



FCC / ISED Test Report

FOR:

Astronautics

Model Name:

AEC115

Product Description:

The AEC115 is an air vehicle equipment for recording and transferring of collected data via cellular and Wi-Fi radio while the vehicle is on the ground.

FCC ID: 2AVRR-AGCS-AEC115

IC: 25923-AEC115

Applied Rules and Standards:

47 CFR Part 15.247 (DTS)

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

REPORT #: EMC_ASTRO-019-22001_15.247_Rev3

DATE: 3-6-2023



A2LA Accredited

IC recognized #
3462B

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1 Assessment

The following device as further described in section 3 of this report 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.

According to the client declaration from Astronautics Corporation of America, the device Cetecom tested has the same Hardware/Software version as the device listed in the grant as:

Manufacturer: Sparklan

Model: WPEQ256ACNRBI

FCC ID: RYK-WPEQ256ACN

IC: 6158A-WPEQ256ACN

No deviations were ascertained.

Company	Description	Model #
Astronautics	The AEC115 is an air vehicle equipment for recording and transferring of collected data via cellular and Wi-Fi radio while the vehicle is on the ground.	AEC115

Responsible for Testing Laboratory:

3-6-2023	Compliance	Arndt Stoecker (Director of Regulatory Services)
Date	Section	Name

Responsible for the Report:

3-6-2023	Compliance	Kris Lazarov (Senior EMC Engineer)
Date	Section	Name

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
Director of Regulatory Services:	Arndt Stoecker
Responsible Project Leader:	Cathy Palacios

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:	Same as client
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment Under Test (EUT)

3.1 EUT Specifications

Model No:	AEC115
HW Version :	282300
SW Version :	282283
FCC ID :	2AVRR-AGCS-AEC115 Contains FCC ID: N7NEM75
IC:	25923-AEC115 Contains IC: 2417C-EM75
FWIN:	N/A
HVIN:	282300-1
PMN:	mini-wACS
Product Description:	The AEC115 is an air vehicle equipment for recording and transferring of collected data via cellular and Wi-Fi radio while the vehicle is on the ground.
Radio Module:	Sparklan WPEQ-256ACNRBI
Frequency Range / number of channels:	Nominal band: 2400 – 2483.5MHz / 11 channels
Modes of Operation / Type(s) of Modulation:	WiFi 802.11b,g,n / BPSK
Antenna Information as declared:	Max Gain 3.32 dBi
Max. Peak Output Power:	20 dBm
Power Supply/ Rated Operating Voltage Range:	28VDC
Operating Temperature Range	-40 °C to 55 °C
Other Radios included in the device:	UMTS / LTE / 802.11a/b/g/n/ac
Sample Revision	<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	101220052	282300	282283	-

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Radio Certification Tester	PN 284438	Astronautics	N/A
2	Cable	PN 283704	Astronautics	N/A
3	Ultra Wide Band Antenna	FXUB66	Taoglas	N/A
4	Dipole Antenna	FXP830	Taoglas	N/A

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1 +AE#2+ AE#3 +AE#4	-----

3.5 Mode of Operation details

Mode of Operation	Description of Operating modes	Additional Information
1	802.11b	The EUT was configured to a fixed channel transmission using software that is not available to the end user.

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 802.11b 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 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

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	-	<input type="checkbox"/>	<input type="checkbox"/>	■	Note 2
§15.247(e) RSS-247 5.2(b)	Power Spectral Density	Nominal	-	<input type="checkbox"/>	<input type="checkbox"/>	■	Note 2
§15.247(b)(1) RSS-247 5.4(d)	Maximum Conducted Output Power and EIRP	Nominal	802.11b	■	<input type="checkbox"/>	<input type="checkbox"/>	Note 2 Note 3
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	-	<input type="checkbox"/>	<input 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"/>	■	Note 2
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions- Radiated	Nominal	802.11g	■	<input type="checkbox"/>	<input type="checkbox"/>	Pass
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	N/A	<input type="checkbox"/>	■	<input type="checkbox"/>	Note 1

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

Note 2: Leveraged from module certification report #: CR8D0605AC against RSS-247 Issue 2 for Sparklan under FCC ID: RYK-WPEQ256ACN; IC: 6158A-WPEQ256ACN

Note 3: Limited power verification testing was conducted only on the middle channel.

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=2.

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

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:

05/10/2022 - 05/16/2022

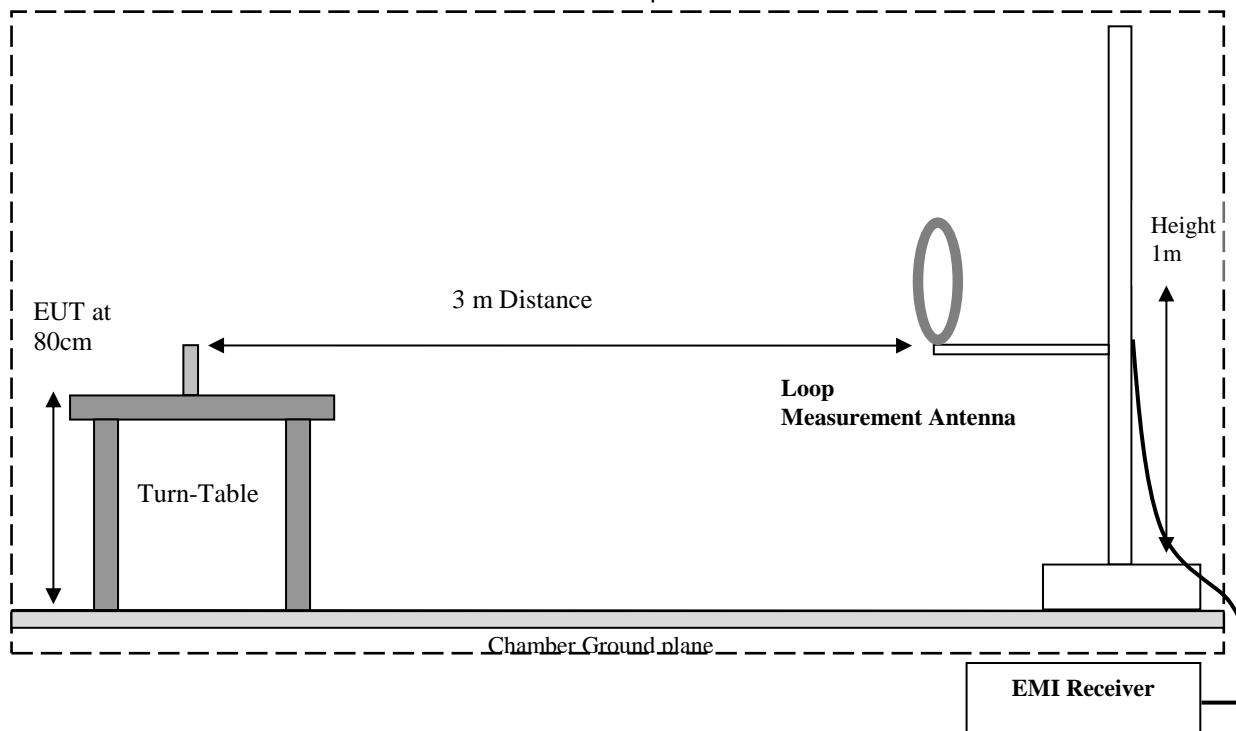
7 Measurement Procedures

7.1 Radiated Measurement

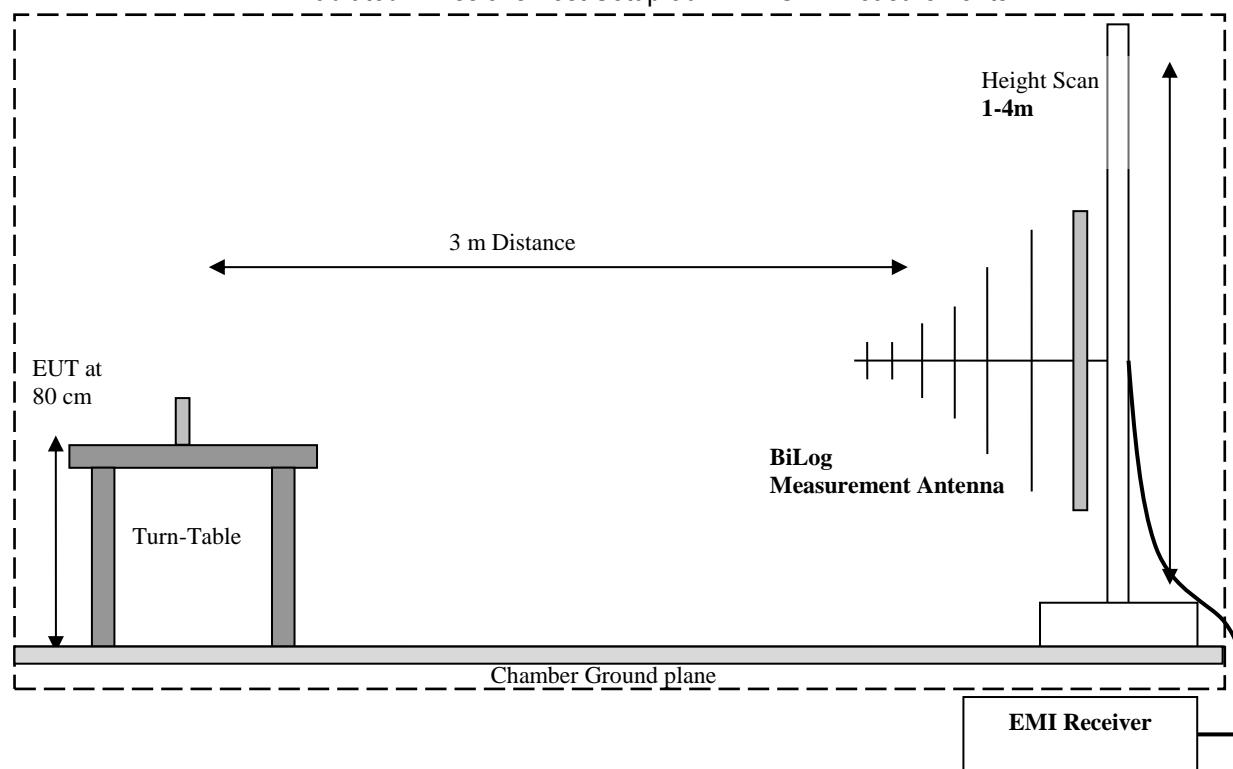
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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.

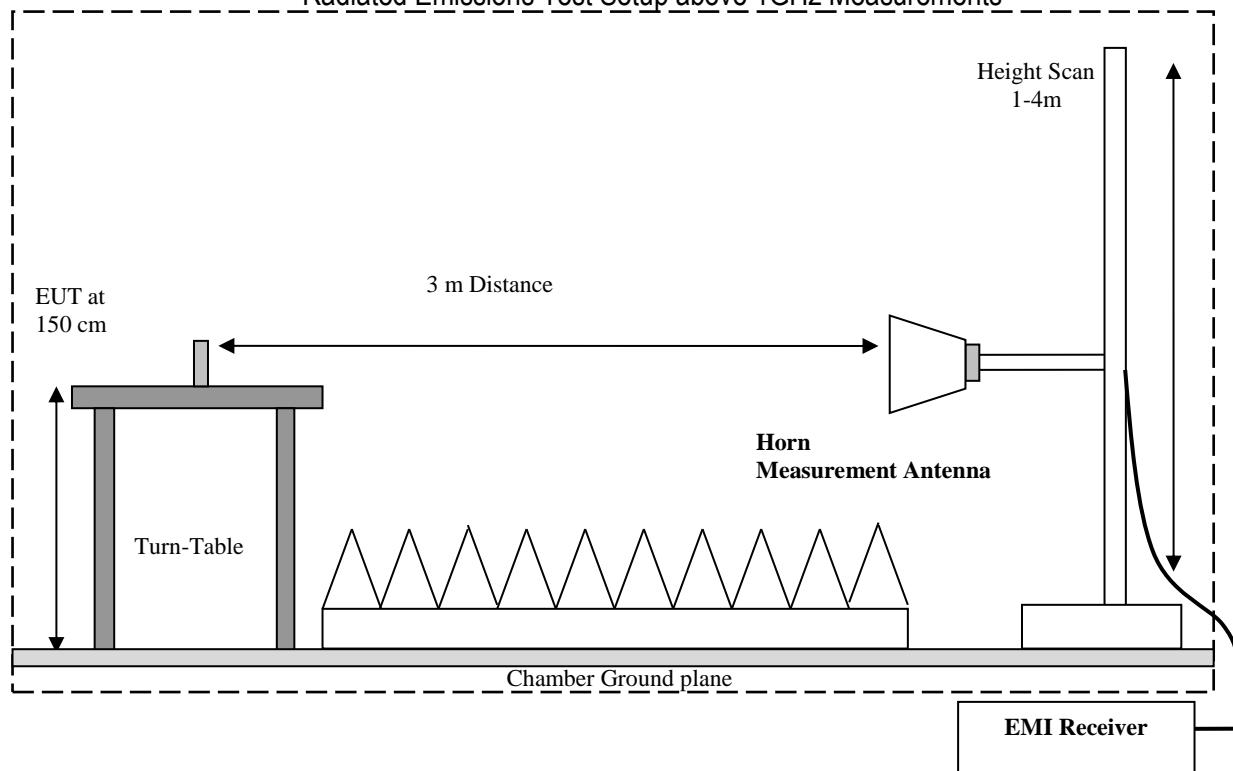
Radiated Emissions Test Setup below 30MHz Measurements



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 dB μ 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 μ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB μ V/m)
1000	80.5	3.5	14	98.0

8 Test Result Data

8.1 Maximum Conducted (Average) Output Power Verification Measurement

8.1.1 Measurement according to FCC 558074 D01 15.247 Meas Guidance v05r02

Spectrum Analyzer settings:

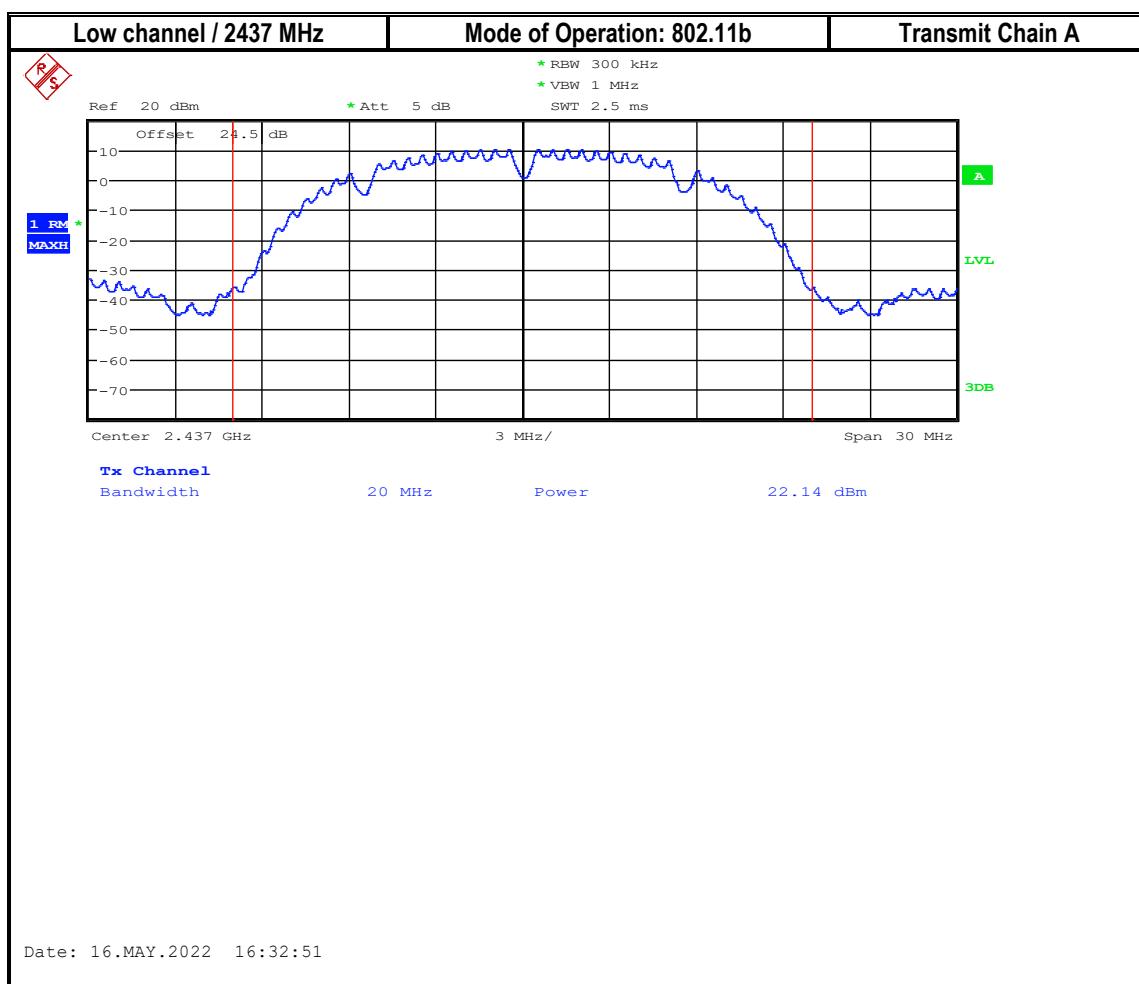
- RBW = 1% to 5% of the OBW, not to exceed 1 MHz
- VBW \geq 3 x RBW
- Span = at least 1.5 times the OBW
- Sweep = Auto couple
- Detector function = RMS
- Trace = Average (at least 100 traces in power averaging (rms) mode)
- Compute power by integrating the spectrum across the OBW of the signal using 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 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22°C	1	802.11b	28 VDC

8.1.3 Measurement result:

Channel	RF Output Power (dBm)	Target power (dBm)	Result
Mid	22	20 \pm 2	Pass



8.2 Radiated Transmitter Spurious Emissions and Restricted Bands

8.2.1 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) = $40 \log(D/d) = 40 \log(300m / 3m) = 80dB$

8.2.2 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 (μ V/m)	Measurement Distance (m)	Field strength @ 3m (dB μ V/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 dB μ V/m
88–216	150	3	43.5 dB μ V/m
216–960	200	3	46 dB μ V/m
Above 960	500	3	54 dB μ V/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 dB μ V/m

*AVG. LIMIT= 54 dB μ V/m

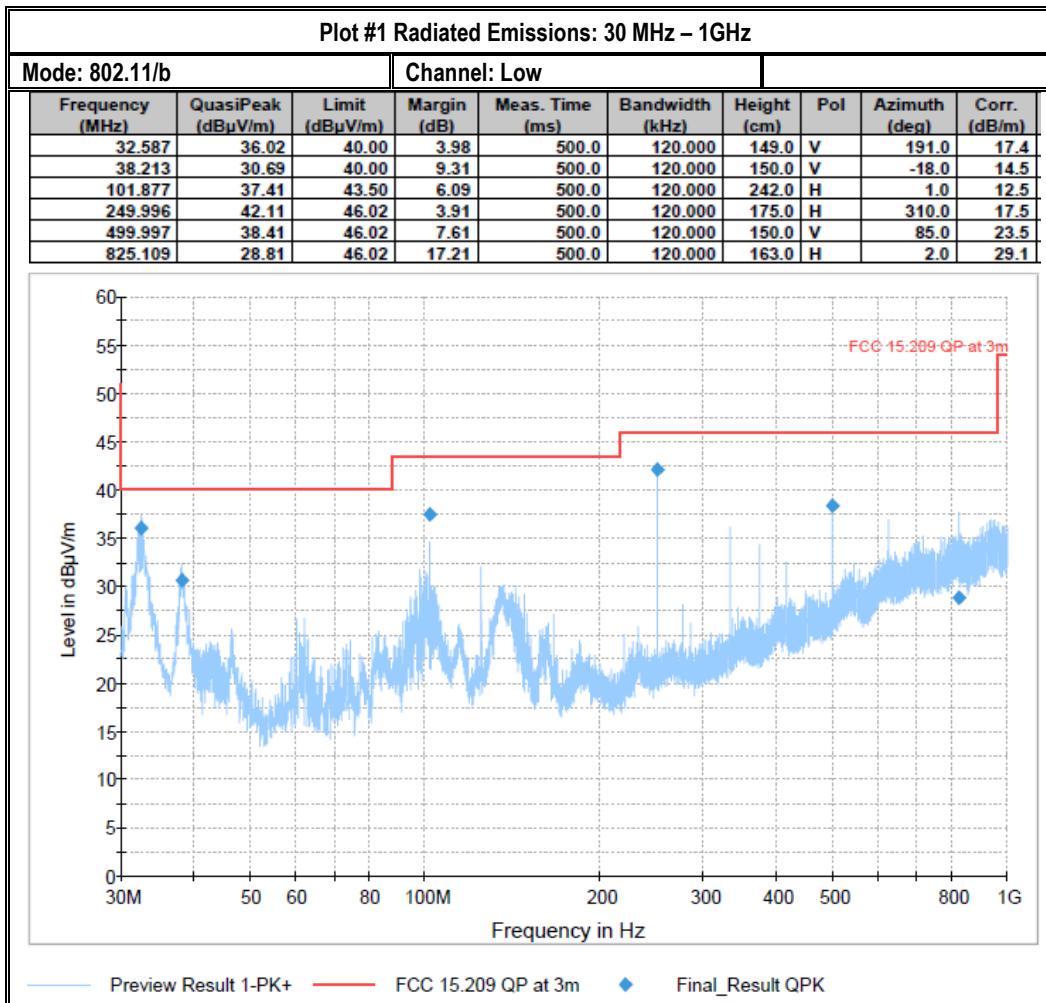
8.2.3 Test conditions and setup:

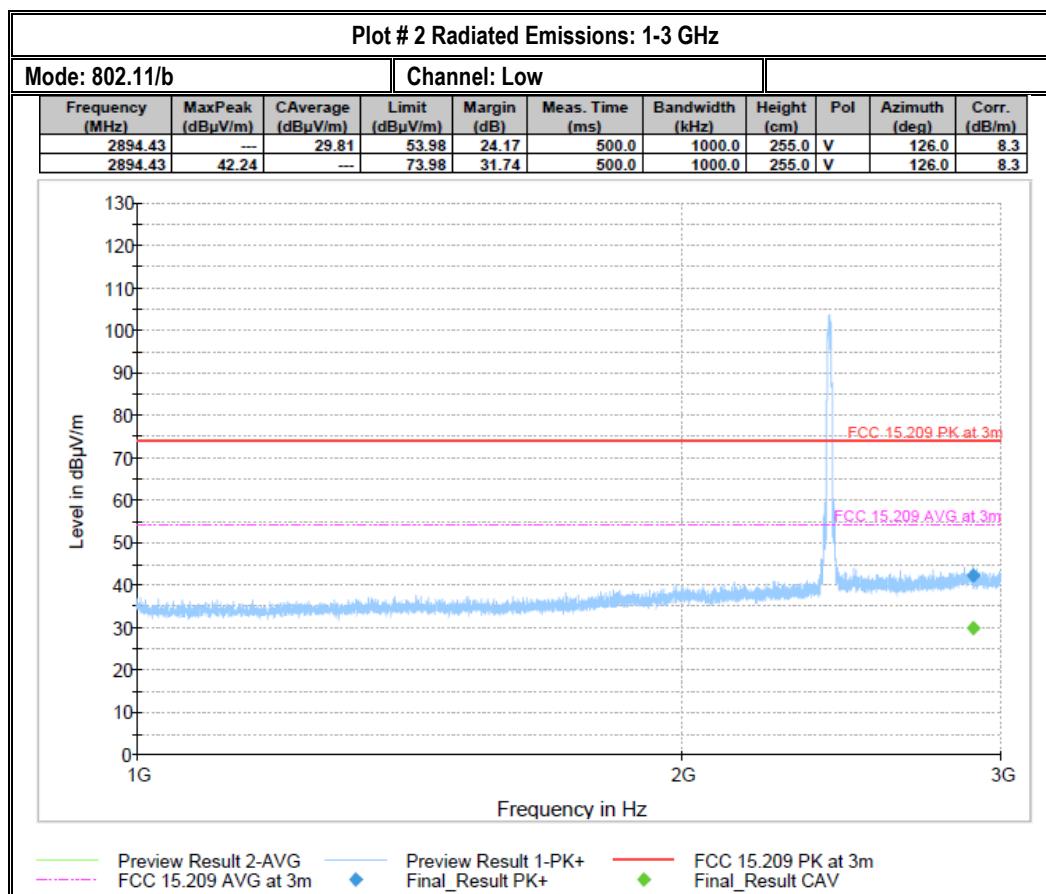
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	802.11b	28 VDC

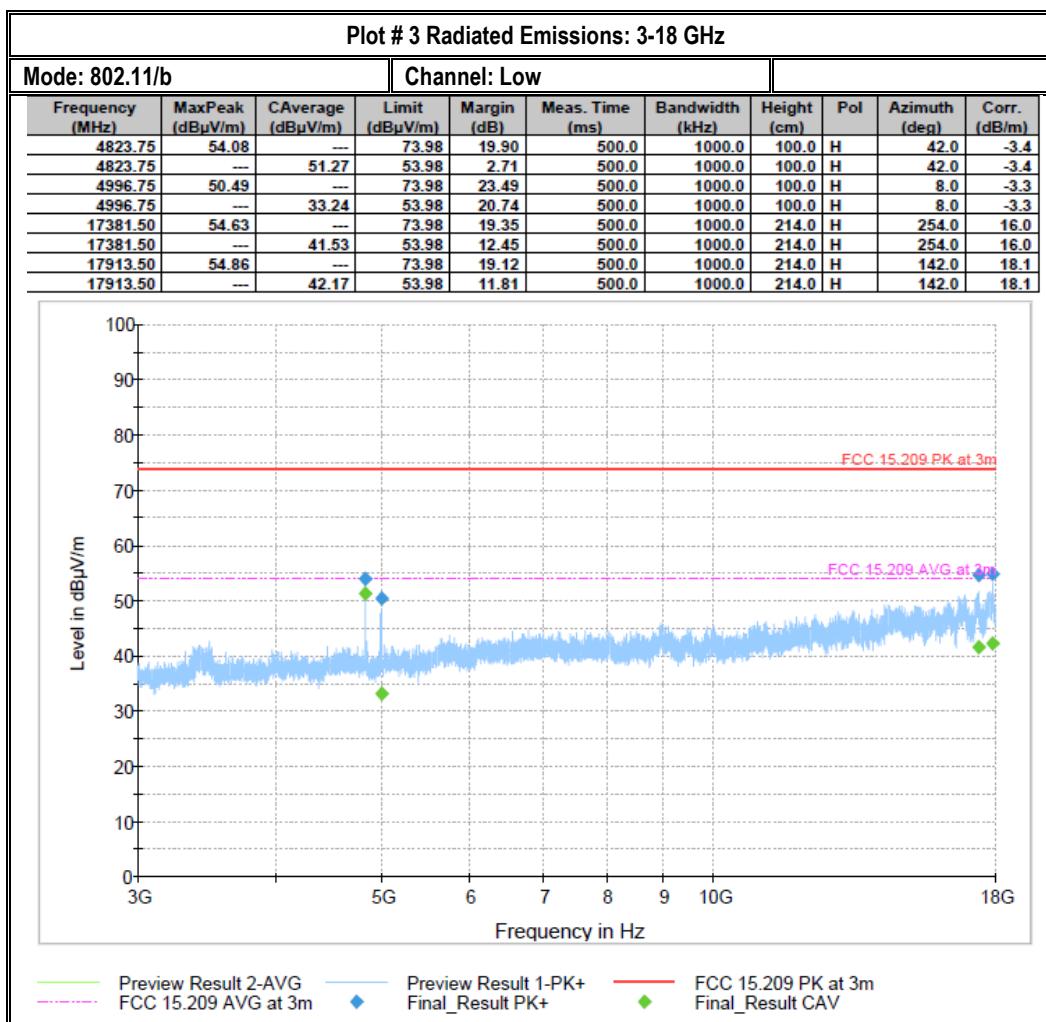
8.2.4 Measurement result:

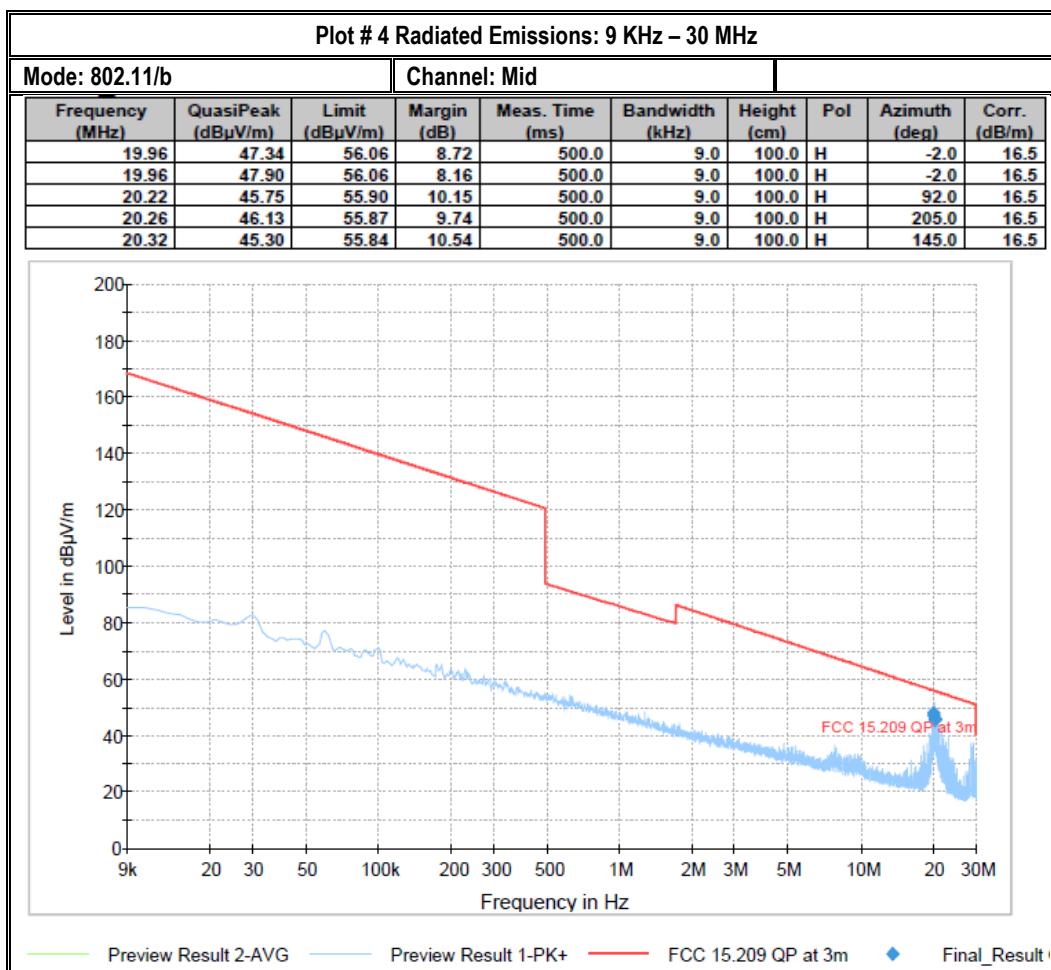
Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.2.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.2.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.2.2	Pass

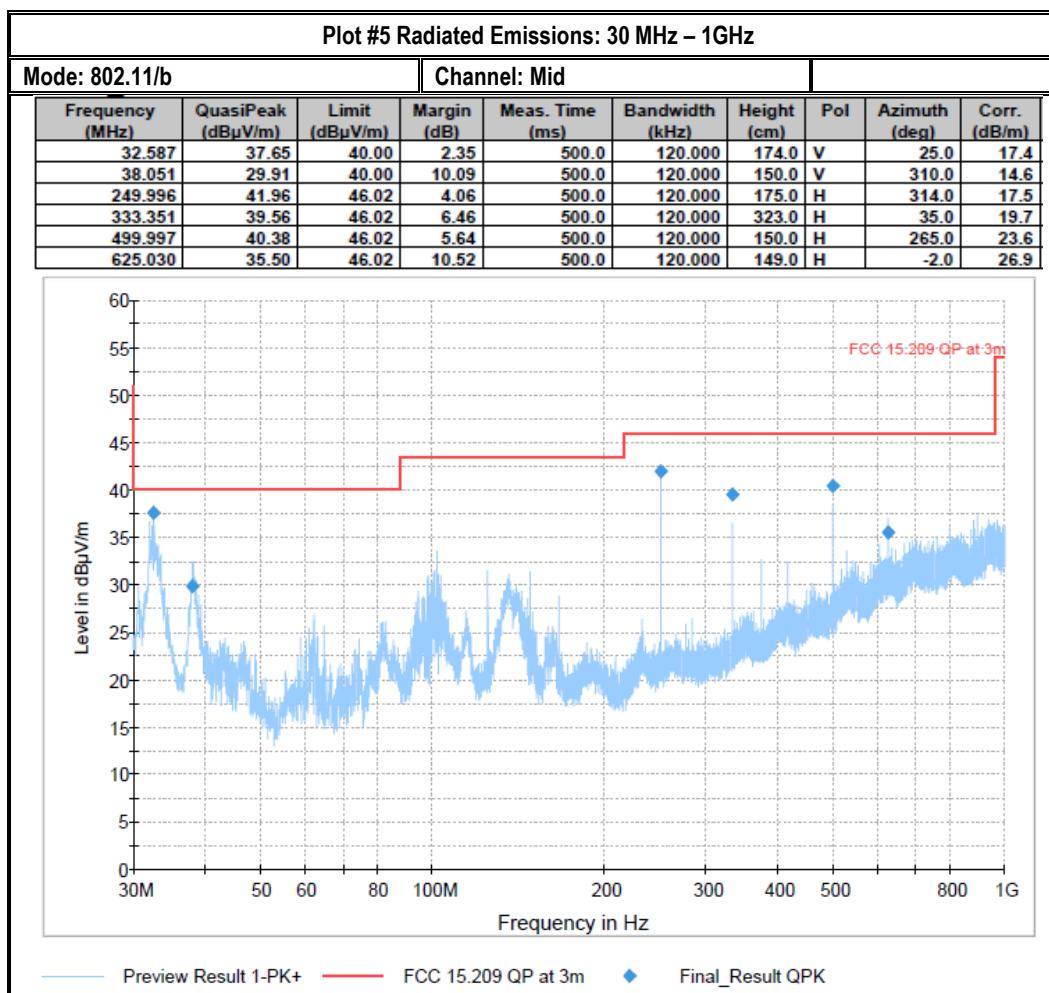
8.2.5 Measurement Plots:

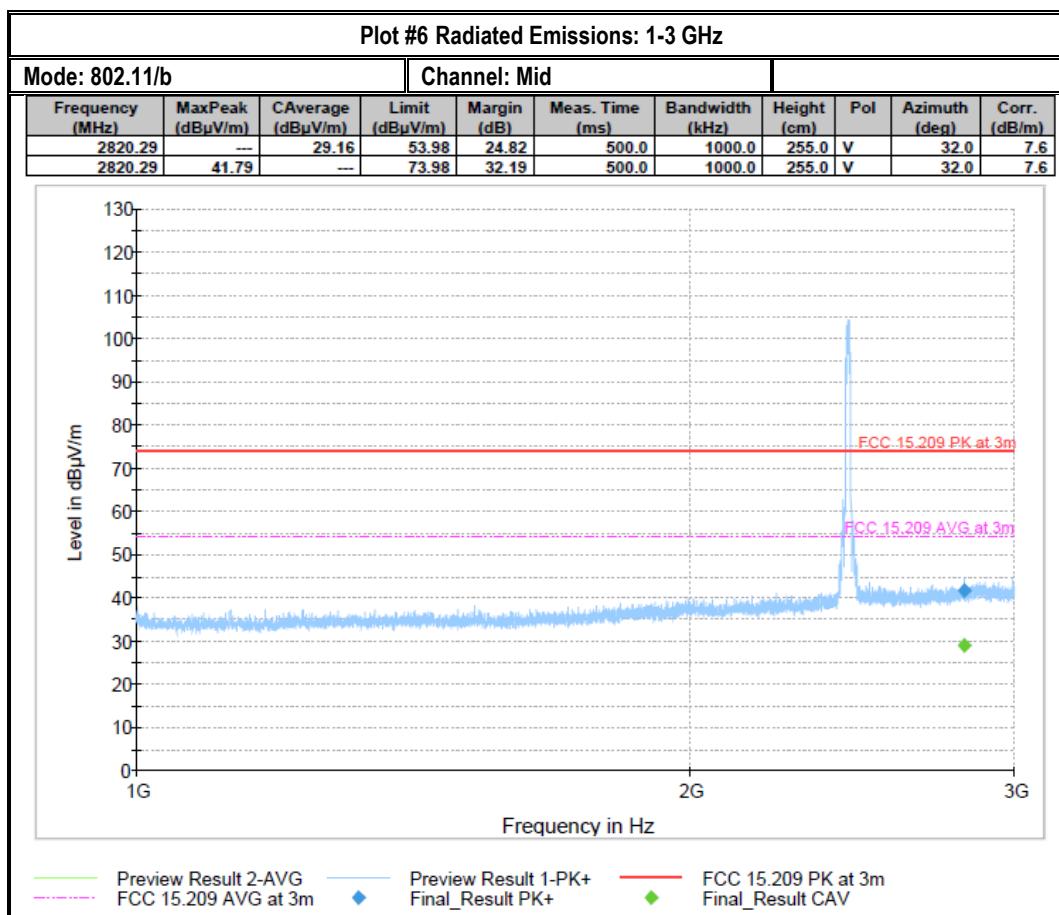


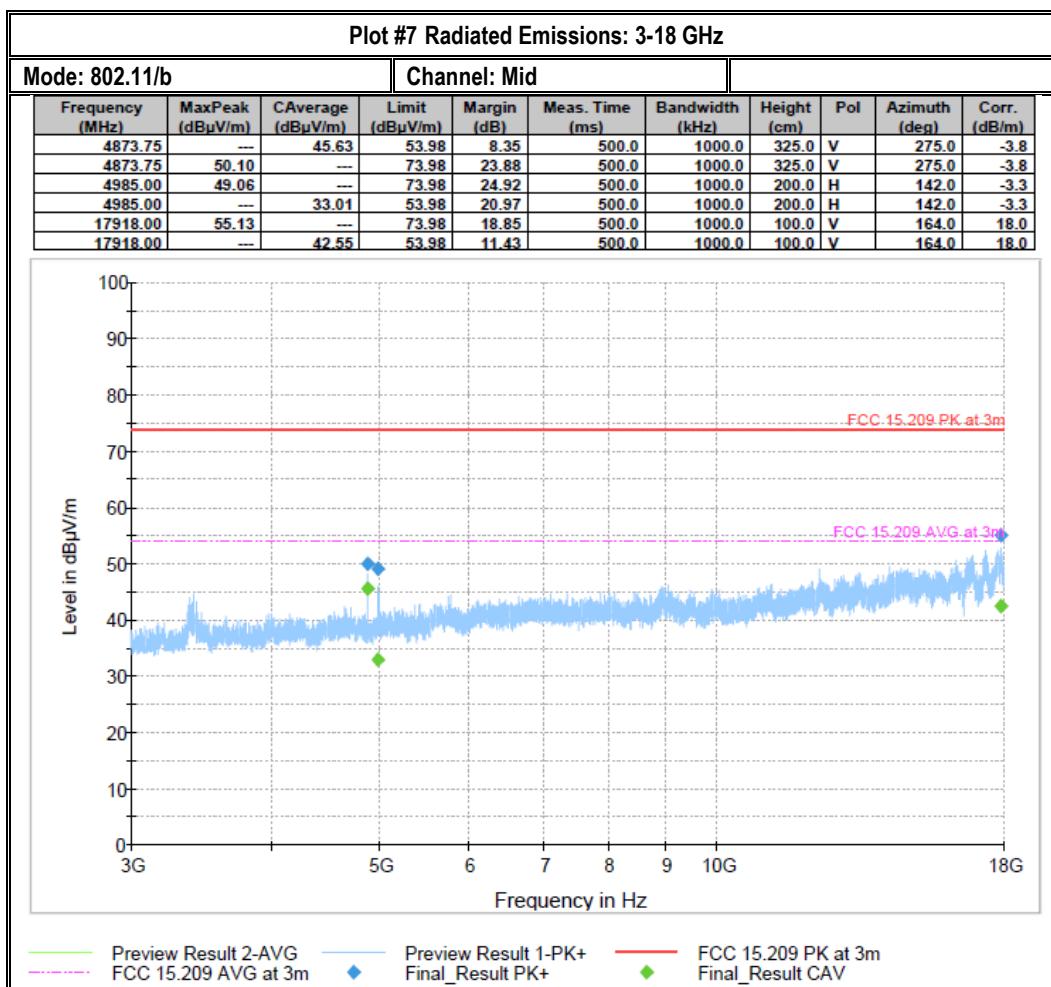


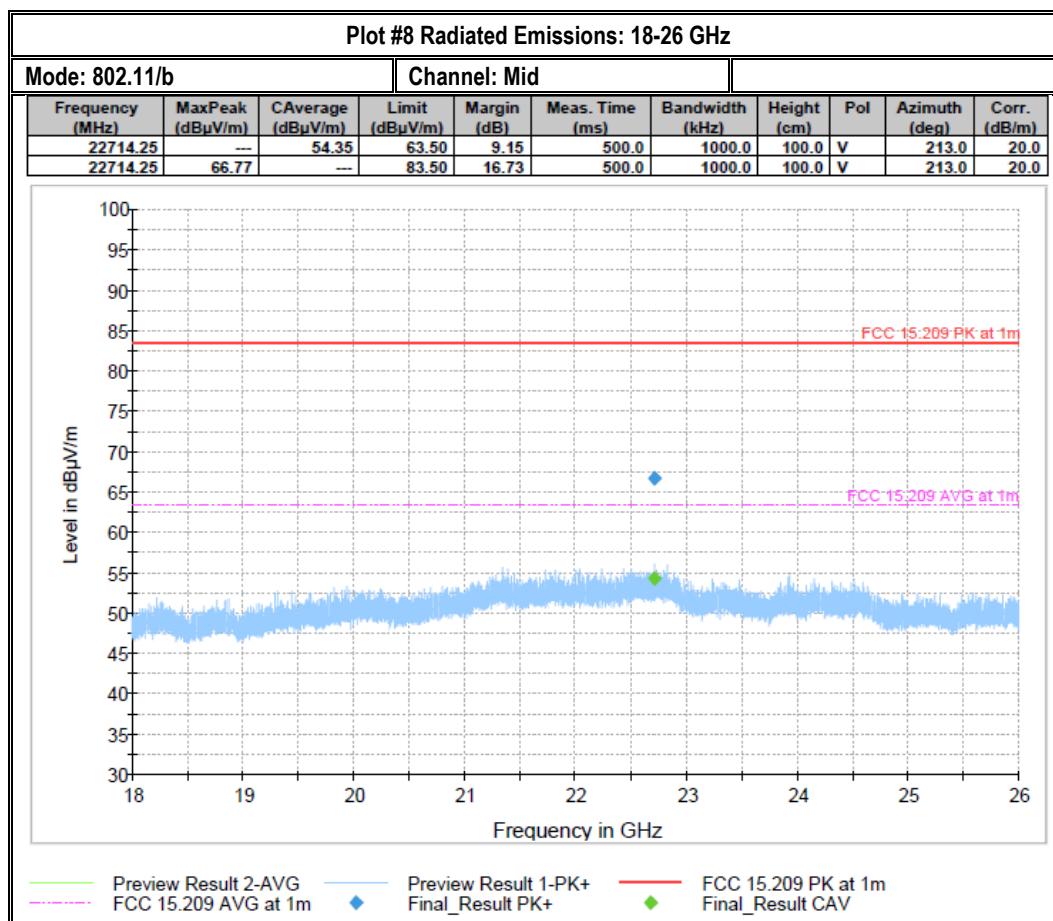


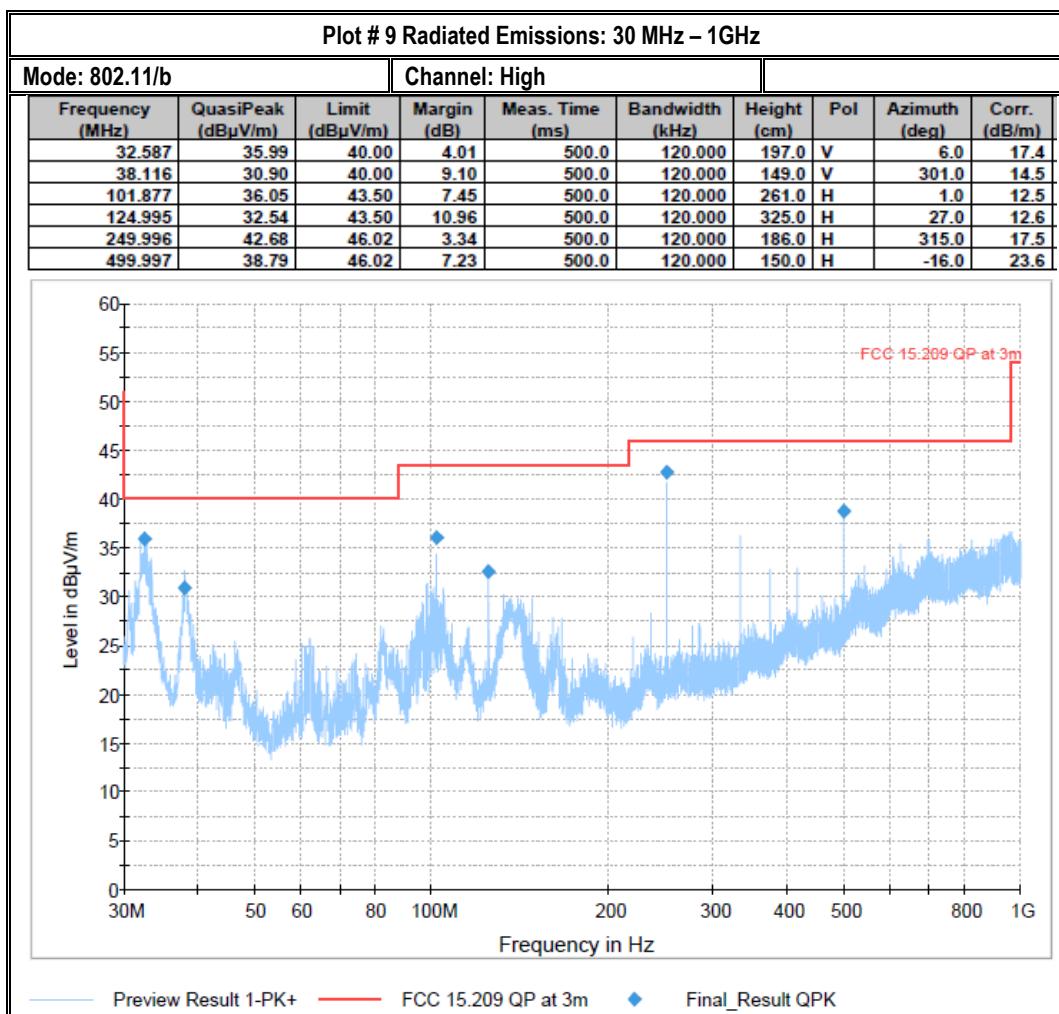


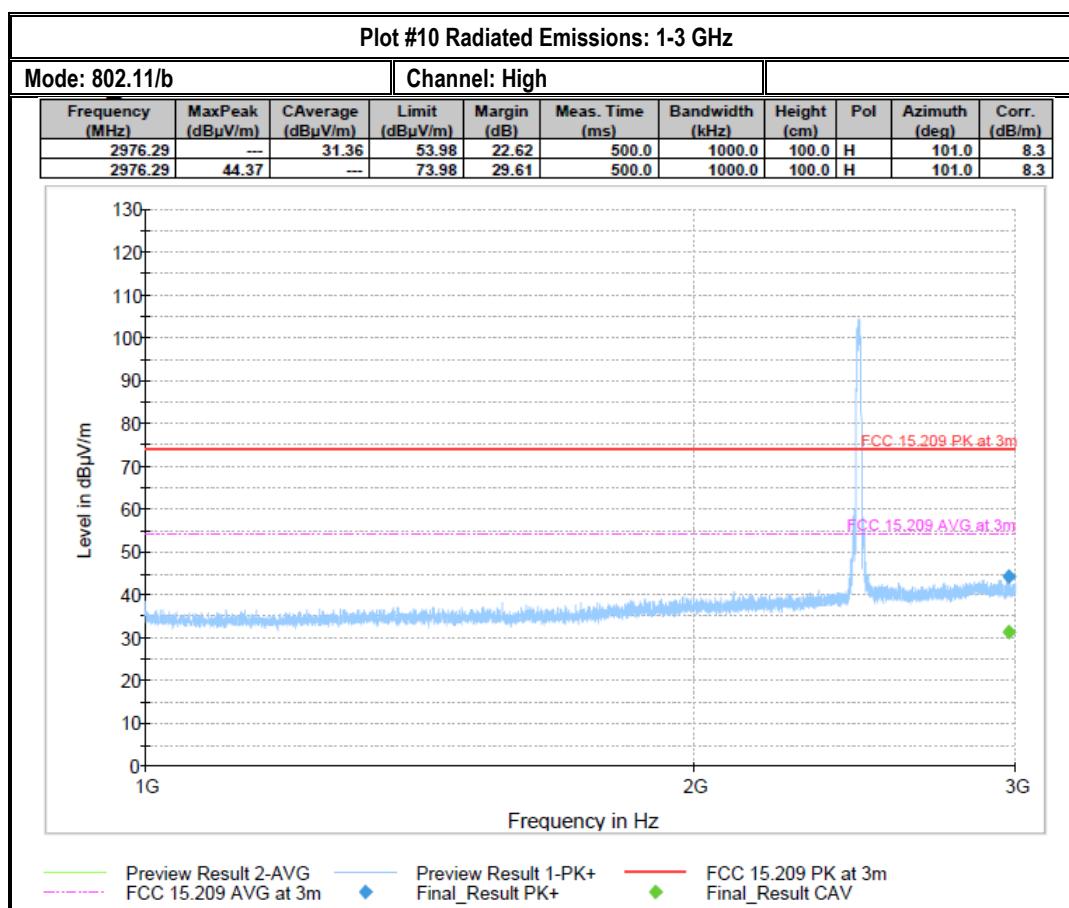


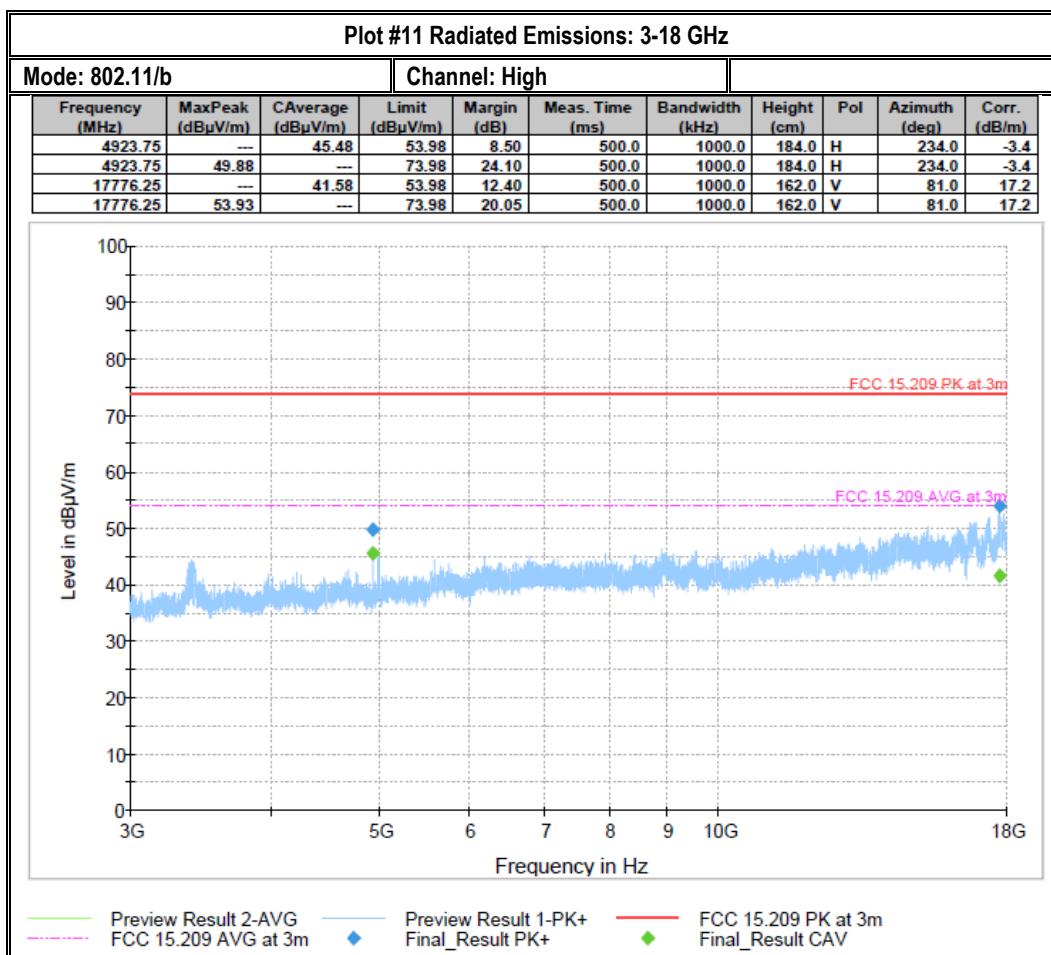












9 Test setup photos

Setup photos are included in supporting file name: "EMC_ASTRO-019-22001_15.247_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	9/13/2021
Biconlog Antenna	EMCO	3142E	166067	3 years	3/12/2020
Horn Antenna	EMCO	3115	35114	3 years	8/10/2020
Horn Antenna	ETS Lindgren	3117-PA	215984	3 years	1/31/2021
Horn Antenna	ETS Lindgren	3116C-PA	169535	3 years	9/30/2020
Digital Thermometer	Control Company	36934-164	191871986	3 Years	10/20/2021
Signal Analyzer	Rohde & Schwarz	FSV40	101022	3 Years	9/14/2021

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
6-10-2022	EMC_ASTRO-019-22001_15.247	Initial Version	Kris Lazarov
11-28-2022	EMC_ASTRO-019-22001_15.247_Rev1	Updated Section 5, Note2; Updated Section 6;	Kris Lazarov
2-28-2023	EMC_ASTRO-019-22001_15.247_Rev2	Updated antenna gain in Section 3.1	Kris Lazarov
3-6-2023	EMC_ASTRO-019-22001_15.247_Rev3	Added reference to customer declaration in Section 1; Added reference to the RF modular report to Section 5	Kris Lazarov

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