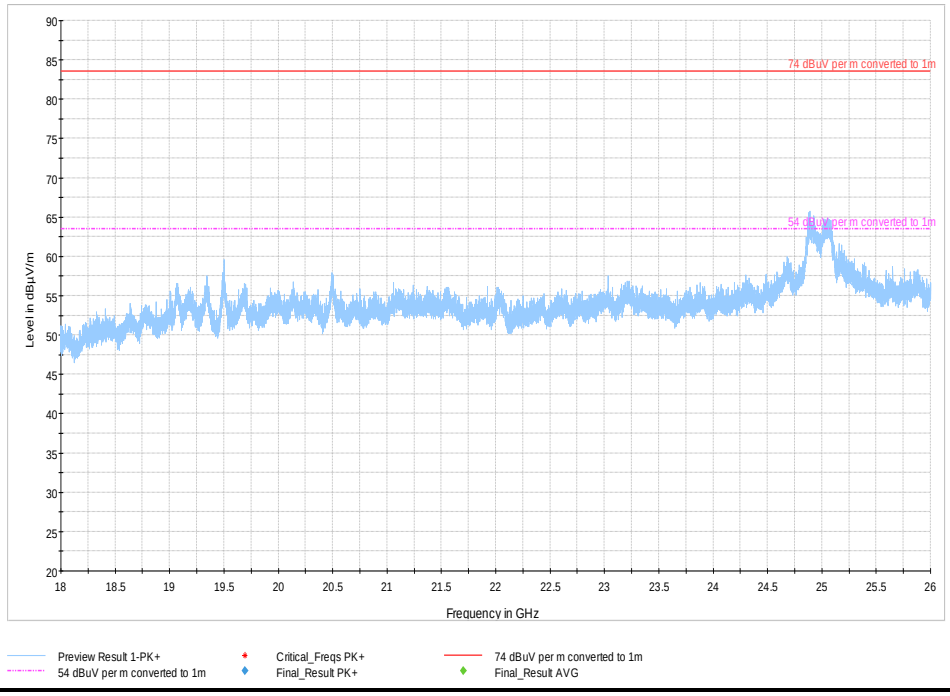
Plot #54 Radiated Emissions: 6-18 GHz

Mode: WLAN 802.11/n	High (161)	



Plot #55 Radiated Emissions: 18-26 GHz

Mode: WLAN 802.11/n	High (161)	



9 Test setup photos

Setup photos are included in supporting file name: “EMC_ASTRO-001-20001_15.407_Setup_Photos.pdf”

10 Test Equipment And Ancillaries Used For Testing

Equipment Name/Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	3 Years	07/16/2019
Biconlog Antenna	EMCO	3142E	166067	3 years	06/27/2017
Horn Antenna	EMCO	3115	35114	3 years	04/17/2019
Horn Antenna	ETS Lindgren	Horn 3117-PA	159547	3 years	8/8/2017
Horn Antenna	ETS Lindgren	Horn 3116	70497	3 years	10/31/2017
Compact Digital Barometer	Control Company	35519-055	91119547	3 Years	6/08/2017

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
2020-04-02	EMC_ASTRO-001-20001_15.407	Initial Version	Kris Lazarov

<<< The End >>>