RSE Co-transmission FCC & ISED Test Report

For:

Astronautics

Model Name:

AFS6460

Product Description:

Connectivity Module

Applied Rules and Standards:
47 CFR Parts 22, 24, 27, 90
RSS: 132 Issue 3, 133 Issue 6, 139 Issue 3

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

REPORT #: EMC_ASTRO-001-20001_22_24_27_90_Rev 1

DATE: 2020-09-14

A2LA Accredited

IC recognized # 3462B-1

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1 Assessment

The radiated spurious emissions in co-transmission mode from the device described in section 3 of this report was evaluated against the applicable criteria specified in the Code of Federal Regulations Title 47 parts 22, 24, 27, 90, and ISED Standards RSS-132 issue 3, RSS-133 issue 6, and RSS-139 issue 3.

No deficiencies were ascertained.

Company Name	Product Description	Model #
Astronautics	Connectivity Module	AFS6460

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2020-09-14	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by cindy.li@cetecom.com DN: CN=cindy.li@cetecom.com Reason: I have reviewed this document Location: Date: 2020-09-14 19:31:30

Responsible for the Report:

Date	Section	Name	Signature
2020-09-14	Compliance	Kris Lazarov (Senior EMC Engineer)	Kris Lazarov Digitally signed by Kris Lazarov Date: 2020.09.14 17:51:04 -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
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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
Cellular Module	FCC ID: N7NEM7455 / IC ID: 10301A-EM7455A
Wi-Fi Module	FCC ID: RYK-WPEQ256ACNI
Power Supply/ Rated Operating Voltage Range	- 37V to – 57V – Nominal – 48V
Operating Temperature Range	-40 ºC to 65 ºC
Sample Revision	☐Prototype ■Production ☐ Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	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

Set-up #	EUT / AE used for 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	FCC 22 + WiFi	The Cellular (LTE mode) and WiFi (802.11 b mode) modules were operating simultaneously on middle channel.
2	FCC 24 + WiFi	The Cellular (LTE mode) and WiFi (802.11 b mode) modules were operating simultaneously on middle channel.
3	FCC 27 + WiFi	The Cellular (LTE mode) and WiFi (802.11 b mode) modules were operating simultaneously on middle channel.
4	FCC 90 + WiFi	The Cellular (LTE mode) and WiFi (802.11 b mode) modules were operating simultaneously on middle channel.

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to evaluate the compliance of the EUT against the relevant requirements for RSE specified in the Code of Federal Regulations Title 47 parts 22, 24, 27, 90, and ISED Standards RSS-132 issue 3, RSS-133 issue 6, and RSS-139 issue 3.

4.1 Dates of Testing:

03/09/2020 – 03/20/2020

4.2 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 30MHz	±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

4.3 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.

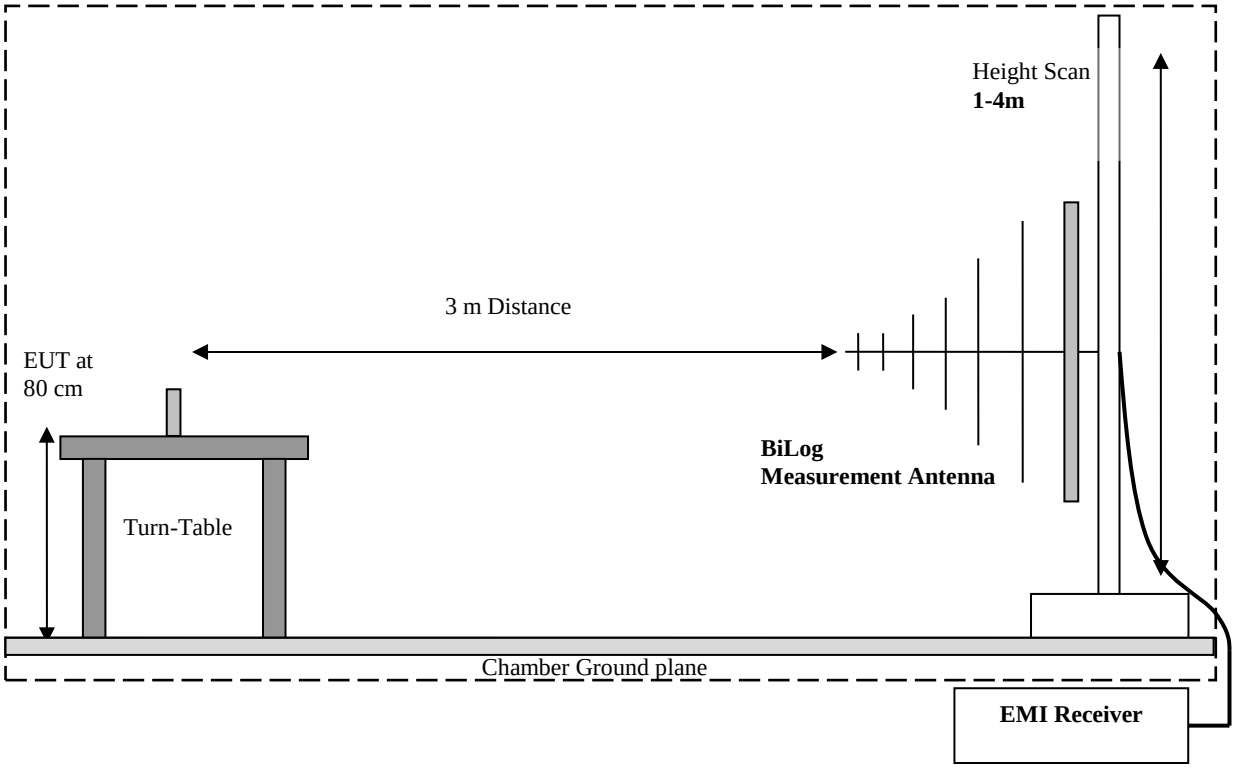
5 Measurement Procedures

Testing is performed according to the guidelines provided in FCC publication (KDB) 971168 D01 v02r02 – "Measurement Guidance for Certification of Licensed Digital Transmitters" and according to relevant parts of ANSI/TIA-603-D-2010 as detailed below.

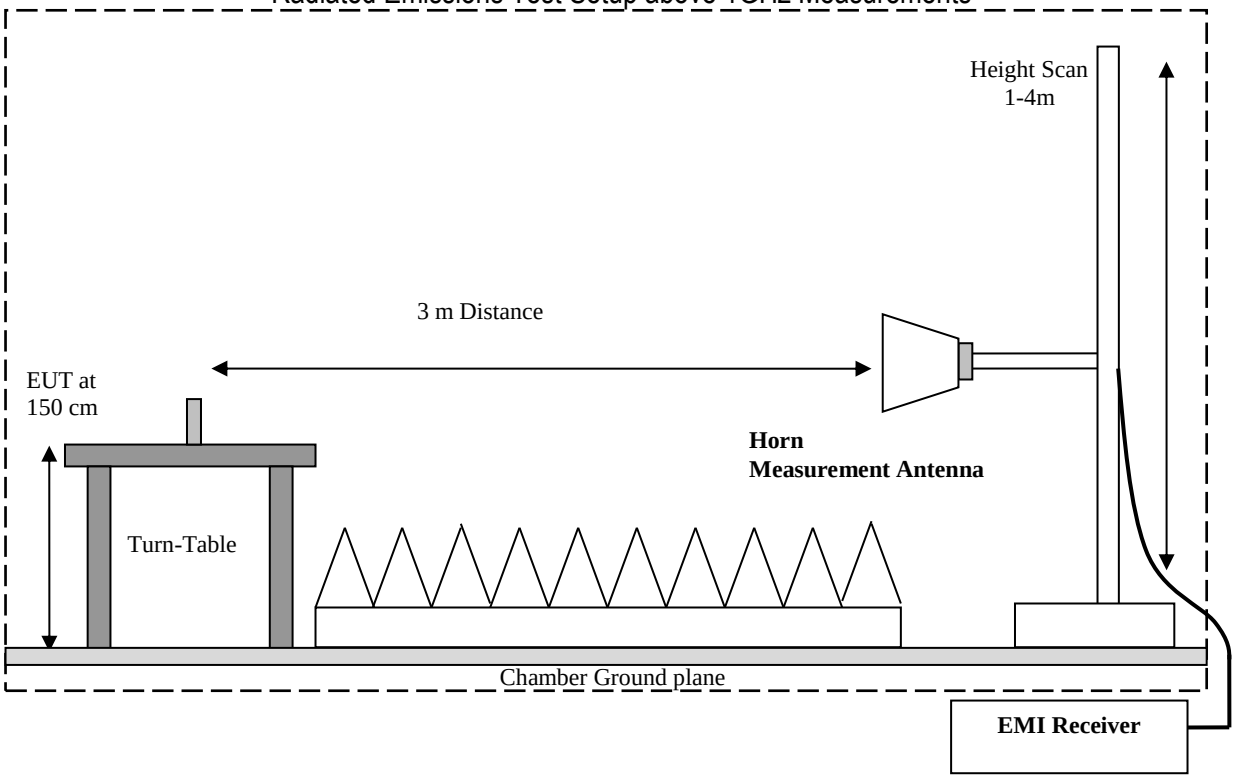
5.1 Radiated Measurement

- 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



5.2 Sample Calculations for Field Strength Measurements

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

- Measured reading in dBµV
- Cable Loss between the receiving antenna and SA in dB and
- 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

6 Measurement Results Summary

6.1 Part 22 / RSS-132

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Result
§2.1053; §22.917	Radiated Spurious Emissions	Nominal	FCC 22 + WiFi	Complies

6.2 Part 24 / RSS-133

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Result
§2.1053; §24.238	Radiated Spurious Emissions	Nominal	FCC 24 + WiFi	Complies

6.3 FCC 27 / RSS-139

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Result
§2.1053; §27.53	Radiated Spurious Emissions	Nominal	FCC 272 + WiFi	Complies

6.4 FCC 90S

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Result
§2.1053; §90.669	Radiated Spurious Emissions	Nominal	FCC 90 + WiFi	Complies

7 Test Result Data

7.1 ERP / EIRP

Module Name:	Sierra Wireless		
Model Number:	EM7455		
FCC ID:	N7NEM7455		
IC ID:	2417C-EM7455		
Max. declared antenna gain:	External Max Gain 6 dBi		
Band	**Frequency range (MHz)**	**ERP (Watts)**	**EIRP (Watts)**
UMTS II	1852.4 ~ 1907.6	-	0.920
UMTS IV	1712.4 ~ 1752.6	-	0.881
UMTS V	826.4 ~ 846.6	-	0.893
LTE 2	1855 ~ 1910	-	0.998
LTE 2	1860 ~ 1905	-	0.986
LTE 4	1715 ~ 1750	-	0.998
LTE 4	1720 ~ 1745	-	0.975
LTE 5	821.5 ~ 841.5	0.991	-
LTE 7	2502.5 ~ 2567.5	-	0.782
LTE 7	2510 ~ 2560	-	0.736
LTE 12	704 ~ 711	0.989	-
LTE 13	779.5 ~ 784.5	0.984	-
LTE 26	821.5 ~ 841.5	0.991	-
LTE 41	2506 ~ 2680	-	0.787

Note: ERP / EIRP are calculated from maximum Average power in cellular module report in dBm, adding the 6 dBi maximum gain of the cellular antenna.

7.2 Radiated Spurious Emissions

7.2.1 Measurement utilizing KDB 971168 D01 Power Meas License Digital Systems v02r02, and according to ANSI/TIA-603-D-2010

Spectrum Analyzer Settings for FCC 22

Frequency Range	30MHz – 1 GHz	1 – 1.58 GHz	1.58 – 9 GHz
Resolution Bandwidth	100 kHz	1 MHz	1 MHz
Video Bandwidth	100 kHz	1 MHz	1 MHz
Detector	Peak	Peak	Peak
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep Time	Auto	Auto	Auto

Spectrum Analyzer Settings for FCC 24

Frequency Range	30MHz – 1 GHz	1 – 2.7 GHz	2.7 – 18 GHz	18 – 19.1 GHz
Resolution Bandwidth	100 kHz	1 MHz	1 MHz	1 MHz
Video Bandwidth	100 kHz	1 MHz	1 MHz	1 MHz
Detector	Peak	Peak	Peak	Peak
Trace Mode	Max Hold	Max Hold	Max Hold	Max Hold
Sweep Time	Auto	Auto	Auto	Auto

7.2.2 Limits:

7.2.2.1 FCC Part 22.917 (a); FCC Part 24.238 (a); FCC Part 27.53 (h); FCC Part 90.699 (a)
The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

7.2.2.2 RSS-132 Part 5.5; RSS-133 Part 6.5; RSS-139 Part 6.6 Transmitter Unwanted Emissions
Mobile and base station equipment shall comply with the limits in (i) and (ii) below.
2020. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).
ii.After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

Note: The limit calculation result is a constant of -13 dBm.

7.2.3 Test conditions and setup:

Ambient Temperature ©	EUT Set-Up #	EUT operating mode	Power Input
23	1	1,2,3,4	29VDC

7.2.4 Measurement result:

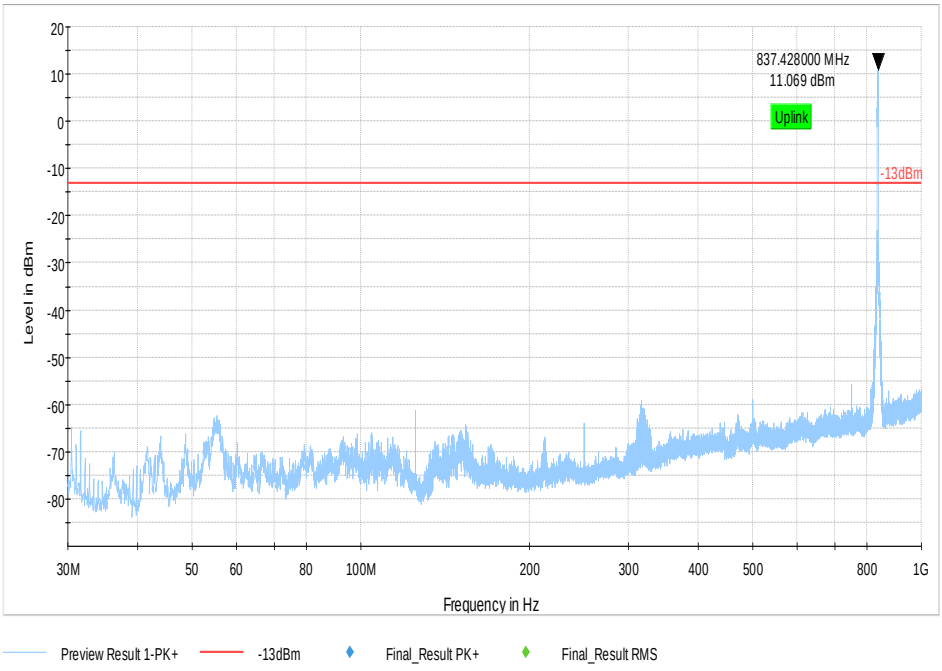
Plot #	EUT Operating Mode	Transmitter Configuration	Scan Frequency	Limit (dBm)	Result
1-3	FCC 22 + WiFi	UMTS V + 802.11b	30 MHz – 18 GHz	-13	Pass
4-6	FCC 22 + WiFi	LTE 5 + 802.11b	30 MHz – 18 GHz	-13	Pass
7-9	FCC 24 + WiFi	UMTS II + 802.11b	30 MHz – 18 GHz	-13	Pass
10-12	FCC 24 + WiFi	LTE 2 + 802.11b	30 MHz – 18 GHz	-13	Pass
13-15	FCC 27 + WiFi	UMTS IV + 802.11b	30 MHz – 18 GHz	-13	Pass
16-18	FCC 27 + WiFi	LTE 4 + 802.11b	30 MHz – 18 GHz	-13	Pass
19-21	FCC 27 + WiFi	LTE 7 + 802.11b	30 MHz – 18 GHz	-13	Pass
22-24	FCC 27 + WiFi	LTE 12 + 802.11b	30 MHz – 18 GHz	-13	Pass
25-27	FCC 27 + WiFi	LTE 13 + 802.11b	30 MHz – 18 GHz	-13	Pass
28-30	FCC 27 + WiFi	LTE 41 + 802.11b	30 MHz – 18 GHz	-13	Pass
31-33	FCC 90 + WiFi	LTE 26 + 802.11b	30 MHz – 18 GHz	-13	Pass

7.2.5 Measurement Plots:

7.2.5.1 FCC 22 + WiFi

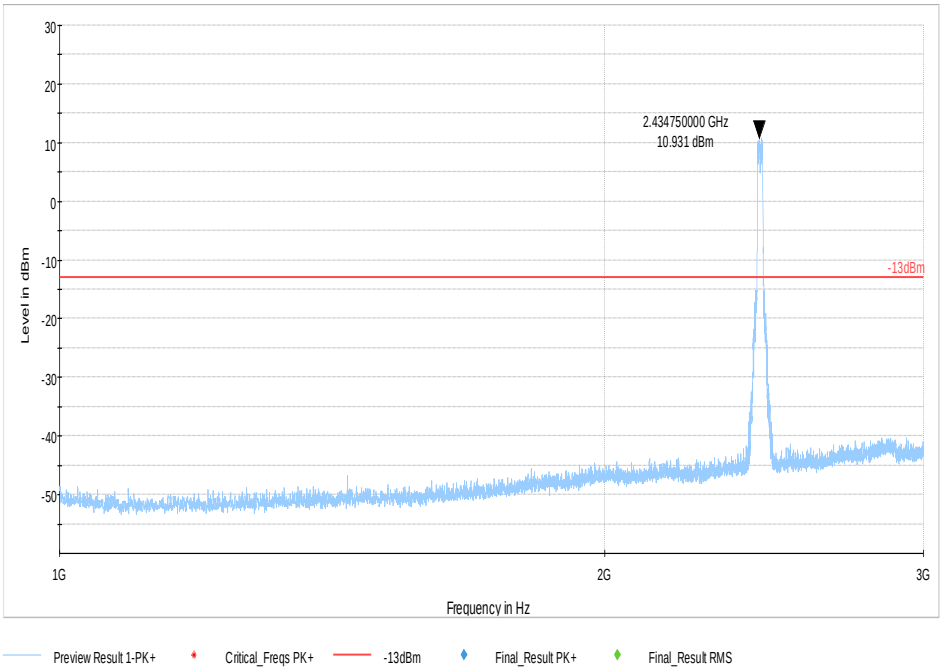
Plot # 1 Radiated Emissions: 30 MHz – 1GHz

UMTS V + 802.11b



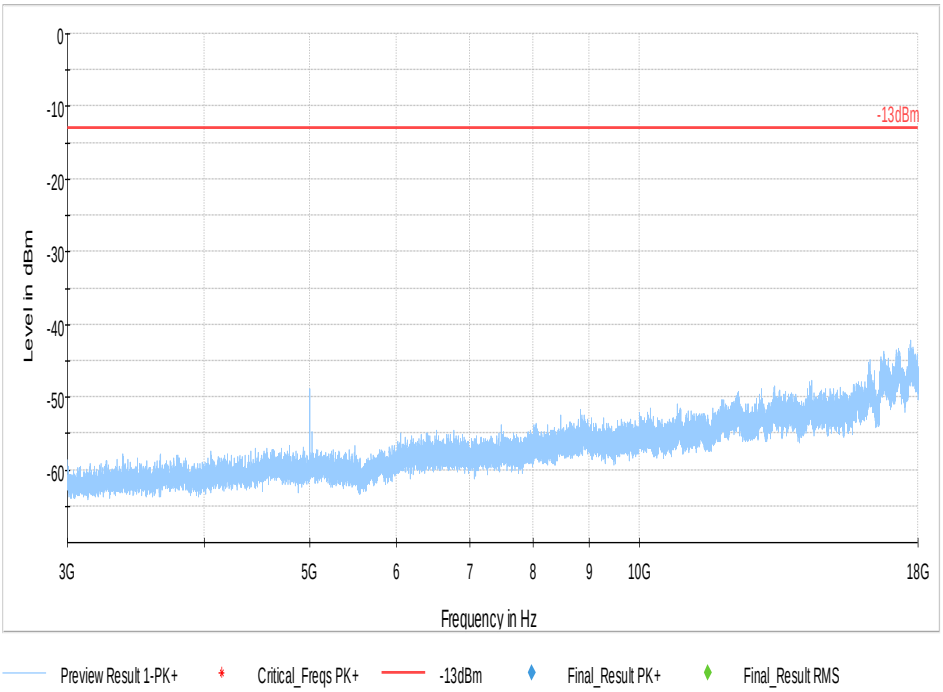
Plot # 2 Radiated Emissions: 1-3 GHz

UMTS V + 802.11b



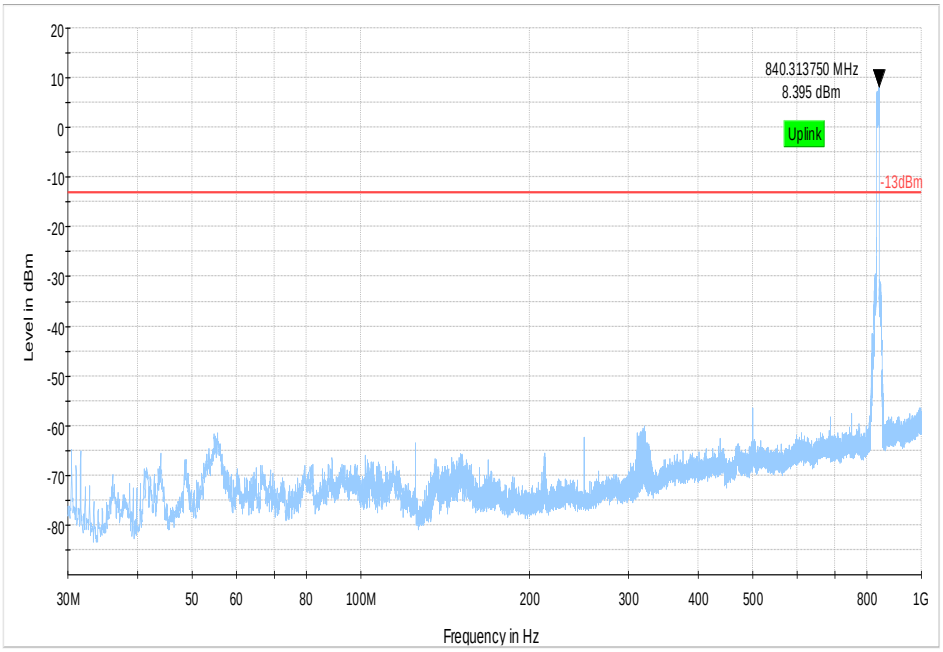
Plot # 3 Radiated Emissions: 3-18 GHz

UMTS V + 802.11b



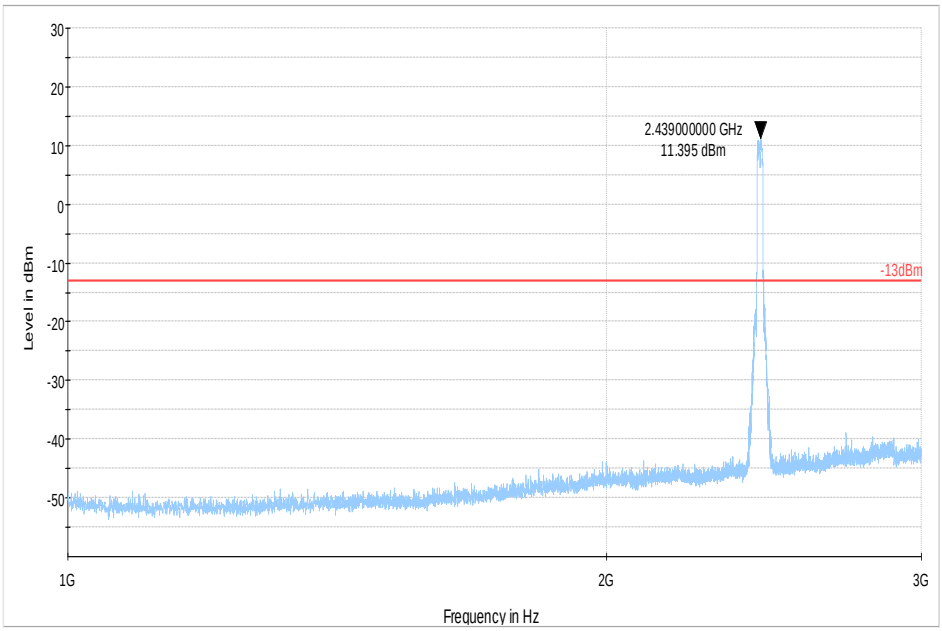
Plot # 4 Radiated Emissions: 30 MHz – 1GHz

LTE 5 + 802.11b



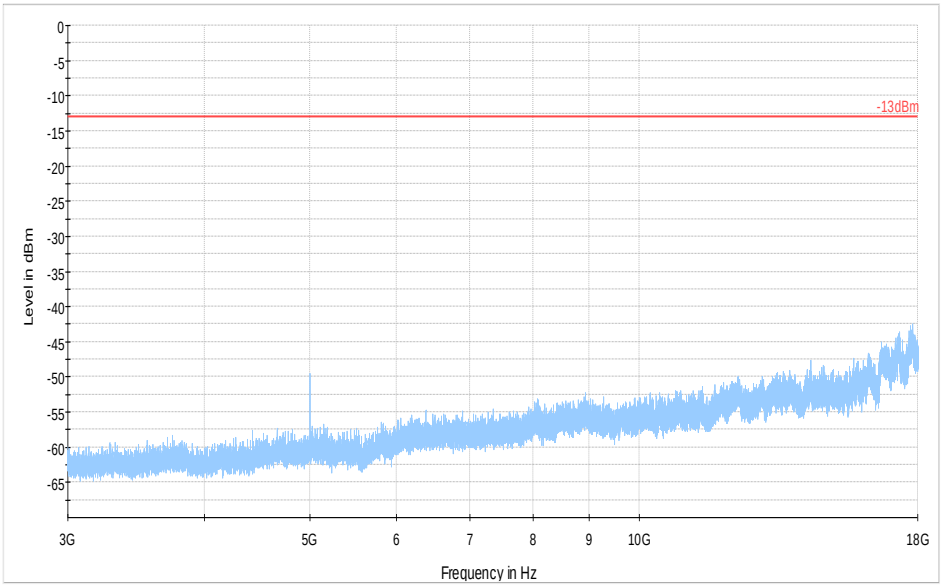
Plot # 5 Radiated Emissions: 1-3 GHz

LTE 5 + 802.11b



Plot # 6 Radiated Emissions: 3-18 GHz

LTE 5 + 802.11b

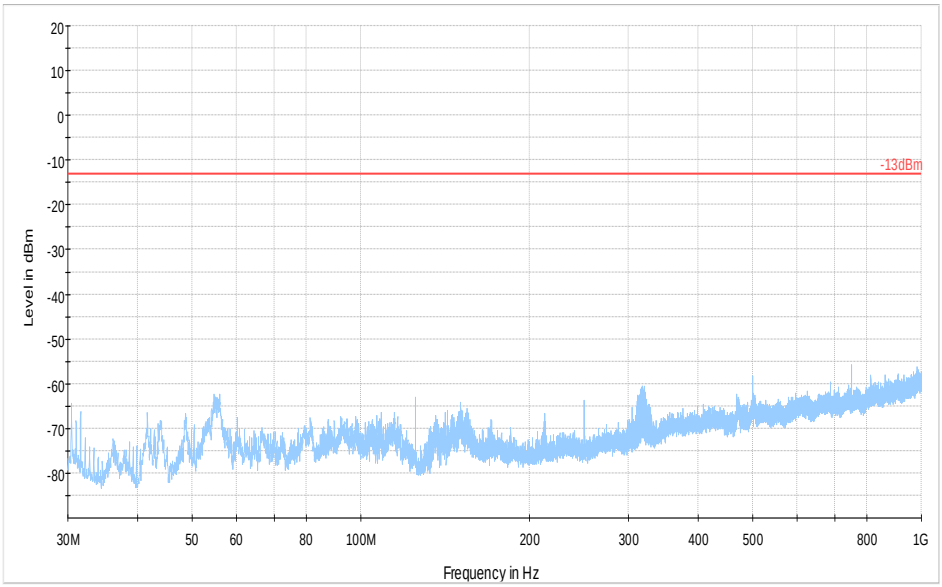


Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

7.2.5.2 FCC 24 + WiFi

Plot # 7 Radiated Emissions: 30 MHz – 1GHz

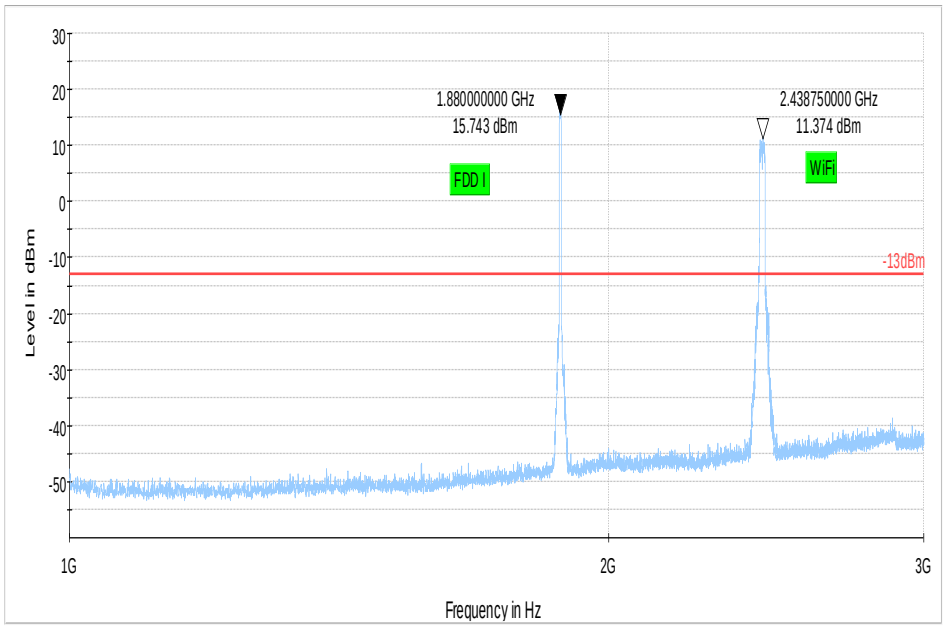
UMTS II + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 8 Radiated Emissions: 1-3 GHz

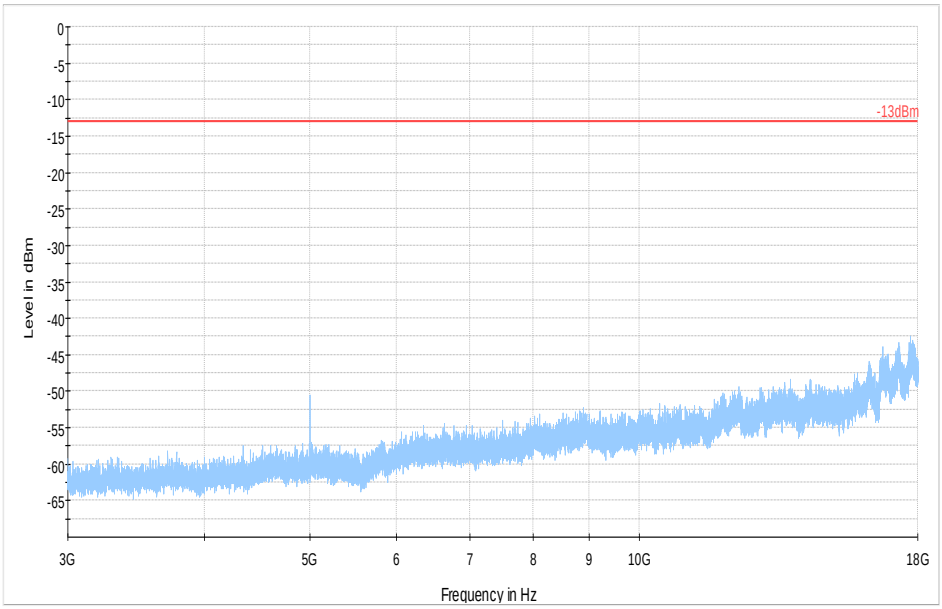
UMTS II + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 9 Radiated Emissions: 3-18 GHz

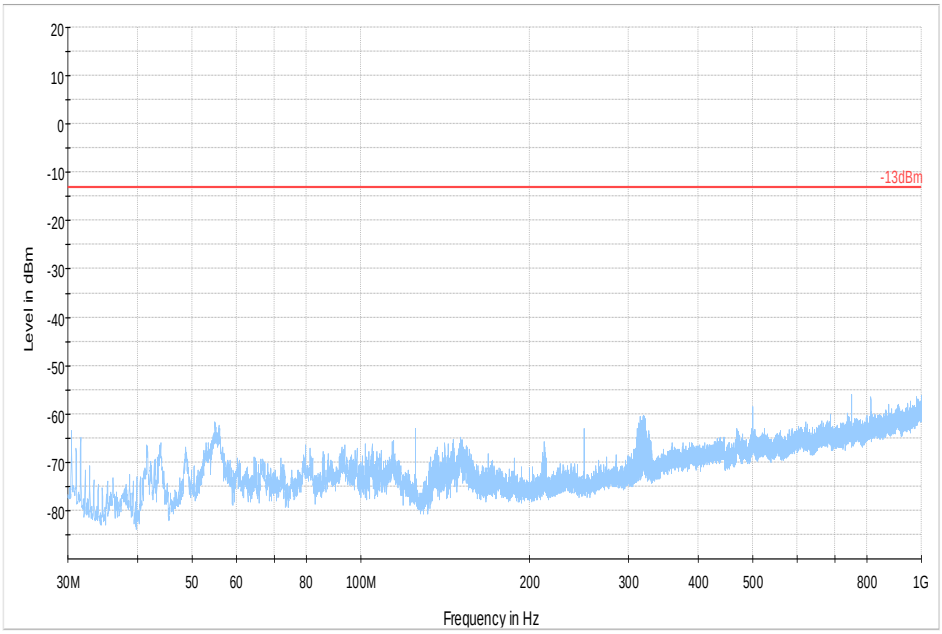
UMTS II + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 10 Radiated Emissions: 30 MHz – 1GHz

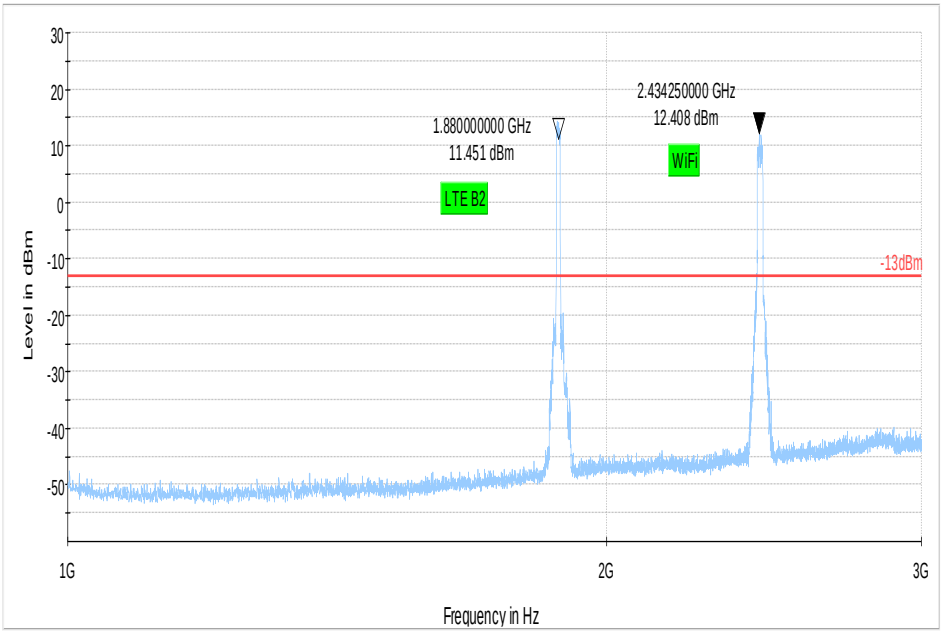
LTE 2 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 11 Radiated Emissions: 1-3 GHz

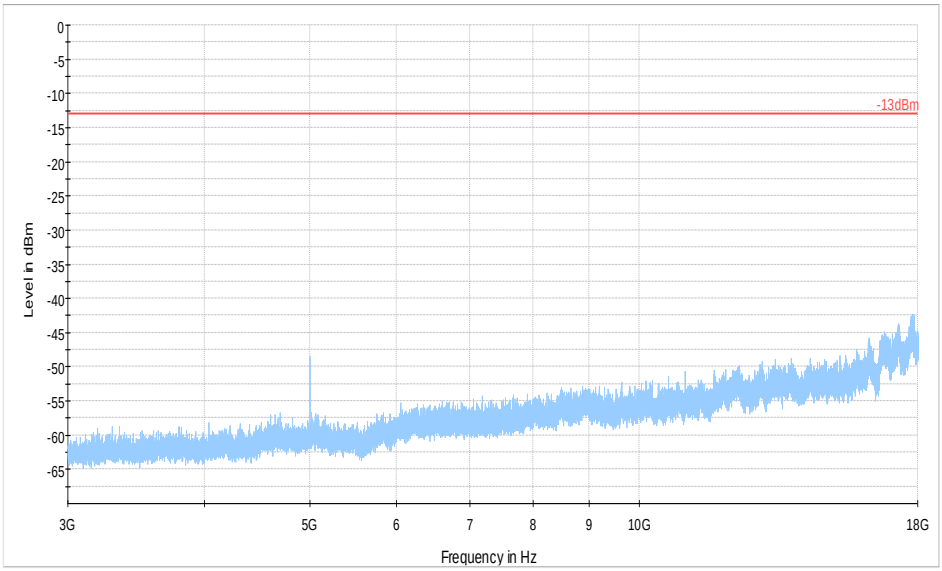
LTE 2 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 12 Radiated Emissions: 3-18 GHz

LTE 2 + 802.11b

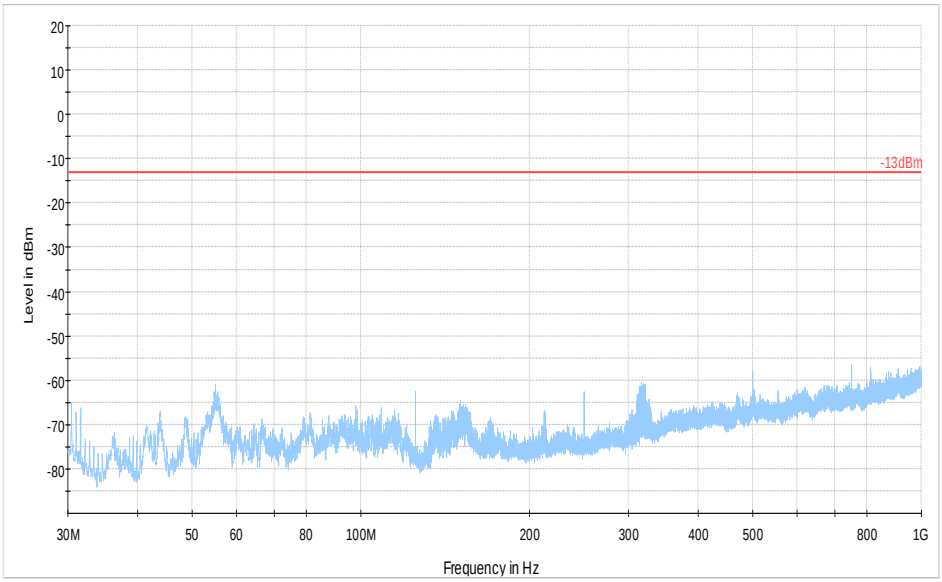


Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

7.2.5.3 FCC 27 + WiFi

Plot # 13 Radiated Emissions: 30 MHz – 1GHz

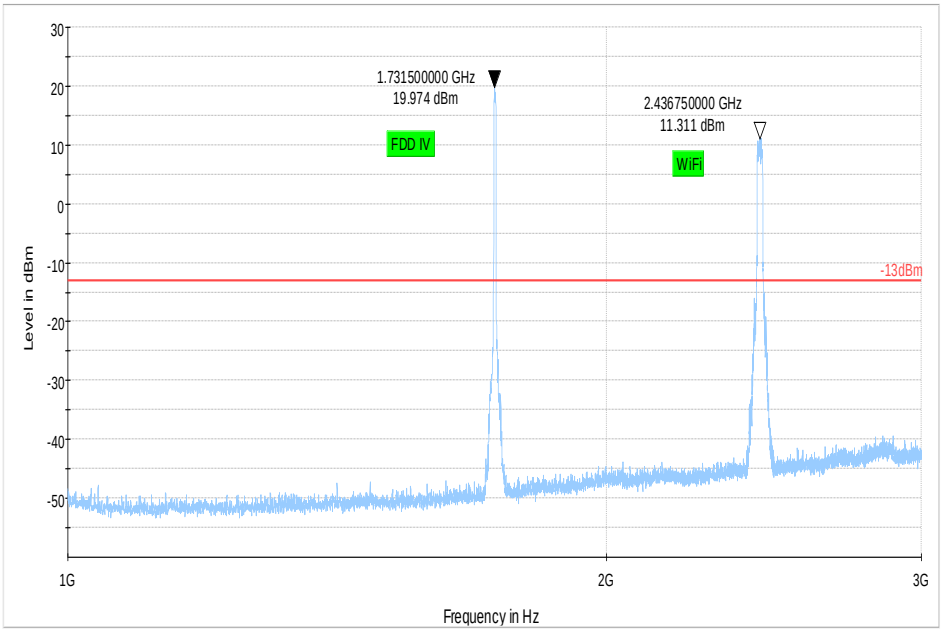
UMTS IV + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

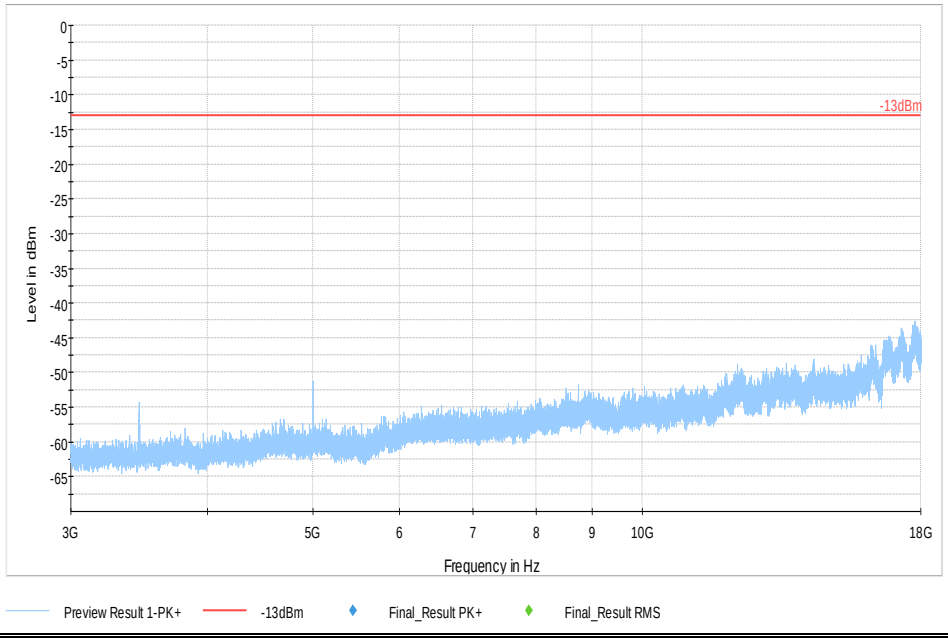
Plot # 14 Radiated Emissions: 1-3 GHz

UMTS IV + 802.11b



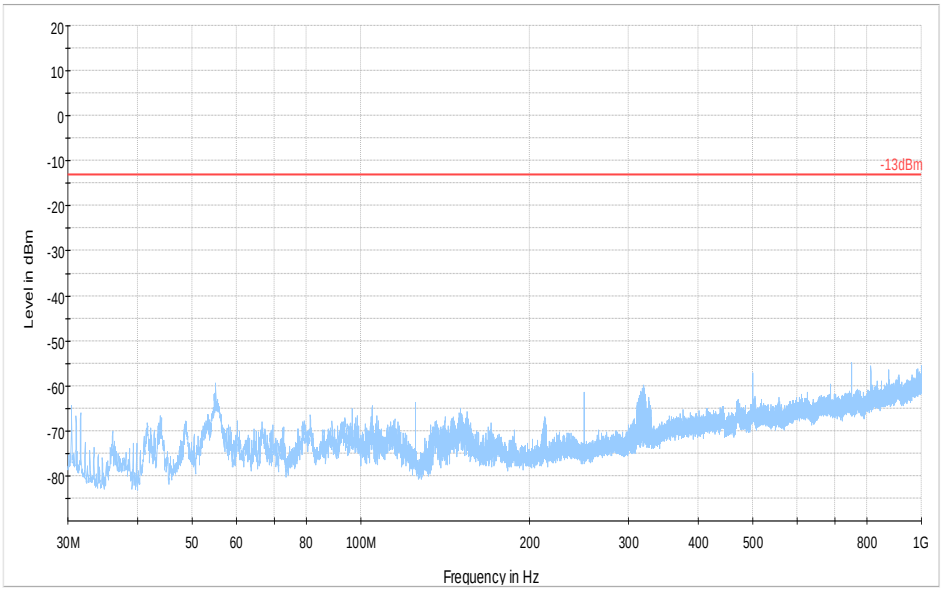
Plot # 15 Radiated Emissions: 3-18 GHz

UMTS IV + 802.11b



Plot # 16 Radiated Emissions: 30 MHz – 1GHz

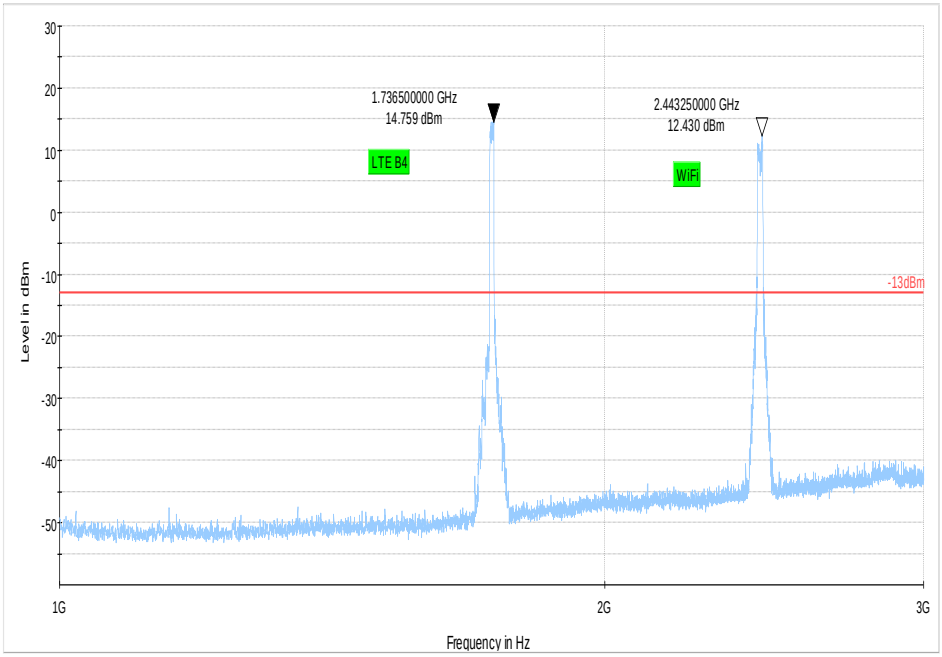
LTE 4 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 17 Radiated Emissions: 1-3 GHz

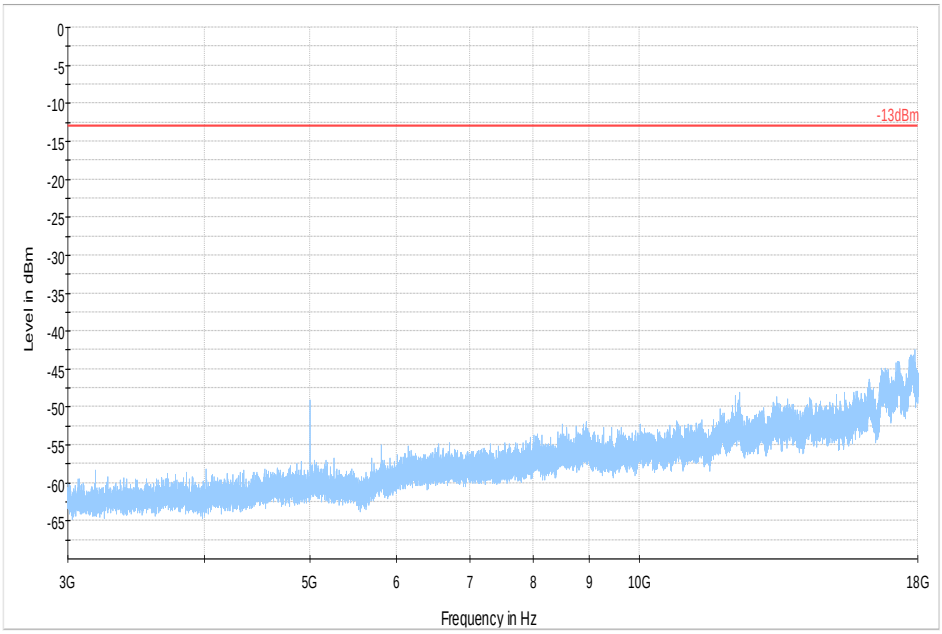
LTE 4 + 802.11b



Preview Result 1-PK+ Critical_Freqs PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 18 Radiated Emissions: 3-18 GHz

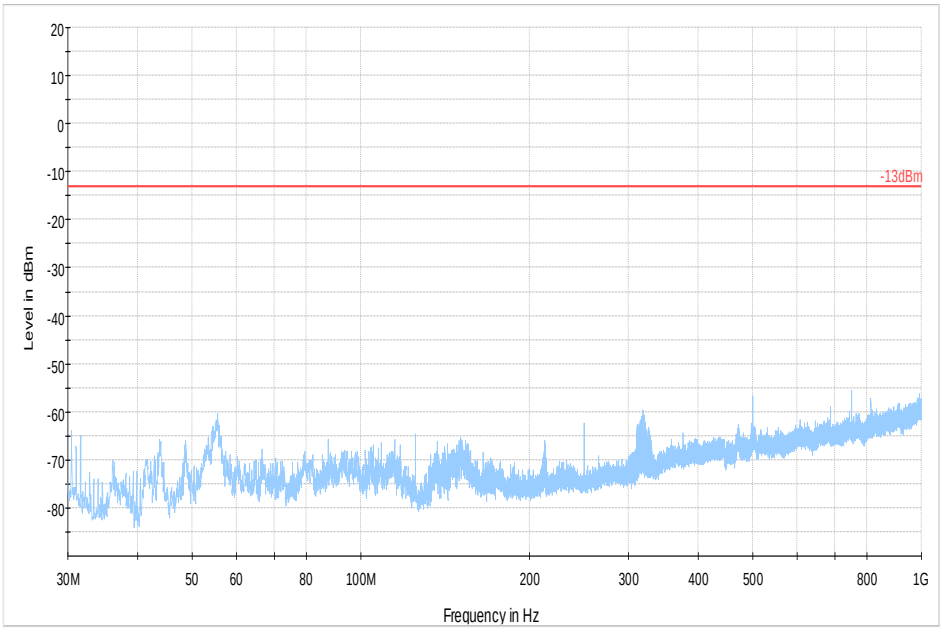
LTE 4 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 19 Radiated Emissions: 30 MHz – 1GHz

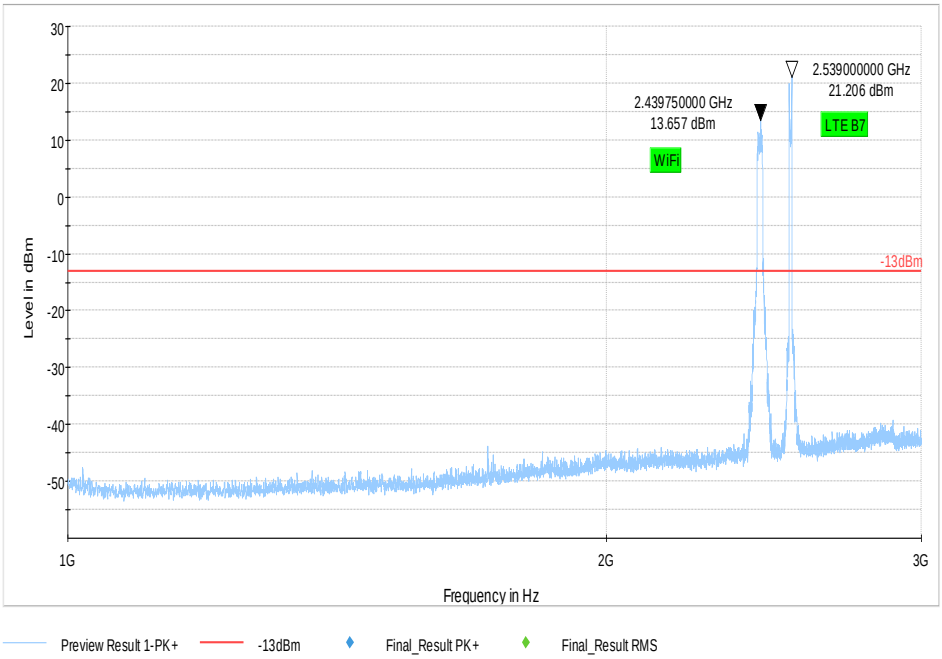
LTE 7 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

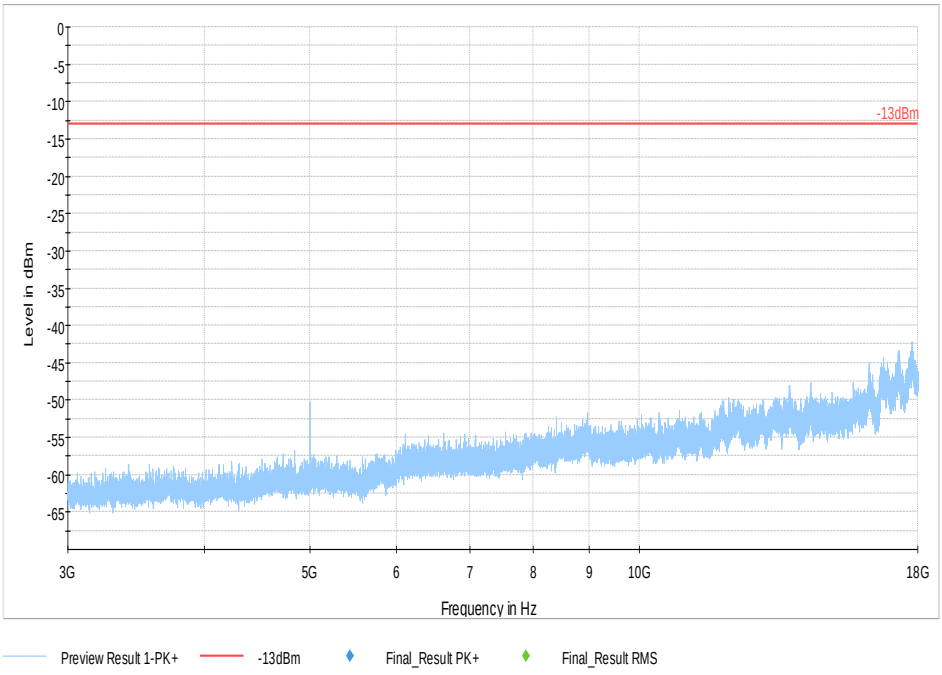
Plot # 20 Radiated Emissions: 1-3 GHz

LTE 7 + 802.11b



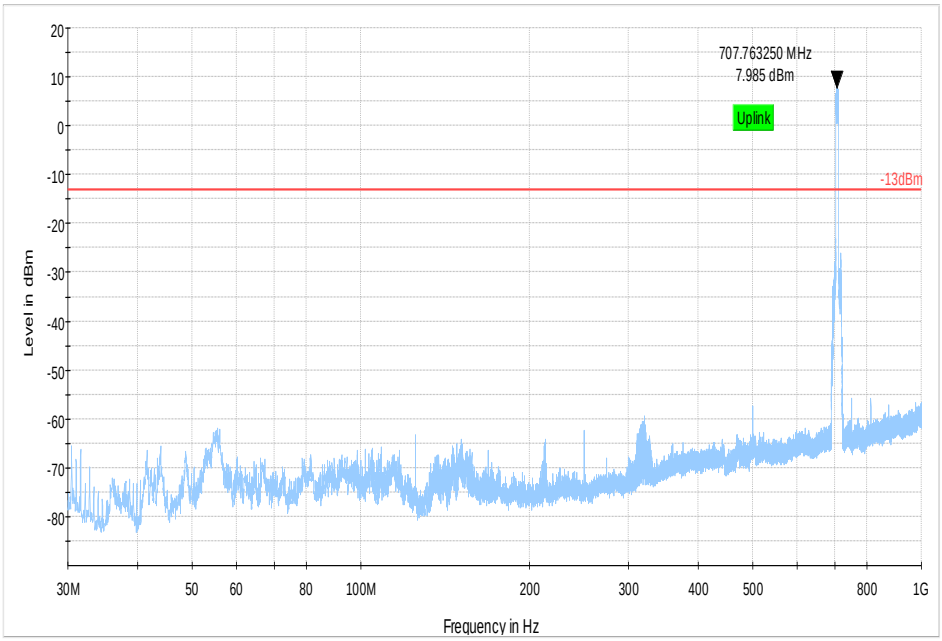
Plot # 21 Radiated Emissions: 3-18 GHz

LTE 7 + 802.11b



Plot # 22 Radiated Emissions: 30 MHz – 1GHz

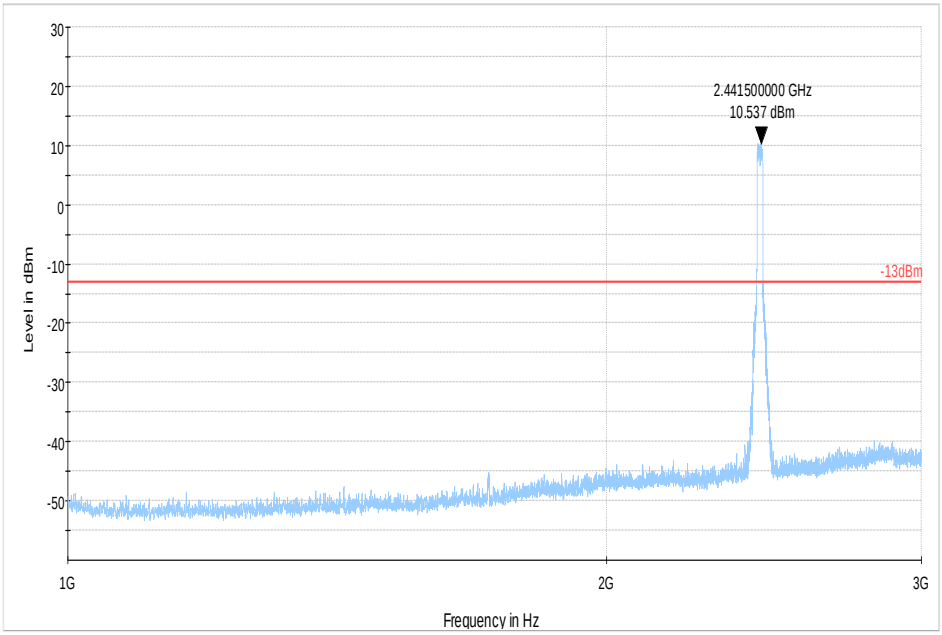
LTE 12 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 23 Radiated Emissions: 1-3 GHz

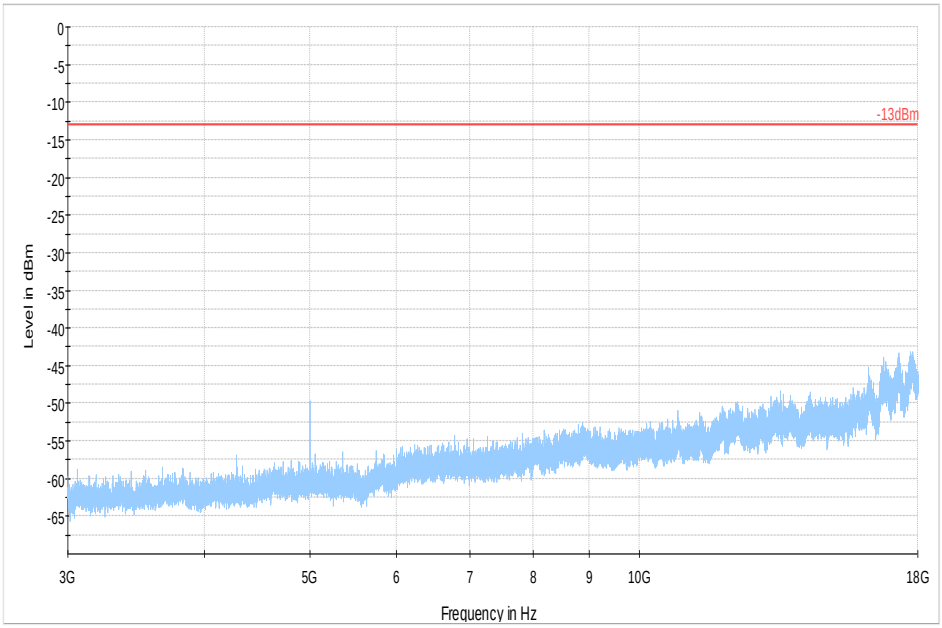
LTE 12 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

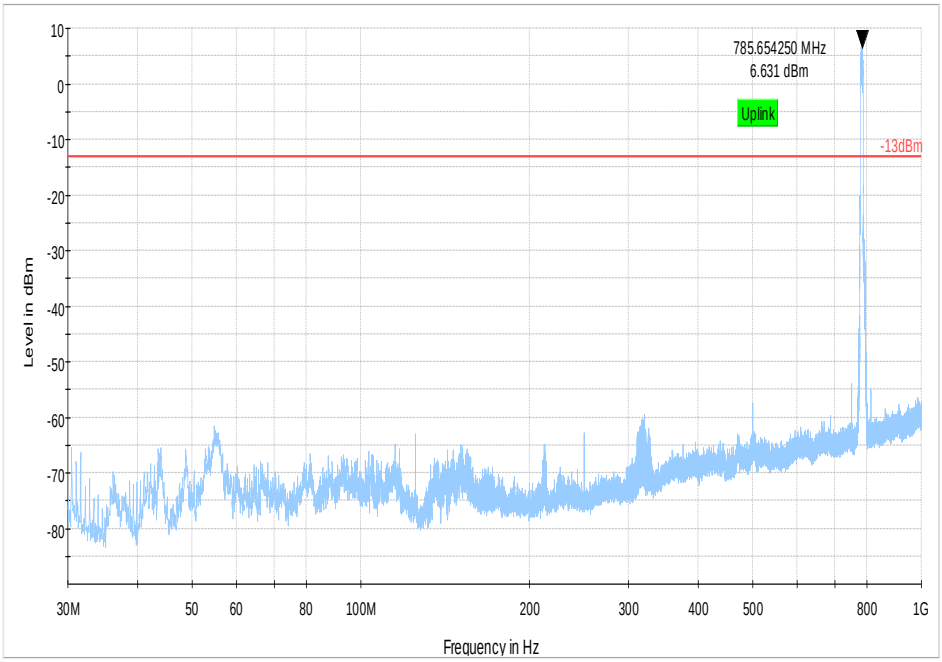
Plot # 24 Radiated Emissions: 3-18 GHz

LTE 12 + 802.11b



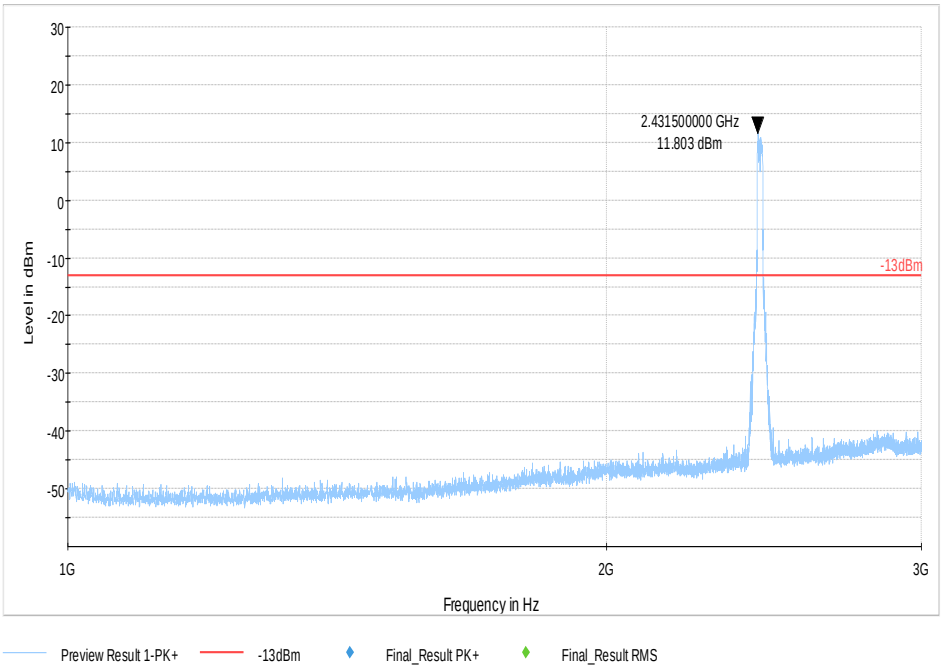
Plot # 25 Radiated Emissions: 30 MHz – 1GHz

LTE 13 + 802.11b



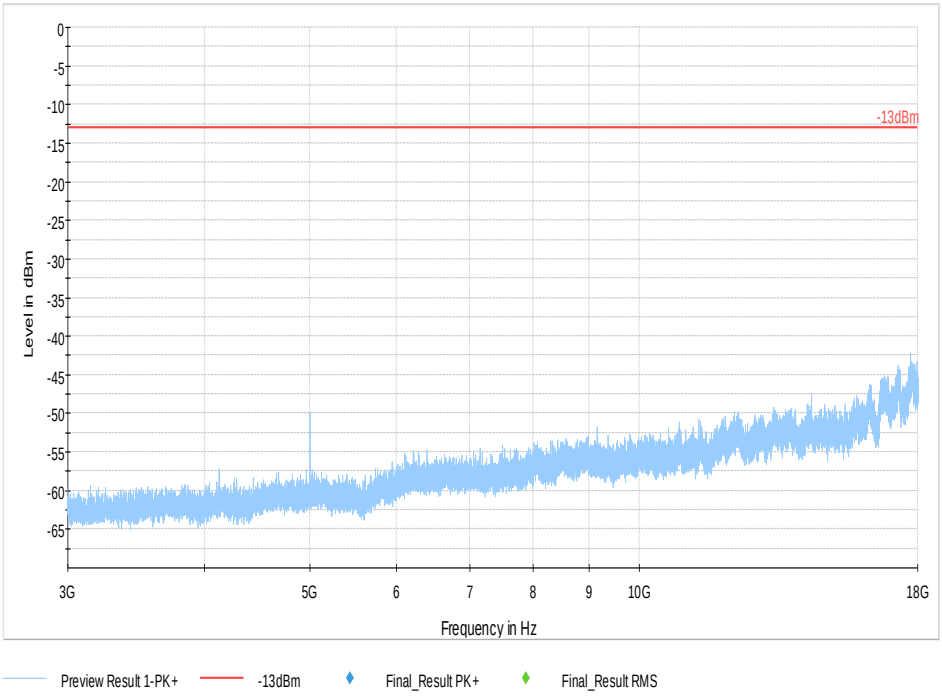
Plot # 26 Radiated Emissions: 1-3 GHz

LTE 13 + 802.11b



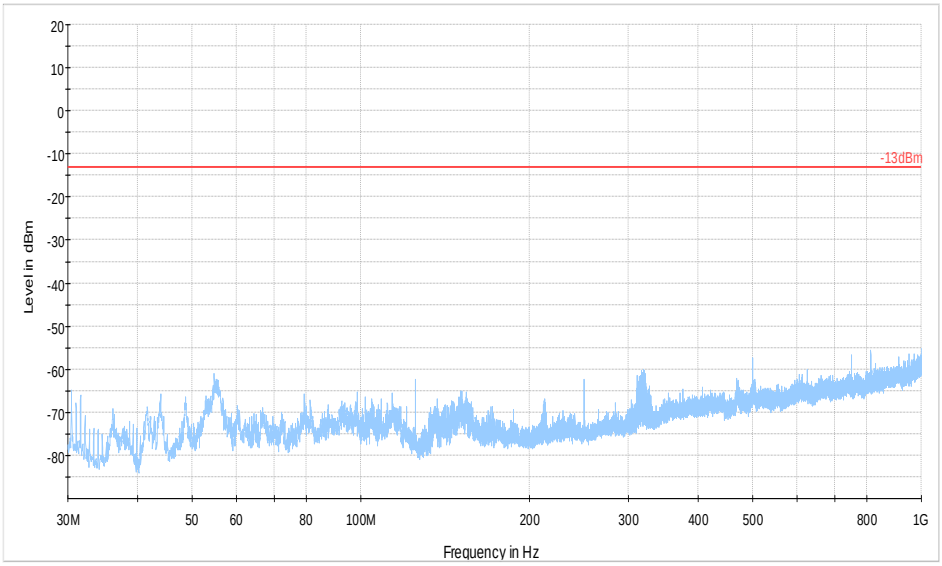
Plot # 27 Radiated Emissions: 3-18 GHz

LTE 13 + 802.11b



Plot # 28 Radiated Emissions: 30 MHz – 1GHz

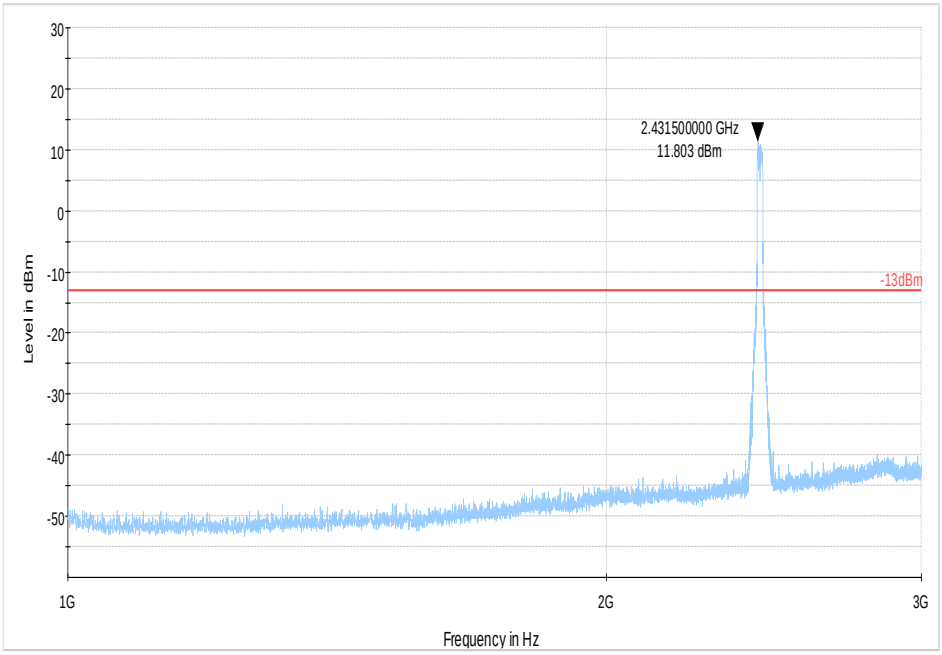
LTE 41 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 29 Radiated Emissions: 1-3 GHz

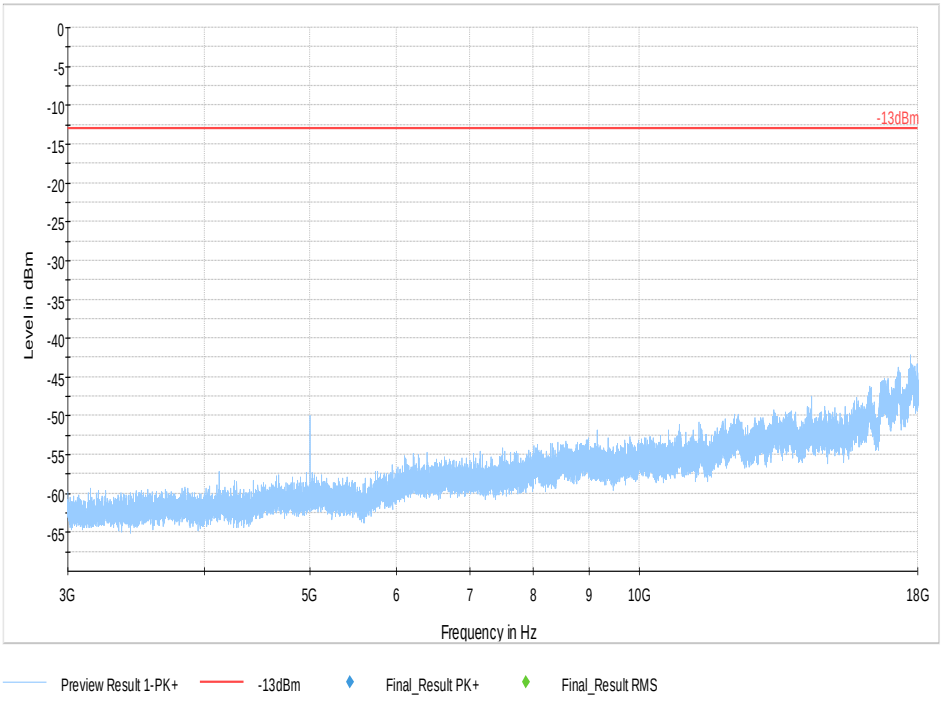
LTE 41 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 30 Radiated Emissions: 3-18 GHz

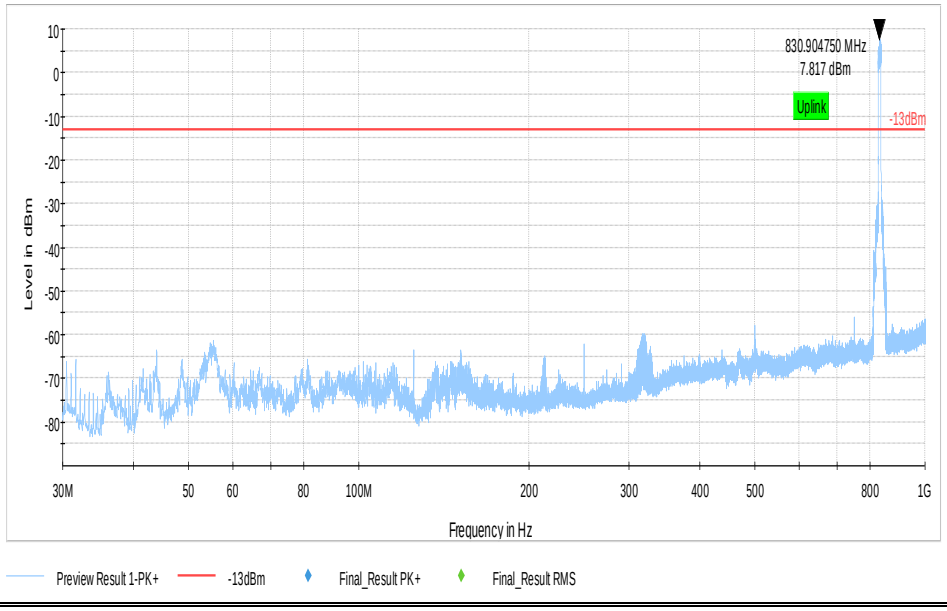
LTE 412 + 802.11b



7.2.5.4 FCC 90 + WiFi

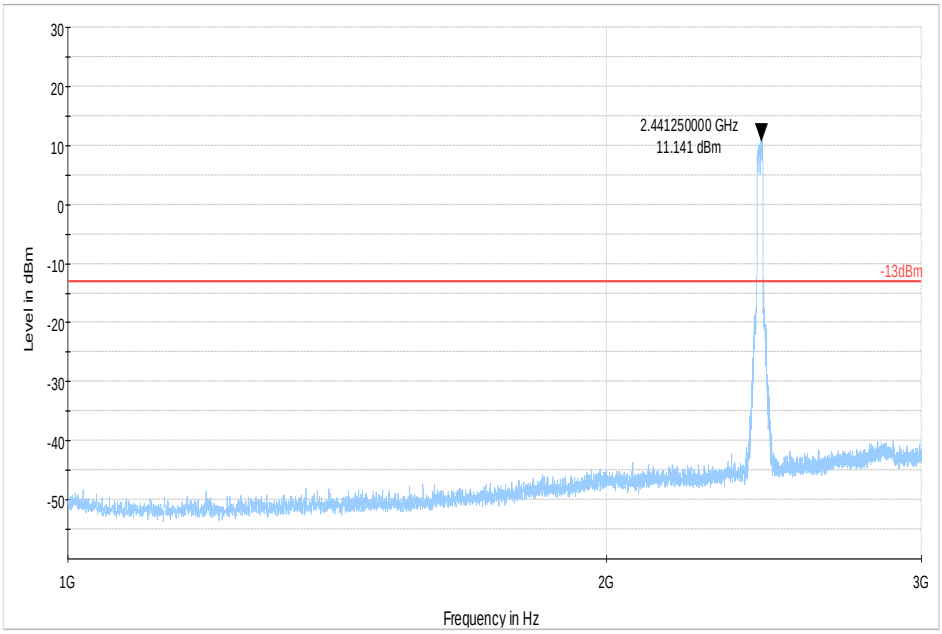
Plot # 31 Radiated Emissions: 30 MHz – 1GHz

LTE 26 + 802.11b



Plot # 32 Radiated Emissions: 1-3 GHz

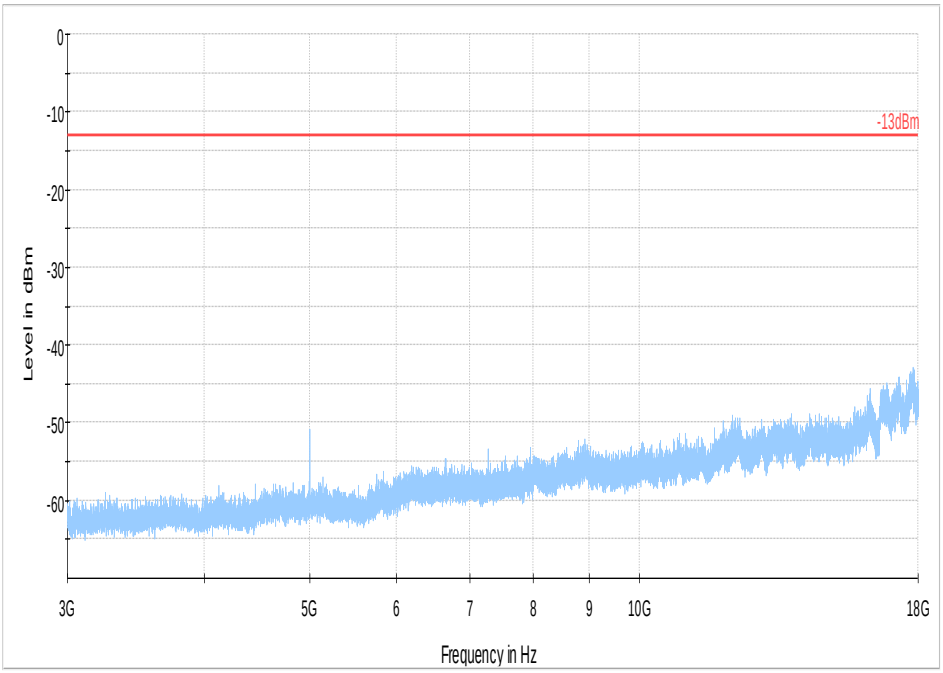
LTE 26 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

Plot # 33 Radiated Emissions: 3-18 GHz

LTE 26 + 802.11b



Preview Result 1-PK+ -13dBm Final_Result PK+ Final_Result RMS

8 Test setup photos

Setup photos are included in supporting file name: "EMC_ASTRO-001-20001_22_24_27_90_Setup_photos.pdf"

9 Test Equipment 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

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.

10 Revision History

Date	Report Name	Changes to report	Report prepared by
2020-04-02	EMC_ASTRO-001-20001_22_24_27_90	Initial Version	Kris Lazarov
2020-07-06	EMC_ASTRO-001-20001_22_24_27_90_Rev 1	Added the ERP/EIRP power from modular report in section 7.1	Kris Lazarov

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