



FCC / ISED Test Report

For:
Nuro

Model:
Camera Aggregator

Product Description:
Host-based automotive Data device

Contains FCC ID: 2A98RDJZCGCA, 2A98RDJZCGWA
Contains IC: 30172-DJZCGCA, 30172-DJZCGWA

Applied Rules and Standards:
47 CFR Part 15.407 (UNII-1) & 5 GHz (UNII-3)
RSS-247 Issue 2 (DTSS) & (LE-LAN), and RSS-Gen Issue 5

REPORT #: EMC_NUROI_006_22001_15_407_UNII

DATE: 2023-08-09



A2LA Accredited

IC recognized #
3462B

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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 #
Nuro	Camera aggregator	CGR3

Responsible for Testing Laboratory:

Arndt Stoecker

2023-08-09

Compliance

(Director of Regulatory Services)

Date	Section	Name	Signature
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Responsible for the Report:

Art Thammanavarat

2023-08-09

Compliance

(Senior EMC Engineer)

Date	Section	Name	Signature
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The test results of this test report relate exclusively to the test item specified in Section 3.

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

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

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

2.1 Identification of the Client

Client Firm/Name:	Nuro
Street Address:	1300 Terra Bella Ave #200
City/Zip Code	Mountain View, CA 94043
Country	USA

2.2 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:	Camera aggregator	
HW Version :	DVT2	
SW Version :	3.14	
Contains FCC ID :	2A98RDJZCGCA 2A98RDJZCGWA	
Contains IC:	30172-DJZCGCA 30172-DJZCGWA	
HVIN:	Camera Aggregator	
Product Description:	Host-based automotive Data device	
Frequency Range / number of channels:	Frequency Range (MHz)	Channel Number
	5150-5250	36-48 [4]
	5725-5850	149-165 [5]
Modes of Operation / Channel Bandwidths:	IEEE Std. 802.11(a,g,n,ac)	Data Rate / MCS
	a	6-54 Mbps
	n: HT20 & HT40	MCS 0-7; MCS 8-15
	ac: VHT20; VHT40; VHT80	MCS 0-9
Transmit Chains(N_{TX})	1 & 2	
Radio Information:	<u>Wi-Fi Modules</u> Model Name : UBlox Model Number : Jody W374 FCC : XPYJODYW374 IC : 8595A-JODYW374 <u>Wireless Technologies</u> Wi-Fi 5GHz	
Antenna Information as declared:	Manufacturer: Taoglas P/N: MA9906.A.007.dp Type: A low-profile heavy duty, fully IP67 waterproof external antenna. Frequency Range: 5150 – 5850 MHz	
	<u>Peak Gain (dBi)</u> <ul style="list-style-type: none"> • Wi-Fi 2 : 8.12 • Wi-Fi 7 : 8.97 	
Max. Conducted Output Power:	<u>Peak Measurement Power :</u> Ch 40 : 17.1 dBm Ch 157 : 17.6 dBm	
Power Supply/ Rated Operating Voltage Range:	12VDC	
Operating Temperature Range	Low : 0 °C Norm 45 °C High 65 °C	

Other Radios included in the device:	Cellular; GPS, Wi-Fi 2.4GHz
Sample Revision	<input checked="" type="checkbox"/> Production Unit; <input type="checkbox"/> Pre-Production

3.2 EUT details

EUT #	Model Number	HW Version	SW Version	Comments
1	Camera Aggregator	DVT2	3.14	N/A

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	GPS Antenna	AA180	Taoglas	180TT18021264
2	Camera #1	40640G032-6PHS2	FLIR	0139786
3	Camera #2	40640G032-6PHS2	FLIR	0139789
4	Camera #3	40640G032-6PHS2	FLIR	0138908
5	Camera #4	60-056989-01	FLIR	200-2149-000168
6	Camera #5	60-056989-01	FLIR	200-2149-000137
7	100/1000 BASE-T1 Media Converter	TE-1401-1	Technica Engineering	210110120 164
8	100/1000 BASE-T1 Media Converter	TE-1401-1	Technica Engineering	210510120 056
9	LiDAR Sensor	Pandar40P	Hesai	N/A

3.4 Support Equipment (SE) details

SE #	Type	Model	Manufacturer	Serial Number
1	Notebook	XPS	DELL	785N0J3
2	Notebook	XPS	DELL	6D27GB3

3.5 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1+(AE 1,2,3,4,5,6,7,8,9)	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software that is not available to the end user.

3.6 Justification for Worst Case Mode of Operation

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

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

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.407 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISSED Canada.

This test report is to support a request for new equipment authorization under the FCC ID: 2A98RDJZCGCA, 2A98RDJZCGWA IC: 30172-DJZCGCA, 0172-DJZCGWA

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	802.11a/n/ac	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 4
§15.407(a) RSS-247 6	Power Spectral Density	Nominal	802.11a/n/ac	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 5
§15.407(a) RSS-247 6	Maximum Output Power	Nominal	802.11a/n/ac	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	See Note 3,6
§15.407; 15.205 RSS-247 6; RSS-Gen 8.10	Band Edge Compliance	Nominal	802.11a/n/ac	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	See Note 7
§15.407(b); §15.209; 15.205 RSS-247 6; RSS-Gen 8.9; 8.10	Radiated TX Spurious Emissions	Nominal	802.11a/n/ac	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	802.11a/n/ac	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	See Note 1,2

Note 1: NA= Not Applicable

Note 2: This device does not connect to AC mains network

Note 3: Power verification testing was conducted only on middle channel.

Note 4: Leveraged from report # MDE_UBLOX_2220_FCC_02, Section 5.3 (FCC ID: XPYJODYW374)

Note 5: Leveraged from report # MDE_UBLOX_2220_FCC_02, Section 5.2 (FCC ID: XPYJODYW374)

Note 6: Leveraged from report # MDE_UBLOX_2220_FCC_02, Section 5.2 (FCC ID: XPYJODYW374)

Note 7: Leveraged from report # MDE_UBLOX_2220_FCC_02, Section 5.4 (FCC ID: XPYJODYW374)

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%

Deviating test conditions are indicated at individual test description where applicable.+

6.2 Date of Testing:

2023-03-01 – 2023-05-08

6.3 Decision Rule:

Cetecom advanced follows ILAC G8:2019 chapter 4.2.1 (Simple Acceptance Rule).

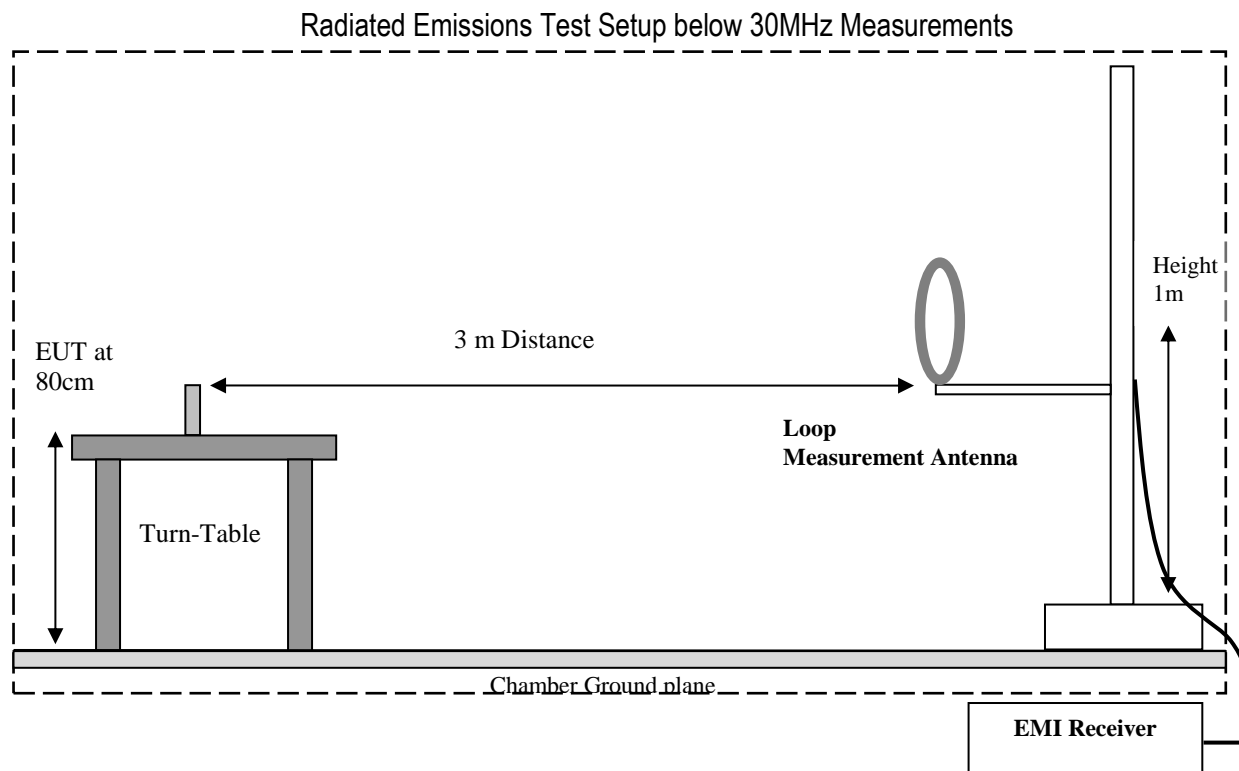
Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3. The measurement uncertainty is mentioned in this test report, See chapter 9, but is not taken into account – neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong.

7 Measurement Procedures

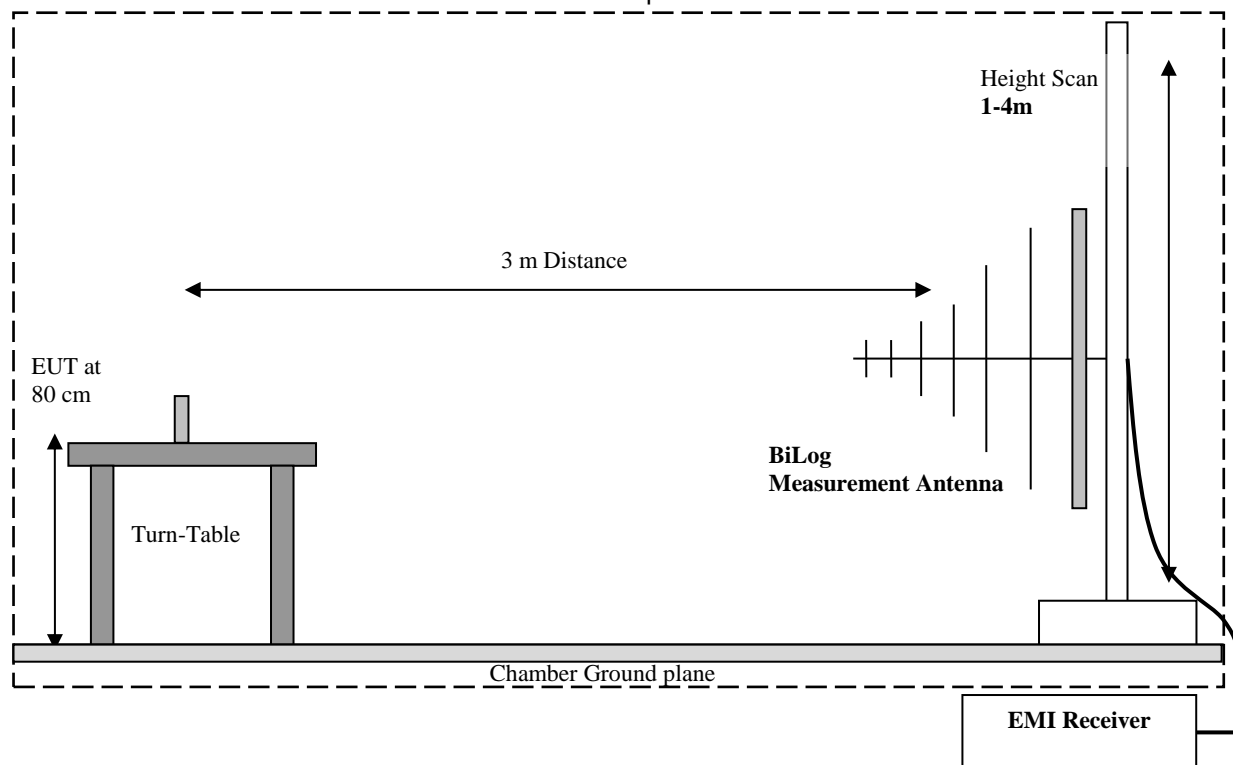
7.1 Radiated Measurement

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

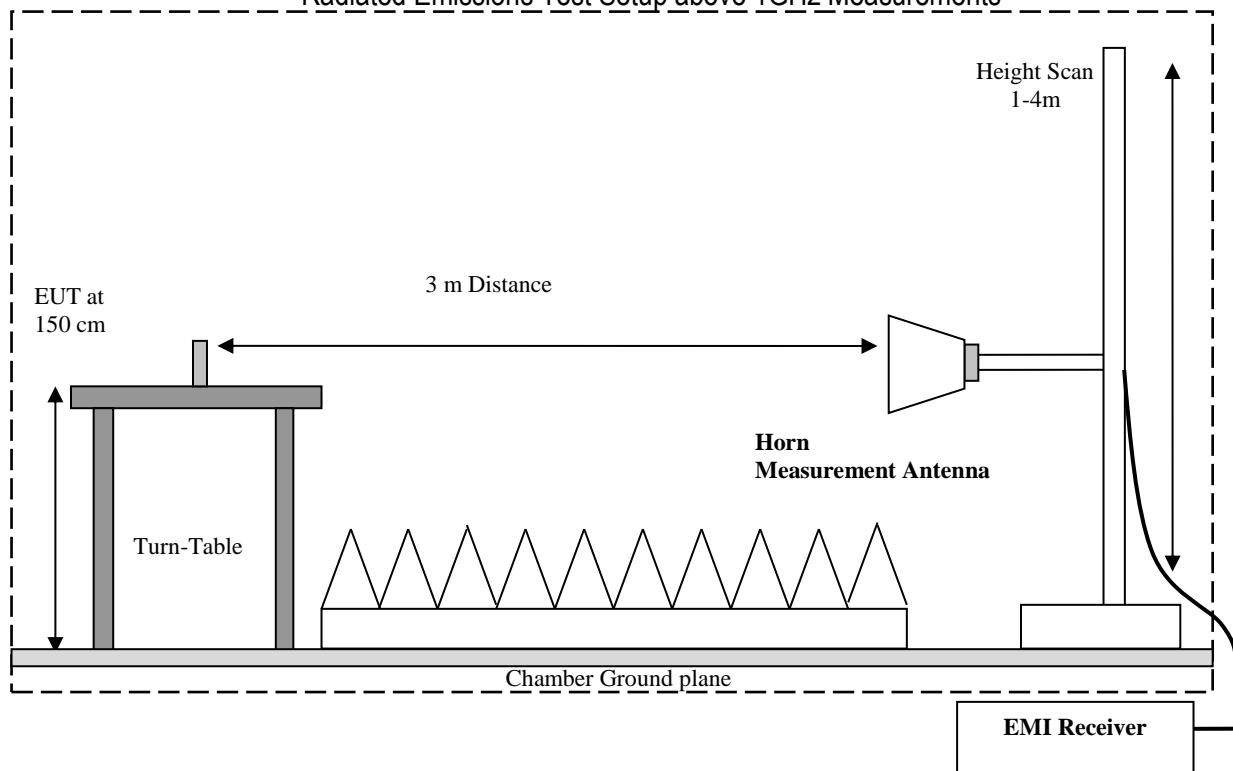
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to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



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

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

1. Measured reading in 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:

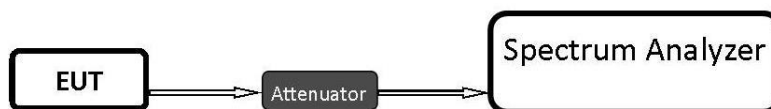
Frequency (MHz)	Measured SA (dB μ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB μ V/m)
1000	80.5	3.5	14	98.0

7.2 Power Line Conducted Measurement Procedure

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

7.3 RF Conducted Measurement Procedure

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



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

8 Test Result Data

8.1 Conducted Power Verification

8.1.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer settings:

- $RBW \geq DTS$ bandwidth.
- $VBW \geq 3 \times RBW$
- $Span \geq [3 \times RBW]$
- Sweep = Auto couple
- Detector function = Peak
- Trace = Max-hold
- Use peak marker function to determine the peak amplitude level.

8.1.2 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
20.9° C	1	802.11n	12 VDC	8.97 dBi

8.1.3 Measurement result:

EUT operating mode #1			
Operating Mode	Channel #	Frequency	Power Measured (dBm)
802.11n MCS8 20MHz MIMO	40	5200	17.1
802.11n MCS8 40MHz MIMO	157	5785	17.6

8.2 Radiated Transmitter Spurious Emissions

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 frequencies below 30 MHz at distance other than the specified in the standard, the limit conversion is calculated by using the FCC materials for the ANSI 63 committee issued on January, 27 1991.

8.2.2 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
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

*PEAK LIMIT= 74 dBμV/m

*AVG. LIMIT= 54 dBμV/m

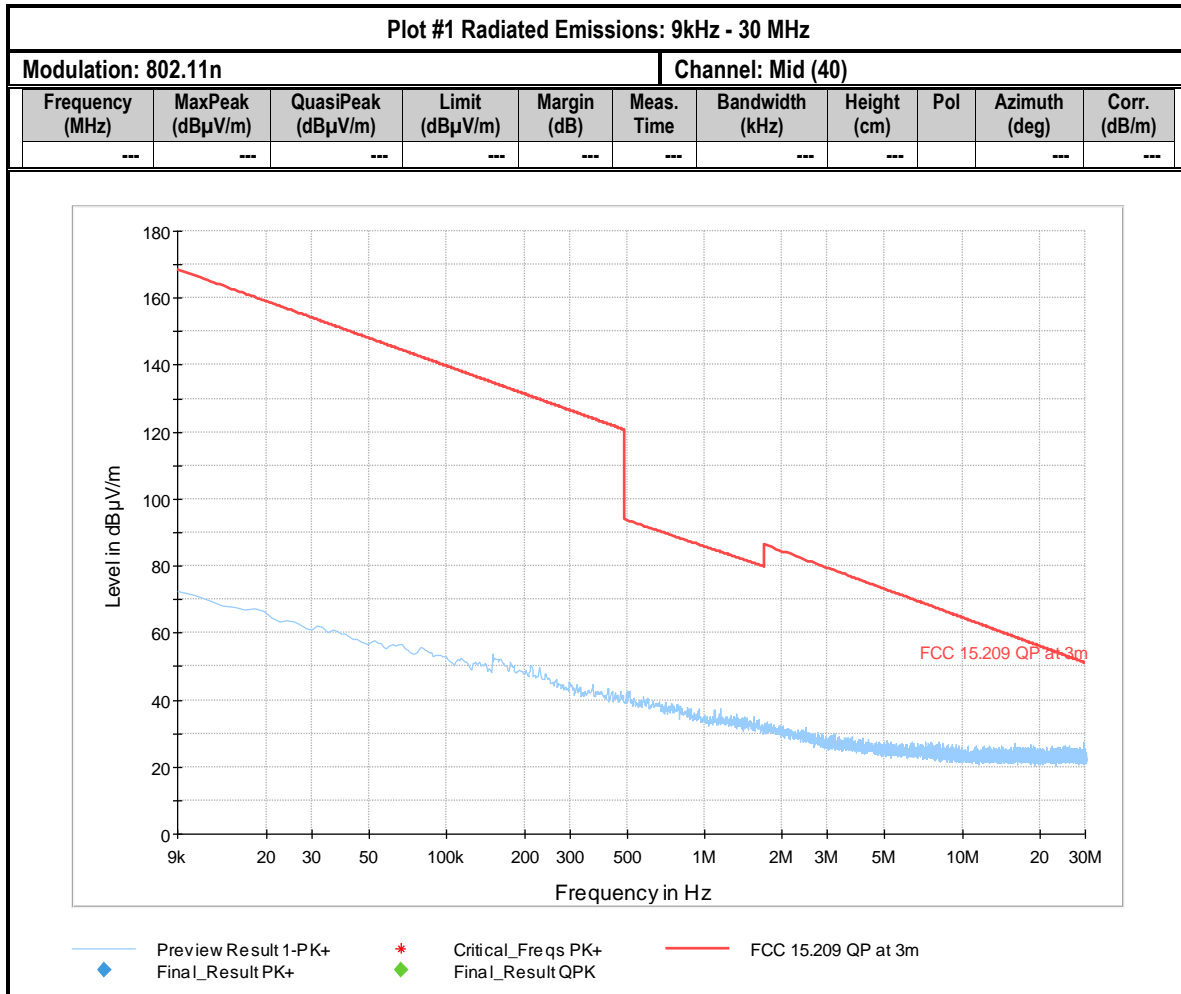
8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
20.9° C	1	802.11n	12 VDC

8.2.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-6	Mid (40)	9 kHz – 40 GHz	See section 8.2.2	Pass
6-12	Mid (157)	9 kHz – 40 GHz	See section 8.2.2	Pass

8.2.5 Measurement Plots:

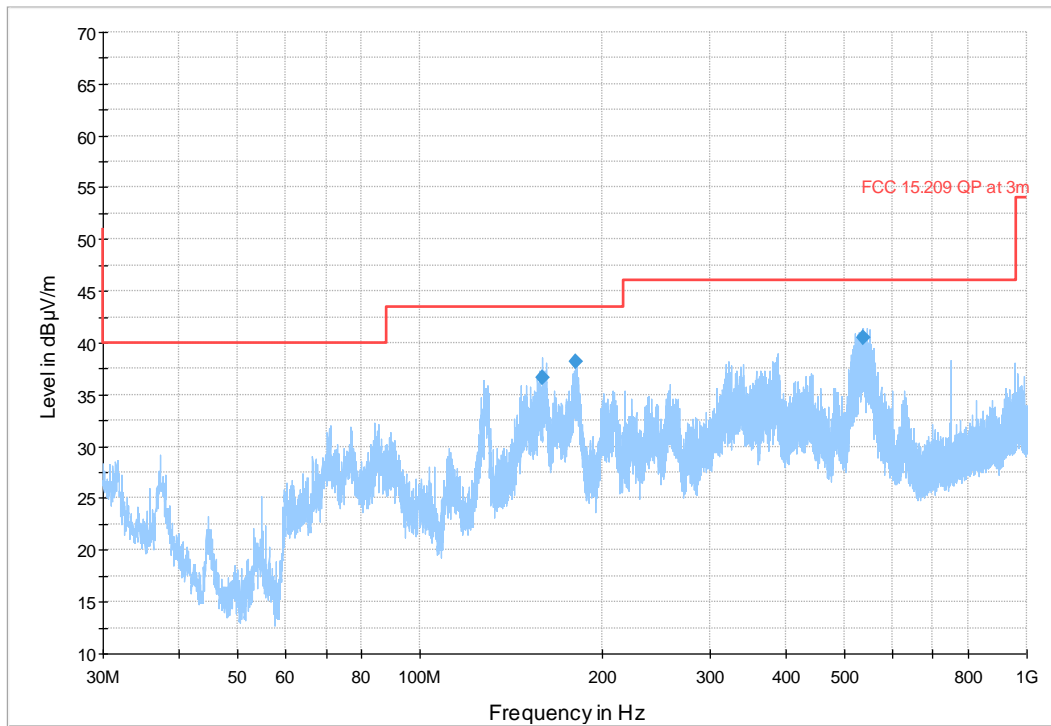


Plot #2 Radiated Emissions 30 MHz – 1GHz

Modulation: 802.11n

Channel: Mid (40)

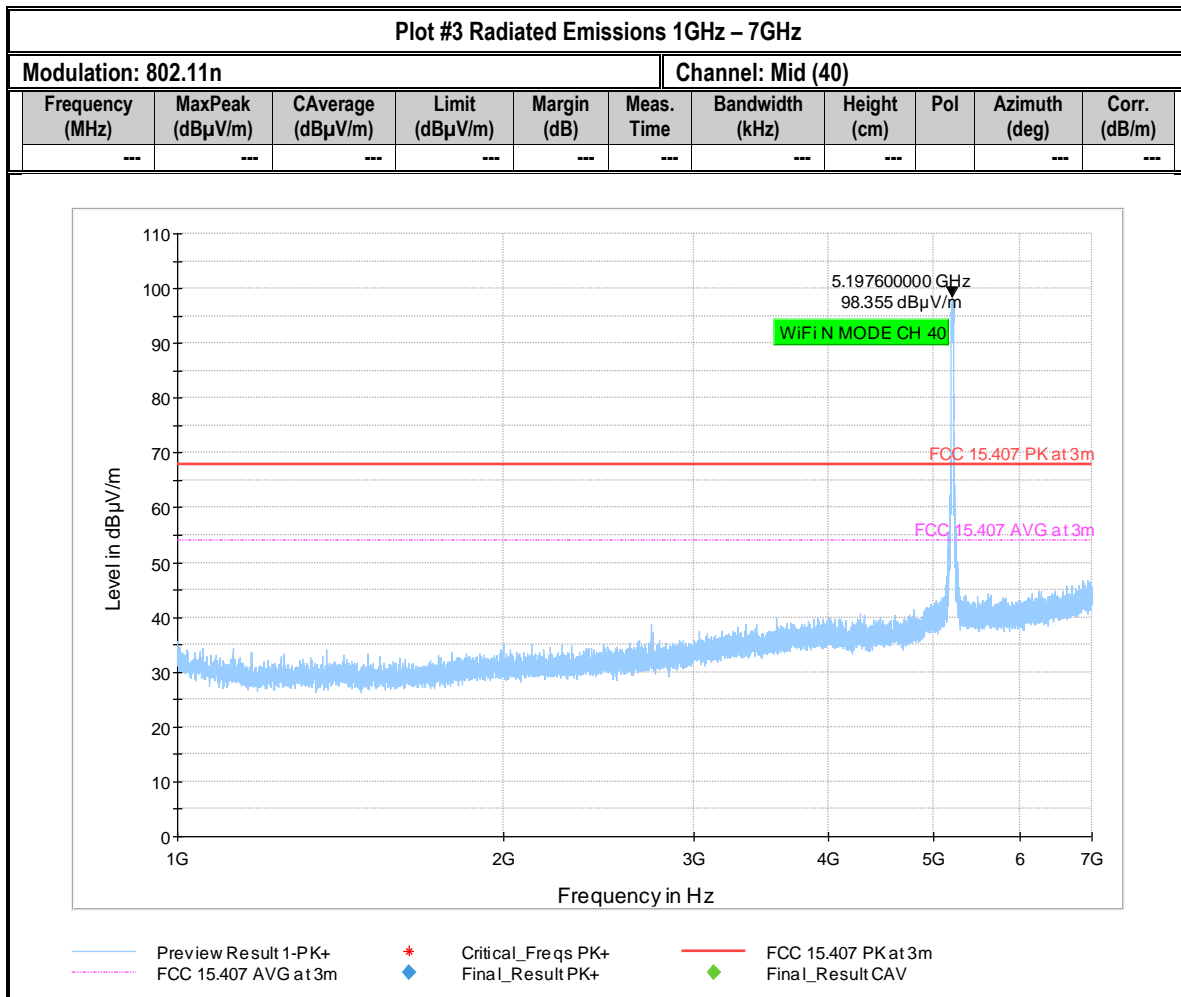
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
158.65	36.59	43.50	6.91	500.0	120.0	100.0	V	186.0	26.2
180.50	38.15	43.50	5.35	500.0	120.0	195.0	V	213.0	22.1
537.29	40.51	46.02	5.51	500.0	120.0	107.0	V	129.0	26.1



Preview Result 1-PK+

FCC 15.209 QP at 3m

Final_Result QPK

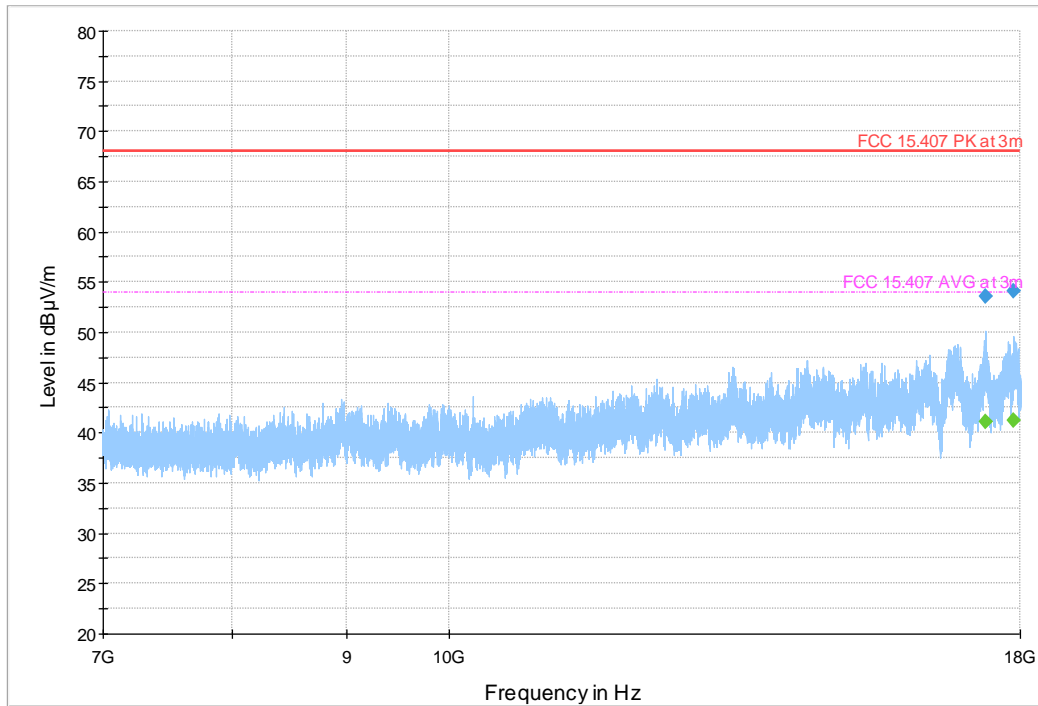


Plot #4 Radiated Emissions 7GHz – 18GHz

Modulation: 802.11n

Channel: Mid (40)

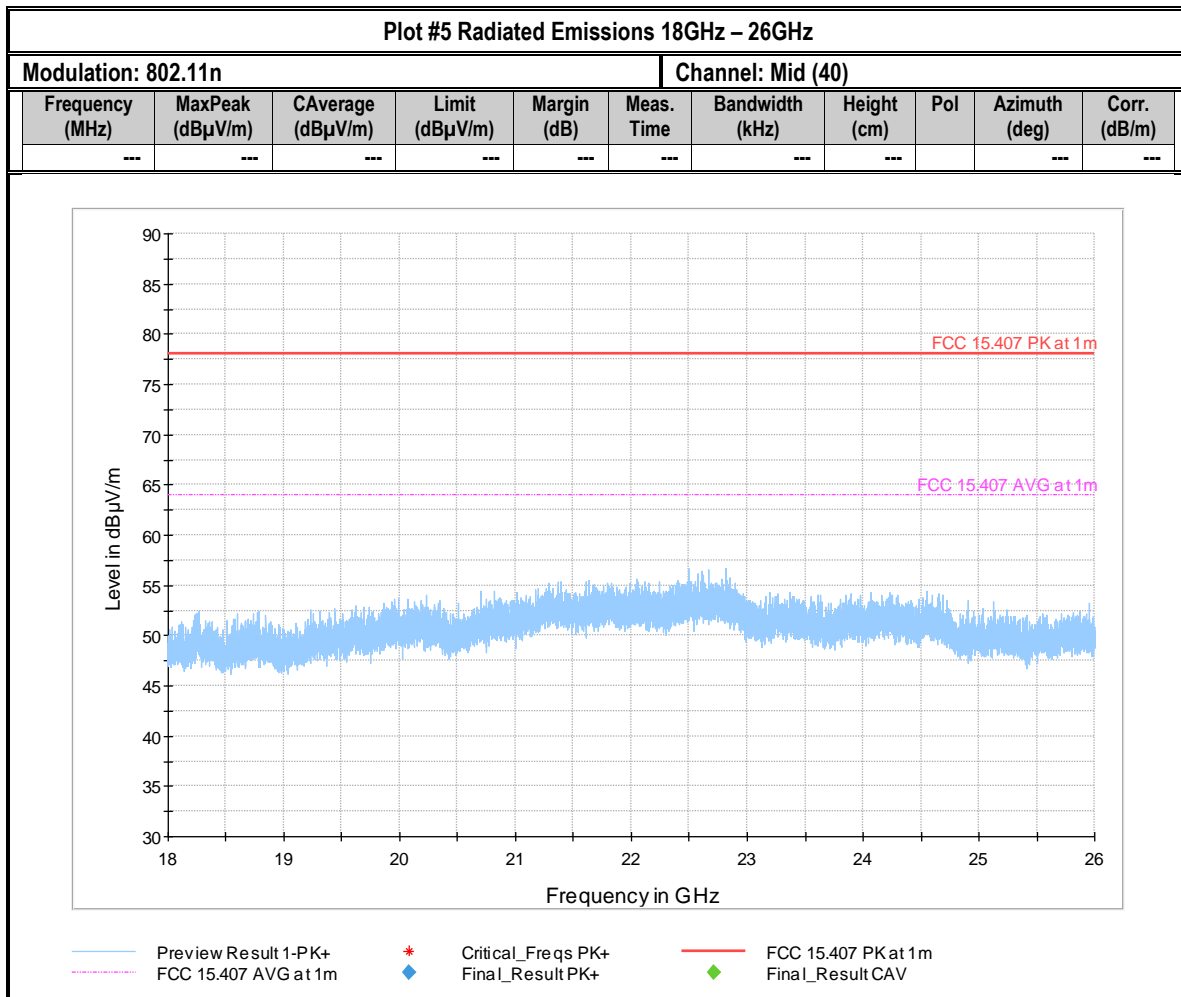
Frequency (MHz)	MaxPeak (dBμV/m)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17376.81	53.60	---	68.00	14.40	500.0	1000.0	160.0	H	116.0	16.0
17376.81	---	41.08	53.98	12.90	500.0	1000.0	160.0	H	116.0	16.0
17873.13	54.13	---	68.00	13.87	500.0	1000.0	168.0	H	-89.0	18.2
17873.13	---	41.20	53.98	12.78	500.0	1000.0	168.0	H	-89.0	18.2

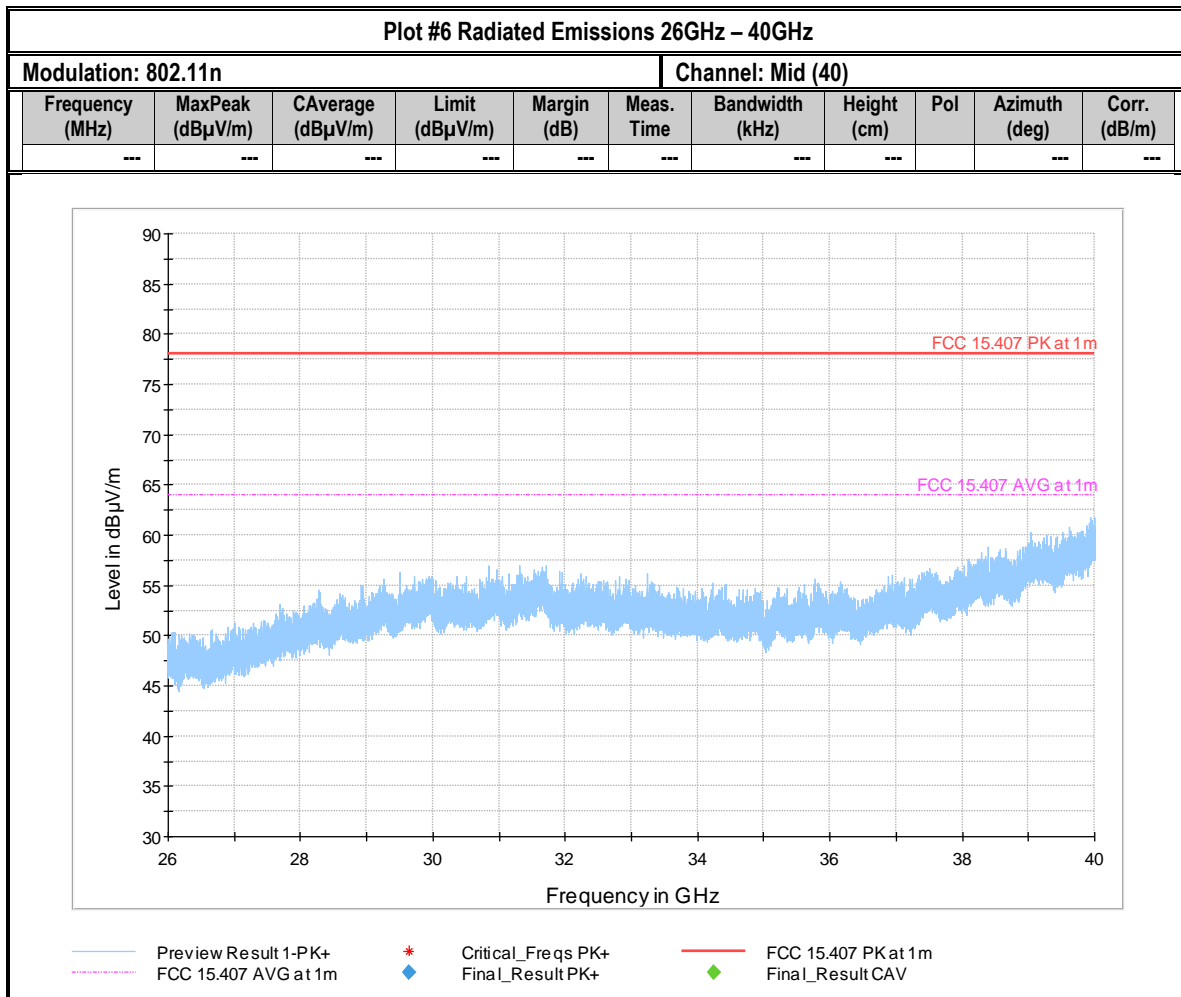


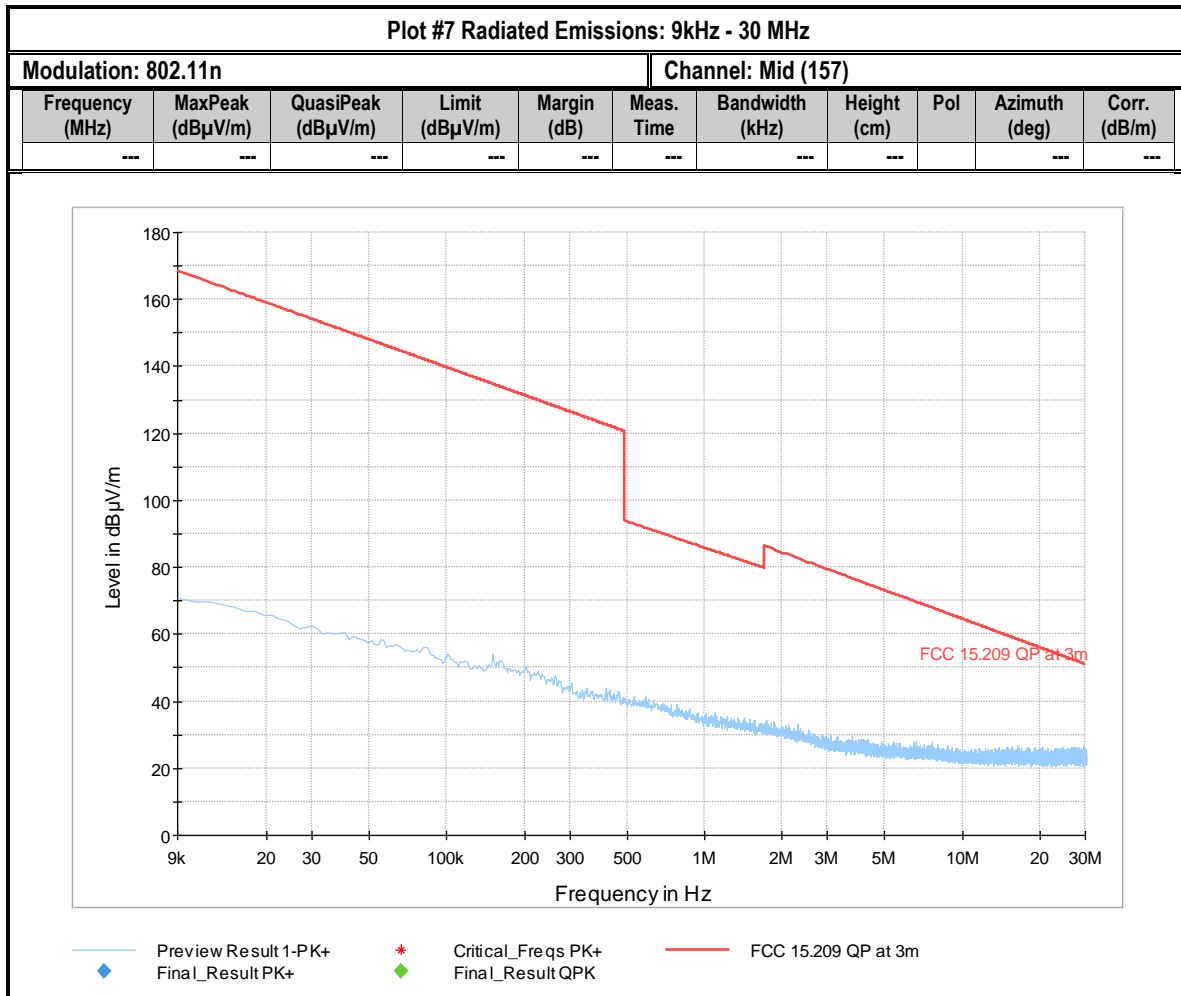
Preview Result 1-PK+
Final_Result PK+

FCC 15.407 PK at 3m
Final_Result CAV

FCC 15.407 AVG at 3m





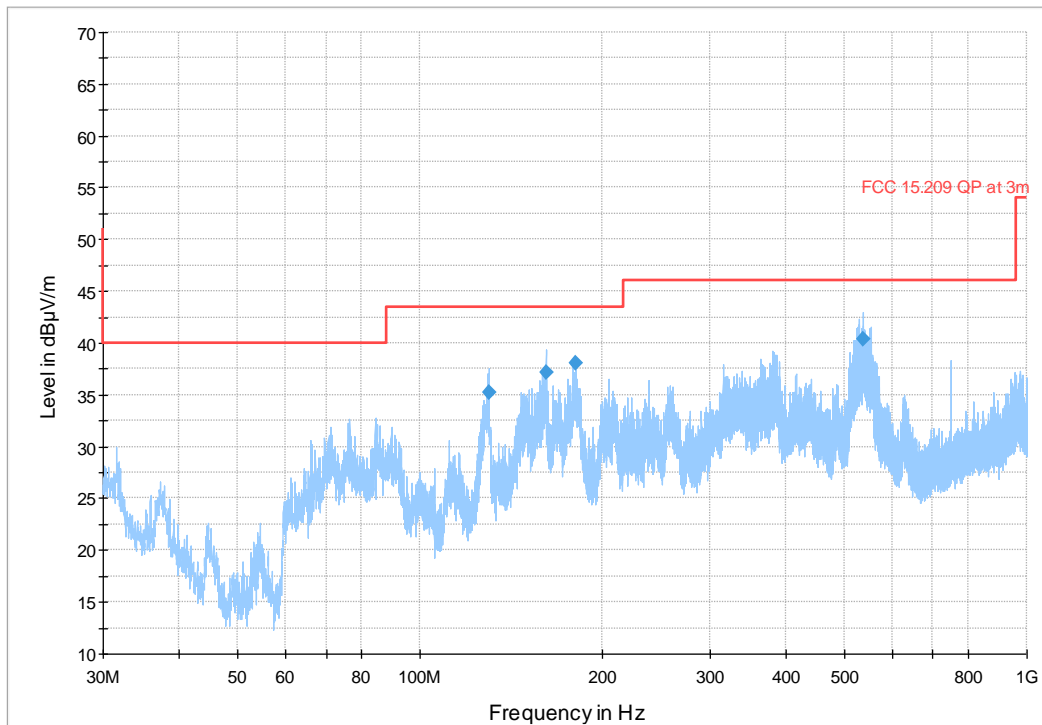


Plot #8 Radiated Emissions 30 MHz – 1GHz

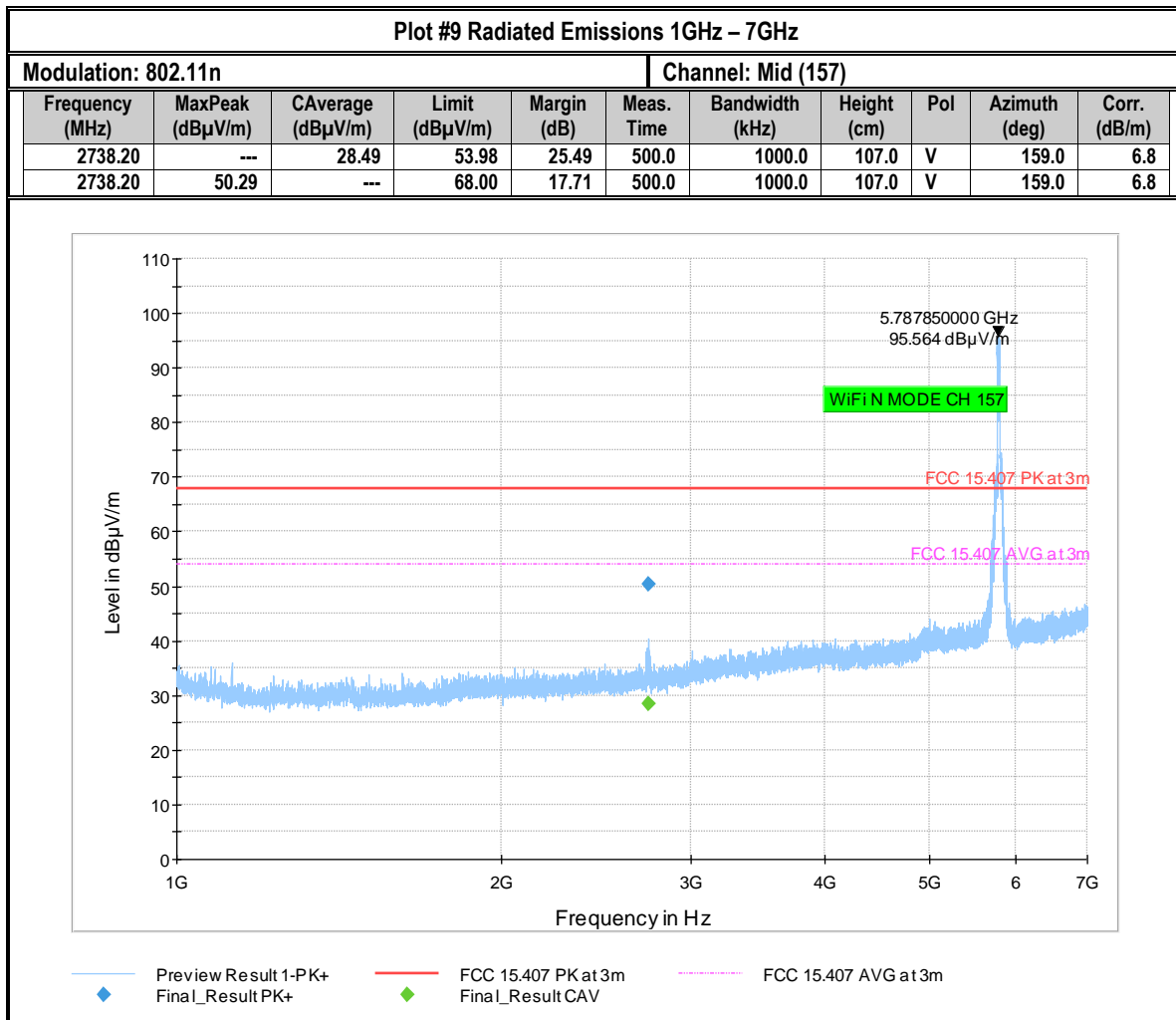
Modulation: 802.11n

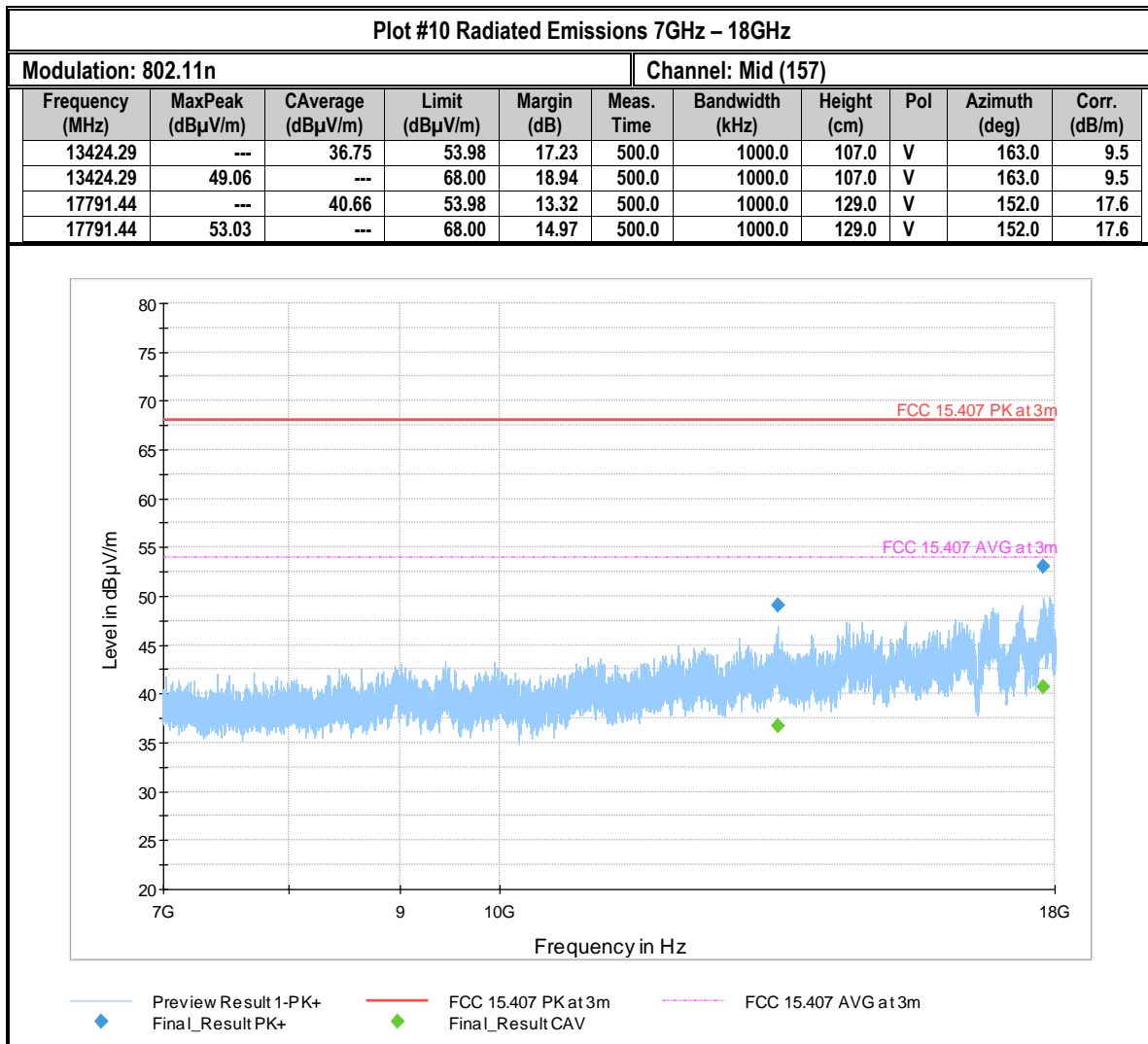
Channel: Mid (157)

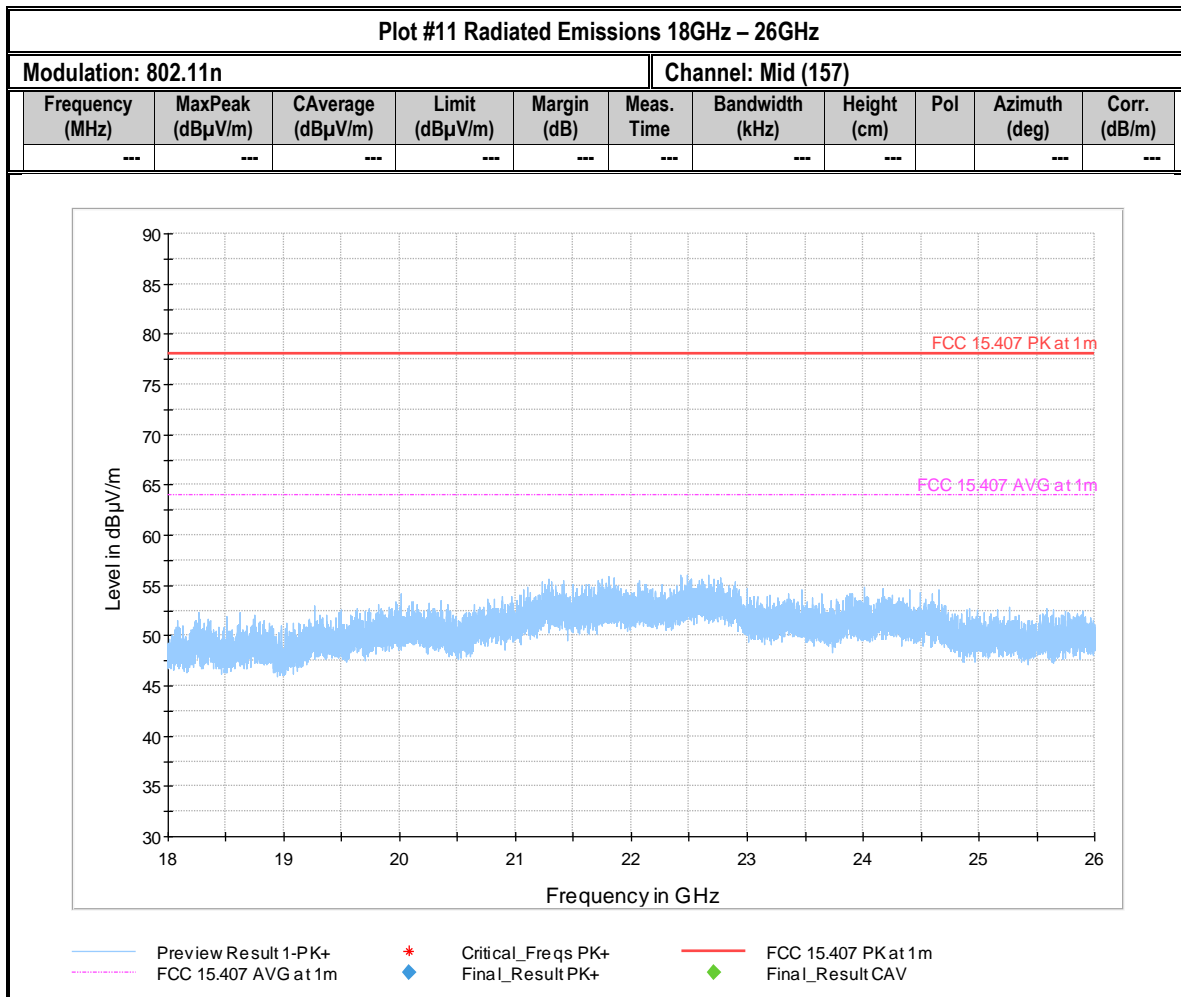
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
129.81	35.18	43.50	8.32	500.0	120.0	107.0	V	114.0	24.9
161.00	37.22	43.50	6.28	500.0	120.0	107.0	V	192.0	26.4
180.18	38.07	43.50	5.43	500.0	120.0	164.0	V	215.0	22.1
536.63	40.38	46.02	5.64	500.0	120.0	143.0	V	132.0	26.1

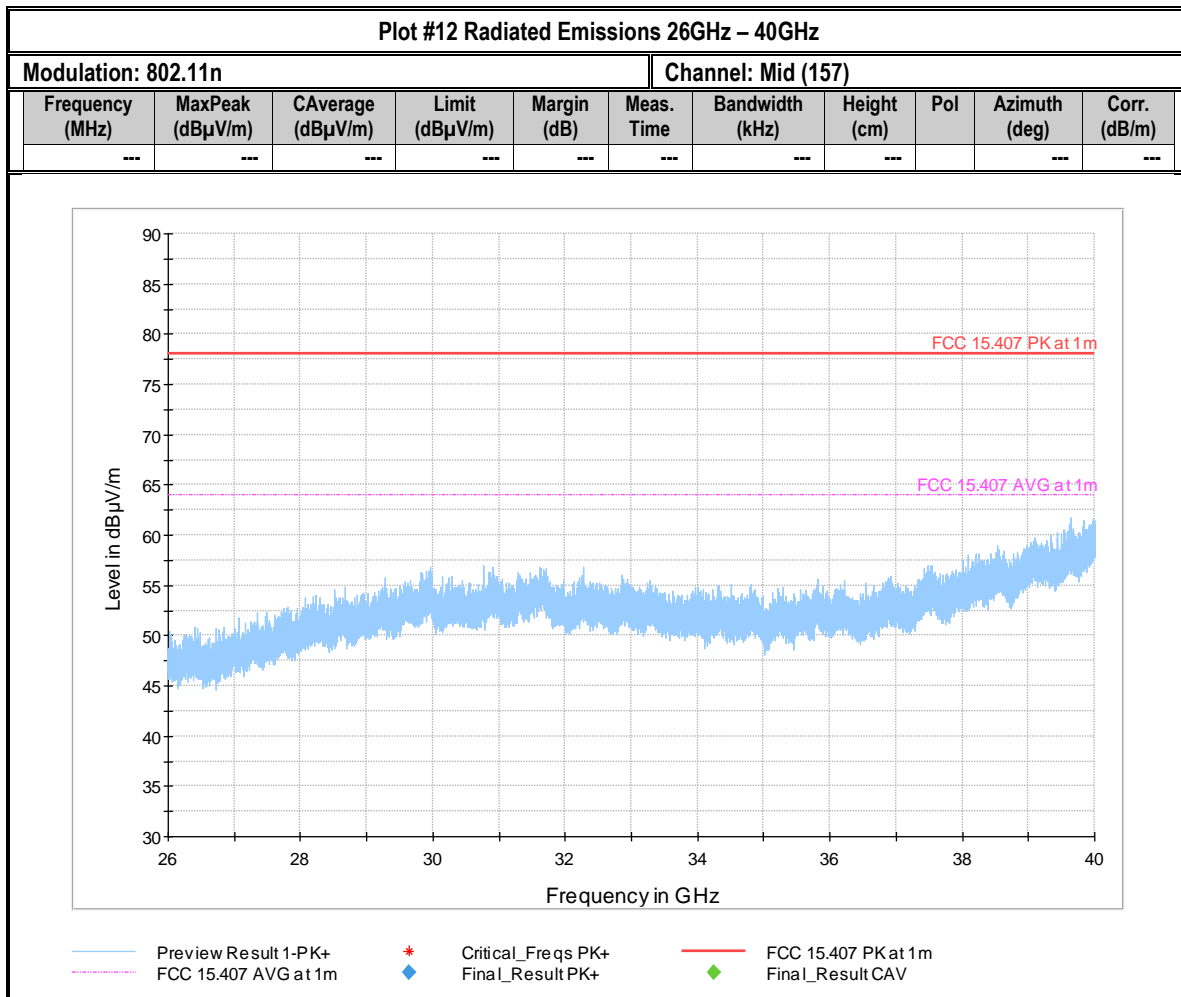


Preview Result 1-PK+ FCC 15.209 QP at 3m Final_Result QPK









9 Test setup photos

Setup photos are included in supporting file name: "EMC_NUROI_006_22001_FCC_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
ACTIVE LOOP ANTENNA	ETS LINDGREN	6507	00161344	3 YEARS	10/30/2020
BILOG ANTENNA	A.H. SYSTEMS	BiLA2G	569	3 YEARS	11/16/2021
HORN ANTENNA	EMCO	3115	00035111	3 YEARS	9/30/2021
HORN ANTENNA	ETS.LINDGREN	3117	00215984	3 YEARS	01/31/2021
HORN ANTENNA	ETS LINDGREN	3116C-PA	00169535	3 YEARS	9/23/2020
ESW.EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	101715	3 YEARS	9/14/2021
Spectrum Analyzer	Rohde & Schwarz	FSU. Spectrum Analyzer	200302	3 YEARS	9/13/2021

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	Template Revision	Changes to report	Prepared by
2023-08-07	EMC_NUROI_006_22001_15_407_UNII	Initial Version	Art Thammanavarat

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