



## FCC / IC Test Report

**FOR:**

Pratt & Whitney, division of RTX

**Model Name:**

HMU200-2

**Product Description:**

Collection of aircraft engine and airframe data in flight and wireless transmission of collected data on ground

**FCC ID:** 2AQWD-HMU200-2

**IC ID:** 25562-HMU2002

**Applied Rules and Standards:**

47 CFR Part 15.247 (DTS)

RSS-247 Issue 2 (DTS) & RSS-Gen Issue 5

**REPORT #:** EMC\_PRATT-009-21001\_15.247\_WLAN\_DTS\_Rev1

**DATE:** 2022-03-16



A2LA Accredited

IC recognized #  
3462B-1

CABID: US0187

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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 #
Pratt & Whitney, division of RTX	Collection of aircraft engine and airframe data in flight and wireless transmission of collected data on ground	HMU200-2

### Responsible for Testing Laboratory:

2022-03-16	Compliance	Kevin Wang (Lab Manager)	
Date	Section	Name	Signature

### Responsible for the Report:

2022-03-16	Compliance	Cheng Song (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

<b>Company Name:</b>	CETECOM Inc.
<b>Department:</b>	Compliance
<b>Street Address:</b>	411 Dixon Landing Road
<b>City/Zip Code</b>	Milpitas, CA 95035
<b>Country</b>	USA
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<b>EMC Lab Manager:</b>	Kevin Wang
<b>Responsible Project Leader:</b>	Cathy Palacios

### 2.2 Identification of the Client

<b>Client's Name:</b>	Pratt & Whitney, division of RTX
<b>Street Address:</b>	400 Main Street, MS 168-15
<b>City/Zip Code:</b>	East Hartford, CT 06118
<b>Country:</b>	USA

### 2.3 Identification of the Manufacturer

<b>Manufacturer's Name:</b>	Collins Aerospace & Setrix
<b>Manufacturers Address:</b>	400 Main Street, MS 168-15
<b>City/Zip Code</b>	East Hartford, CT 06118
<b>Country</b>	USA

### 3 Equipment Under Test (EUT)

#### 3.1 EUT Specifications

<b>Model No:</b>	HMU200-2
<b>HW Version :</b>	5
<b>SW Version :</b>	1.28.6
<b>FCC-ID:</b>	2AQWD-HMU200-2
<b>IC-ID:</b>	25562-HMU2002
<b>HVIN:</b>	HMU200-2
<b>PMN:</b>	eFAST
<b>Product Description:</b>	Collection of aircraft engine and airframe data in flight and wireless transmission of collected data on ground
<b>Frequency Range / number of channels:</b>	<p><b>WiFi:</b></p> <ul style="list-style-type: none"> <li>• Manufacture: Silicon Labs</li> <li>• Module name/number: WFM200S022XNN3</li> <li>• FCC ID: QOQWFM200 IC ID: 5123A-WFM200</li> <li>• Nominal band: 2400 MHz – 2483.5 MHz;</li> <li>• Center to center: 2412 MHz (ch 1) – 2462 MHz (ch 11), 11 channels</li> </ul>
<b>Type(s) of Modulation:</b>	BPSK, QPSK, 16-QAM, 64QAM
<b>Modes of Operation:</b>	802.11b/g/n, 20MHz
<b>Antenna Information as declared:</b>	Antenna Type: 1/4 wave monopole Antenna Gain: 3 dBi
<b>Max Output Power:</b>	Conducted Power 16.4 dBm
<b>Power Supply/ Rated Operating Voltage Range:</b>	Vmin: 23.8 VDC/ Vnom: 28 VDC / Vmax: 32.2 VDC
<b>Operating Temperature Range:</b>	-30°C to 70 °C
<b>Other Radios included in the device:</b>	<p><b>Cellular:</b></p> <p>Module: THALES PLS83-W                  FCC ID: QIPPLS83-W; IC ID: 7830A-PLS83W;</p>
<b>Sample Revision:</b>	<input type="checkbox"/> Prototype Unit; <input type="checkbox"/> Production Unit; <input checked="" type="checkbox"/> Pre-Production

### 3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	5011087	5	1.28.6	Radiated Emissions

### 3.3 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1	Buttons on the EUT in test mode used to configure the WLAN radio to 802.11b low, mid and high channels provided by the client that will not be available to the end user.  For radiated measurements, the external antenna was connected.

### 3.4 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on WLAN 802.11b low, mid and high channels. The EUT was configured to the highest duty cycle and maximum output power.

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 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

Testing procedures are based on 558074 D01 DTS Meas Guidance v05r02 – “GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247” - 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(1)	Emission Bandwidth	Nominal		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Note 2
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Note 2
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Note 2
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Note 2
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Note 2
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions- Radiated	Nominal	802.11b	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	802.11b	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Complies

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

**Note 2:** Leveraged from module certification Silicon Labs WFM200S022XNN3 (FCC ID: QQQWFM200; IC ID: 5123A-WFM200)



## 6 Module Summary

Band	Frequency Range (MHz)	Power conducted (W)	Emission Designator	Antenna Gain + Cable loss (dBi)	gain linear	ERP < 1 GHz EIRP > 1 GHz (W)	Frequency deviation (ppm)	Limit EIRP (W)
802.11b	2412 - 2462	0.04365	13M4G1W	1.93	1.56	0.068	13M4G1W	3W
802.11g	2412 - 2462	0.02239	17M1W1D	1.93	1.56	0.035	17M1W1D	3W
802.11n	2412 - 2462	0.01995	17M8W1D	1.93	1.56	0.031	17M8W1D	3W

The emissions above accounting antenna gain and cable loss are derived from the conducted Module reports for the Silicon Labs WFM200S module with FCC: QQQWMF200, IC: 5123A-WFM200 and named 297217-1-1 from SGS FIMKO.



## 7 Measurements

### 7.1 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.

Measurement System	EMC 1	EMC 2
Conducted emissions (mains port)	1.12 dB	0.46 dB
Radiated emissions (< 30 MHz)	3.66 dB	3.88 dB
(30 MHz – 1GHz)	3.17 dB	3.34 dB
(1 GHz – 3 GHz)	5.01 dB	4.45 dB
(>3 GHz)	4.0 dB	4.79 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.

### 7.2 Environmental Conditions During Testing:

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

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

### 7.3 Dates of Testing:

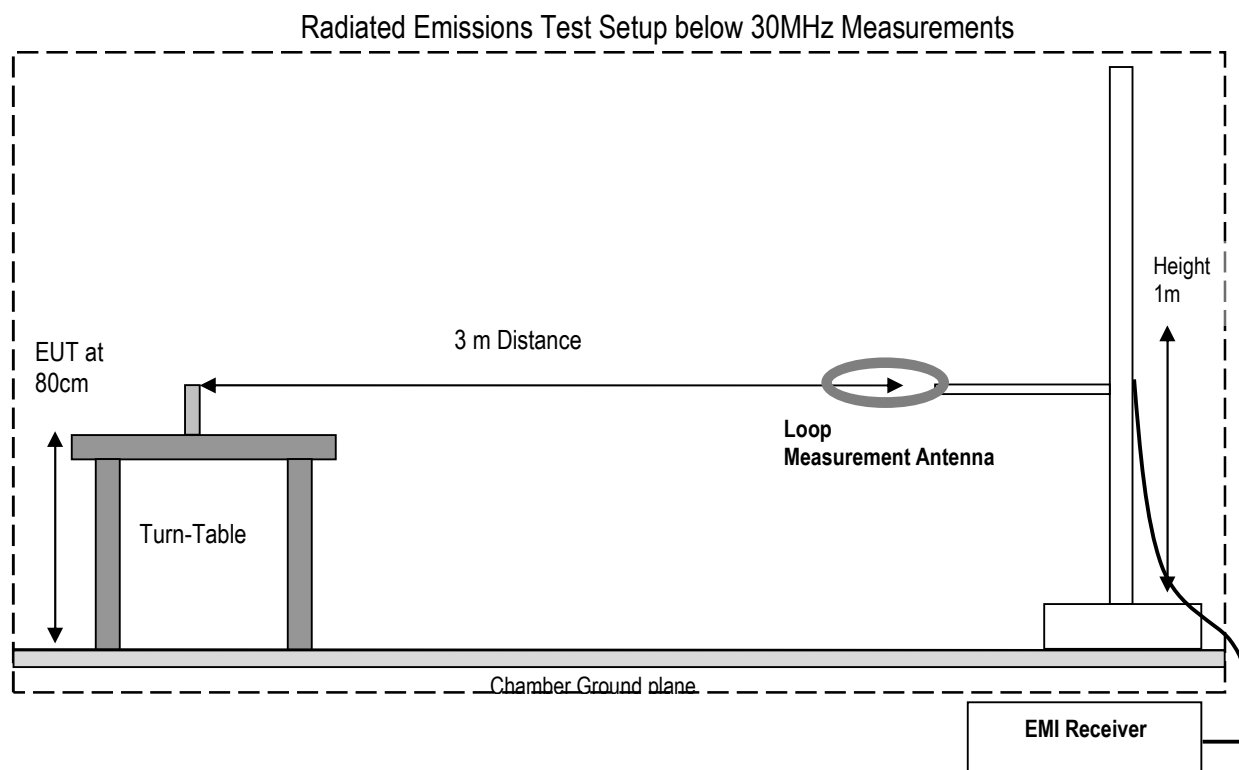
1/12/2022– 1/17/2022

## 8 Measurement Procedures

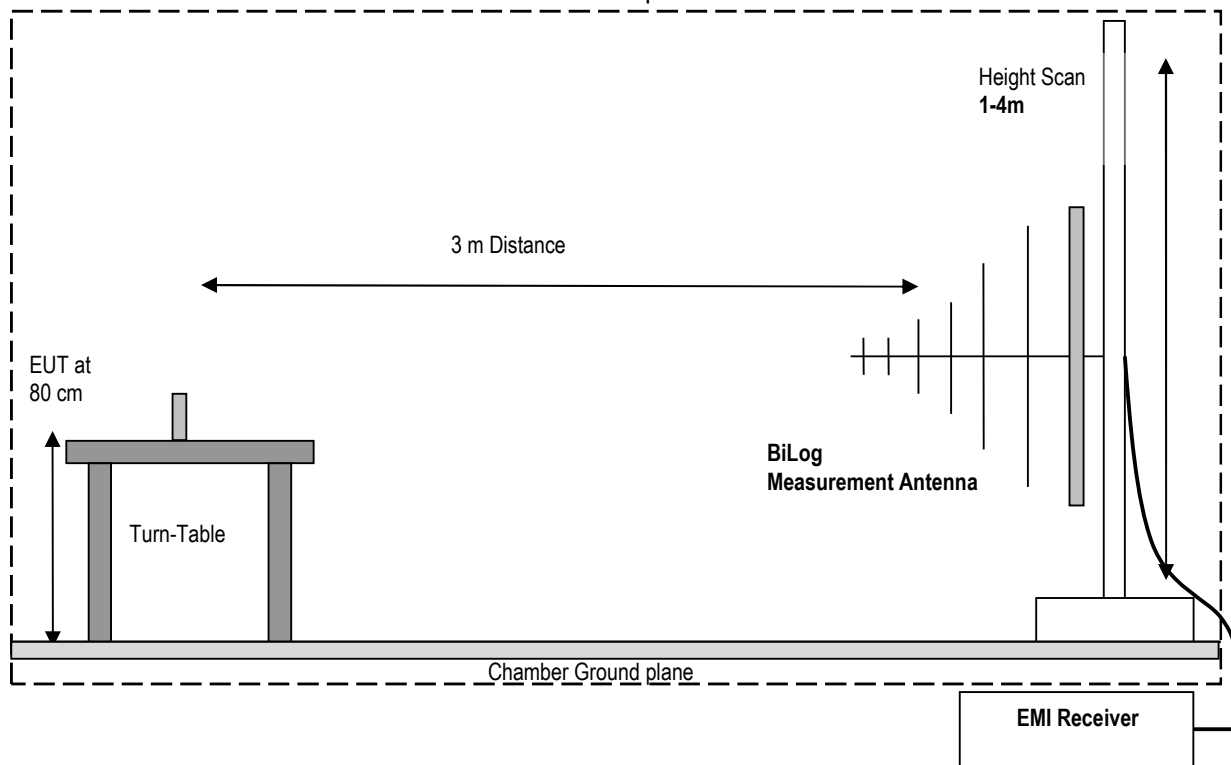
### 8.1 Radiated Measurement

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

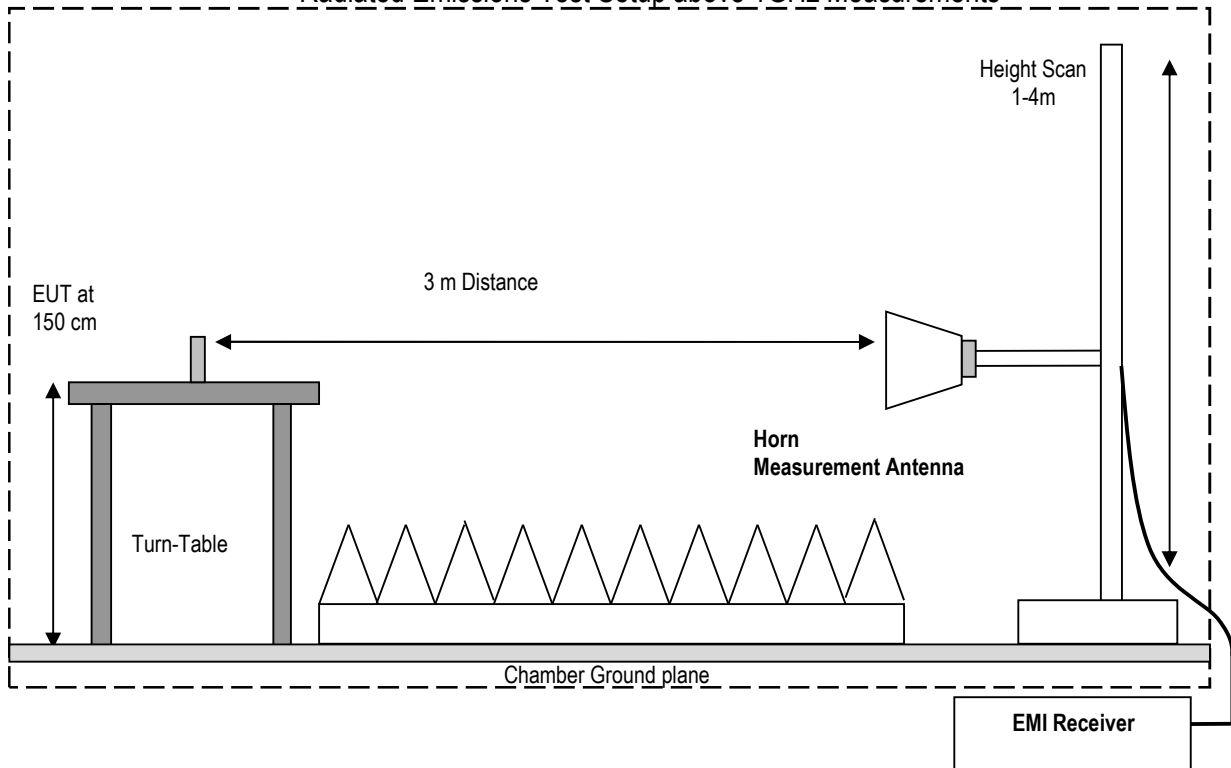
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to 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





### 8.1.1 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 dB $\mu$ V
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 (dB $\mu$ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB $\mu$ V/m)
1000	80.5	3.5	14	98.0

## 9 Test Result Data

### 9.1 Radiated Transmitter Spurious Emissions and Restricted Bands

#### 9.1.1 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) =  $40 \log (D/d) = 40 \log (300m / 3m) = 80dB$

#### 9.1.2 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



### 9.1.3 Test conditions and setup:

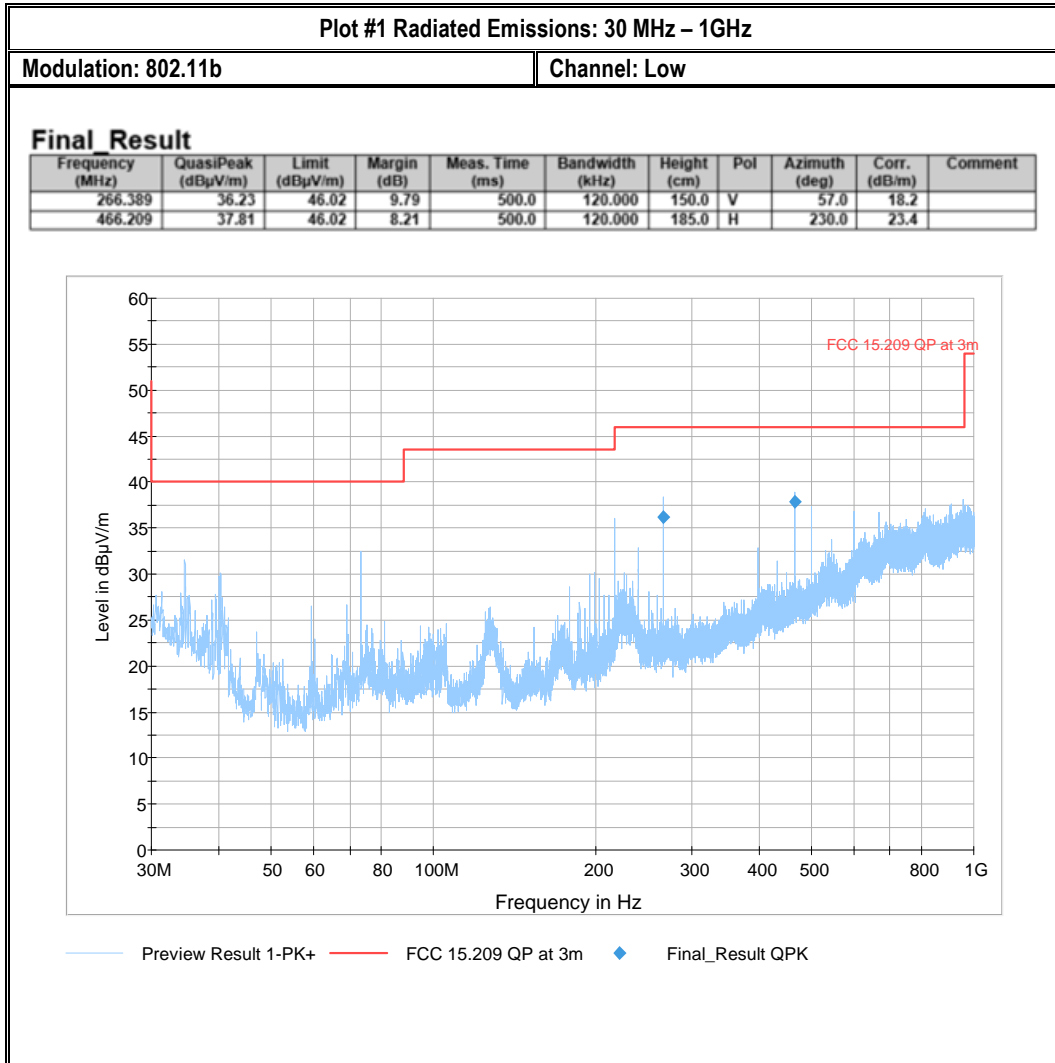
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	1	802.11b	28 VDC

### 9.1.4 Measurement result:

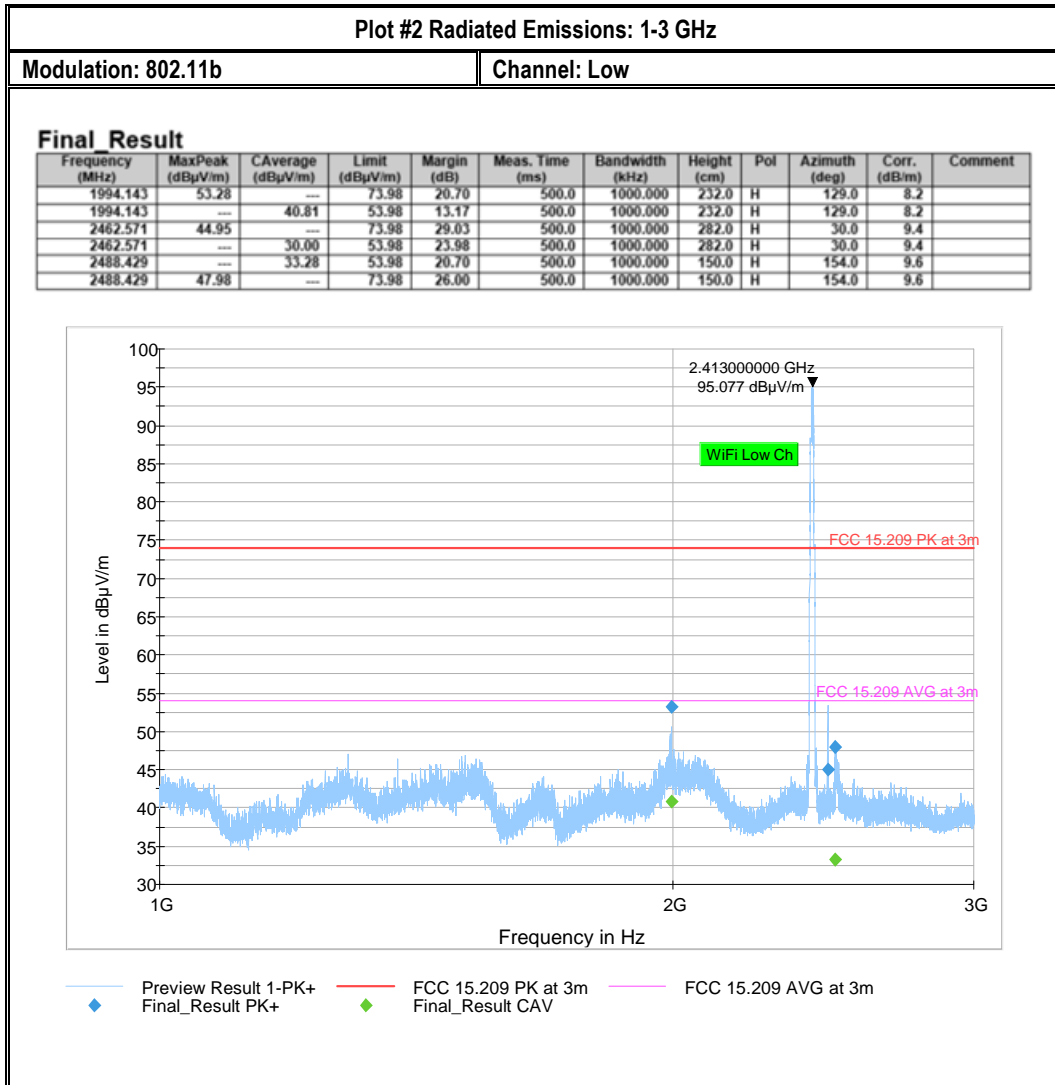
Plot #	WiFi Module	Channel #	Scan Frequency	Limit	Result
1-3	1	Low	30 MHz – 18 GHz	See section 9.1.2	Pass
4-8	1	Mid	9 kHz – 26 GHz	See section 9.1.2	Pass
9-11	1	High	30 MHz – 18 GHz	See section 9.1.2	Pass

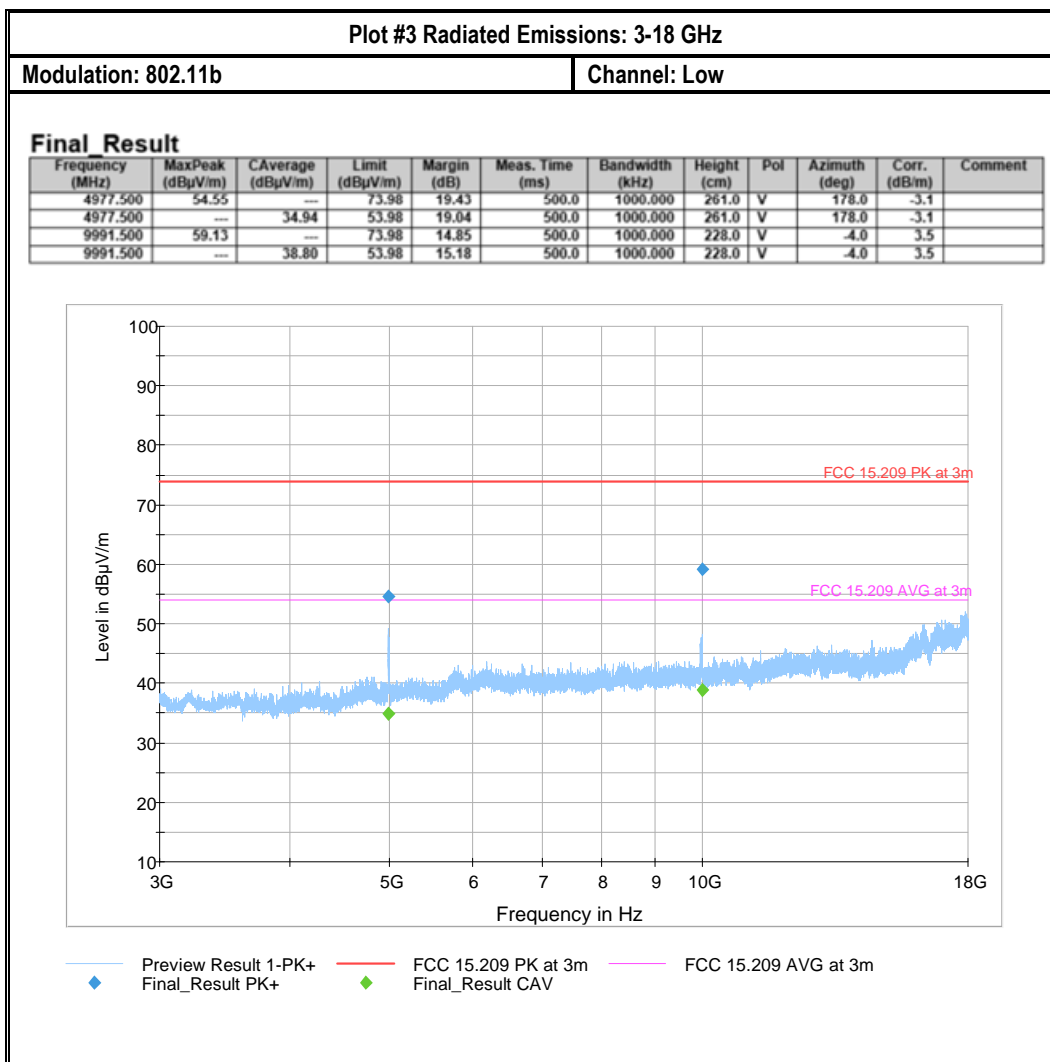


### 9.1.5 Measurement Plots:











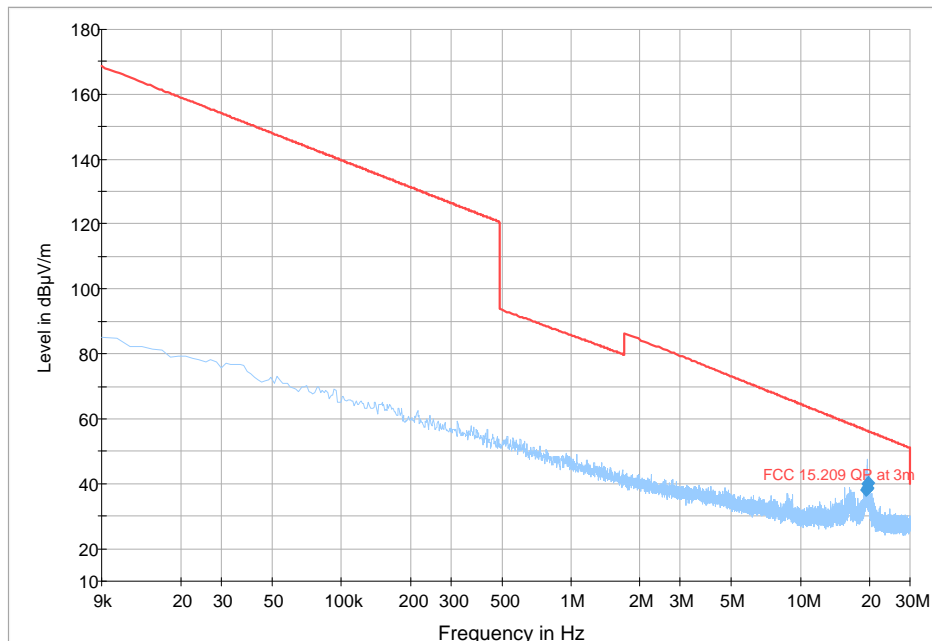
**Plot #4 Radiated Emissions: 9 KHz – 30 MHz**

Modulation: 802.11b

Channel: Mid

**Final Result**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
19.395	38.18	56.41	18.23	500.0	9.000	150.0	V	324.0	16.5	
19.446	38.85	56.38	17.53	500.0	9.000	150.0	V	314.0	16.5	
19.581	38.52	56.29	17.77	500.0	9.000	174.0	V	315.0	16.5	
19.644	39.84	56.25	16.41	500.0	9.000	174.0	V	314.0	16.5	
19.722	40.21	56.20	15.99	500.0	9.000	150.0	V	310.0	16.5	



— Preview Result 1-PK+    — FCC 15.209 QP at 3m    ◆ Final\_Result QPK



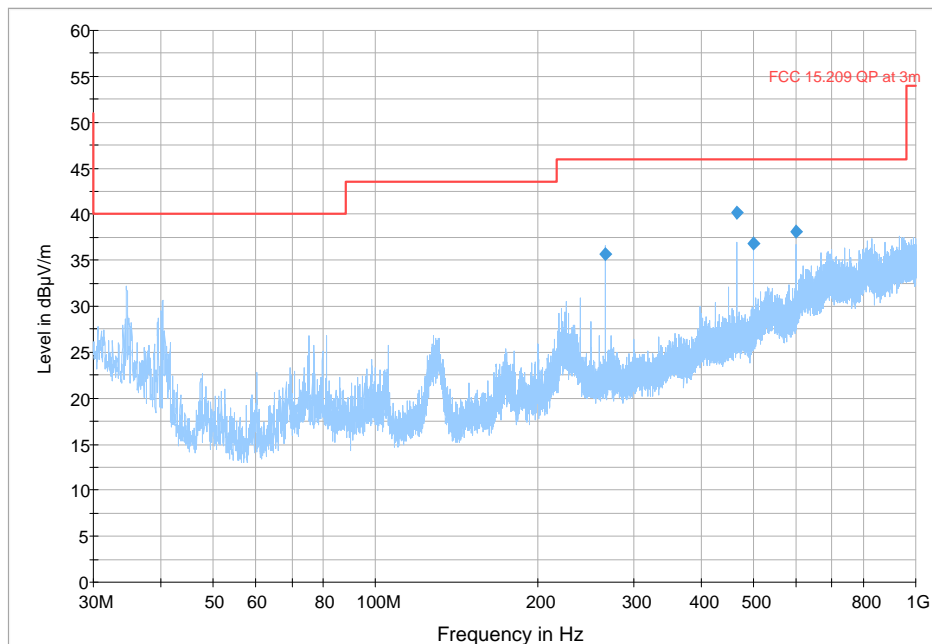
**Plot #5 Radiated Emissions: 30 MHz – 1GHz**

Modulation: 802.11b

Channel: Mid

**Final Result**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
266.389	35.69	46.02	10.33	500.0	120.000	150.0	H	260.0	18.2	
466.177	40.17	46.02	5.85	500.0	120.000	217.0	H	225.0	23.4	
499.997	36.82	46.02	9.20	500.0	120.000	150.0	H	229.0	23.7	
599.390	38.09	46.02	7.93	500.0	120.000	186.0	V	158.0	25.9	



— Preview Result 1-PK+    — FCC 15.209 QP at 3m    ◆ Final\_Result QPK



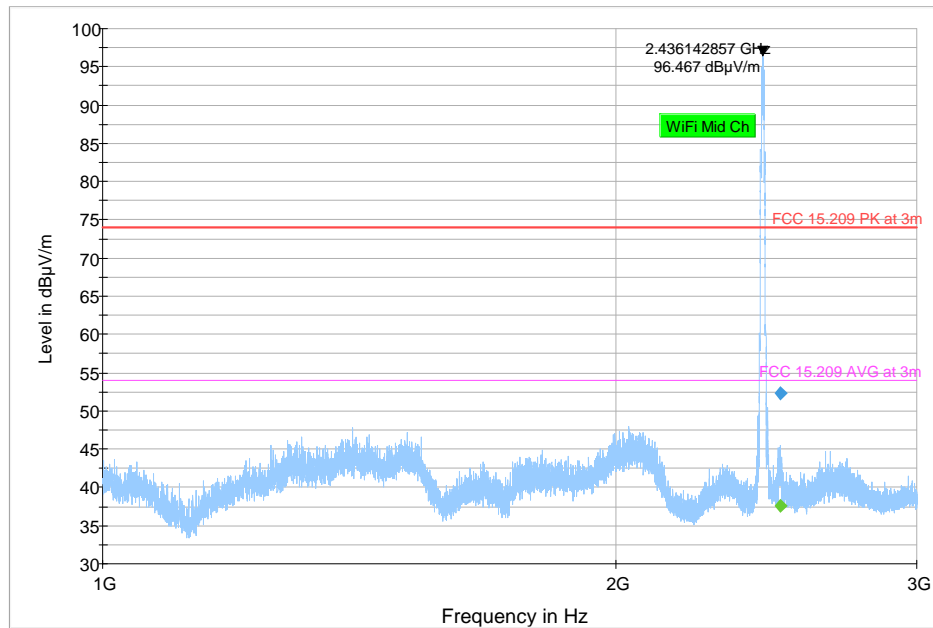
**Plot #6 Radiated Emissions: 1-3 GHz**

Modulation: 802.11b

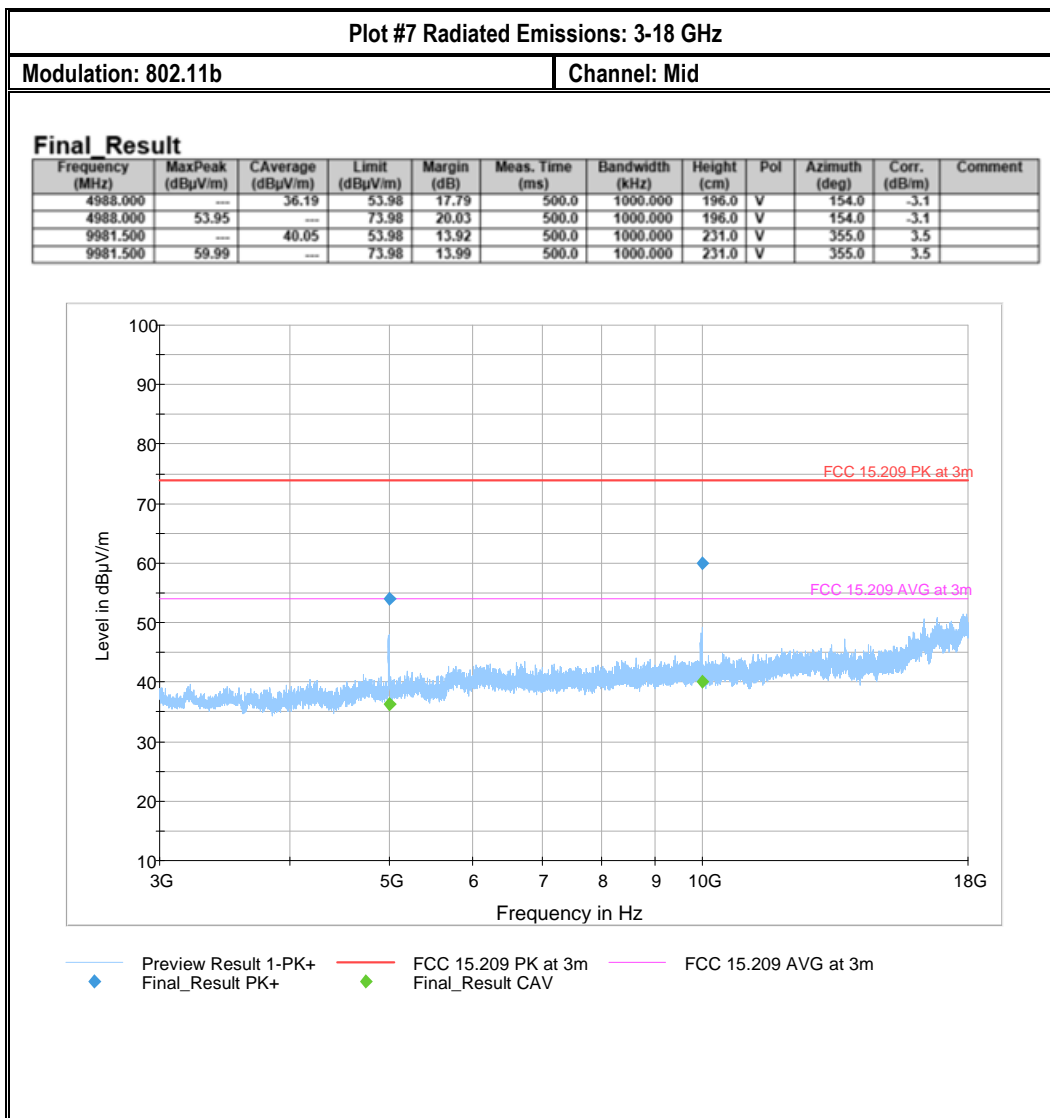
Channel: Mid

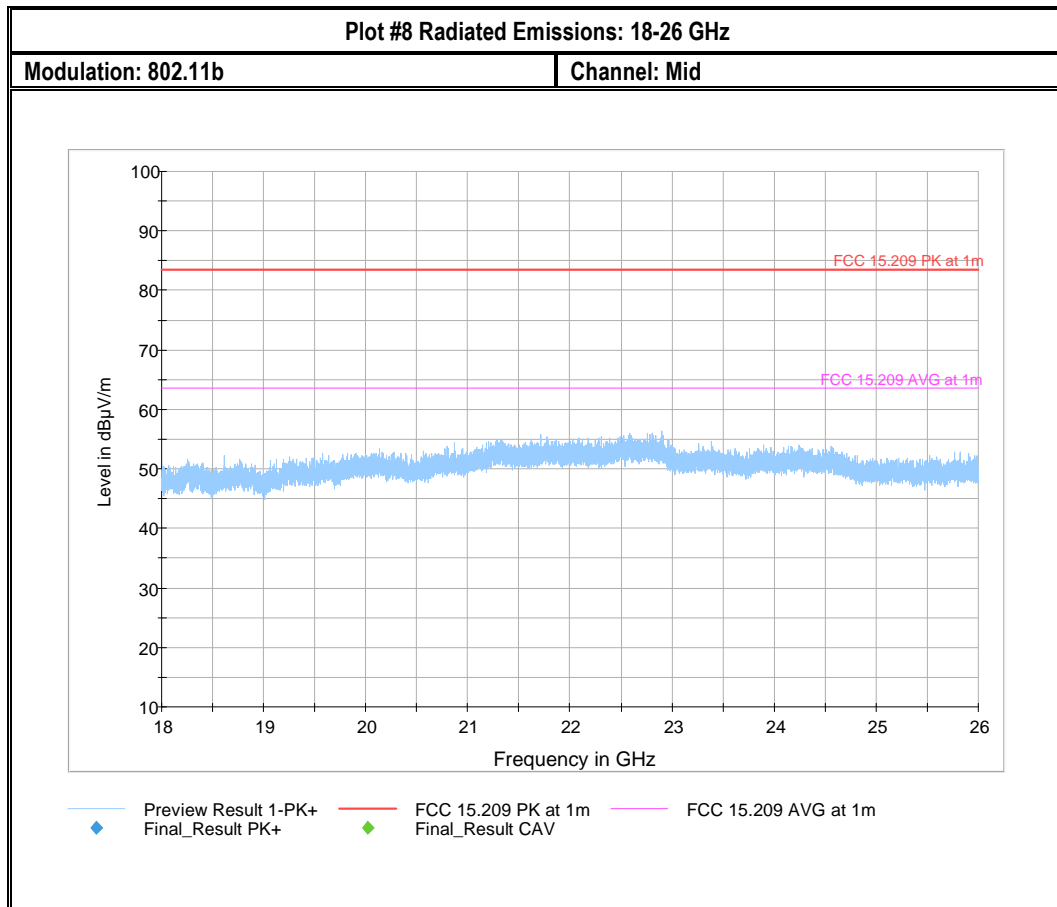
**Final Result**

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
2494.857	---	37.52	53.98	16.46	500.0	1000.000	218.0	H	209.0	9.7	
2494.857	52.32	---	73.98	21.66	500.0	1000.000	218.0	H	209.0	9.7	



◆ Preview Result 1-PK+ Final\_Result PK+    
 — FCC 15.209 PK at 3m    
 — FCC 15.209 AVG at 3m  
◆ Final\_Result CAV







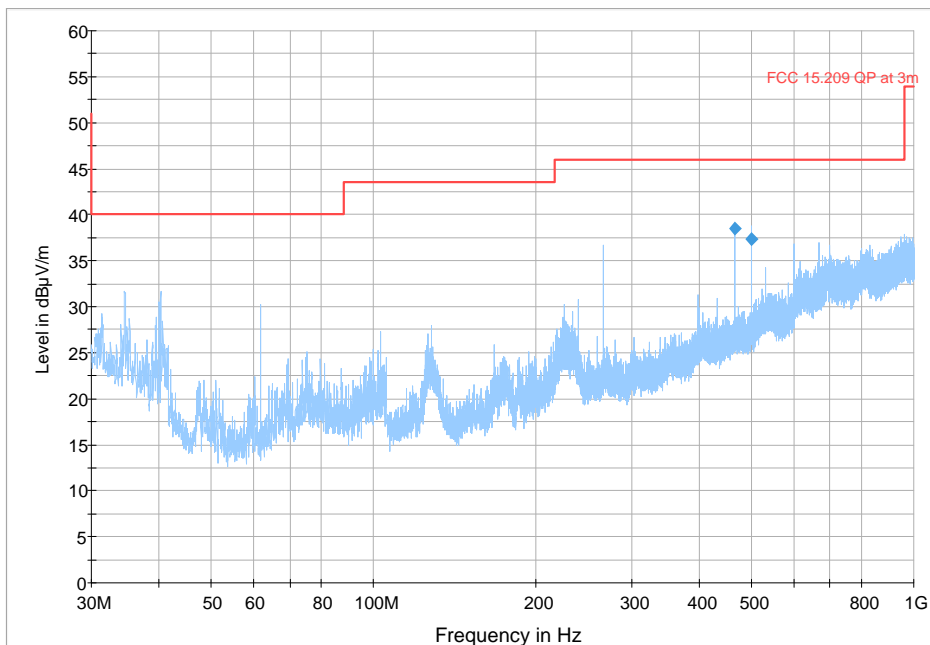
**Plot #9 Radiated Emissions: 30 MHz – 1GHz**

**Modulation: 802.11b**

**Channel: High**

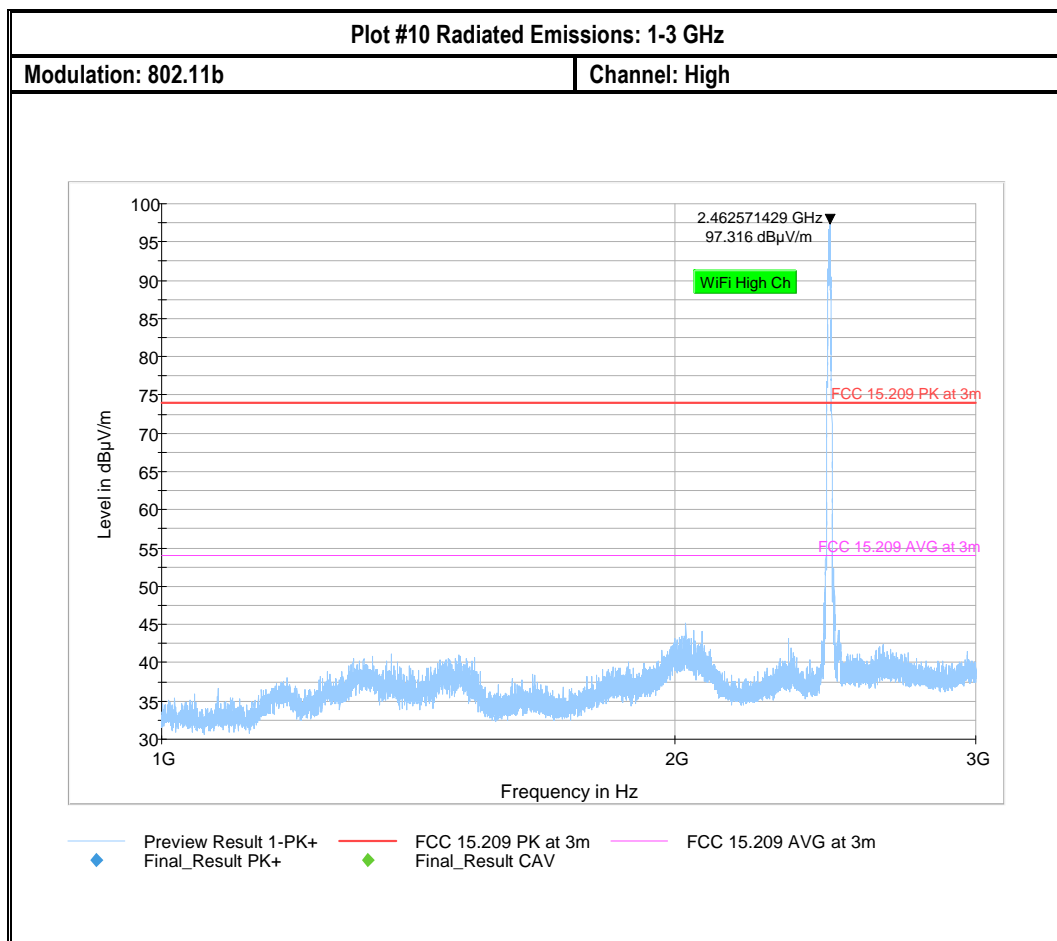
**Final Result**

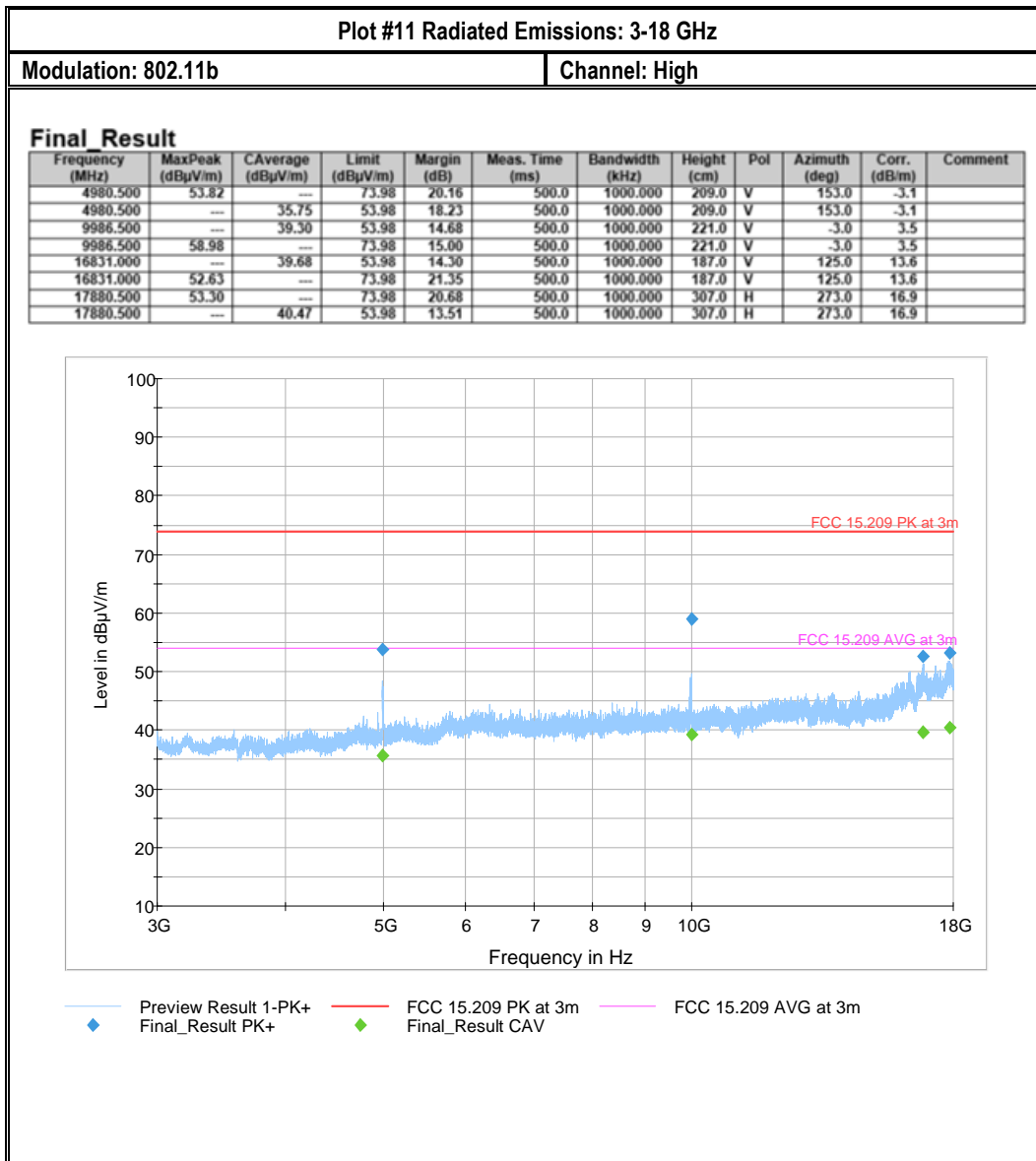
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
466.209	38.45	46.02	7.57	500.0	120.000	198.0	H	227.0	23.4	
499.997	37.39	46.02	8.63	500.0	120.000	149.0	H	222.0	23.7	



— Preview Result 1-PK+    — FCC 15.209 QP at 3m    ◆ Final\_Result QPK









## 10 Test setup photos

Setup photos are included in supporting file name: "EMC\_PRATT\_009\_21001\_Setup\_Photos\_Rev1.pdf"

## 11 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
ACTIVE LOOP ANTENNA	ETS LINDGREN	6507	00161344	2 YEARS	10/30/2020
BILOG ANTENNA	ETS.LINDGREN	3142E	00166067	2 YEARS	03/12/2020
HORN ANTENNA	EMCO	3115	00035114	2 YEARS	08/10/2020
HORN ANTENNA	ETS.LINDGREN	3117	00215984	2 YEARS	01/31/2021
HORN ANTENNA	ETS.LINDGREN	3116	00070497	2 YEARS	11/23/2020
TEST RECEIVER	R&S	ESU40	100251	2 YEARS	09/13/2021
COMPACT DIGITAL BAROMETER	CONTROL COMPANY	10510-922	200236891	2 YEARS	04/13/2020
DIGITAL THRMOMETER	CONTROL COMPANY	36934-164	181230565	3 YEARS	01/10/2019

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.



## 12 Revision History

Date	Report Name	Changes to report	Report prepared by
2022-02-16	EMC_PRATT_009_21001_15.247_WLAN_DTS	Initial version	Cheng Song
2022-03-16	EMC_PRATT_009_21001_15.247_WLAN_DTS_Rev1	Updated Section 6 Mudule Summary	Cheng Song

<<The End>>