



FCC / ISED & Test Report

For:

CalAmp

Model Name:

TTU-2900

Product Description:

Telematics Gateway with built in ECU (Engine Control unit)

Applied Rules and Standards:

47 CFR Parts 22, 24, and 27

RSS: 132 Issue 3, 133 Issue 6, 139 Issue 3

FCC ID: APV-2900LABL

IC ID: 5843C-2900LABL

REPORT #: EMC_CALAM-116-20001_FCC_22_24_27_Rev1

DATE: 2020-12-17



A2LA Accredited

**IC recognized #
3462B-1**

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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 the Code of Federal Regulations Title 47 parts 22 and 24, and Industry Canada Standards RSS-GEN issue 3, RSS-132 issue 3 and RSS-133 issue 6.

No deficiencies were ascertained.

Company Name	Product Description	Model #
CalAmp	Telematics Gateway with built in ECU (Engine Control unit)	TTU-2900

Responsible for Testing Laboratory:

2020-12-17	Compliance	Cindy Li (EMC Lab Manager)	
Date	Section	Name	Signature

Responsible for the Report:

2020-12-17	Compliance	Kevin Wang (Senior 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

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:	Cathy Palacios

2.2 Identification of the Client

Client's Name:	CalAmp
Street Address:	2200 Faraday Avenue, Suite 220
City/Zip Code	Carlsbad, CA 92008
Country	USA

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	TTU-2900
HW Version	REV B2
SW Version	8.4
FCC-ID	APV-2900LABL
IC-ID:	5843C-2900LABL
HVIN:	REV B2
PMN:	TTU-2900
Product Description	Telematics Gateway with built in ECU (Engine Control unit)
Transceiver Technology / Type(s) of Modulation	Module: Telit LE910-NA1 FCC ID: RI7LE910NAV2; IC ID: 5131A-LE910NAV2; 4G: FDD LTE Bands 2, 4, 5, 12, 13 3G: UMTS FDD Bands II, V
Frequency Range	LTE Band 2: 1850 – 1910 MHz LTE Band 4: 1710 – 1755 MHz LTE Band 5: 824 – 849 MHz LTE Band 12: 699 – 716 MHz LTE Band 13: 777 – 787 MHz UMTS Band II: 1852.4 – 1907.6 MHz UMTS Band V: 826.4 – 846.6 MHz
Max. declared antenna gain	PCB Trace Antenna: UMTS Band II: 4.81 dBi UMTS Band V: 3.3 dBi LTE Band 2: 4.81 dBi LTE Band 4: 3.48 dBi LTE Band 5: 3.3 dBi LTE Band 12: 1.36 dBi LTE Band 13: 5.22 dBi
Other Radios included in the device:	BTLE
Power Supply/ Rated Operating Voltage Range	Dedicated Battery Pack Vmin: 8 VDC/ Vnom: 12 VDC / Vmax: 32 VDC
Operating Temperature Range	-30 °C to 70 °C
Sample Revision	☐ Prototype Unit; ☒ Production Unit; ☐ Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	4674642338	REV B2	8.4	Radiated Sample

3.3 Accessory Equipment (AE) details

N/A

3.4 Test Sample Configuration

Set-up #	EUT / AE used for set-up	Comments
1	EUT#1	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. The internal antenna was connected.

3.5 Mode of Operation details

Mode of Operation	Description of Operating modes	Additional Information
Op. 1	Cellular and BTLE Co-Transmission	Cellular was tested on Low, Mid, High Channels at maximum power in a co-transmission mode Bluetooth radio was configured to Mid channel using special commands through command window provided by the client that will not be 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 at the maximum power simultaneous transmission with Bluetooth LE, which is the worst case of the radios supported, based on the maximum average conducted output power from the reports.

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 evaluate the compliance of the EUT against the relevant requirements specified in the Code of Federal Regulations Title 47 parts 22, 24, 27 and ISED Standards RSS-132 issue 3, RSS-133 issue 6, and RSS-139 issue 3.

4.1 **Dates of Testing:**

11/10/2020 - 11/18/2020

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)
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RF conducted measurement	± 0.5 dB
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4.3 **Environmental Conditions during Testing:**

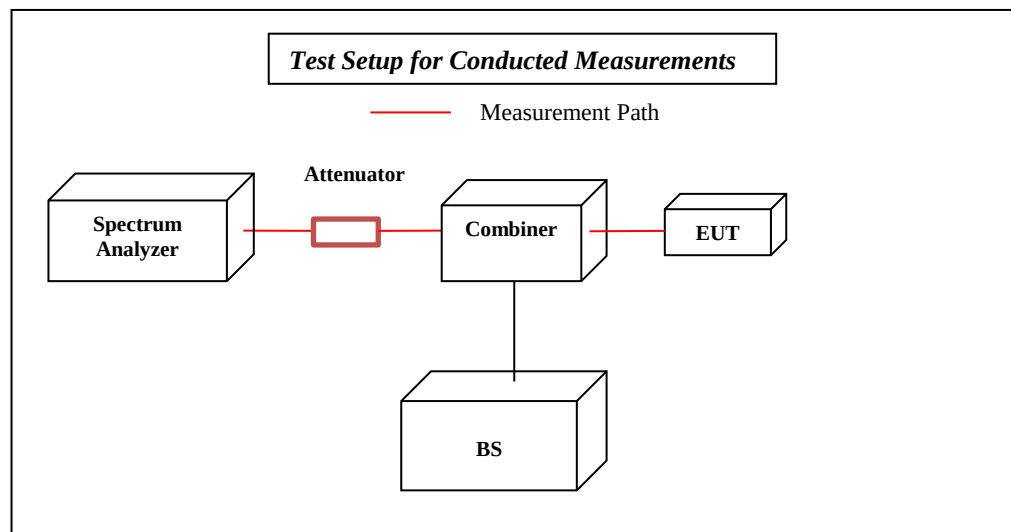
The following environmental conditions were maintained during the course of testing:

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

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

5 Measurement Procedures

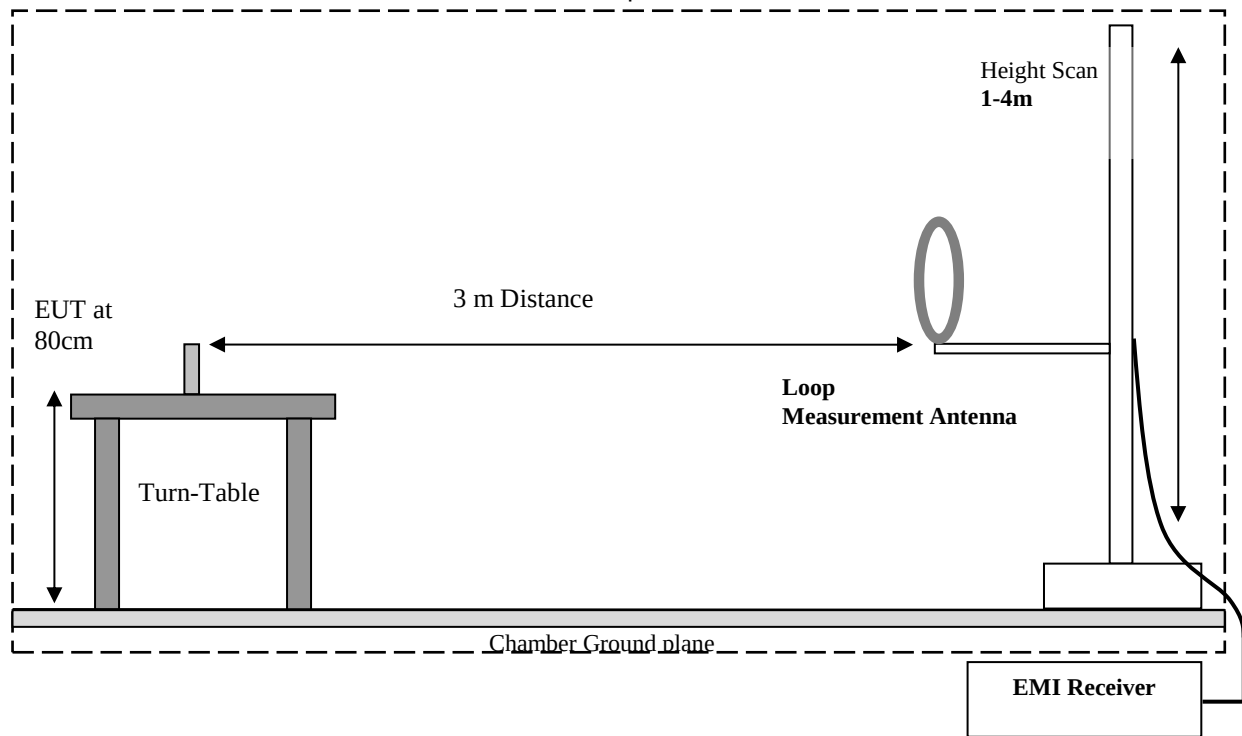
Testing is performed according to the guidelines provided in FCC publication (KDB) 971168 D01 v03r01 – “Measurement Guidance for Certification of Licensed Digital Transmitters” and according to relevant parts of ANSI/TIA-603-D-2010 as detailed below.



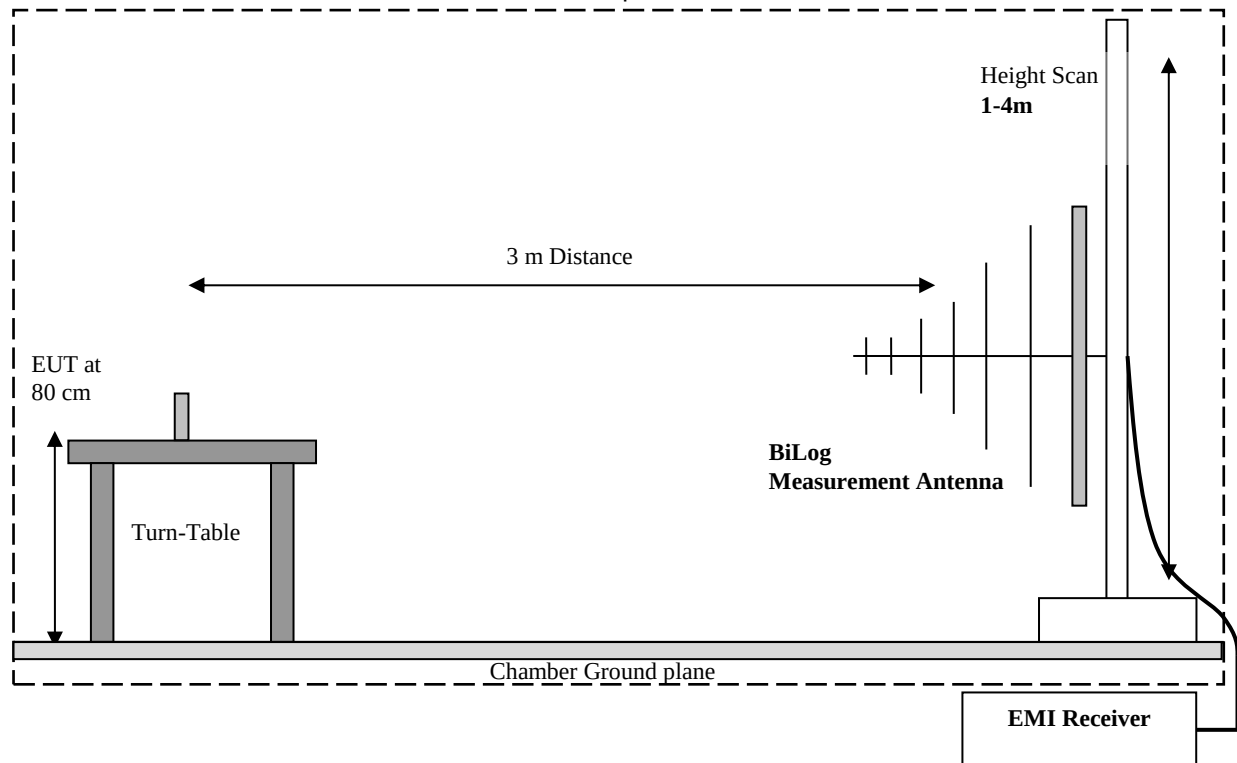
5.1 Radiated Measurement

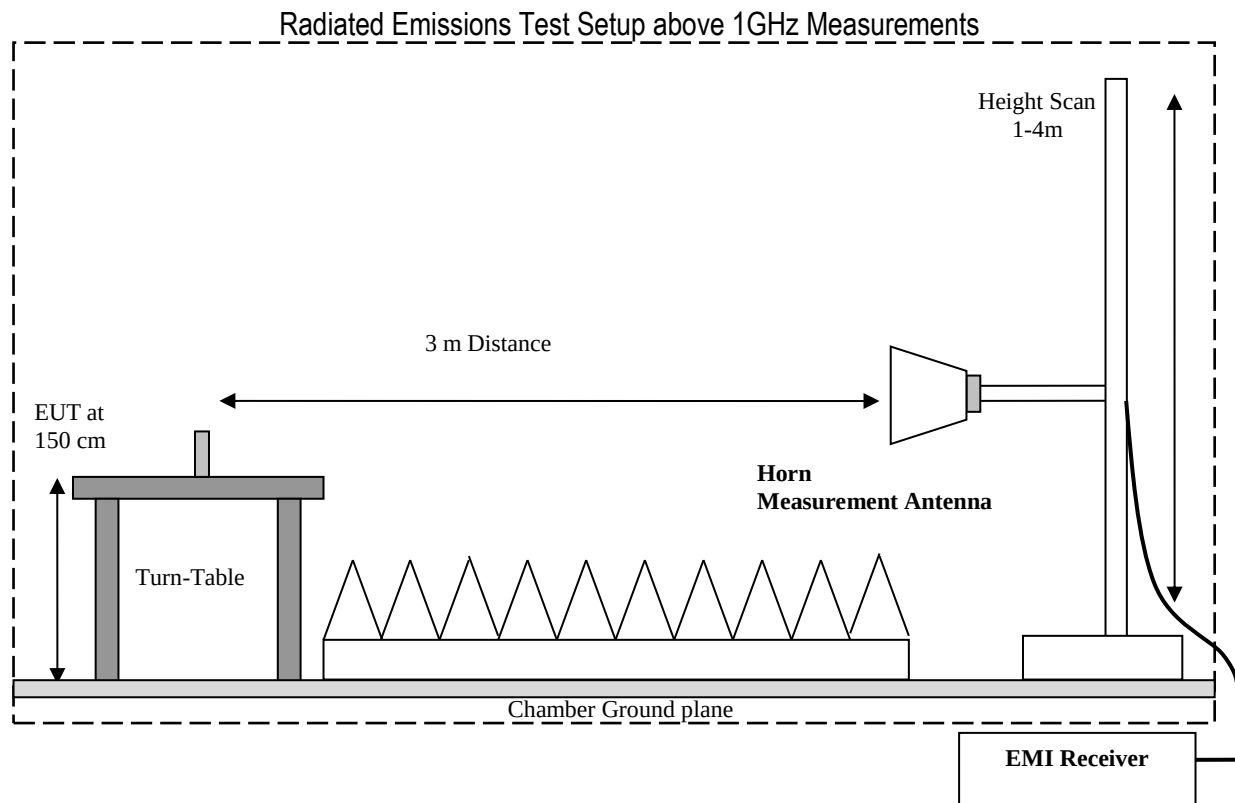
- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to 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 below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-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 dB μ V
- 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:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

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

6 Measurement Results Summary

6.1 Part 22 / RSS-132

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046; §22.913 (a)	RF Output Power	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1055; §22.355	Frequency Tolerance	Extreme Temperature and Voltage	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1049; §22.917	Occupied Bandwidth	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1051; §22.917	Band Edge Compliance	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1051; §22.917	Conducted Spurious Emissions	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1053; §22.917	Radiated Spurious Emissions	Nominal	Op. 1	☒	☐	☐	☐	Complies

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

Note 2: Leveraged from module certification Telit LE910-NA1 (FCC ID: RI7LE910NAV2; IC ID: 5131A-LE910NAV2)

6.2 Part 24 / RSS-133

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046; §24.232 (a)	RF Output Power	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1055; §24.235	Frequency Stability	Extreme Temperature and Voltage	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1049; §24.238	Occupied Bandwidth	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1051; §24.238	Band Edge Compliance	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1051; §24.238	Conducted Spurious Emissions	Nominal	-	☐	☐	☐	☒	Complies Note 1 Note 2
§2.1053; §24.238	Radiated Spurious Emissions	Nominal	Op. 1	☒	☐	☐	☐	Complies

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

Note 2: Leveraged from module certification Telit LE910-NA1 (FCC ID: RI7LE910NAV2; IC ID: 5131A-LE910NAV2)

6.3 FCC 27 / RSS-139

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046; §27.50	RF Output Power	Nominal	-	☐	☐	☐	■	Complies Note 1 Note 2
§2.1055; §27.54	Frequency Stability	Extreme Temperature and Voltage	-	☐	☐	☐	■	Complies Note 1 Note 2
§2.1049; §27.53	Occupied Bandwidth	Nominal	-	☐	☐	☐	■	Complies Note 1 Note 2
§2.1051; §27.53	Band Edge Compliance	Nominal	-	☐	☐	☐	■	Complies Note 1 Note 2
§2.1051; §27.53	Conducted Spurious Emissions	Nominal	-	☐	☐	☐	■	Complies Note 1 Note 2
§2.1053; §27.53	Radiated Spurious Emissions	Nominal	Op. 1	■	☐	☐	☐	Complies

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

Note 2: Leveraged from module certification Telit LE910-NA1 (FCC ID: R17LE910NAV2; IC ID: 5131A-LE910NAV2)

7 Test Result Data

7.1 ERP/EIRP

Radio	Frequency Range (MHz)		E(I)RP output W	E(I)RP limit W	Frequency Tolerance (% , Hz, ppm)		Emission Designator (NOT for Part 15 devices)	Equipment Code (ex: DTS, DSS, PCE)	Rule Part (ex: 15.247, etc.)
UMTS V	826.4	846.6	0.298	7.00	1	ppm	4M08D7D	PCB	22H
UMTS II	1852.4	1907.6	0.702	2.00	1	ppm	4M09D7D	PCB	24E
LTE 2	1857.5	1902.5	0.666	2.00	1	ppm	13M5D7D	PCB	24E
LTE 2	1860	1900	0.663	2.00	1	ppm	17M9D7D	PCB	24E
LTE 4	1710.7	1754.3	0.457	1.00	1	ppm	1M08D7D	PCB	27
LTE 4	1720	1745	0.452	1.00	1	ppm	18M0D7D	PCB	27
LTE 12	709	711	0.164	3.00	1	ppm	8M96D7D	PCB	27
LTE 13	779.5	784.5	0.393	3.00	1	ppm	4M47D7D	PCB	27
LTE 13	782	782	0.381	3.00	1	ppm	8M96D7D	PCB	27
LTE 5	825.5	847.5	0.254	7.00	1	ppm	2M69D7D	PCB	22H
LTE 5	829	844	0.248	7.00	1	ppm	8M97D7D	PCB	22H

Note 1: Power Conducted (dBm) leveraged from test report "1506FR22-01" and "1506FR21-01" prepared by A Test Lab Techno Corp. for cellular module Telit LE910-NA1 (FCC ID: RI7LE910NAV2; IC ID: 5131A-LE910NAV2).

Note 2: ERP/EIRP are based on calculations from Power Conducted by adding the declared maximum gain of the utilized cellular antenna per operational description.

7.2 Radiated Spurious Emissions

7.2.1 Measurement utilizing KDB 971168 D01 Power Meas License Digital Systems v03r01, 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 and 27

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)

Out of band emissions. 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.

i. 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 $43 + 10 \log_{10} P$ (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 $43 + 10 \log_{10} P$ (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 (°C)	EUT Set-Up #	EUT operating mode	Power Input
22.0	1	Op. 1	12 VDC

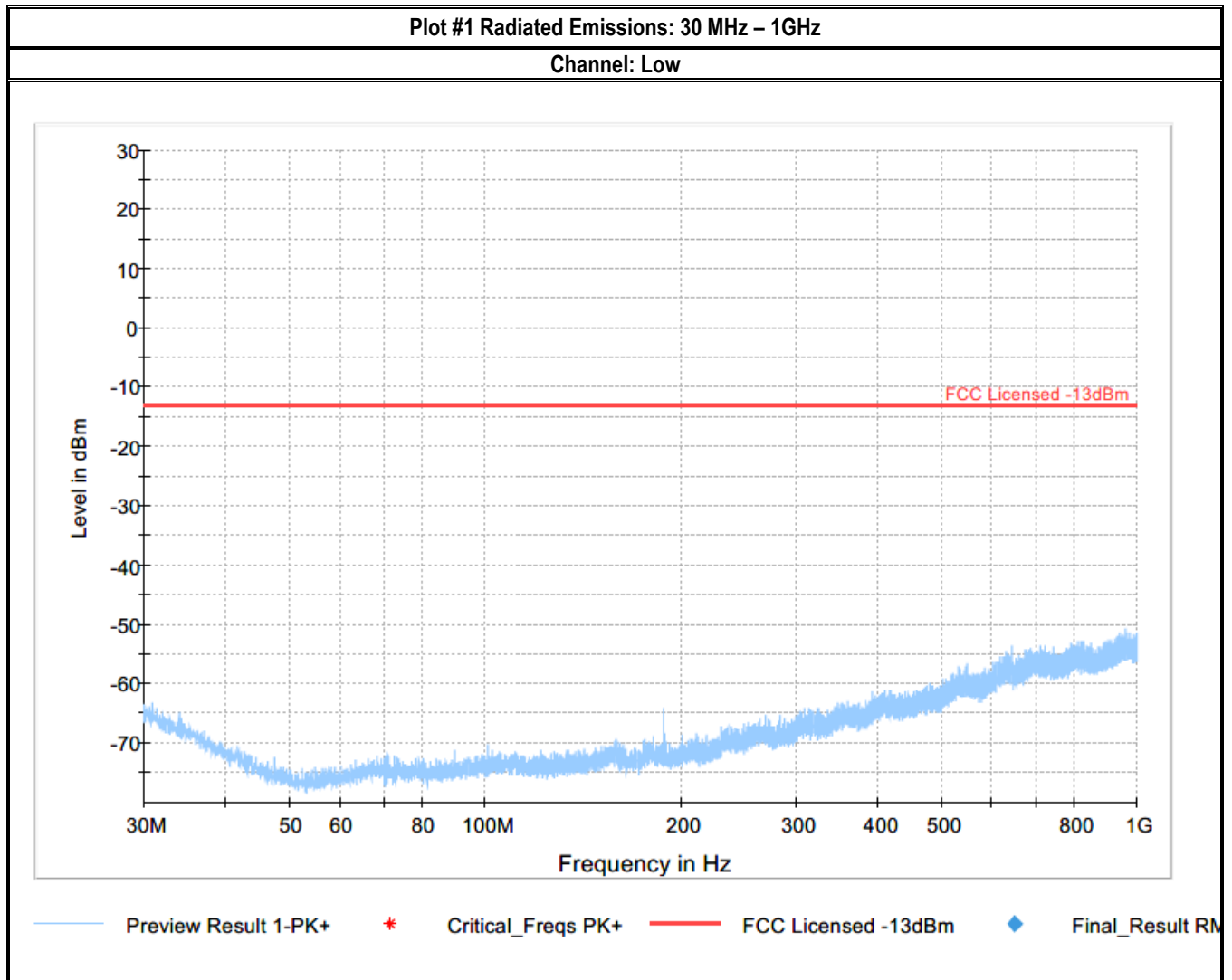
7.2.4 Measurement result:

Plot #	Channel	EUT operating mode	Scan Frequency	Limit (dBm)	Result
1-3	Low	LTE Band 2	30 MHz – 18 GHz	-13	Pass
4-8	Mid		9 kHz – 26 GHz	-13	Pass
9-11	High		30 MHz – 18 GHz	-13	Pass
12-14	Low	LTE Band 4	30 MHz – 18 GHz	-13	Pass
15-18	Mid		9 kHz – 18 GHz	-13	Pass
19-21	High		30 MHz – 18 GHz	-13	Pass
22-24	Low	LTE Band 5	30 MHz – 18 GHz	-13	Pass
25-28	Mid		9 kHz – 18 GHz	-13	Pass
29-31	High		30 MHz – 18 GHz	-13	Pass
32-34	Low	LTE Band 12	30 MHz – 18 GHz	-13	Pass
35-38	Mid		9 kHz – 18 GHz	-13	Pass
39-41	High		30 MHz – 18 GHz	-13	Pass
42-45	Mid	LTE Band 13	9 kHz – 18 GHz	-13	Pass
46-48	Low	UMTS Band II	30 MHz – 18 GHz	-13	Pass
49-53	Mid		9 kHz – 26 GHz	-13	Pass
54-56	High		30 MHz – 18 GHz	-13	Pass
57-59	Low	UMTS Band V	30 MHz – 18 GHz	-13	Pass
60-63	Mid		9 kHz – 18 GHz	-13	Pass
64-66	High		30 MHz – 18 GHz	-13	Pass

Note: Co-Transmission with Bluetooth Mid Channel.

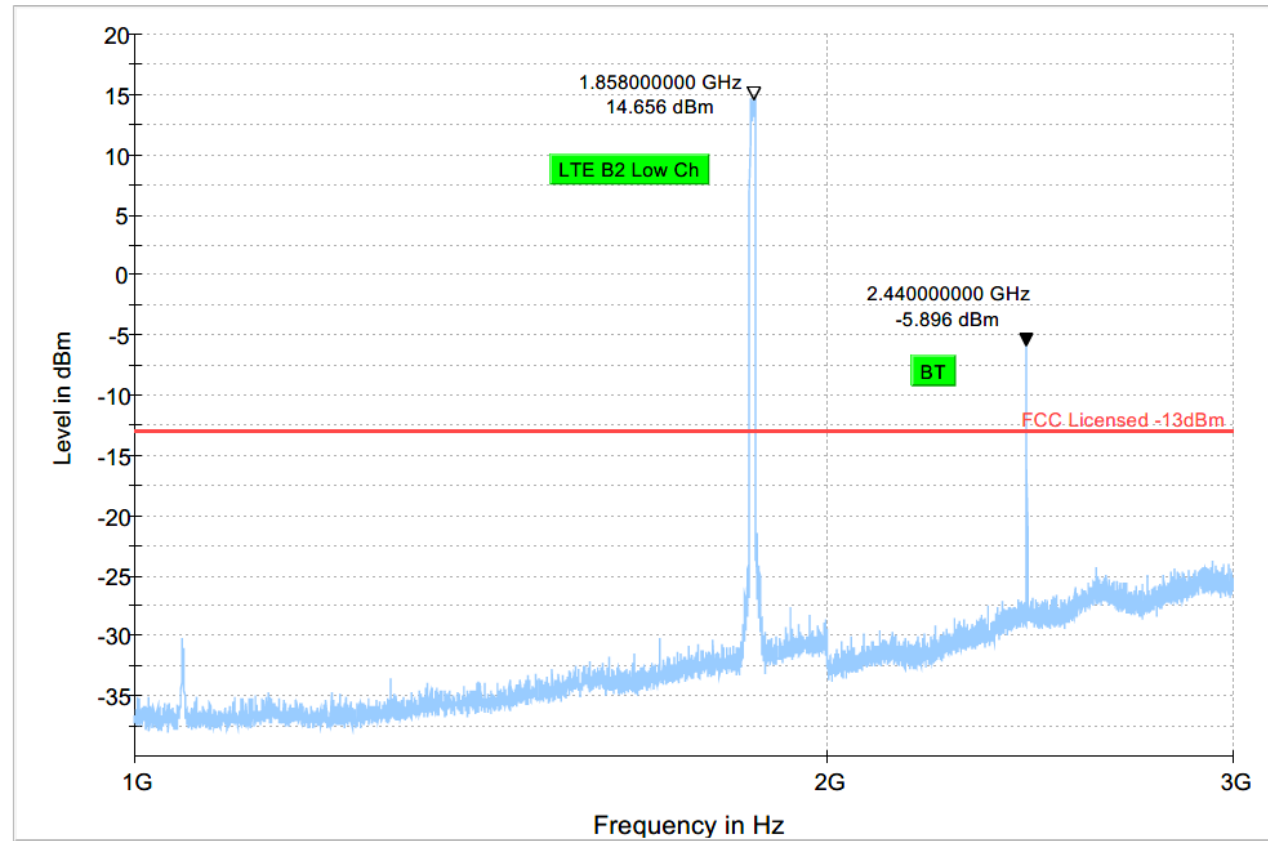
7.2.5 Measurement Plots:

LTE Band 2



Plot # 2 Radiated Emissions: 1-3 GHz

Channel: Low



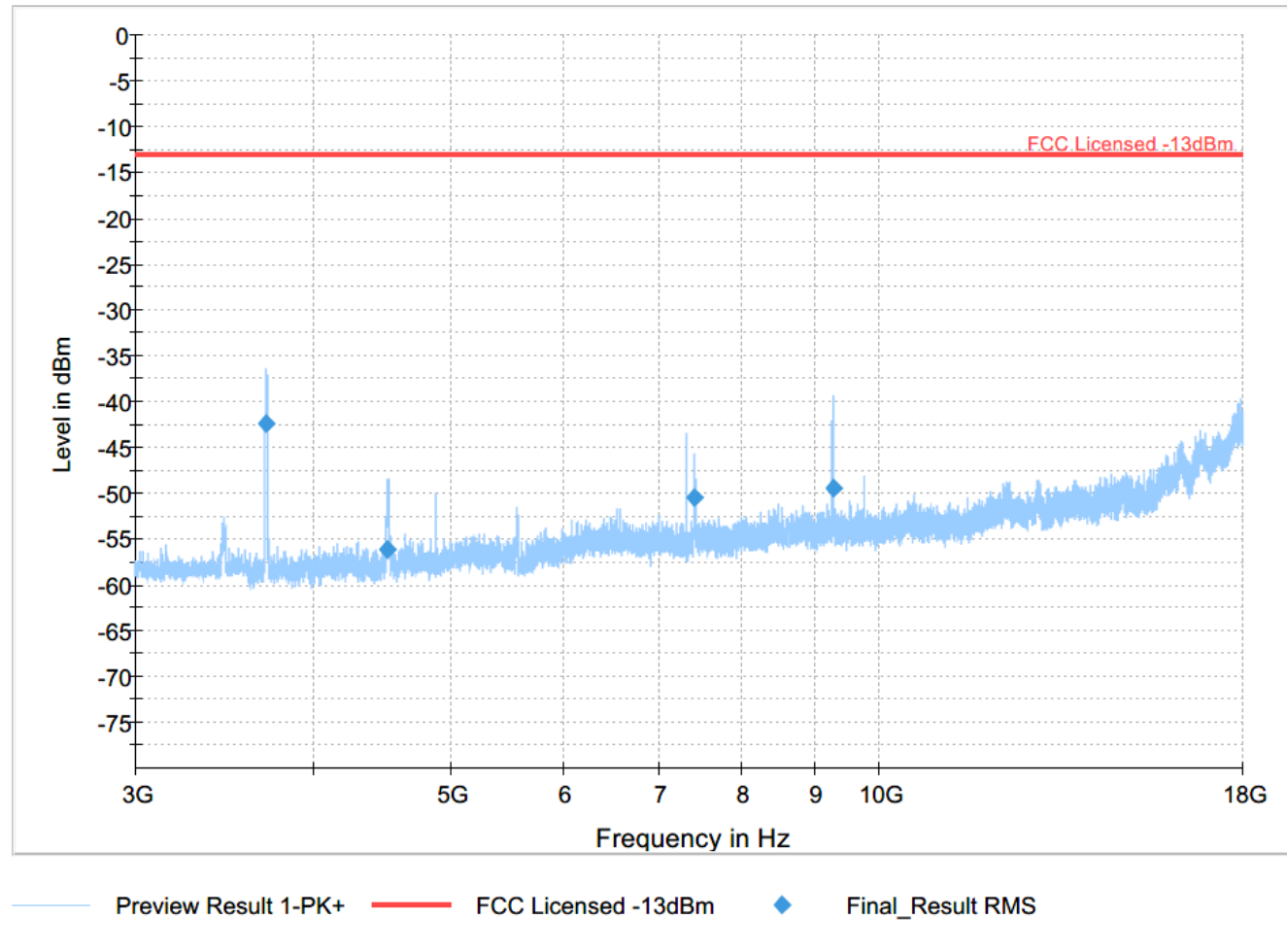
— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot # 3 Radiated Emissions: 3-18 GHz

Channel: Low

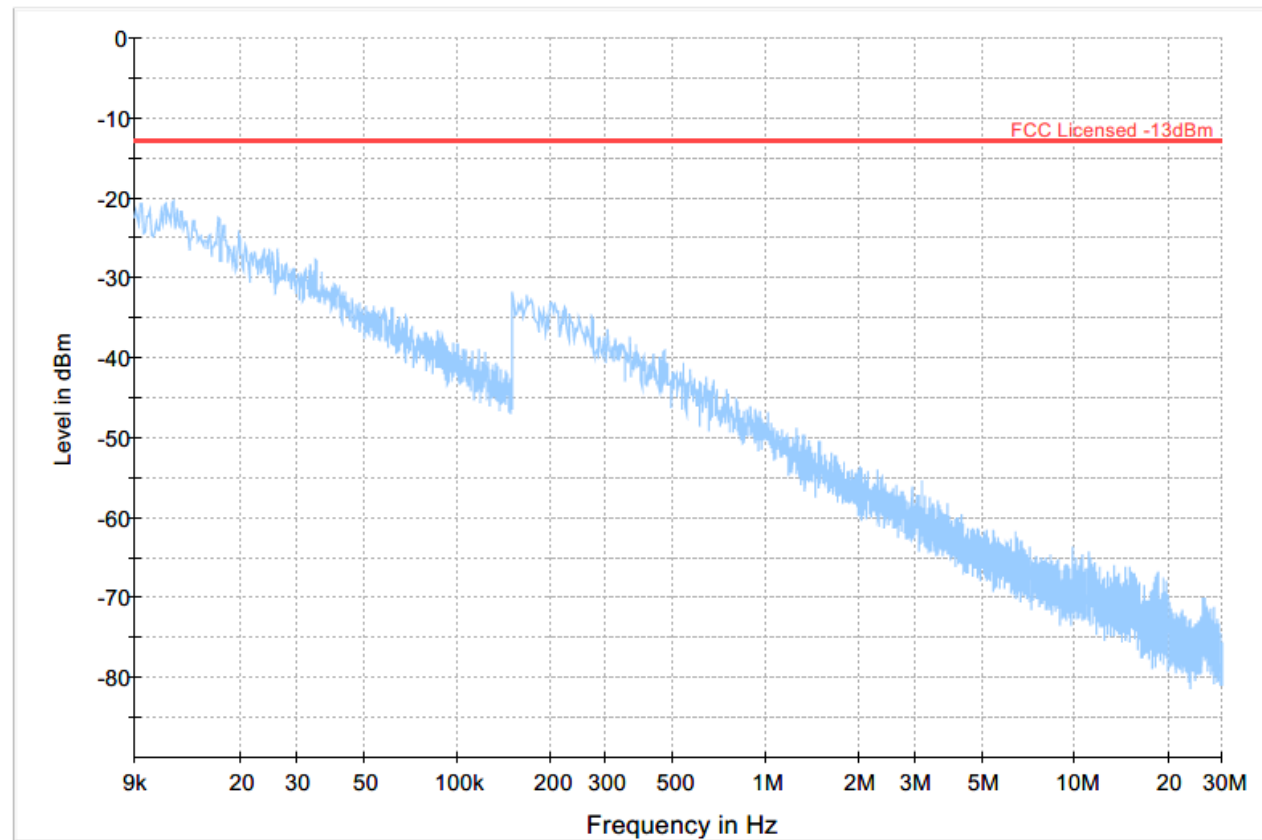
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3710.500	-42.36	-13.00	29.36	500.0	1000.000	140.0	V	34.0	-101.6	
4517.000	-56.12	-13.00	43.12	500.0	1000.000	140.0	H	168.0	-100.5	
7420.000	-50.54	-13.00	37.54	500.0	1000.000	140.0	V	340.0	-95.4	
9278.000	-49.36	-13.00	36.36	500.0	1000.000	164.0	V	135.0	-93.7	



Plot #4 Radiated Emissions: 9 kHz – 30 MHz

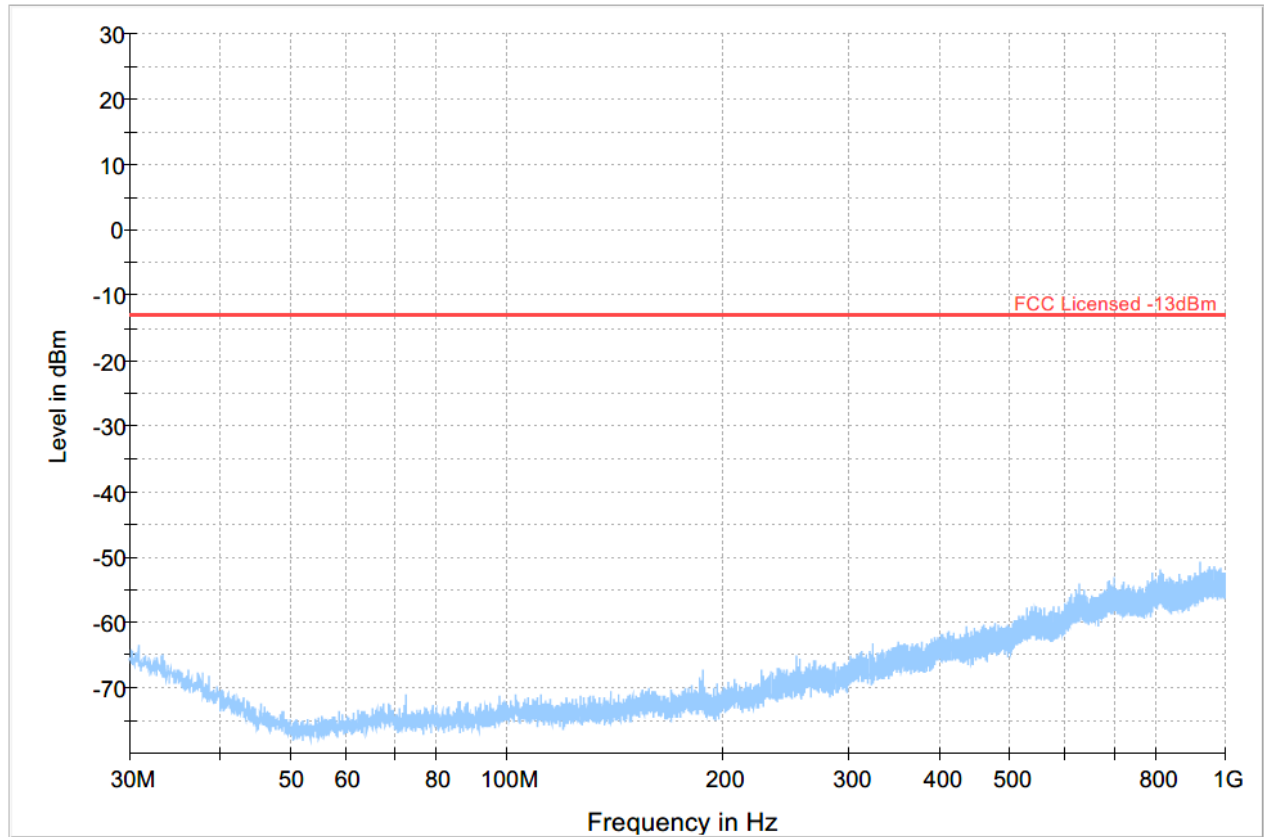
Channel: Mid



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #5 Radiated Emissions: 30 MHz – 1 GHz

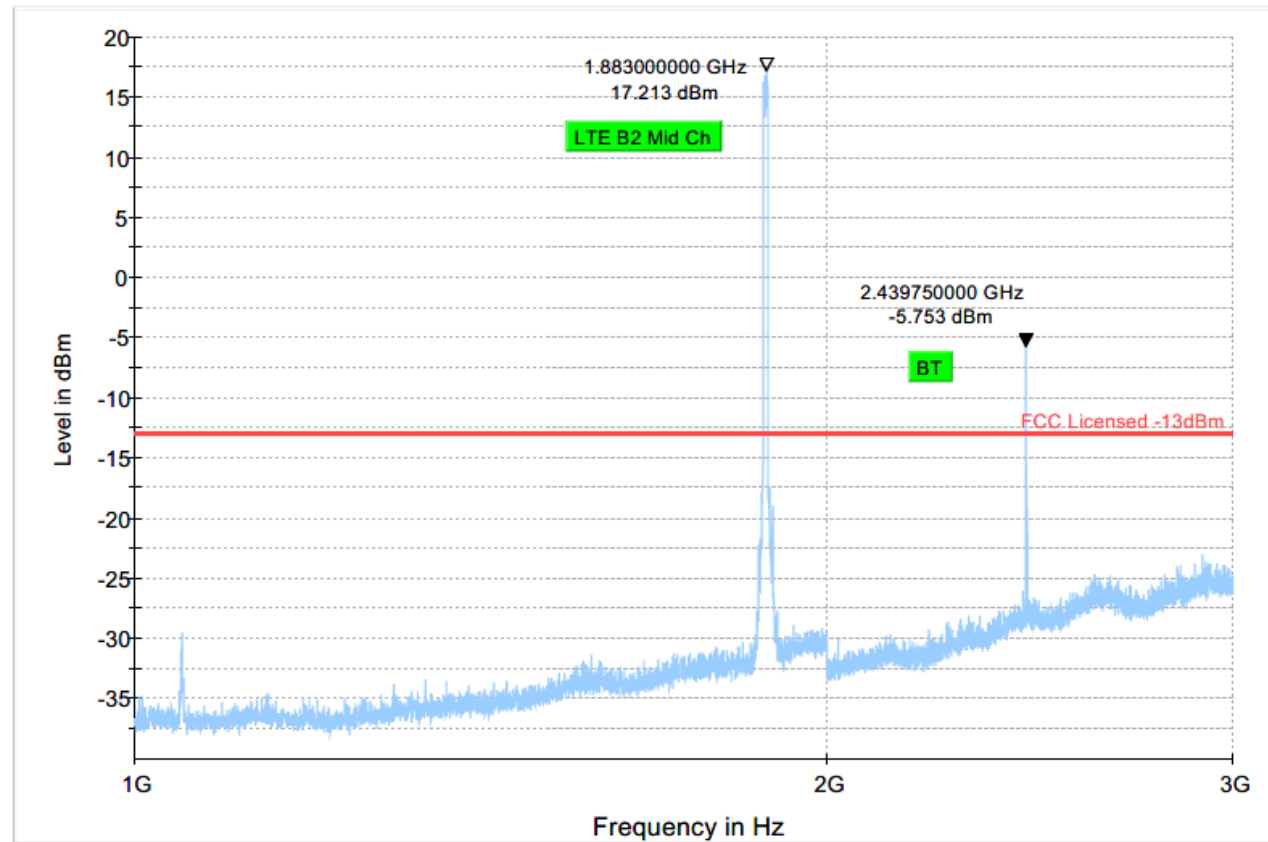
Channel: Mid



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #6 Radiated Emissions: 1-3 GHz

Channel: Mid



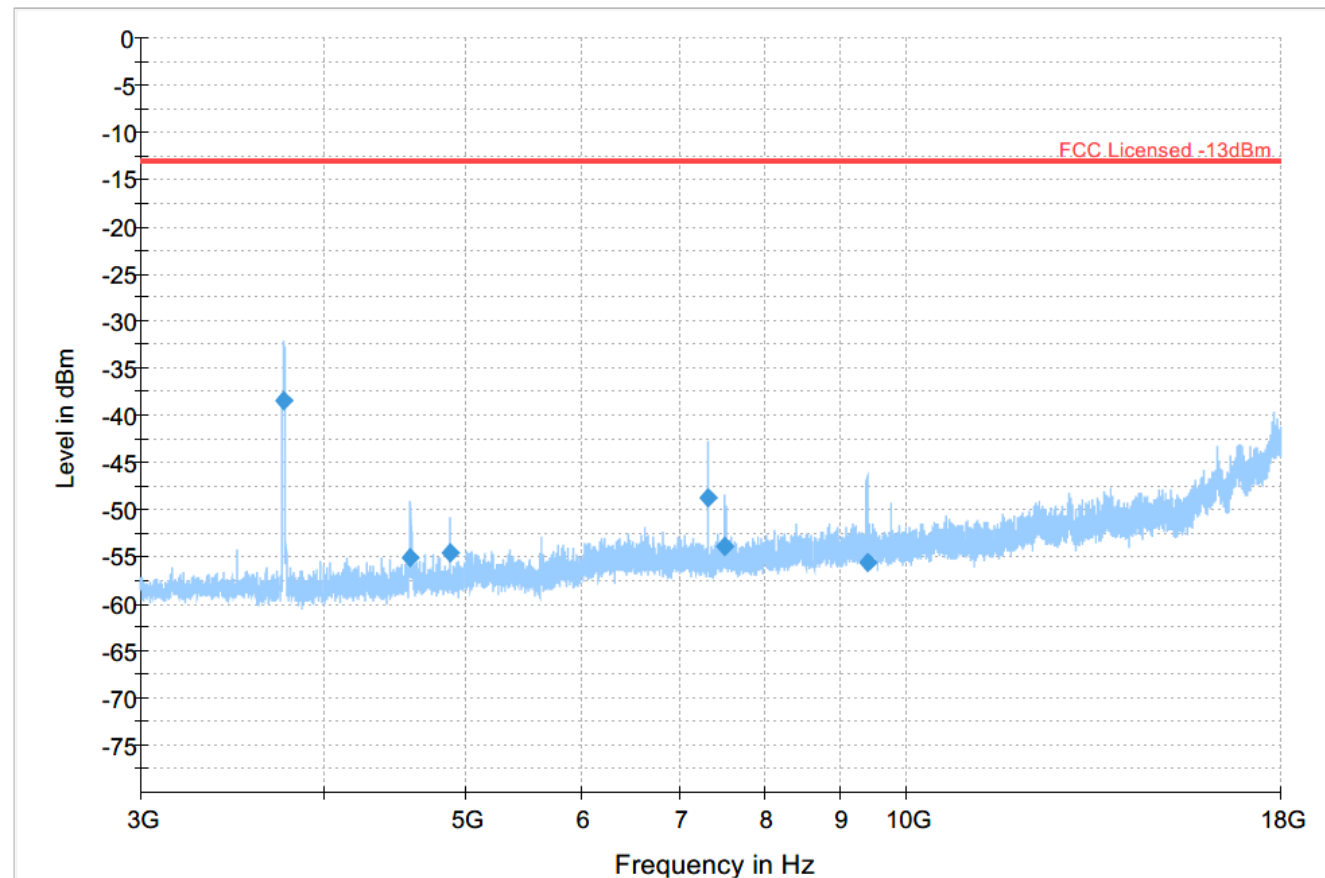
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #7 Radiated Emissions: 3-18 GHz

Channel: Mid

Final Result

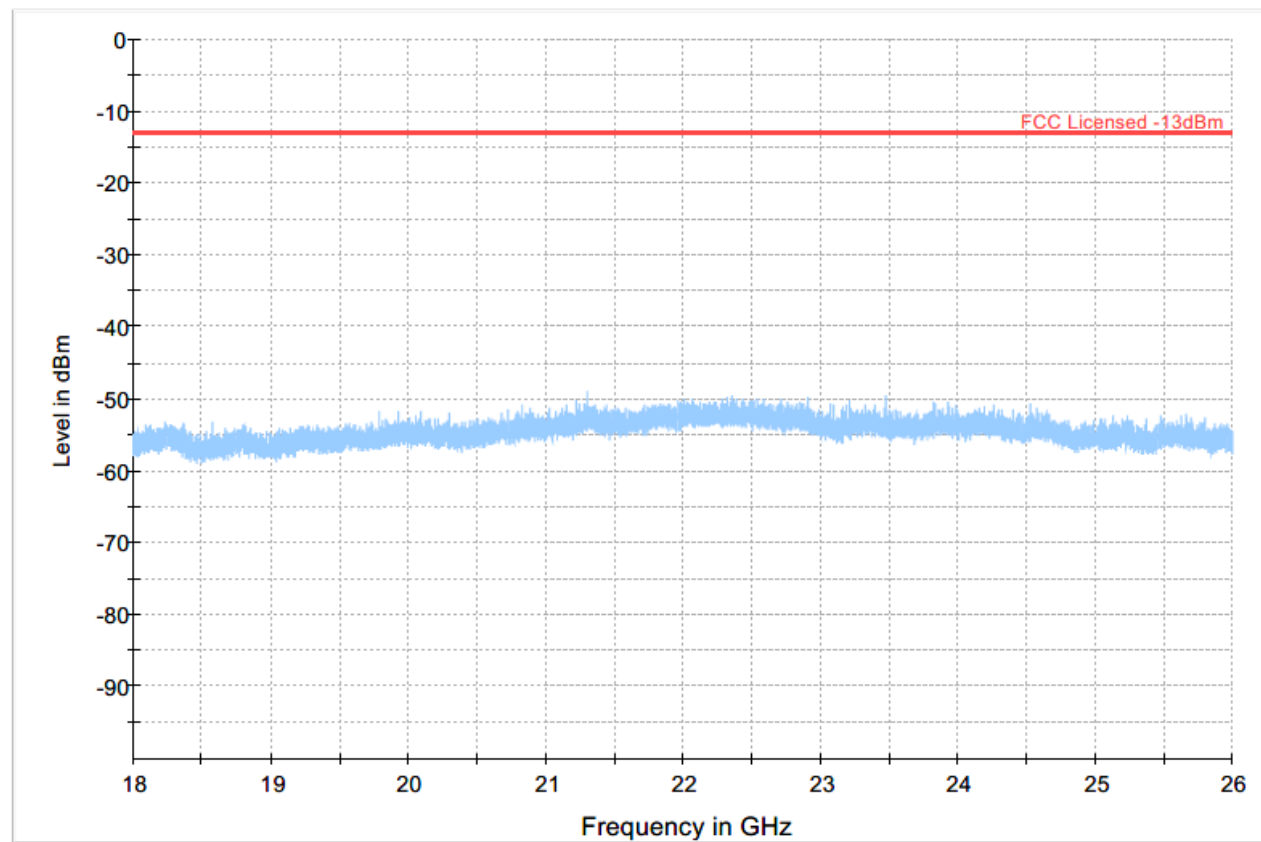
Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3756.500	-38.51	-13.00	25.51	500.0	1000.000	279.0	V	19.0	-101.7	
4589.000	-55.11	-13.00	42.11	500.0	1000.000	232.0	V	152.0	-100.0	
4880.000	-54.60	-13.00	41.60	500.0	1000.000	152.0	V	150.0	-100.2	
7320.000	-48.70	-13.00	35.70	500.0	1000.000	164.0	V	130.0	-95.7	
7520.000	-53.98	-13.00	40.98	500.0	1000.000	140.0	V	198.0	-95.3	
9405.500	-55.67	-13.00	42.67	500.0	1000.000	152.0	V	177.0	-93.4	



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

Plot #8 Radiated Emissions: 18-26 GHz

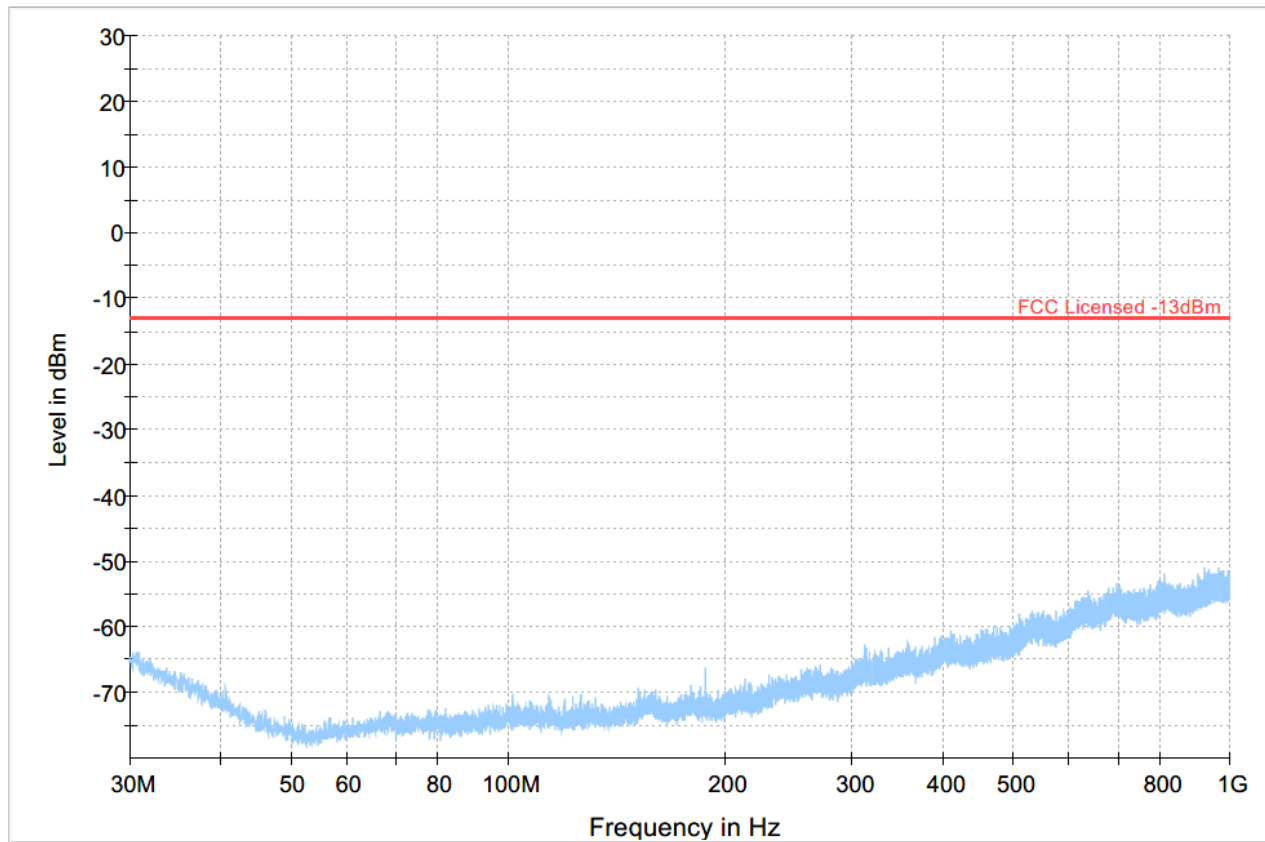
Channel: Mid



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #9 Radiated Emissions: 30 MHz – 1 GHz

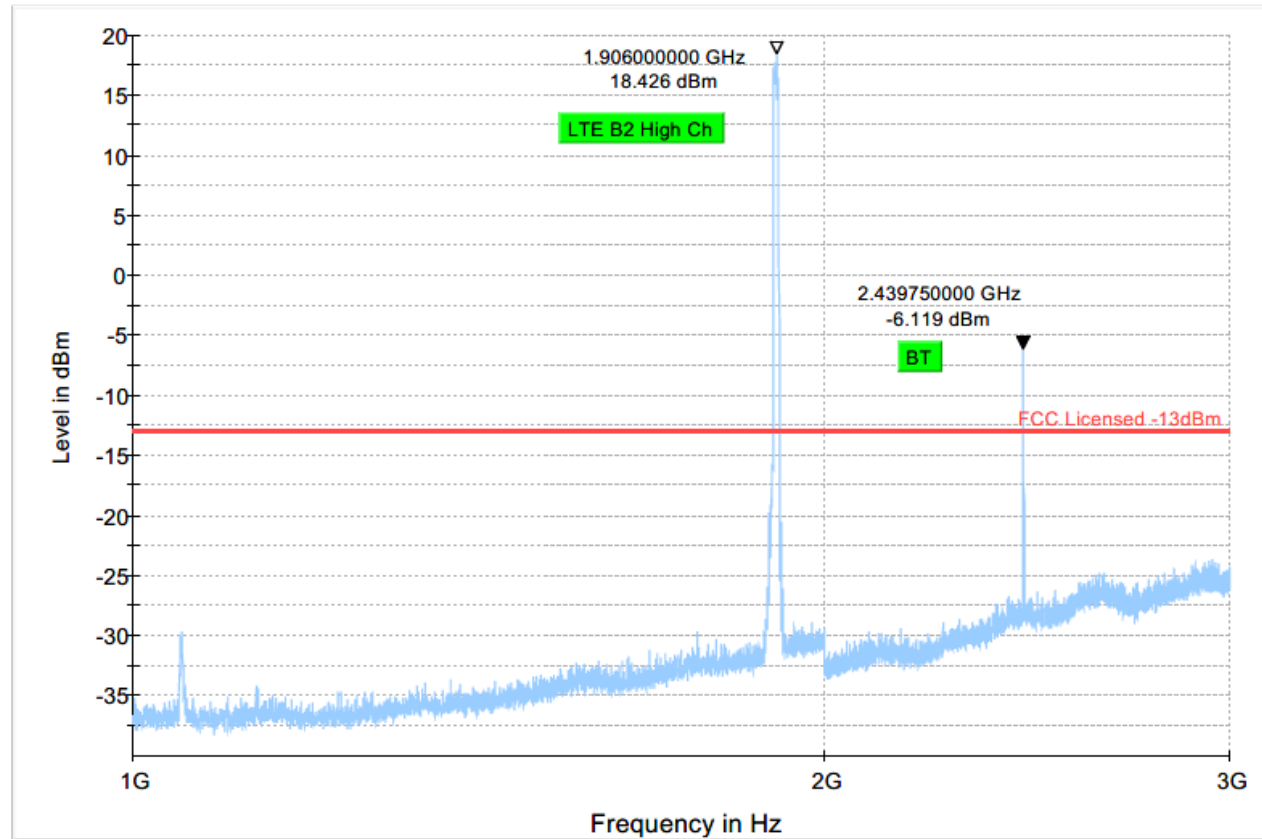
Channel: High



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #10 Radiated Emissions: 1-3 GHz

Channel: High



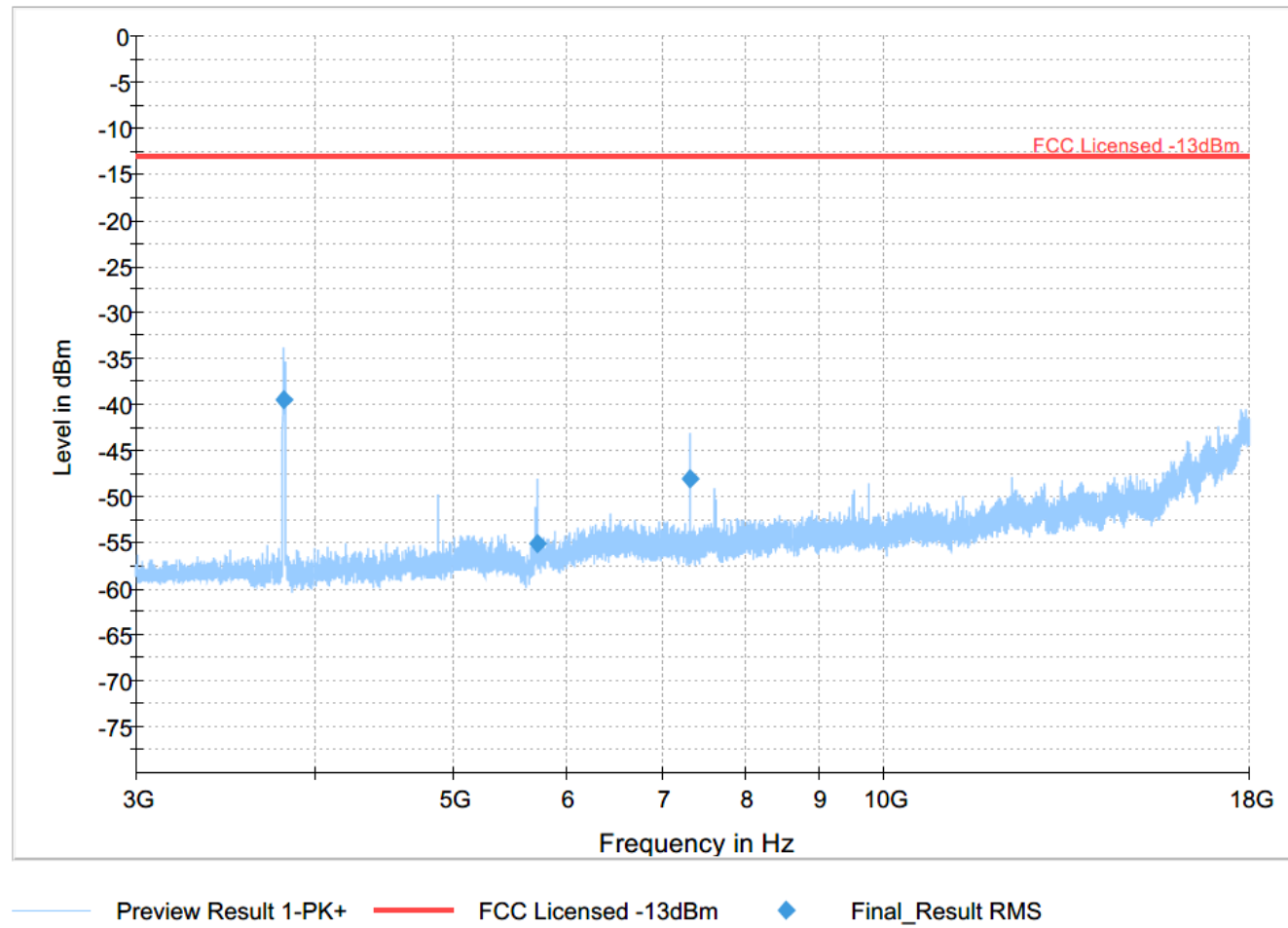
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

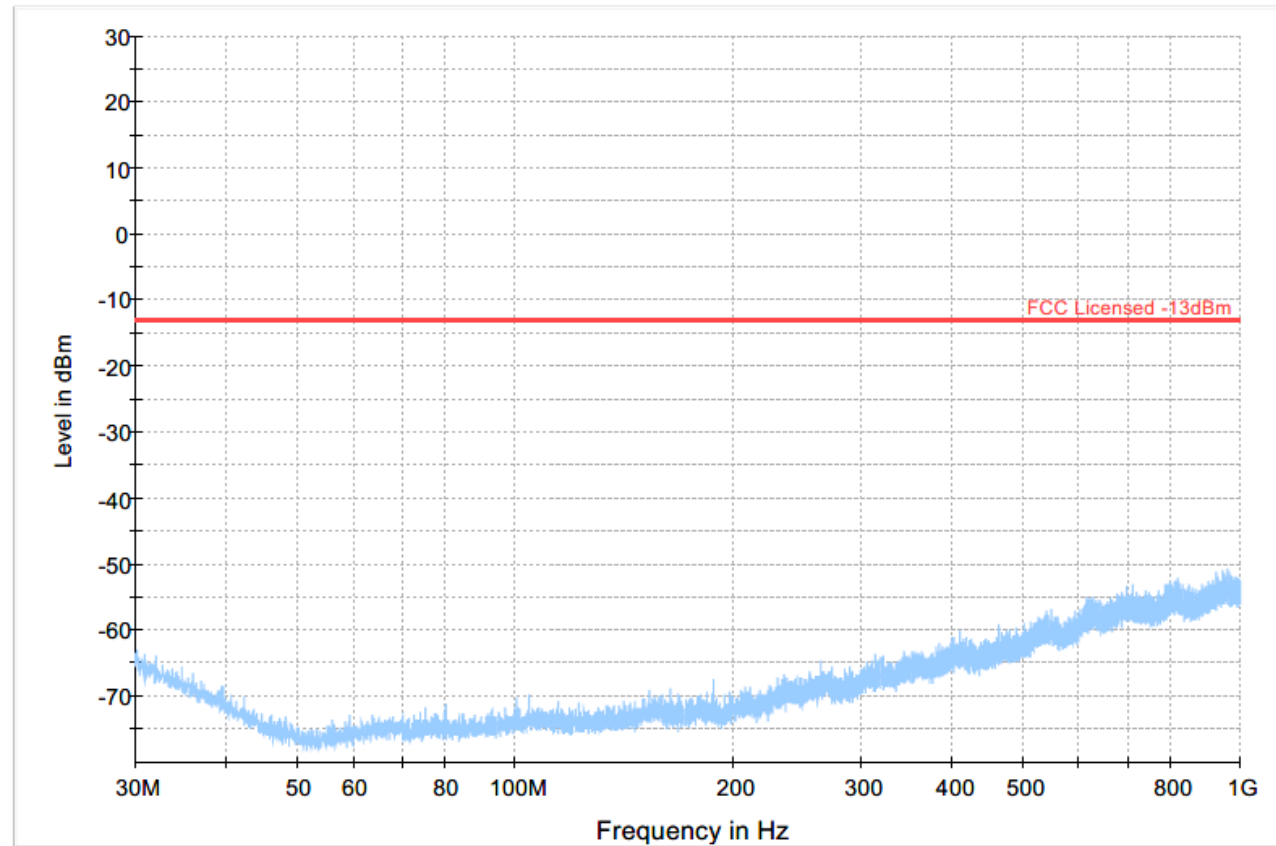
Plot #11 Radiated Emissions: 3-18 GHz

Channel: High

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3810.000	-39.41	-13.00	26.41	500.0	1000.000	140.0	V	164.0	-101.6	
5717.500	-55.06	-13.00	42.06	500.0	1000.000	175.0	V	158.0	-98.7	
7319.500	-48.11	-13.00	35.11	500.0	1000.000	140.0	V	131.0	-95.7	

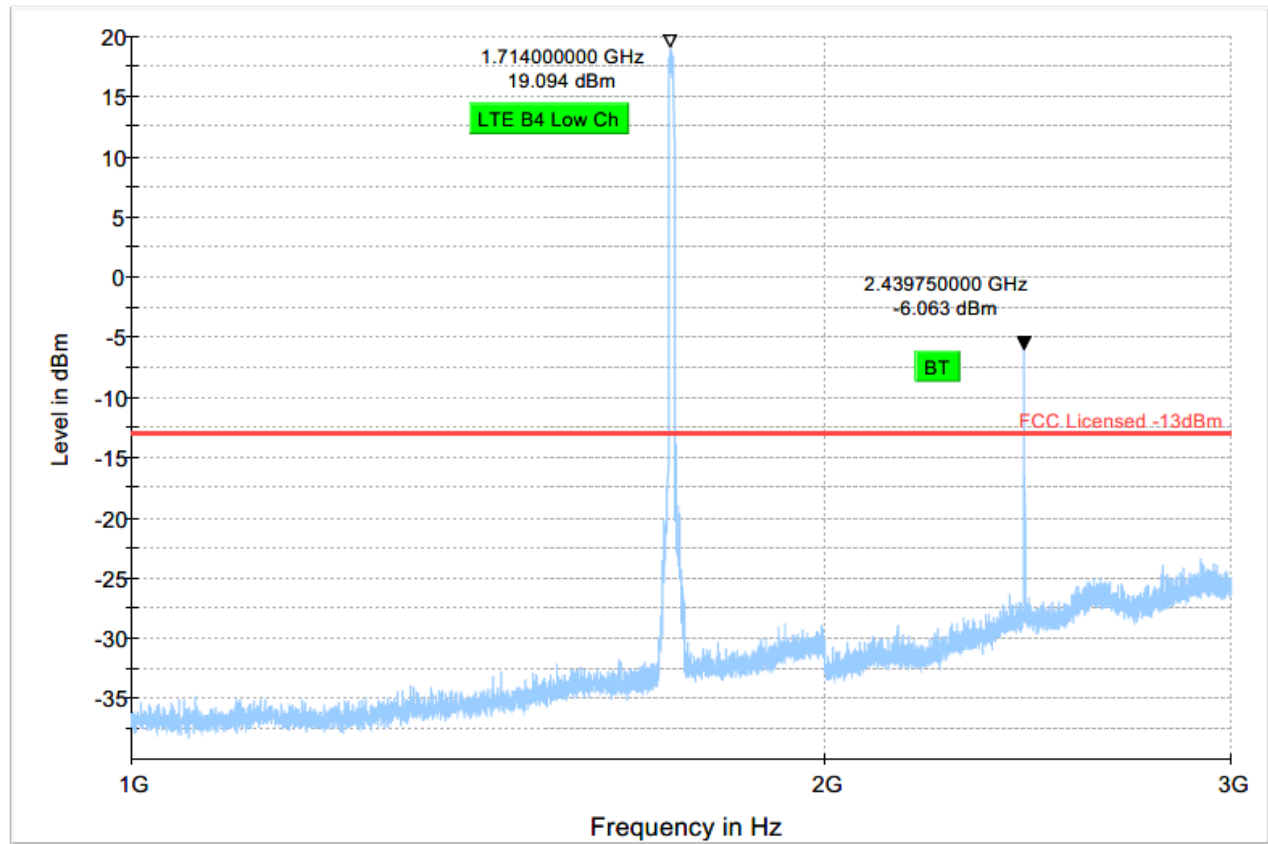


LTE Band 4**Plot #12 Radiated Emissions: 30 MHz – 1GHz****Channel: Low**

Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result R

Plot # 13 Radiated Emissions: 1-3 GHz

Channel: Low



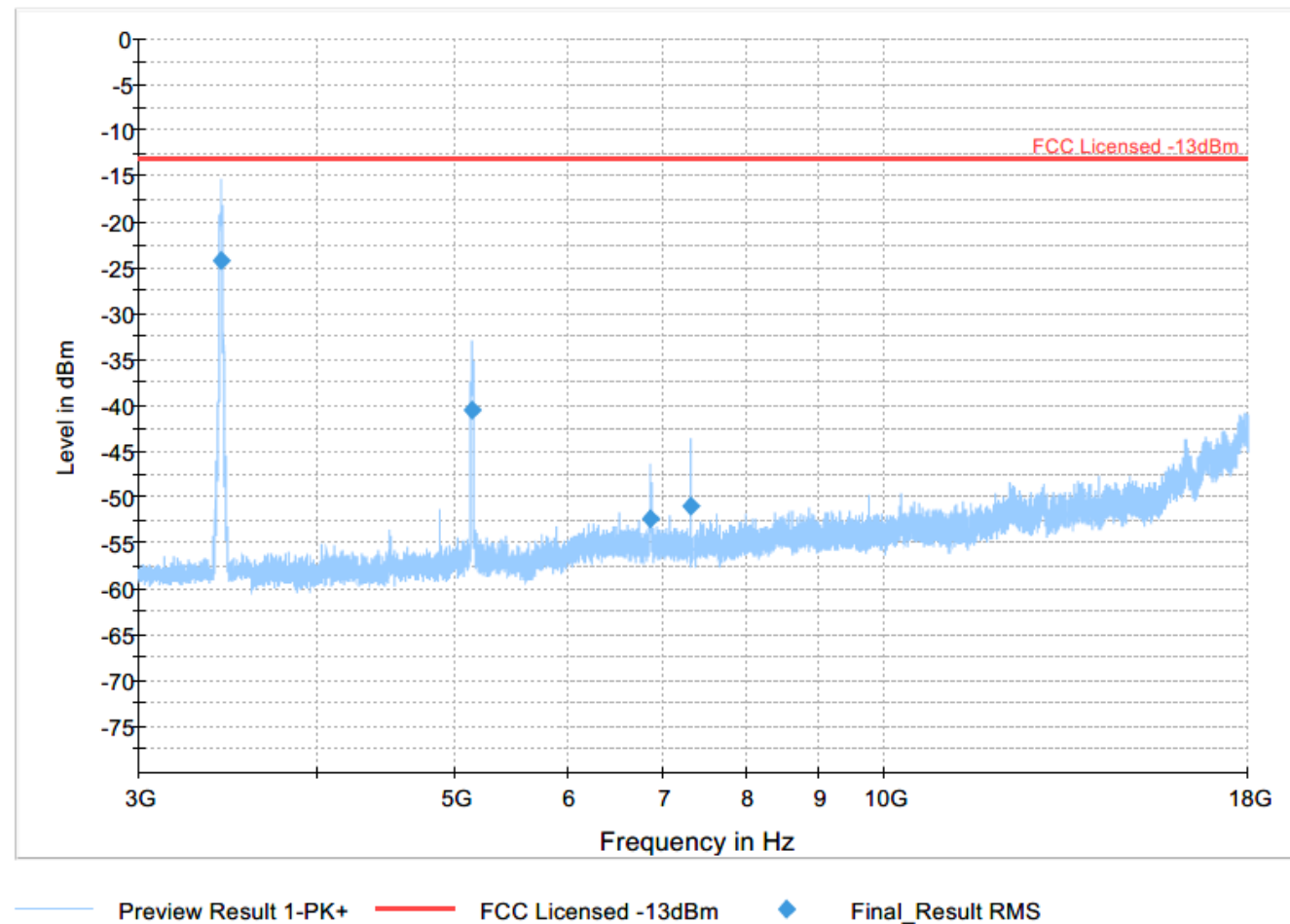
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result R

Plot # 14 Radiated Emissions: 3-18 GHz

Channel: Low

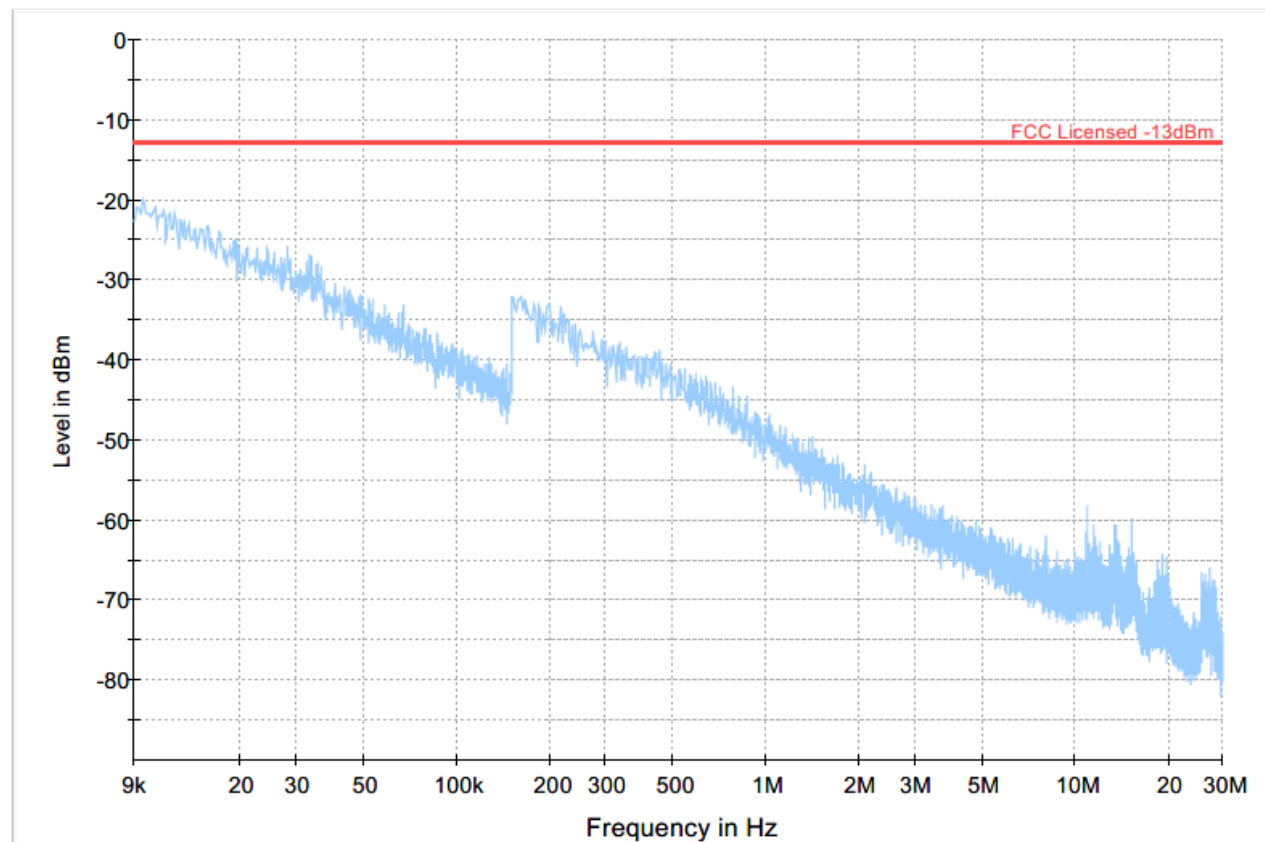
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3430.000	-24.17	-13.00	11.17	500.0	1000.000	153.0	V	173.0	-103.2	
5145.000	-40.52	-13.00	27.52	500.0	1000.000	140.0	V	30.0	-99.1	
6851.000	-52.29	-13.00	39.29	500.0	1000.000	159.0	V	186.0	-95.7	
7319.000	-50.97	-13.00	37.97	500.0	1000.000	140.0	V	130.0	-95.7	



Plot #15 Radiated Emissions: 9 kHz – 30 MHz

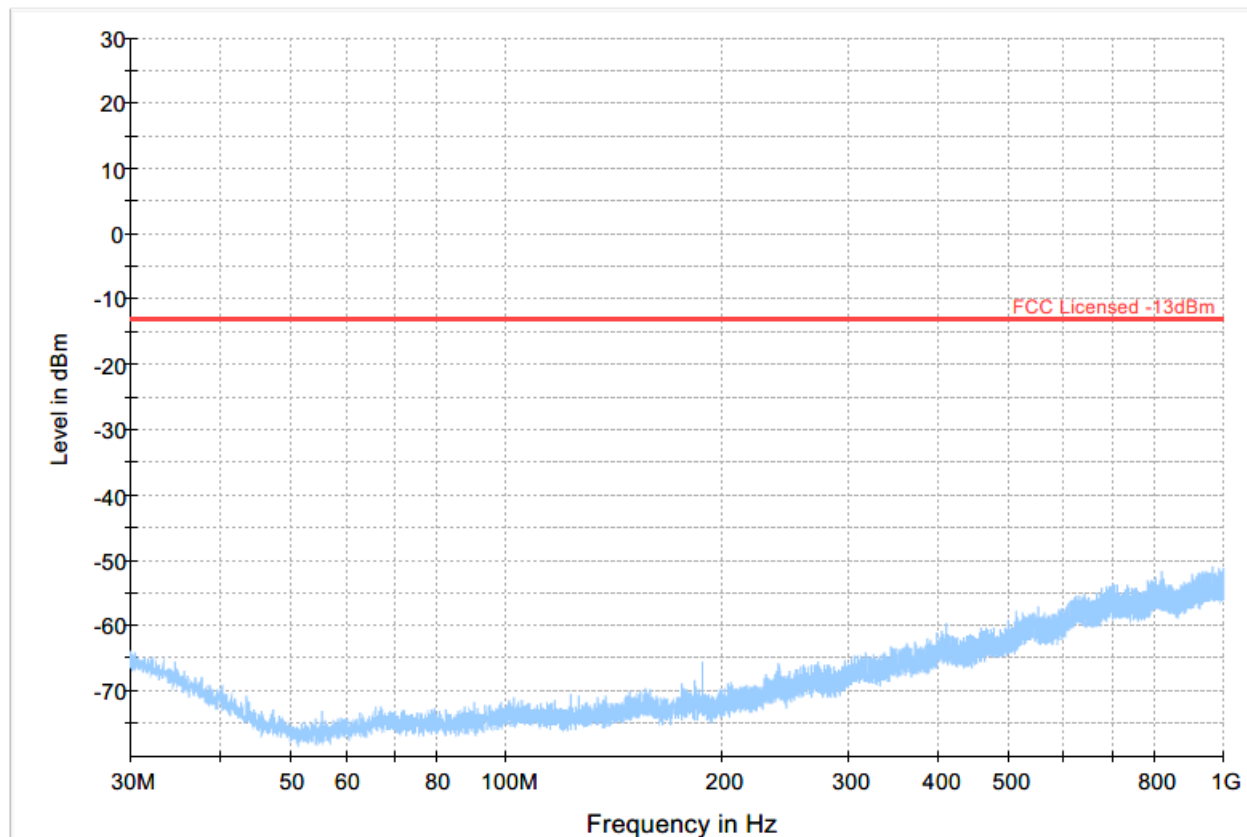
Channel: Mid



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #16 Radiated Emissions: 30 MHz – 1 GHz

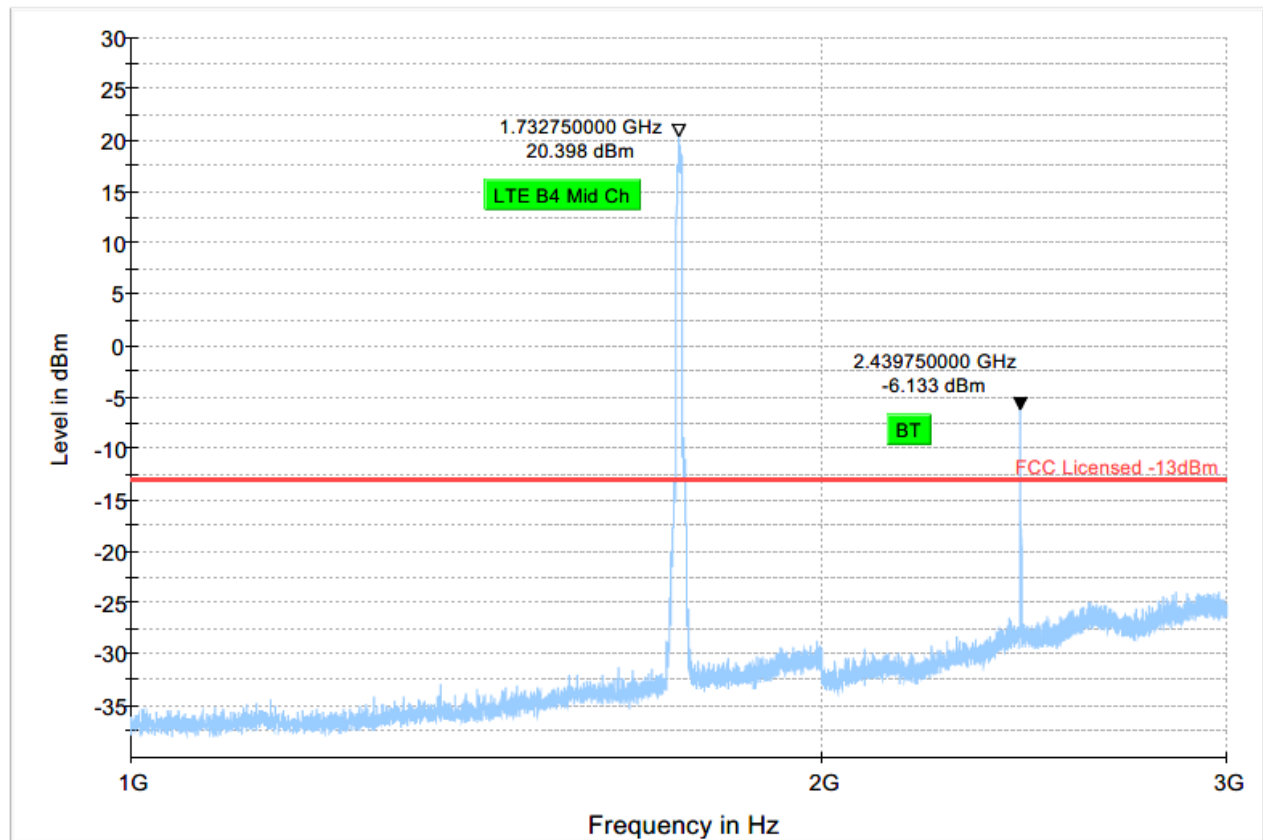
Channel: Mid



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #17 Radiated Emissions: 1-3 GHz

Channel: Mid



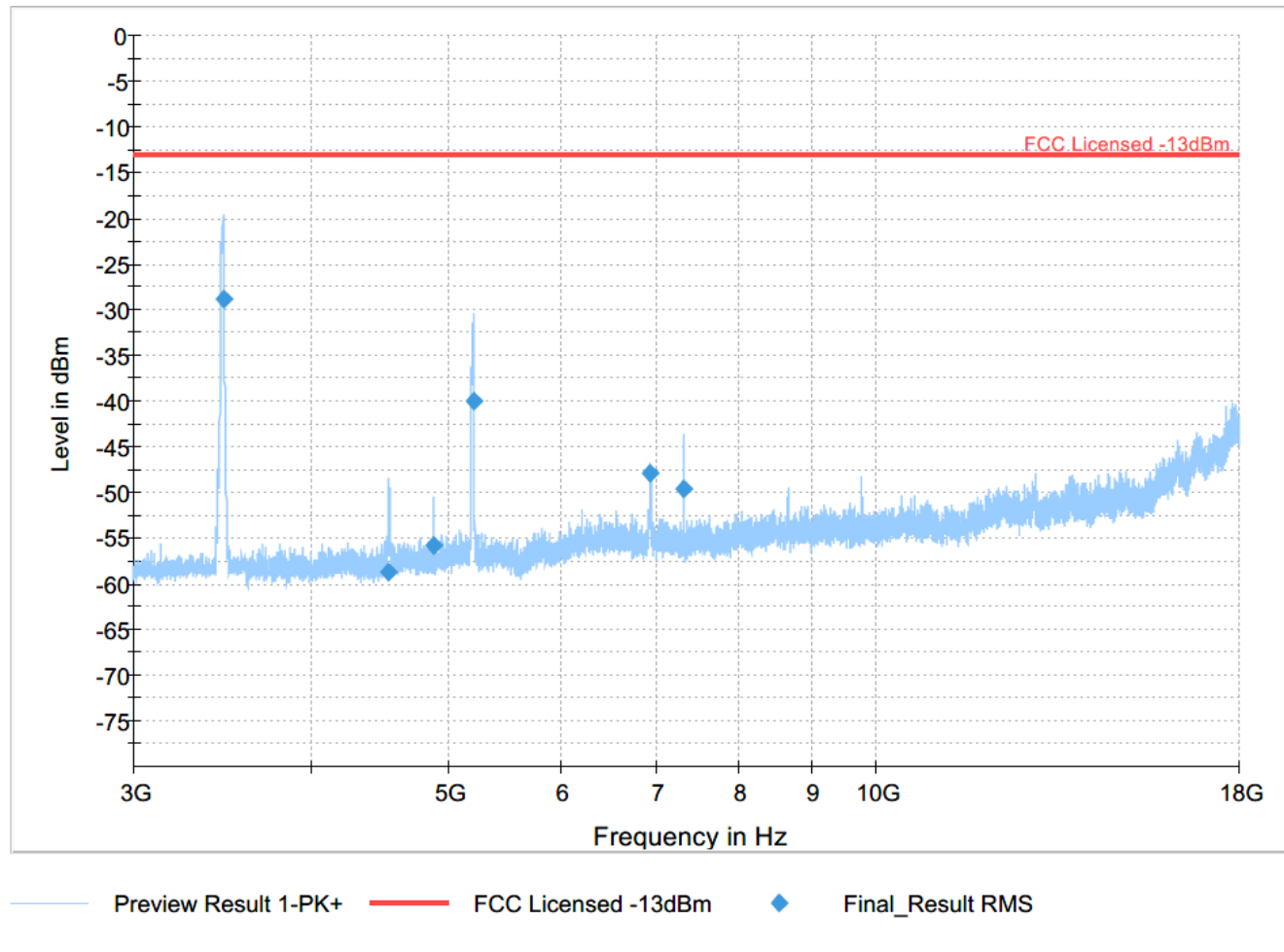
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #18 Radiated Emissions: 3-18 GHz

Channel: Mid

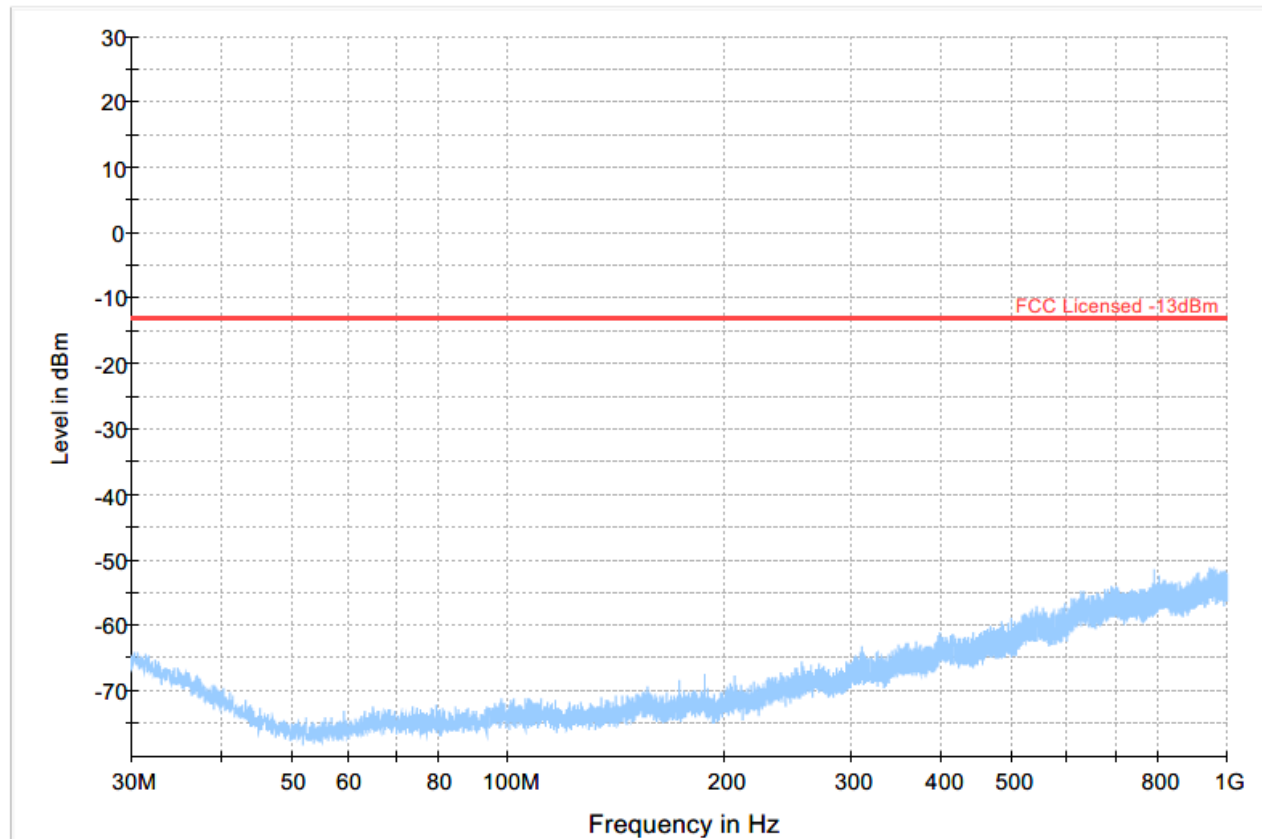
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3469.000	-28.83	-13.00	15.83	500.0	1000.000	165.0	V	173.0	-103.1	
4535.500	-58.74	-13.00	45.74	500.0	1000.000	151.0	V	203.0	-100.3	
4880.000	-55.72	-13.00	42.72	500.0	1000.000	152.0	V	37.0	-100.2	
5205.500	-40.07	-13.00	27.07	500.0	1000.000	140.0	V	181.0	-99.2	
6930.000	-47.98	-13.00	34.98	500.0	1000.000	140.0	V	202.0	-95.6	
7320.500	-49.62	-13.00	36.62	500.0	1000.000	140.0	V	131.0	-95.7	



Plot #19 Radiated Emissions: 30 MHz – 1 GHz

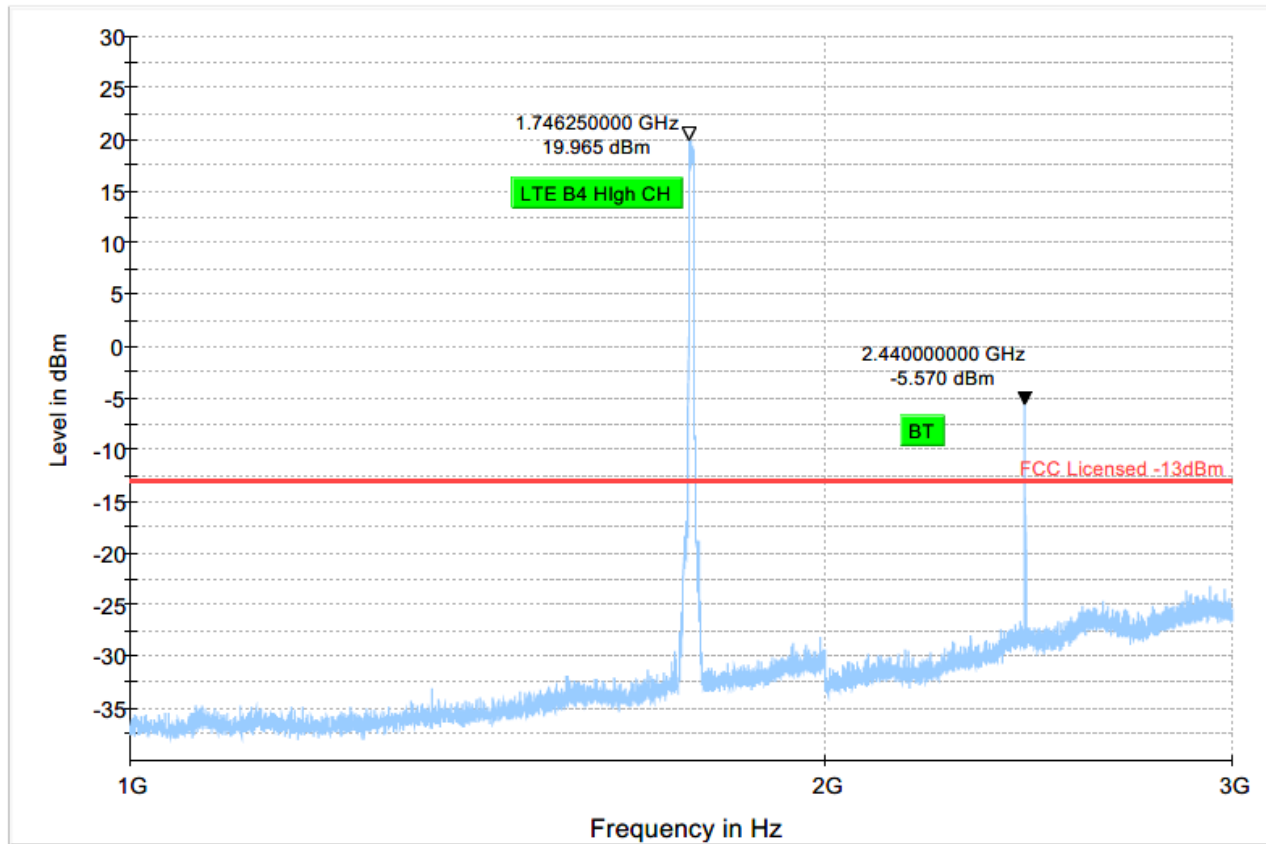
Channel: High



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #20 Radiated Emissions: 1-3 GHz

Channel: High



Preview Result 1-PK+



Critical_Freqs PK+

FCC Licensed -13dBm



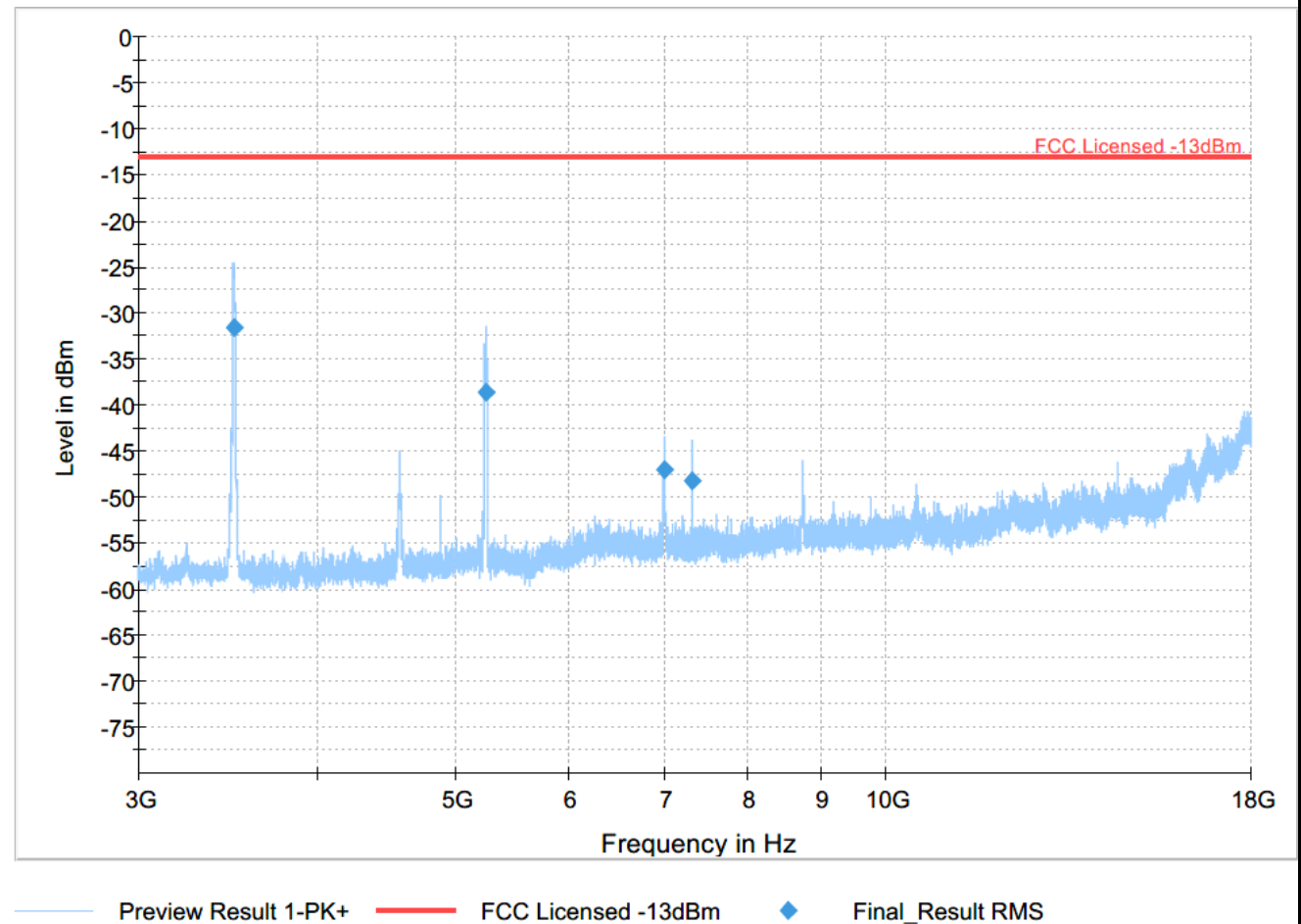
Final_Result RM

Plot #21 Radiated Emissions: 3-18 GHz

Channel: High

Final Result

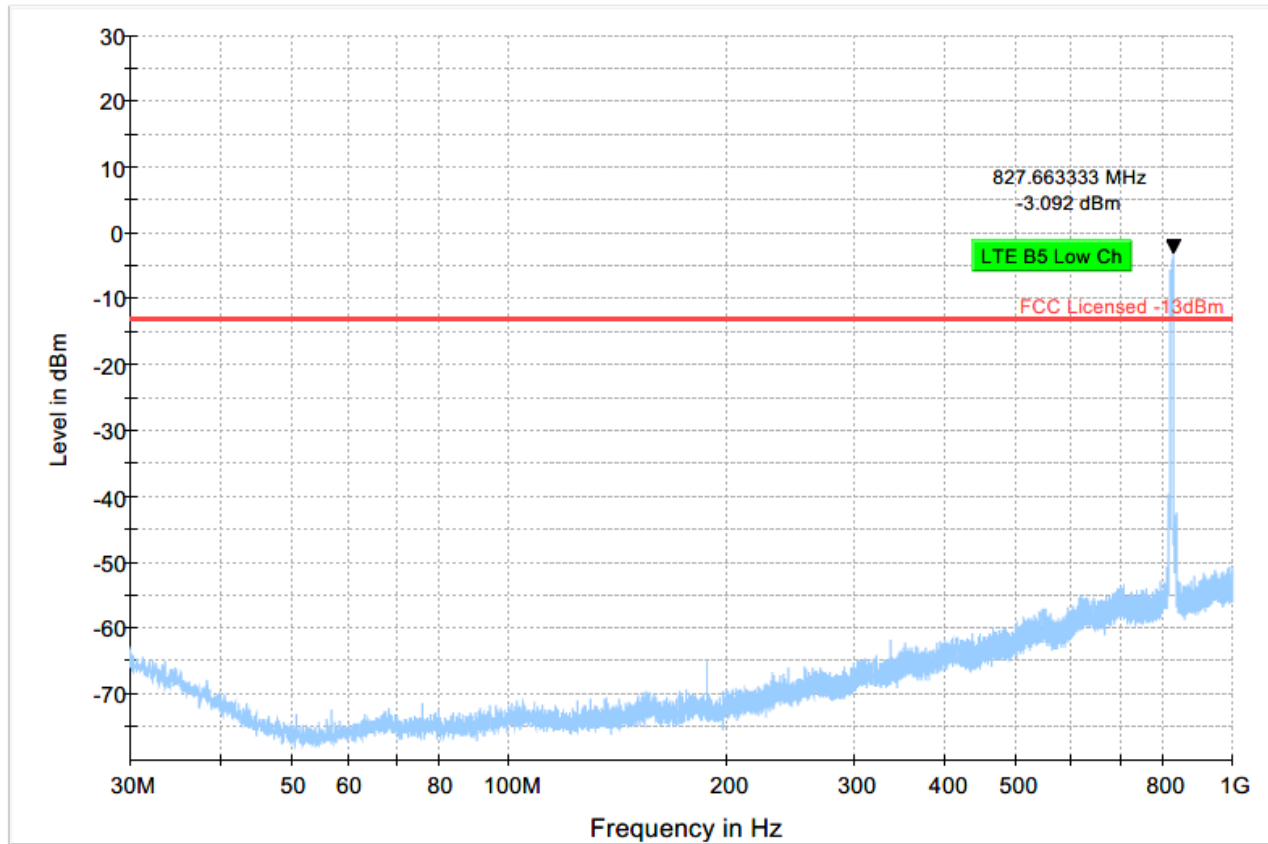
Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3497.000	-31.62	-13.00	18.62	500.0	1000.000	140.0	V	175.0	-102.9	
5248.000	-38.64	-13.00	25.64	500.0	1000.000	140.0	V	182.0	-99.2	
7000.000	-47.01	-13.00	34.01	500.0	1000.000	140.0	V	21.0	-95.5	
7320.000	-48.25	-13.00	35.25	500.0	1000.000	140.0	V	131.0	-95.7	



LTE Band 5

Plot #22 Radiated Emissions: 30 MHz – 1GHz

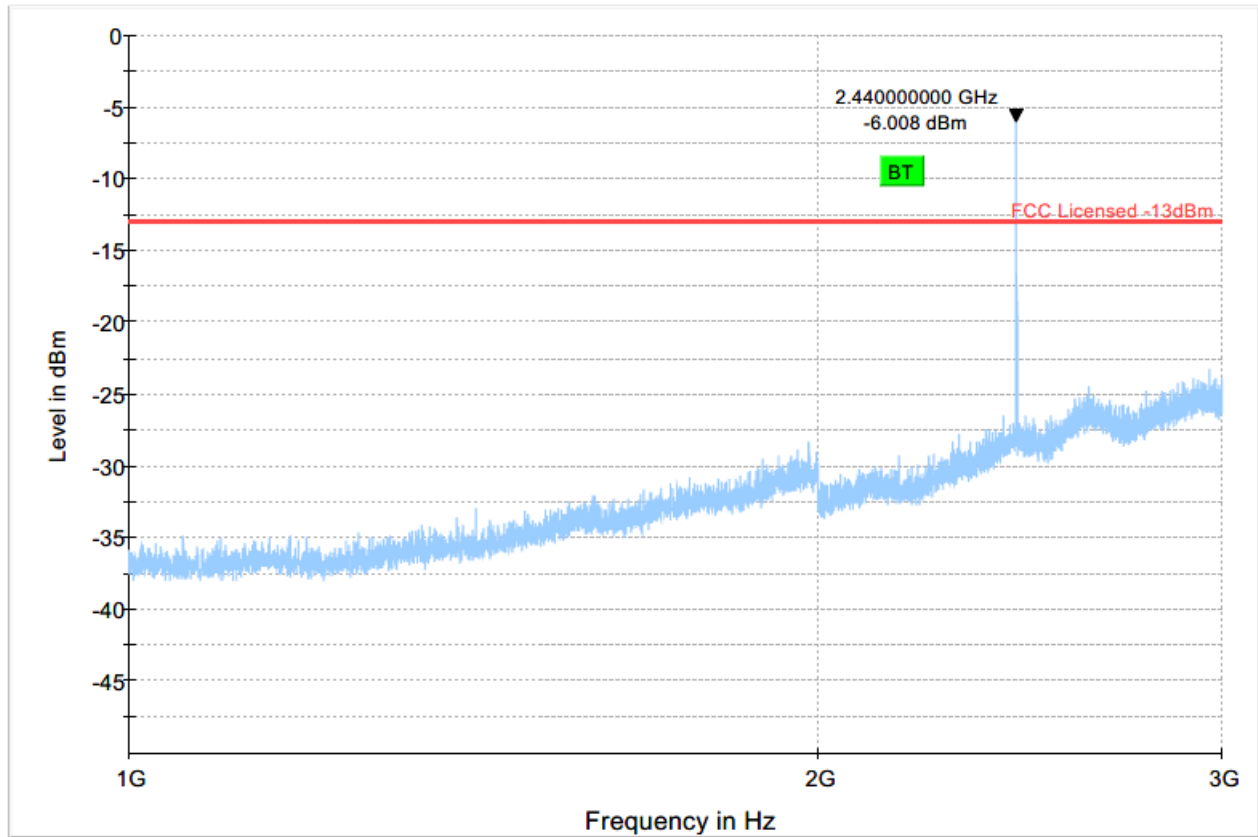
Channel: Low



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result R

Plot # 23 Radiated Emissions: 1-3 GHz

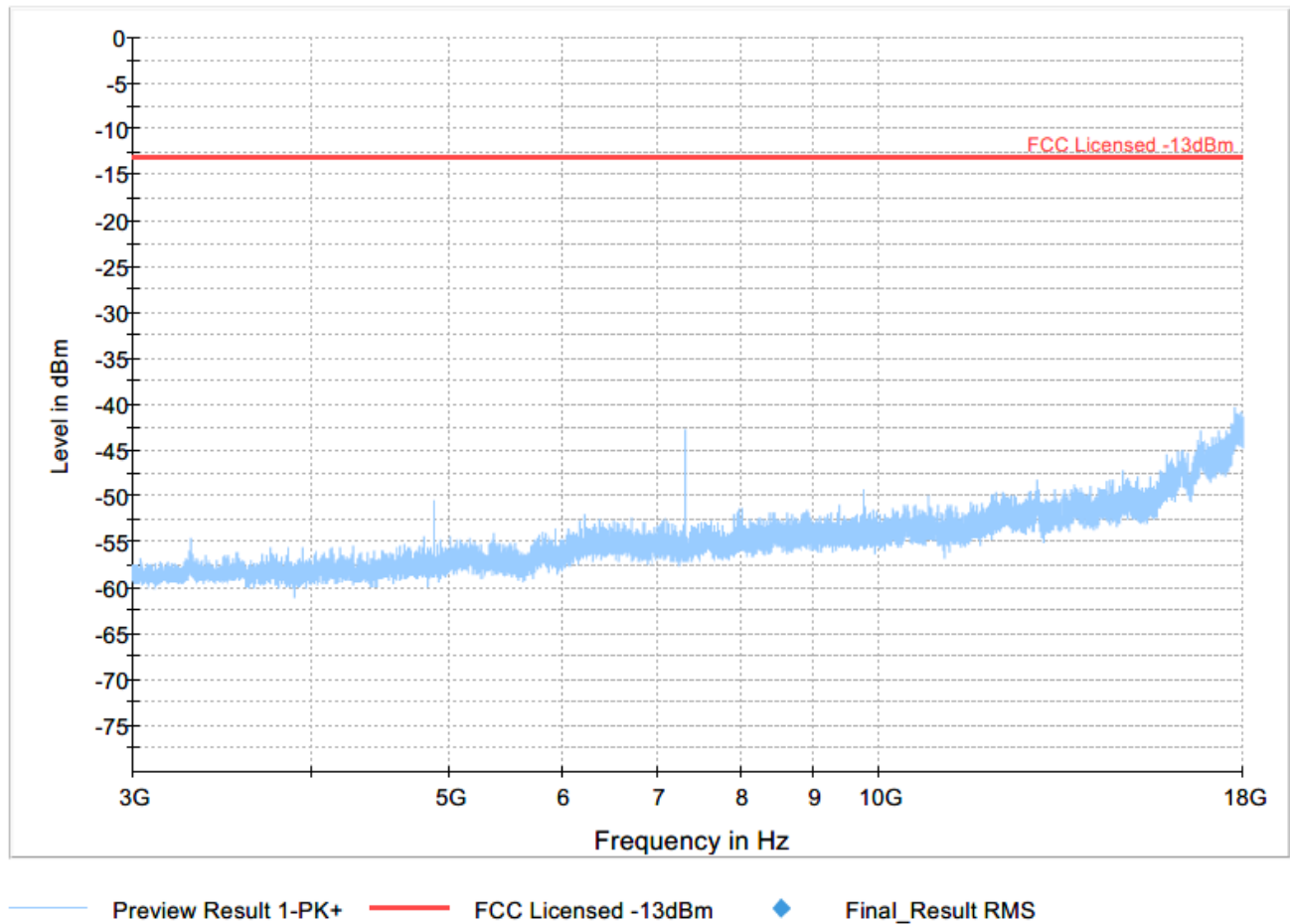
Channel: Low



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot # 24 Radiated Emissions: 3-18 GHz

Channel: Low

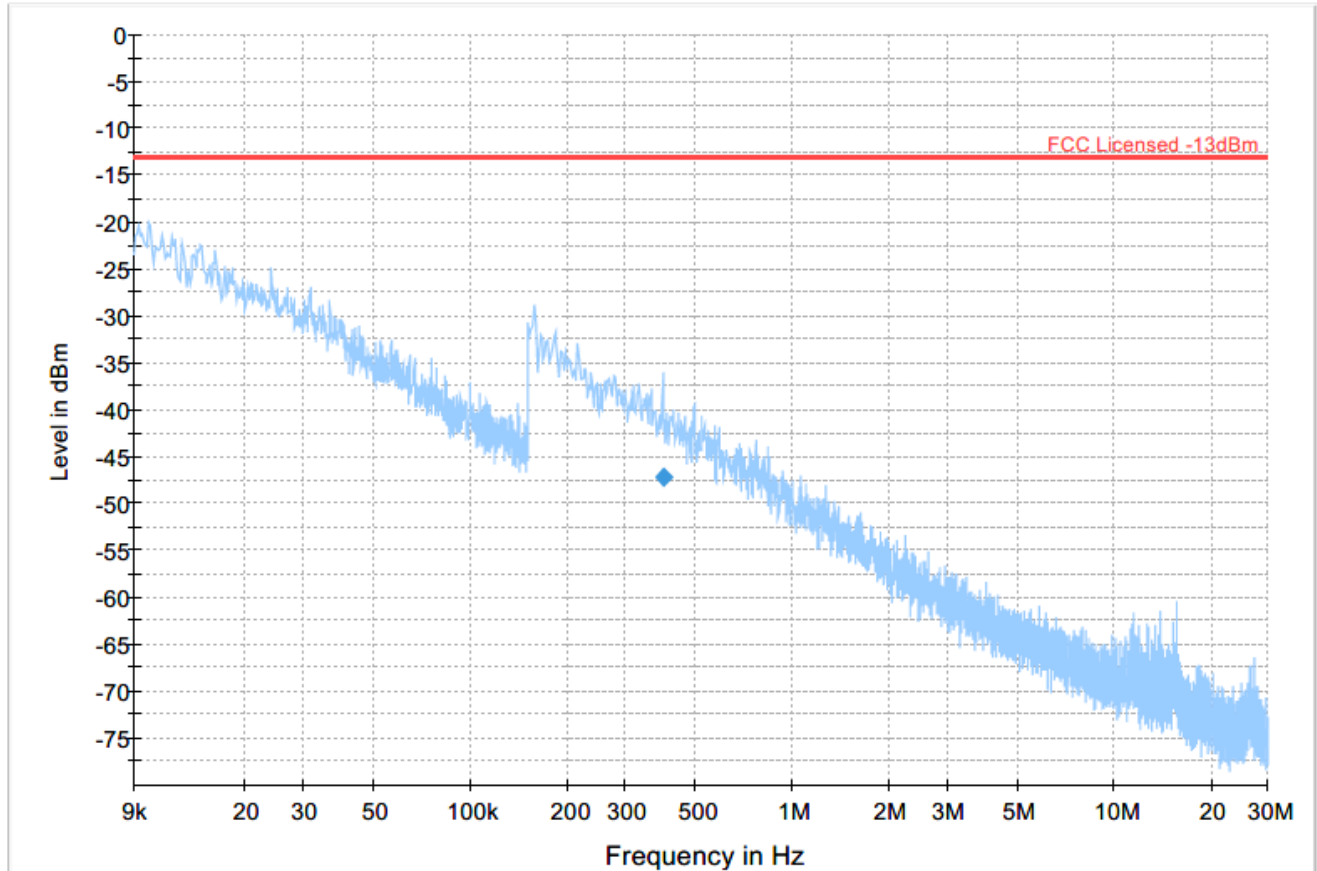


Plot #25 Radiated Emissions: 9 kHz – 30 MHz

Channel: Mid

Final Result

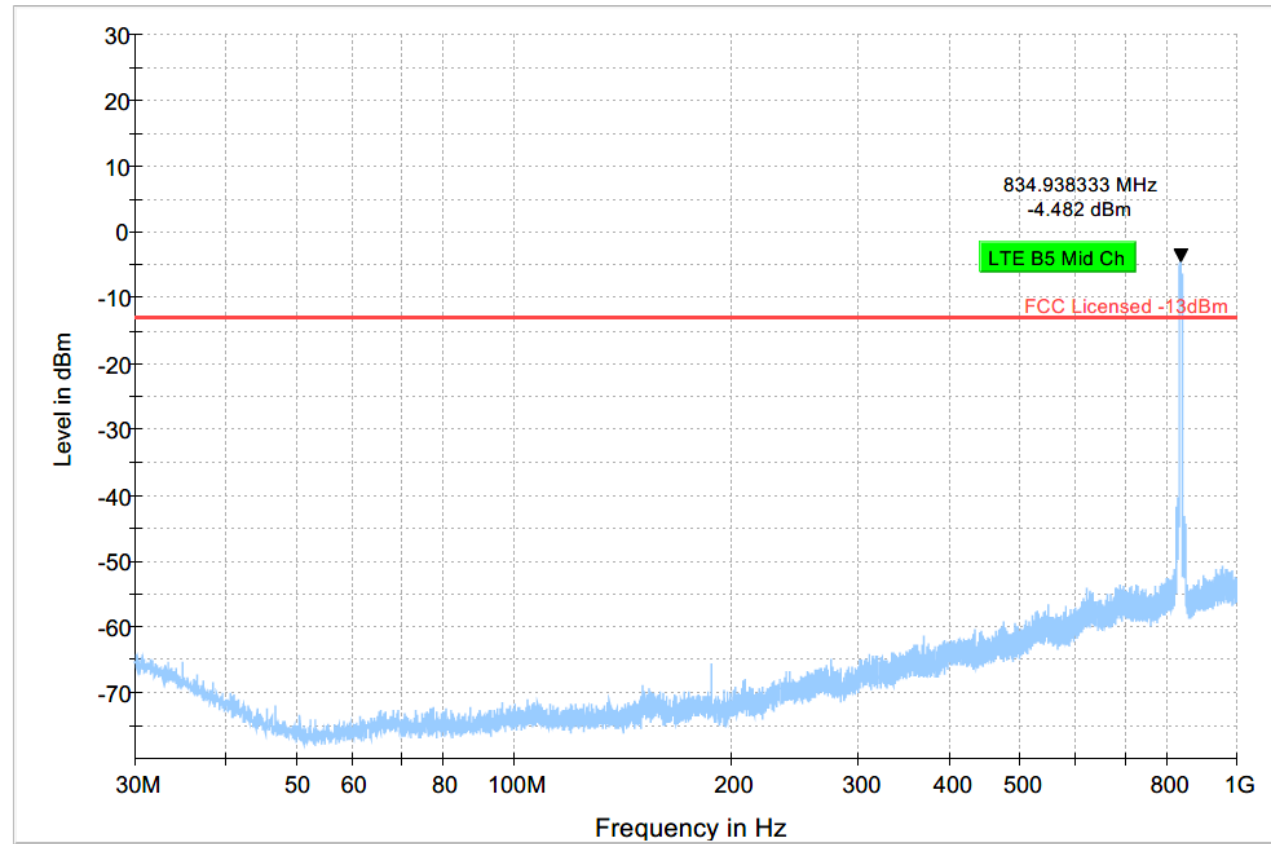
Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.398	-47.21	-13.00	34.21	500.0	3.000	250.0	H	40.0	-76.5	



— Preview Result 1-PK+ — FCC Licensed -13dBm ◆ Final_Result RMS

Plot #26 Radiated Emissions: 30 MHz – 1 GHz

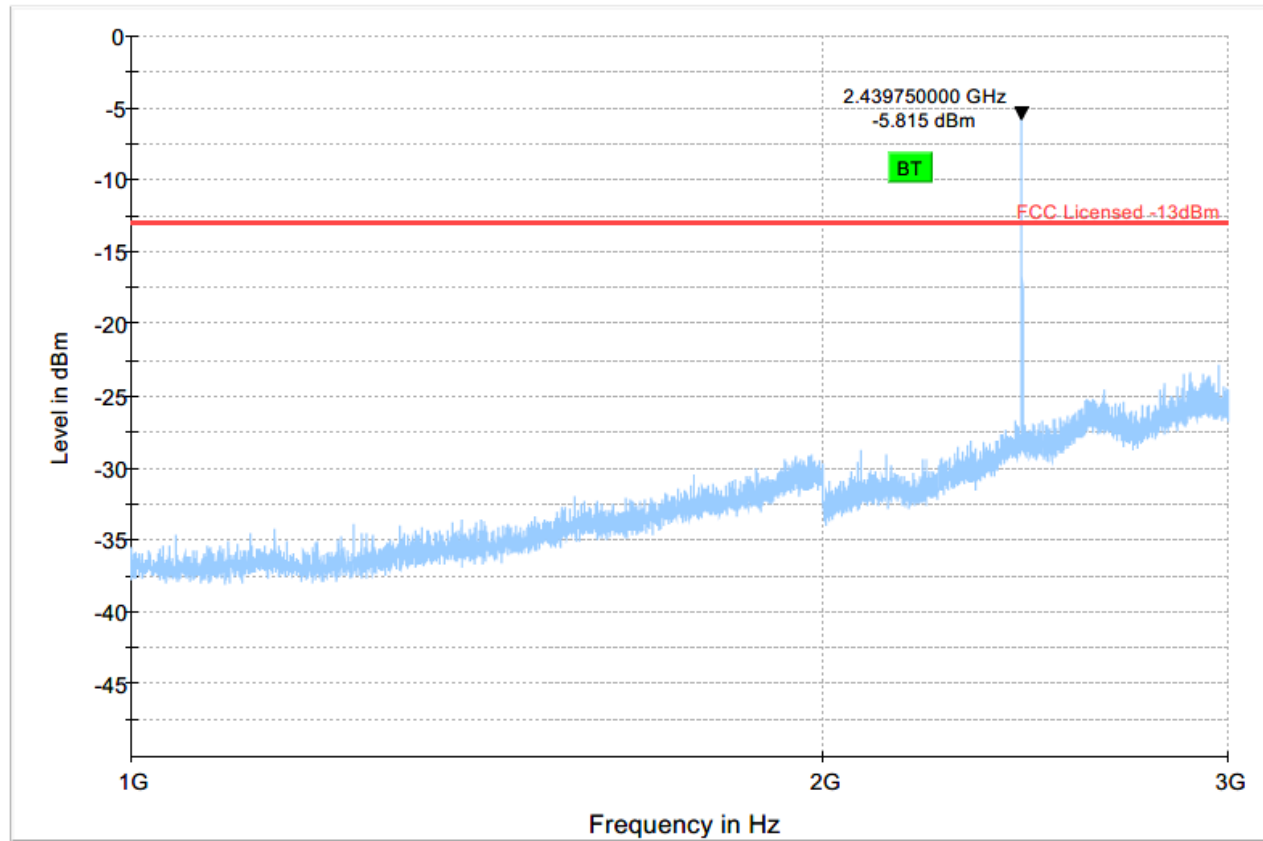
Channel: Mid



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #27 Radiated Emissions: 1-3 GHz

Channel: Mid



Preview Result 1-PK+



Critical_Freqs PK+



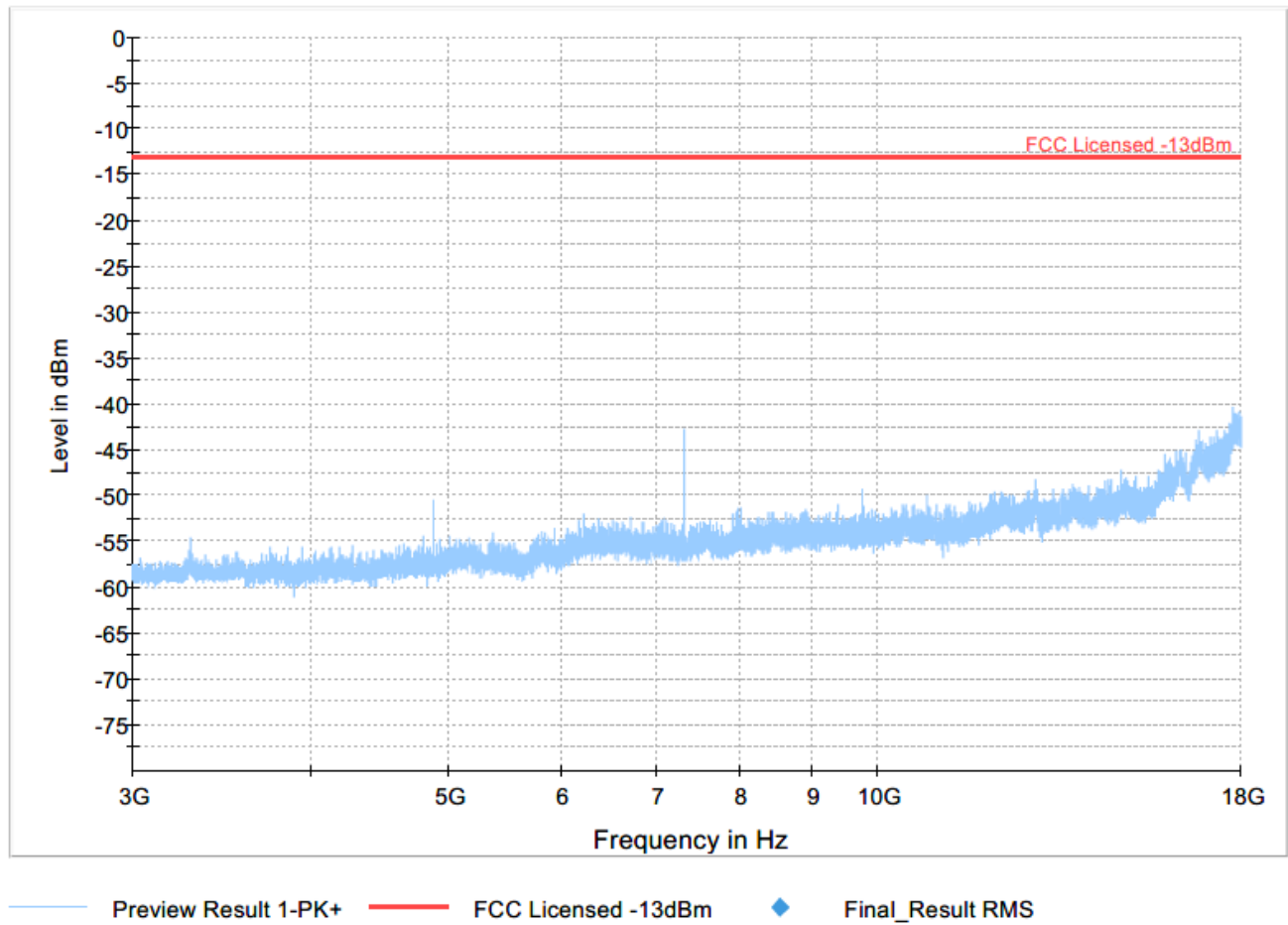
FCC Licensed -13dBm



Final_Result RM

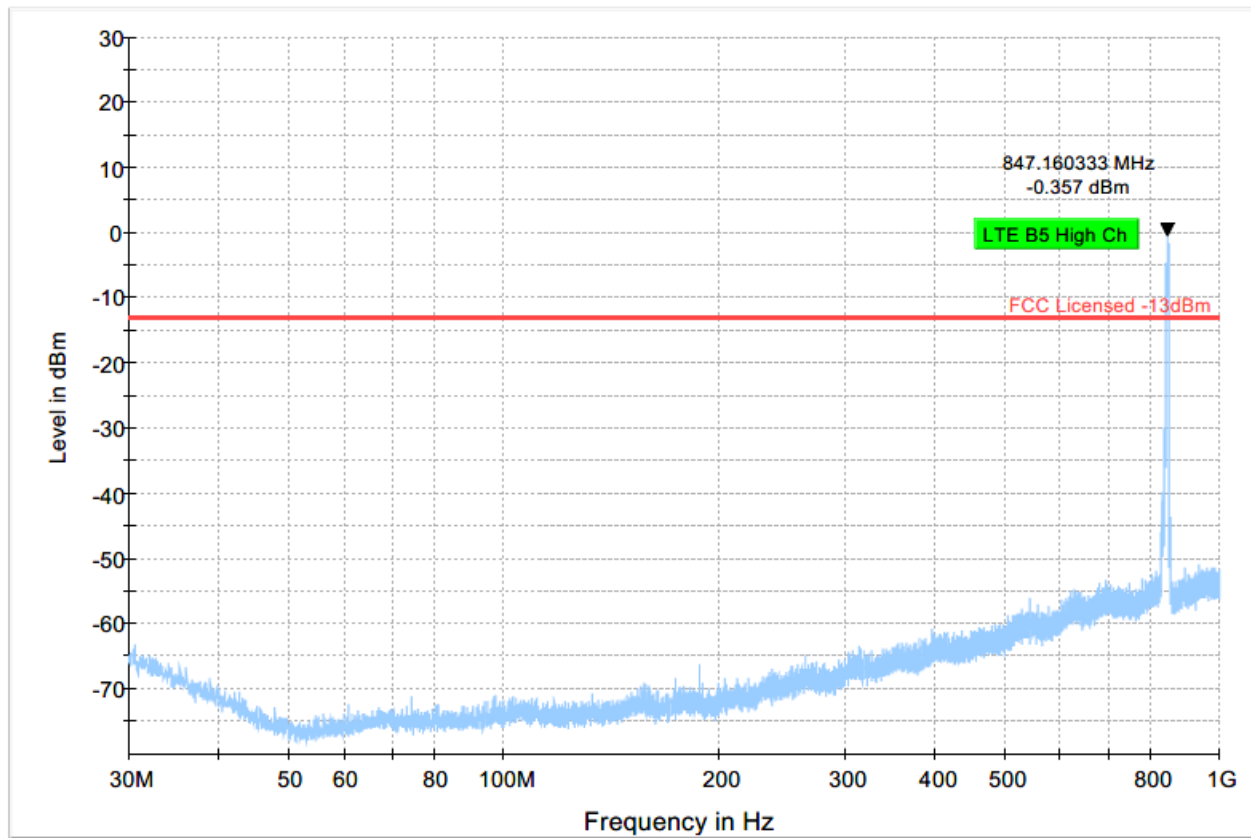
Plot #28 Radiated Emissions: 3-18 GHz

Channel: Mid



Plot #29 Radiated Emissions: 30 MHz – 1 GHz

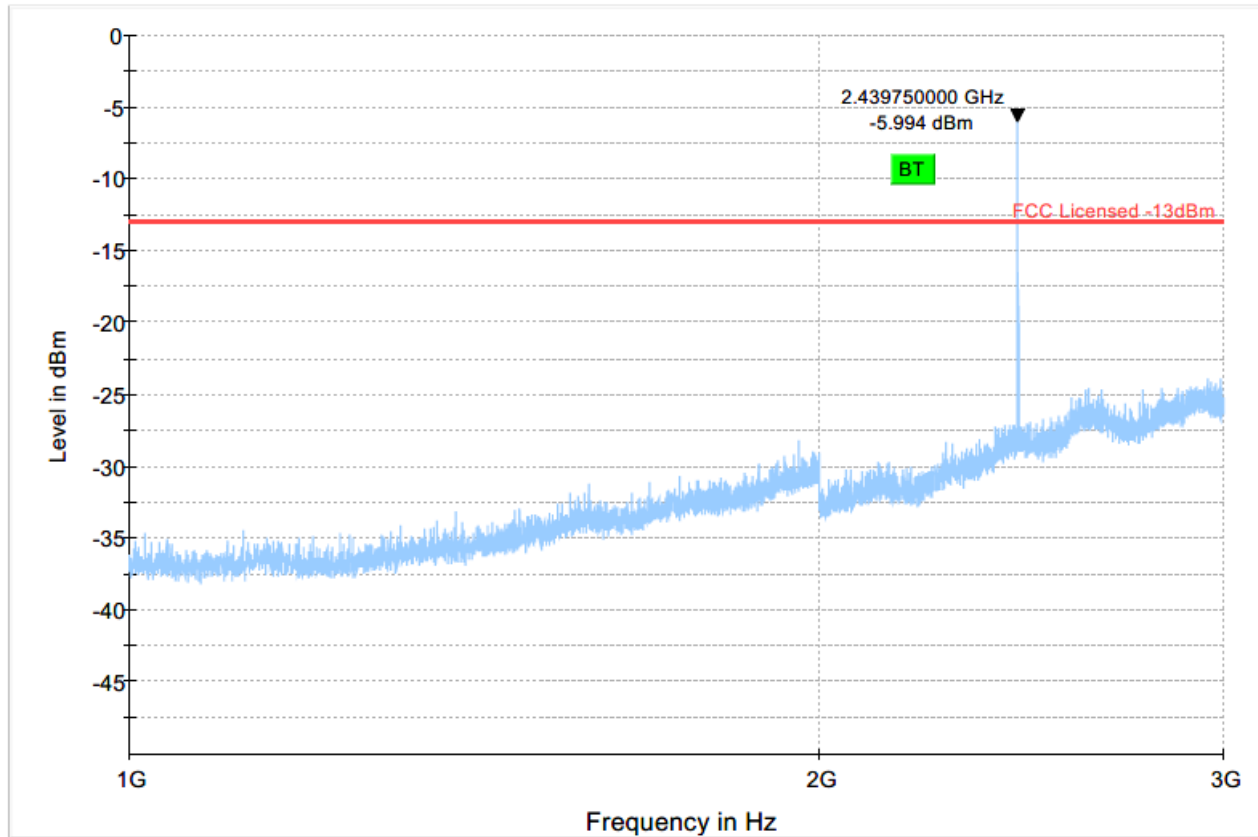
Channel: High



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #30 Radiated Emissions: 1-3 GHz

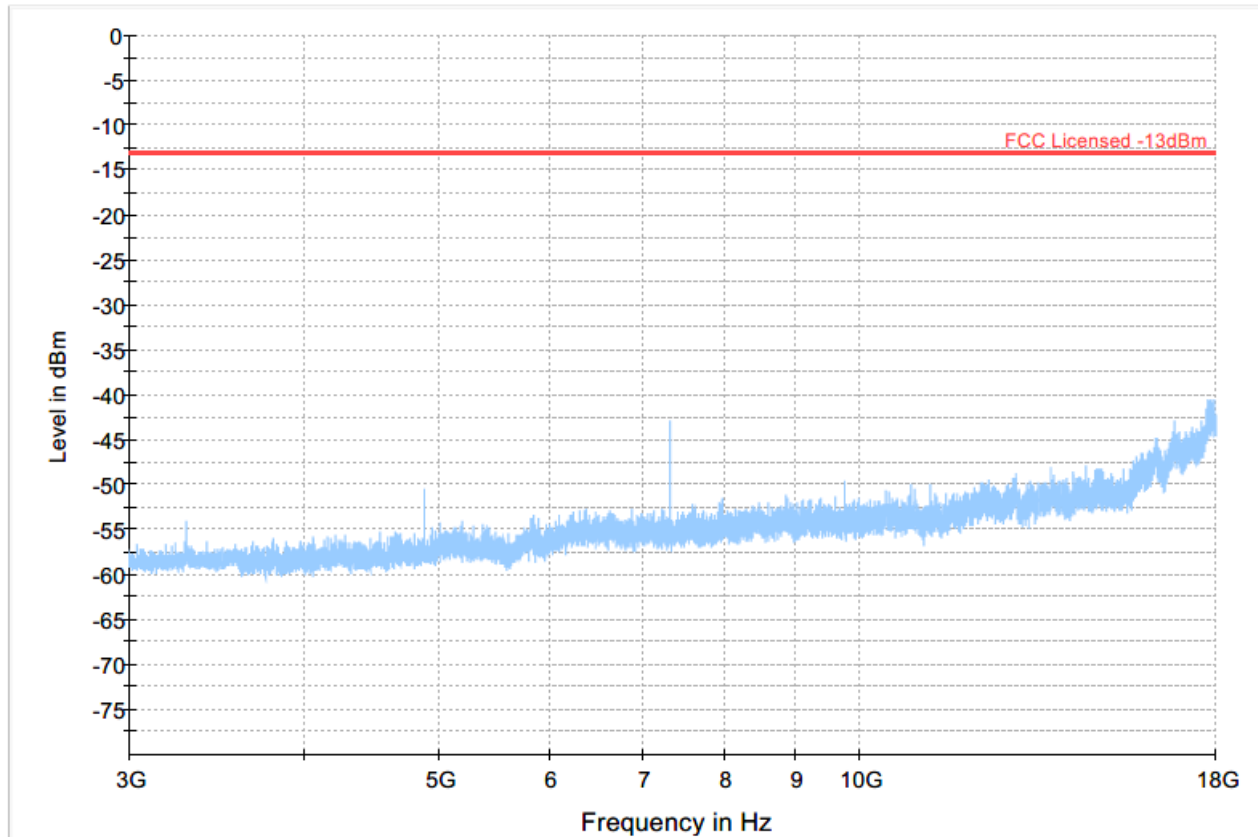
Channel: High



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #31 Radiated Emissions: 3-18 GHz

Channel: High

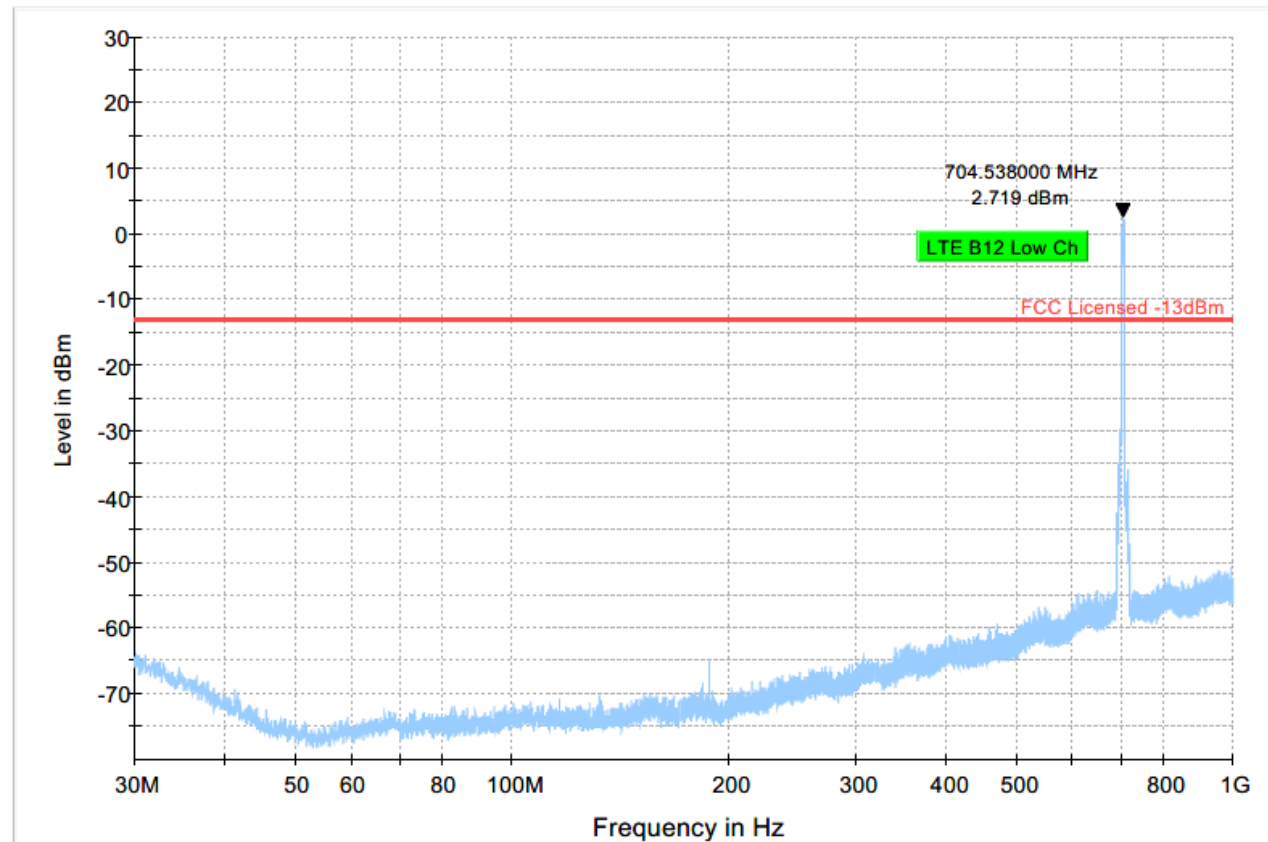


Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

LTE Band 12

Plot #32 Radiated Emissions: 30 MHz – 1GHz

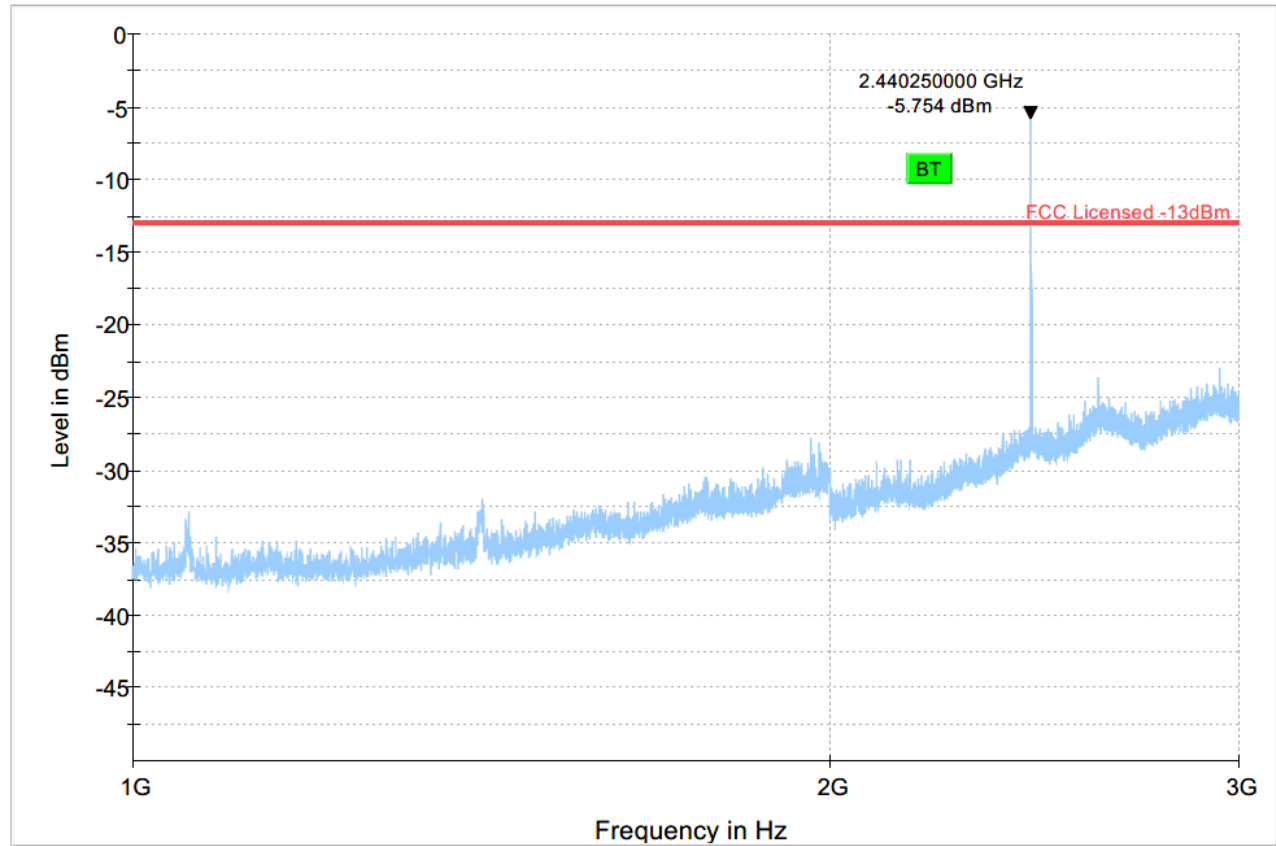
Channel: Low



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot # 33 Radiated Emissions: 1-3 GHz

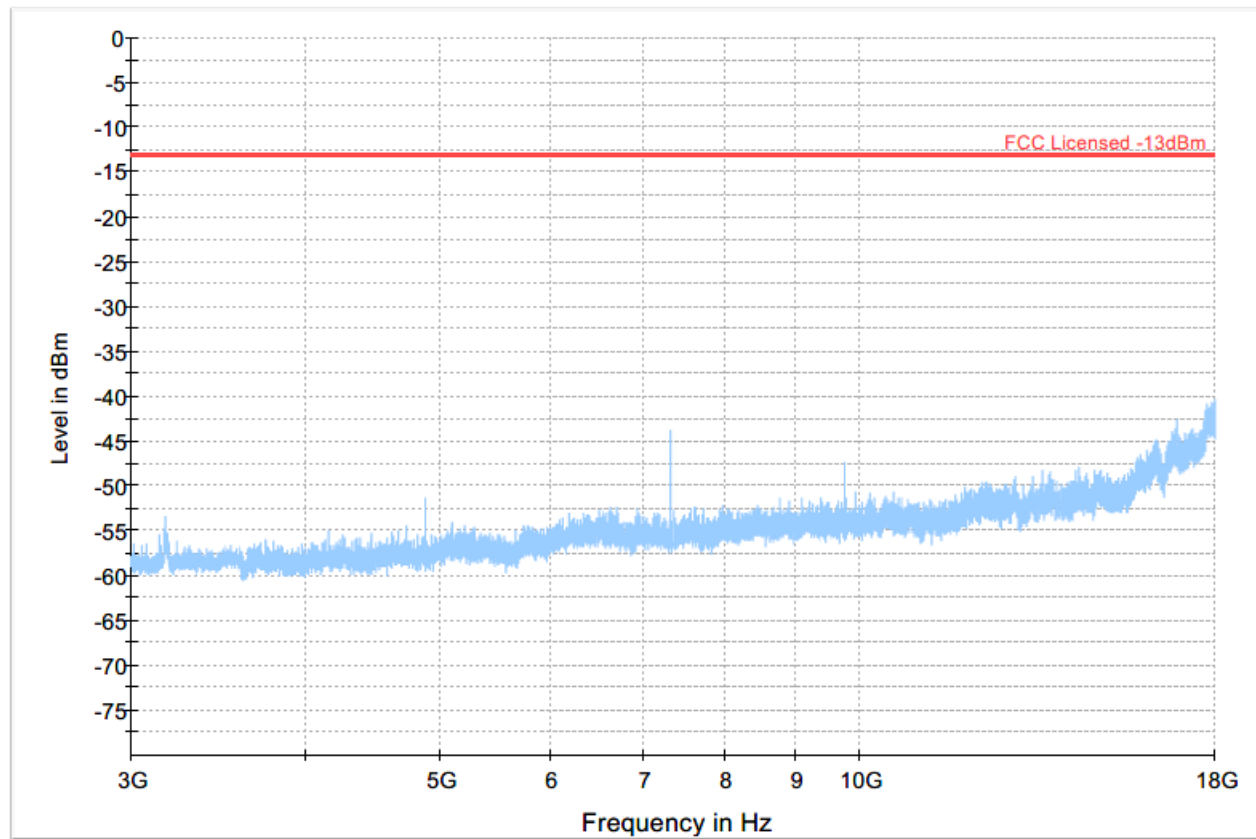
Channel: Low



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result R

Plot # 34 Radiated Emissions: 3-18 GHz

Channel: Low



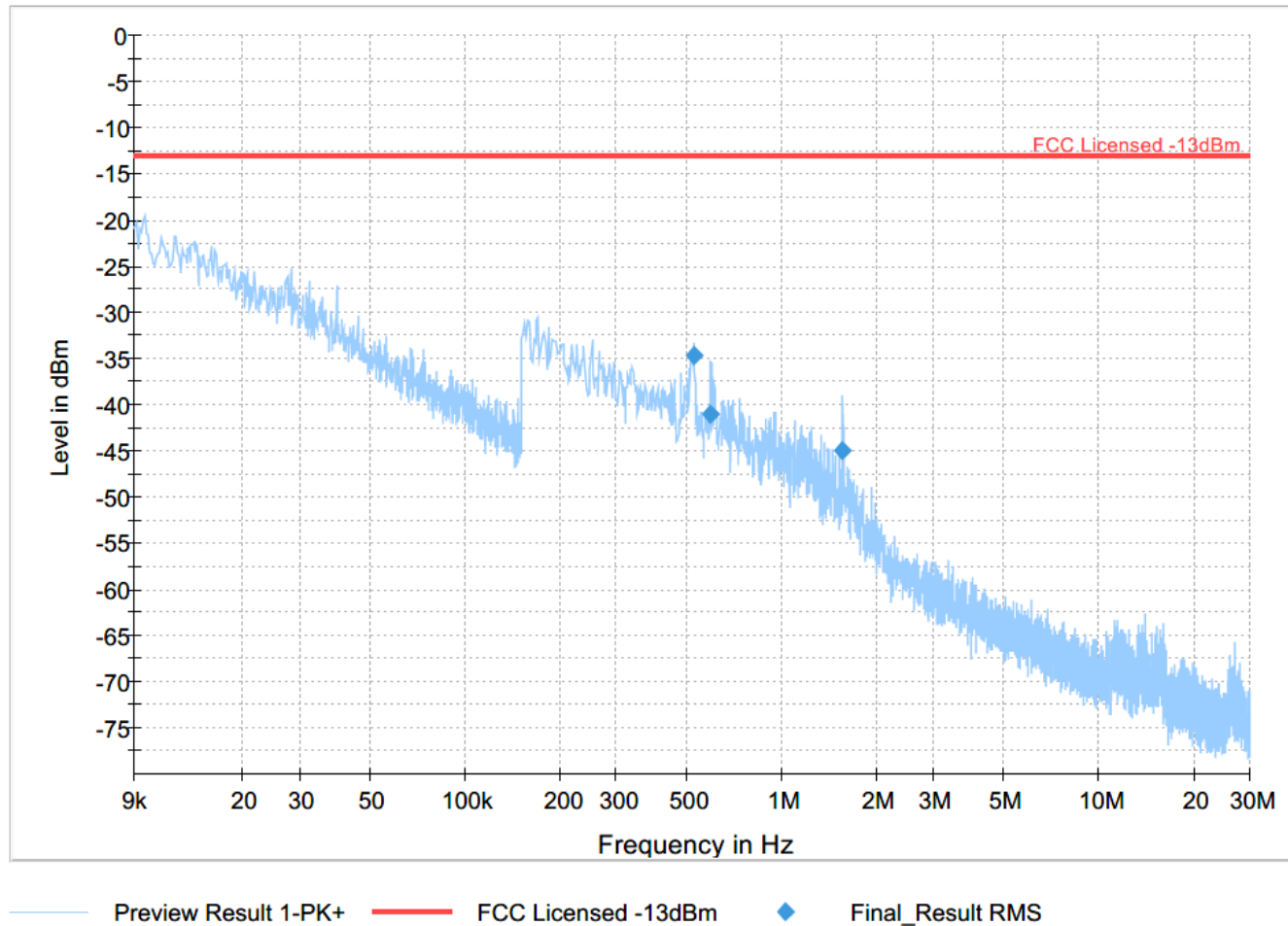
— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #35 Radiated Emissions: 9 kHz – 30 MHz

Channel: Mid

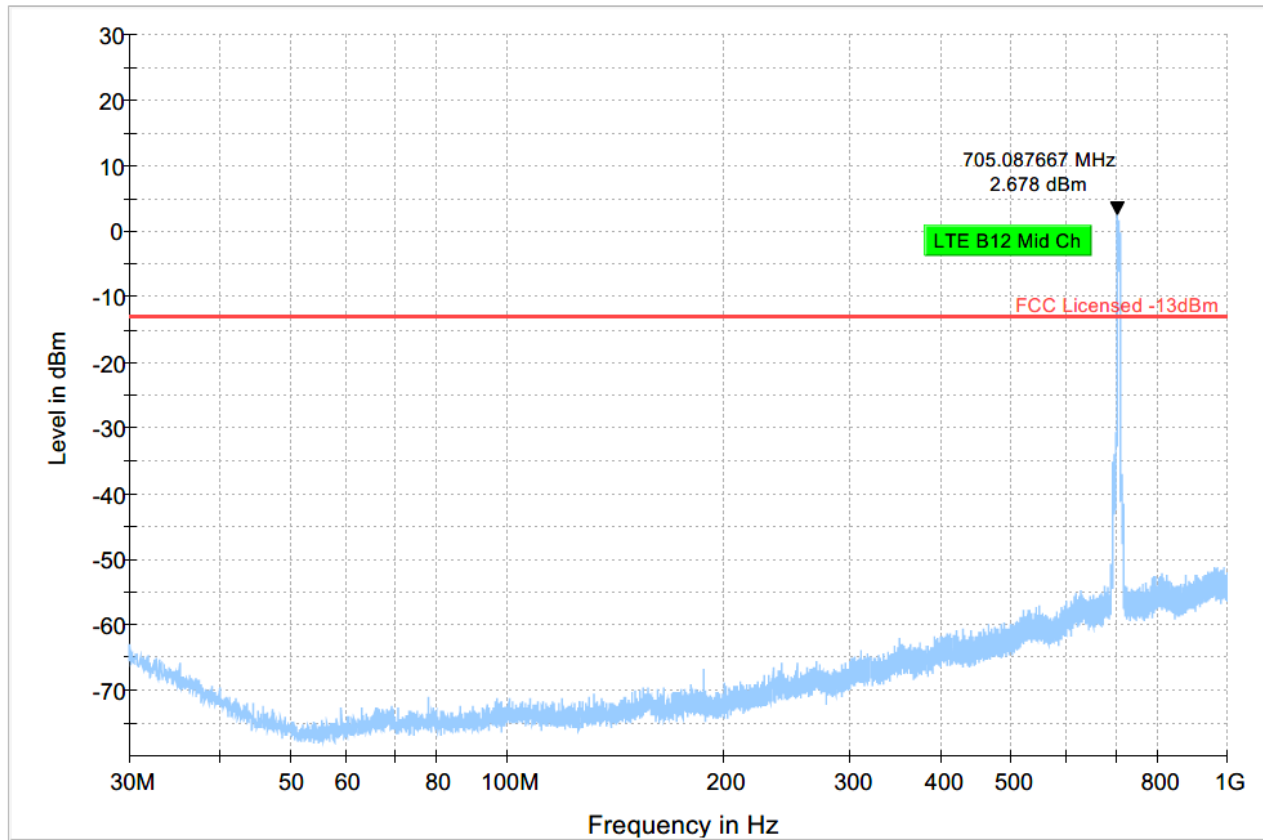
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.529	-34.71	-13.00	21.71	500.0	3.000	239.0	V	170.0	-76.5	
0.598	-41.09	-13.00	28.09	500.0	3.000	242.0	V	170.0	-76.5	
1.562	-45.04	-13.00	32.04	500.0	3.000	241.0	V	44.0	-76.4	



Plot #36 Radiated Emissions: 30 MHz – 1 GHz

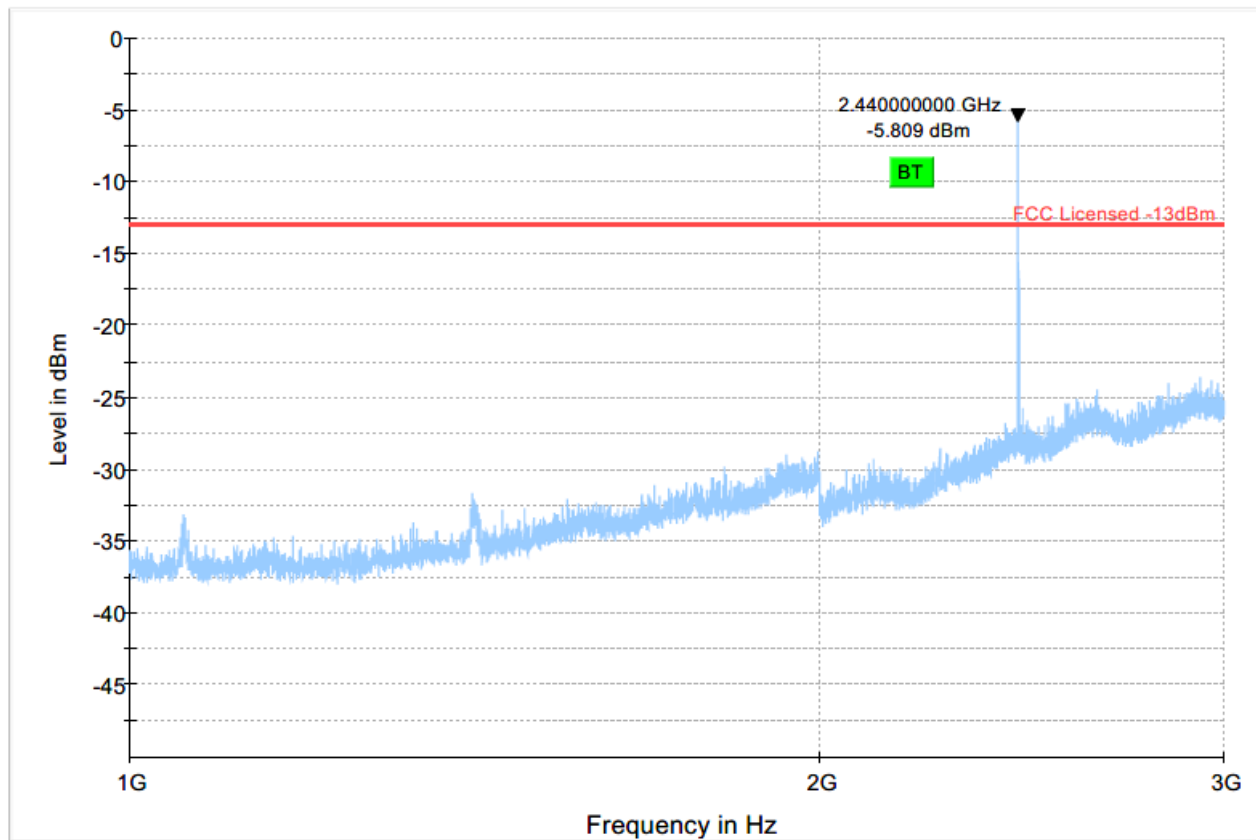
Channel: Mid



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #37 Radiated Emissions: 1-3 GHz

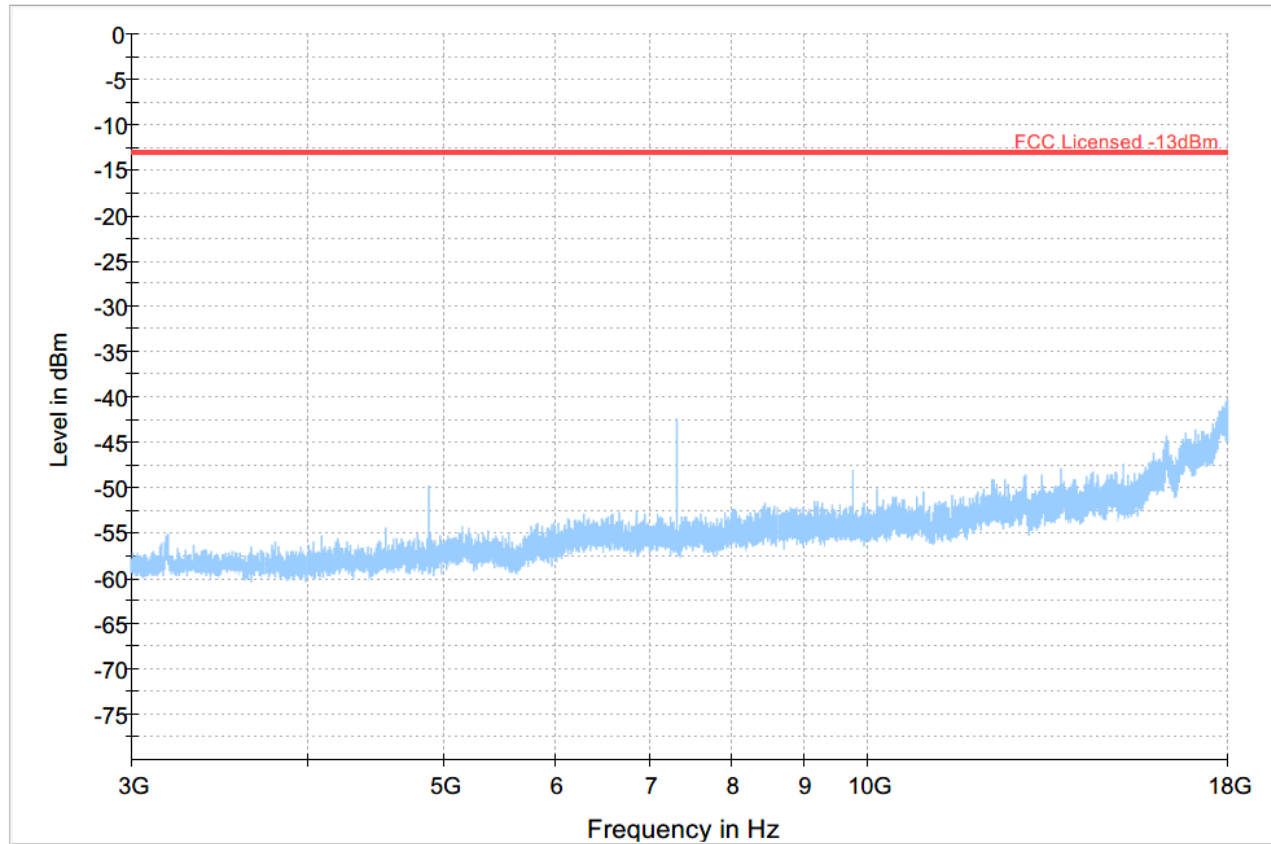
Channel: Mid



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #38 Radiated Emissions: 3-18 GHz

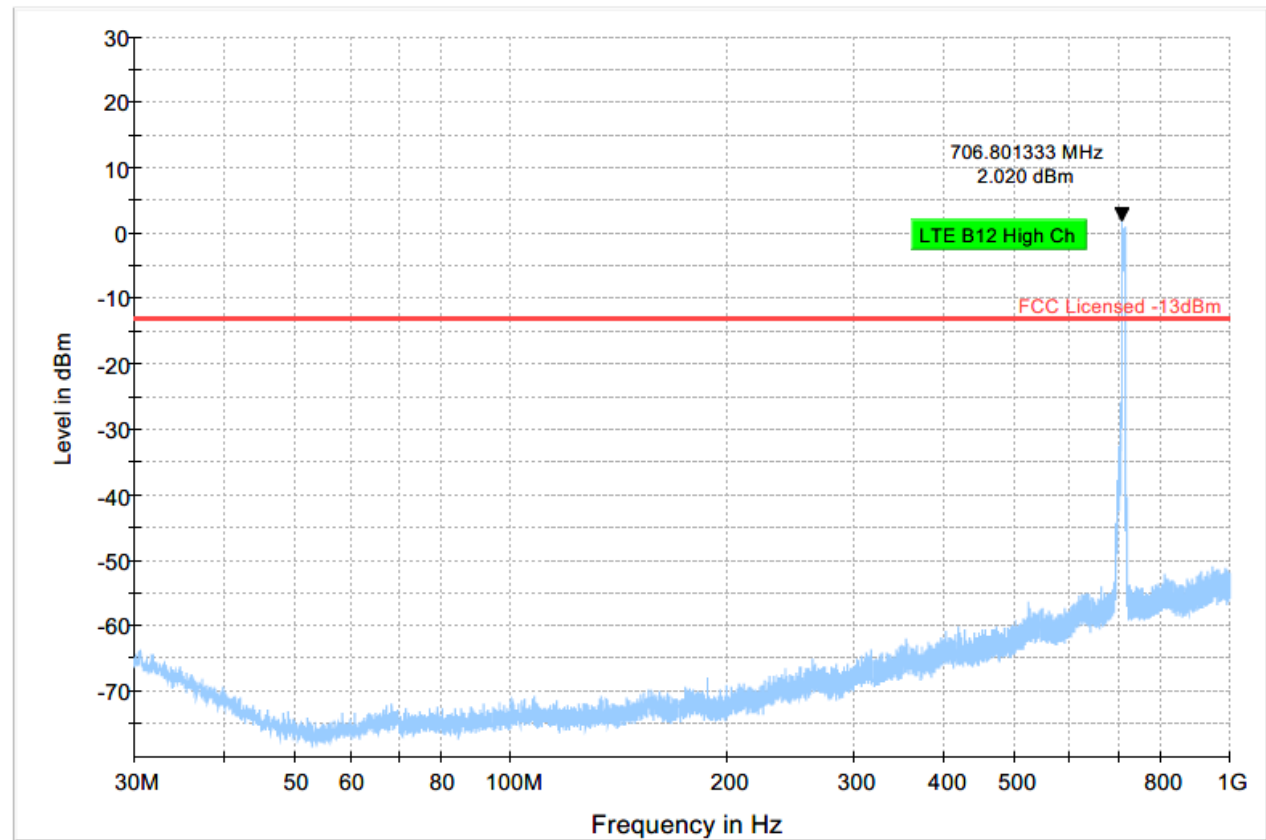
Channel: Mid



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #39 Radiated Emissions: 30 MHz – 1 GHz

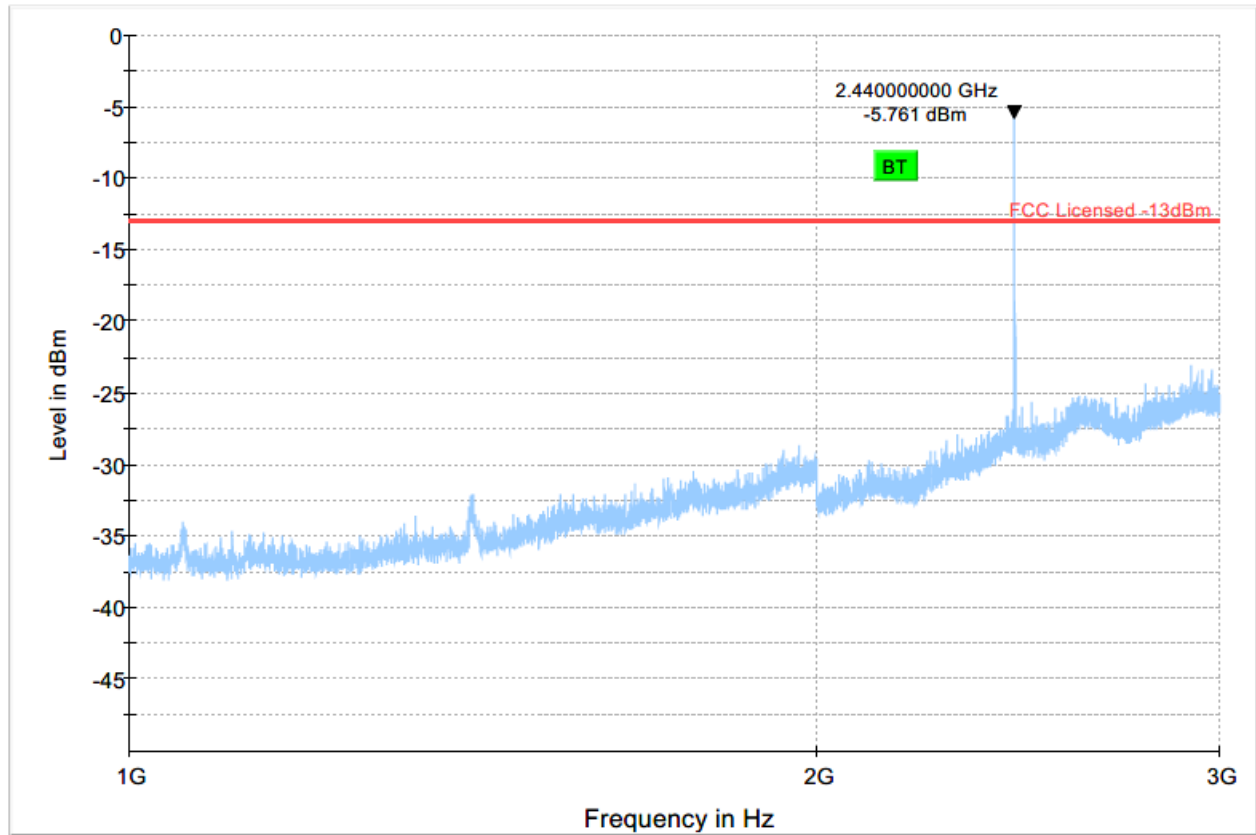
Channel: High



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #40 Radiated Emissions: 1-3 GHz

Channel: High



Preview Result 1-PK+



Critical_Freqs PK+

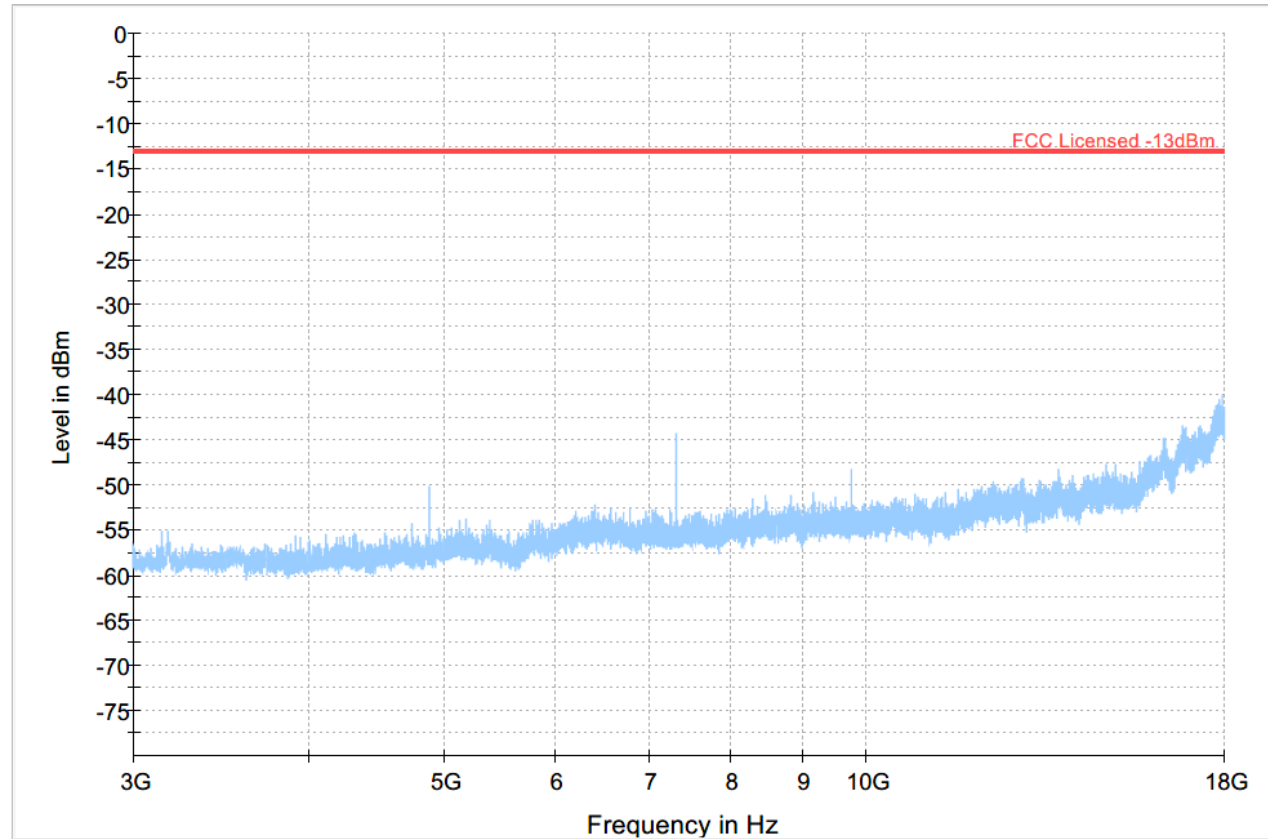
FCC Licensed -13dBm



Final_Result RM

Plot #41 Radiated Emissions: 3-18 GHz

Channel: High



Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

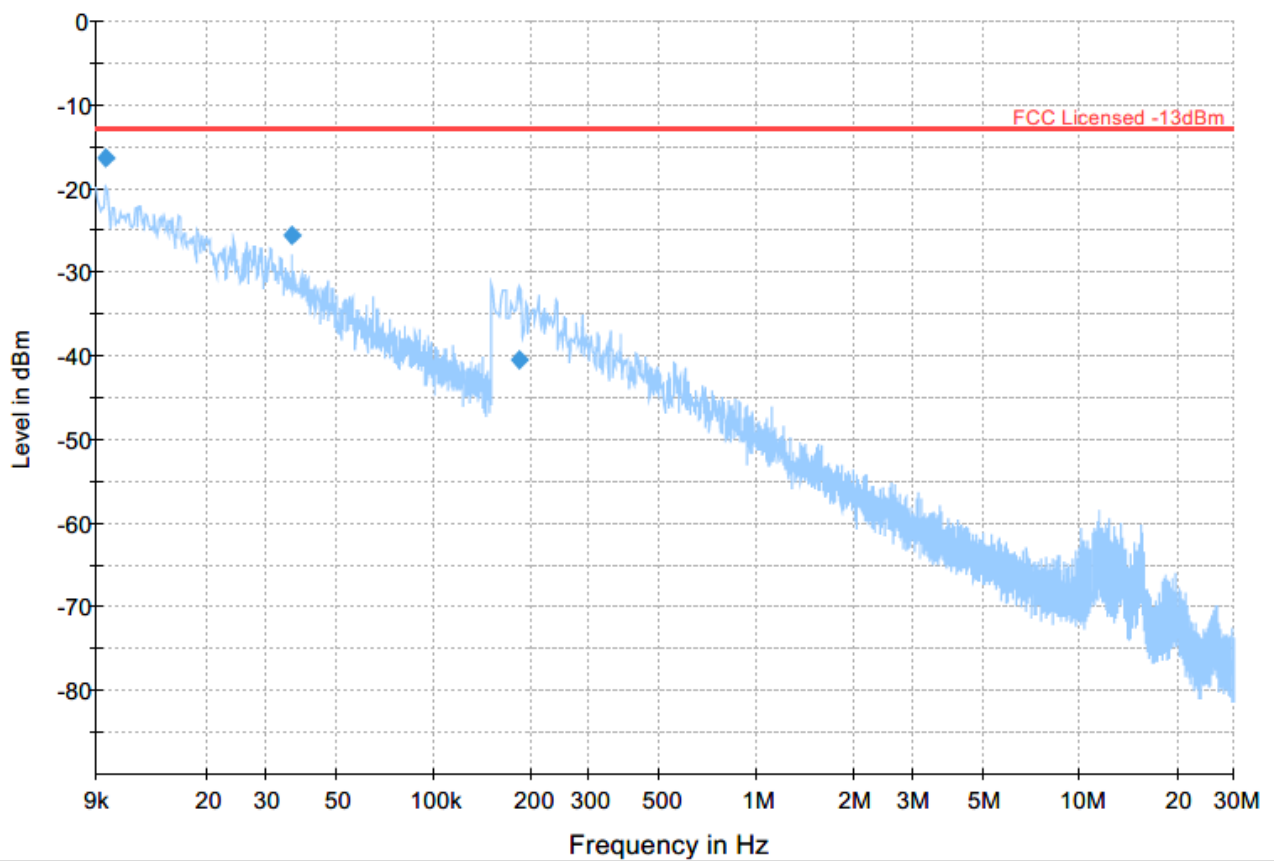
LTE Band 13

Plot #42 Radiated Emissions: 9 kHz – 30 MHz

Channel: Mid

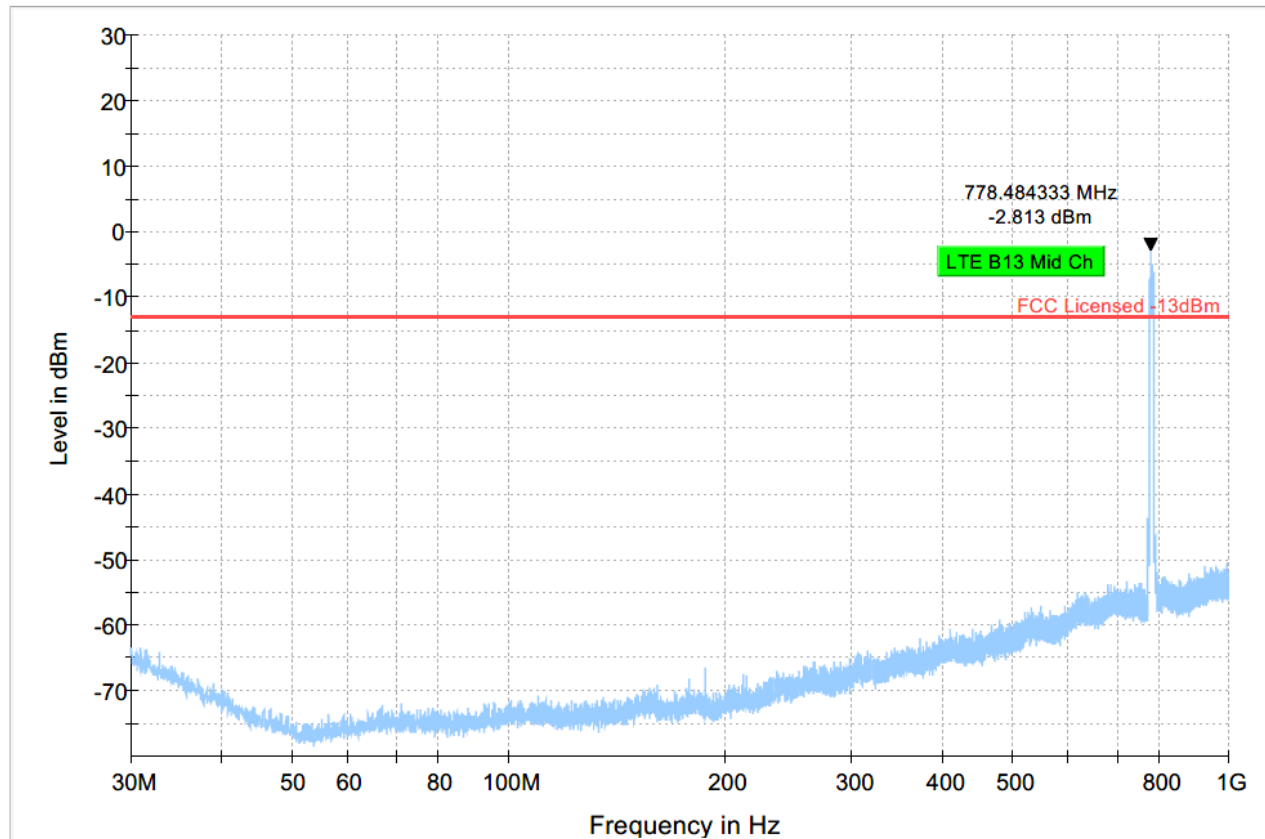
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.010	-16.32	-13.00	3.32	500.0	3.000	315.0	V	155.0	-65.0	
0.036	-25.73	-13.00	12.73	500.0	3.000	251.0	V	99.0	-73.1	
0.185	-40.54	-13.00	27.54	500.0	3.000	315.0	V	185.0	-76.5	



Plot #43 Radiated Emissions: 30 MHz – 1 GHz

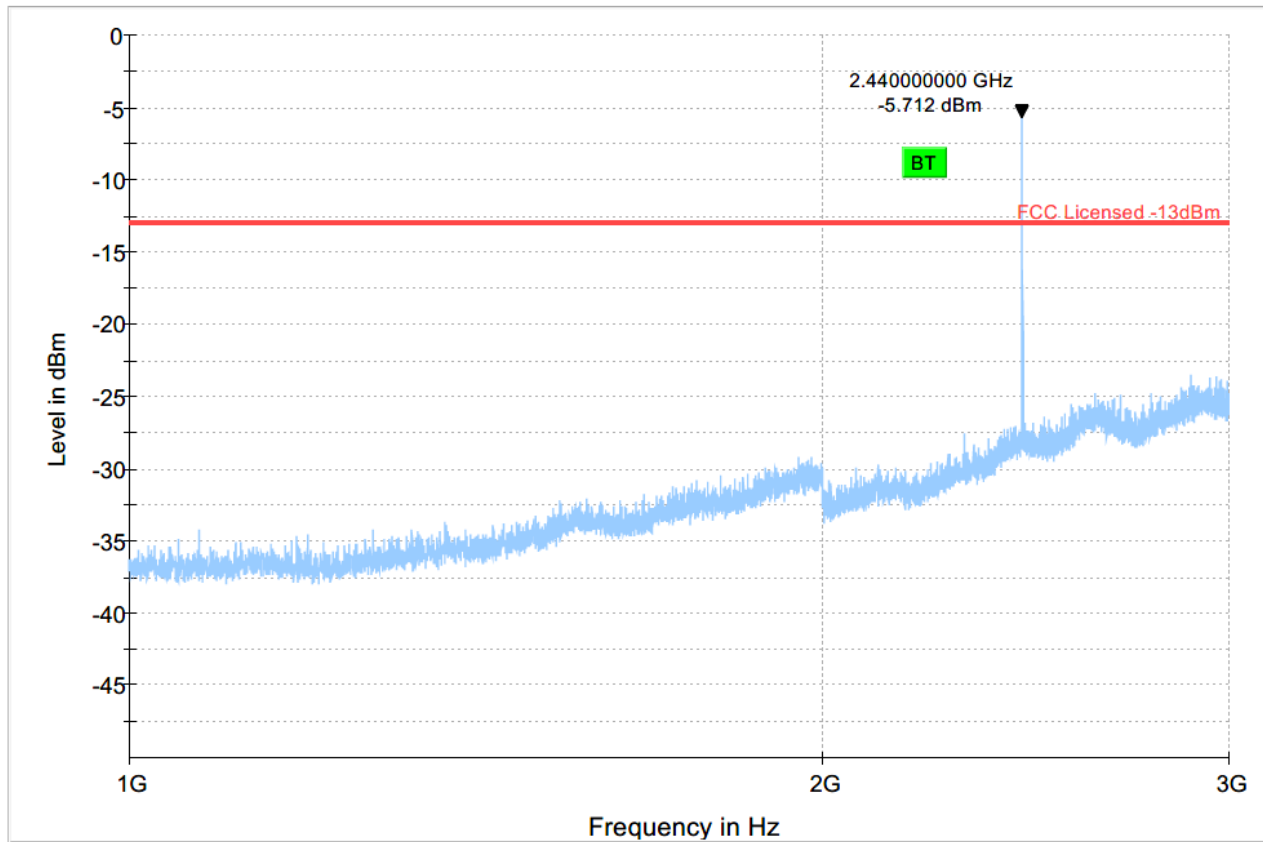
Channel: Mid



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #44 Radiated Emissions: 1-3 GHz

Channel: Mid



— Preview Result 1-PK+

*

Critical_Freqs PK+

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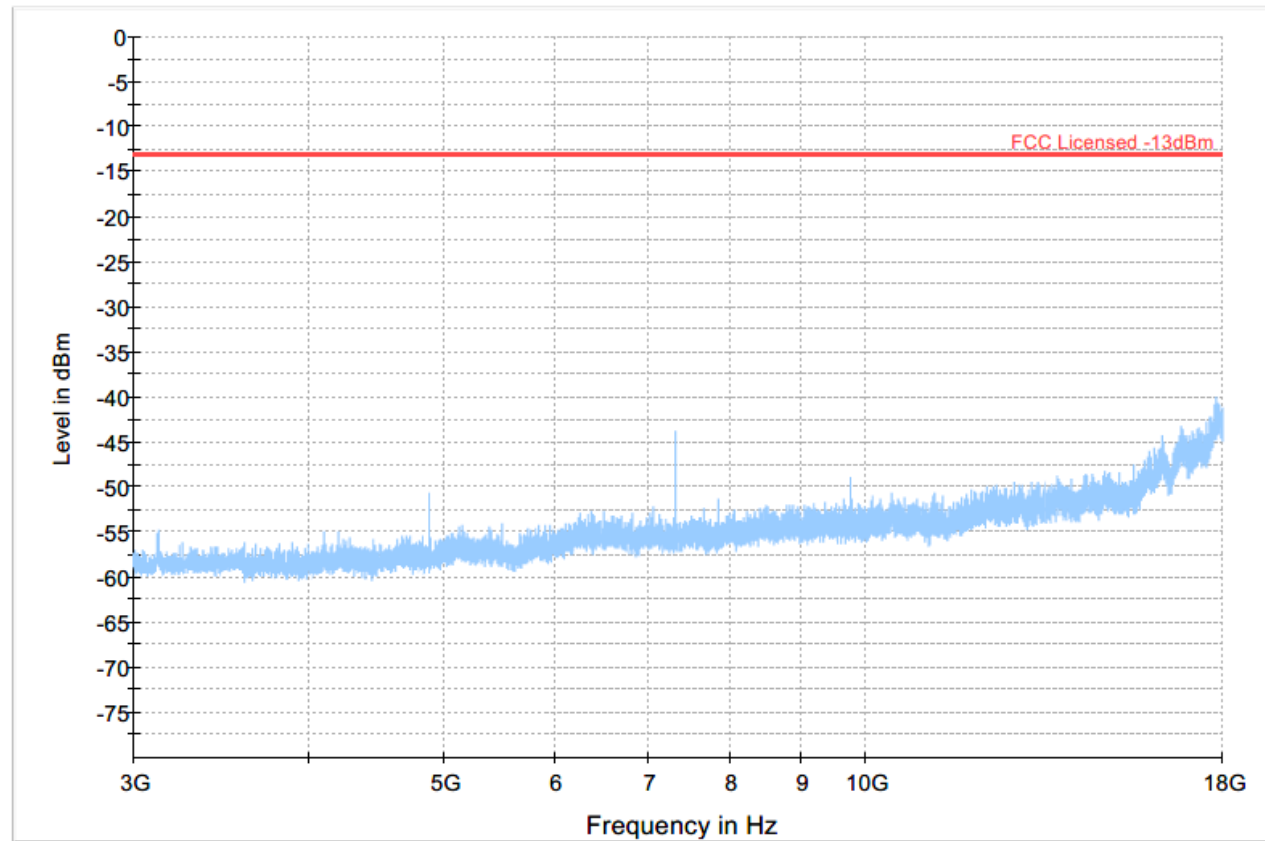
FCC Licensed -13dBm

◆

Final_Result RM

Plot #45 Radiated Emissions: 3-18 GHz

Channel: Mid

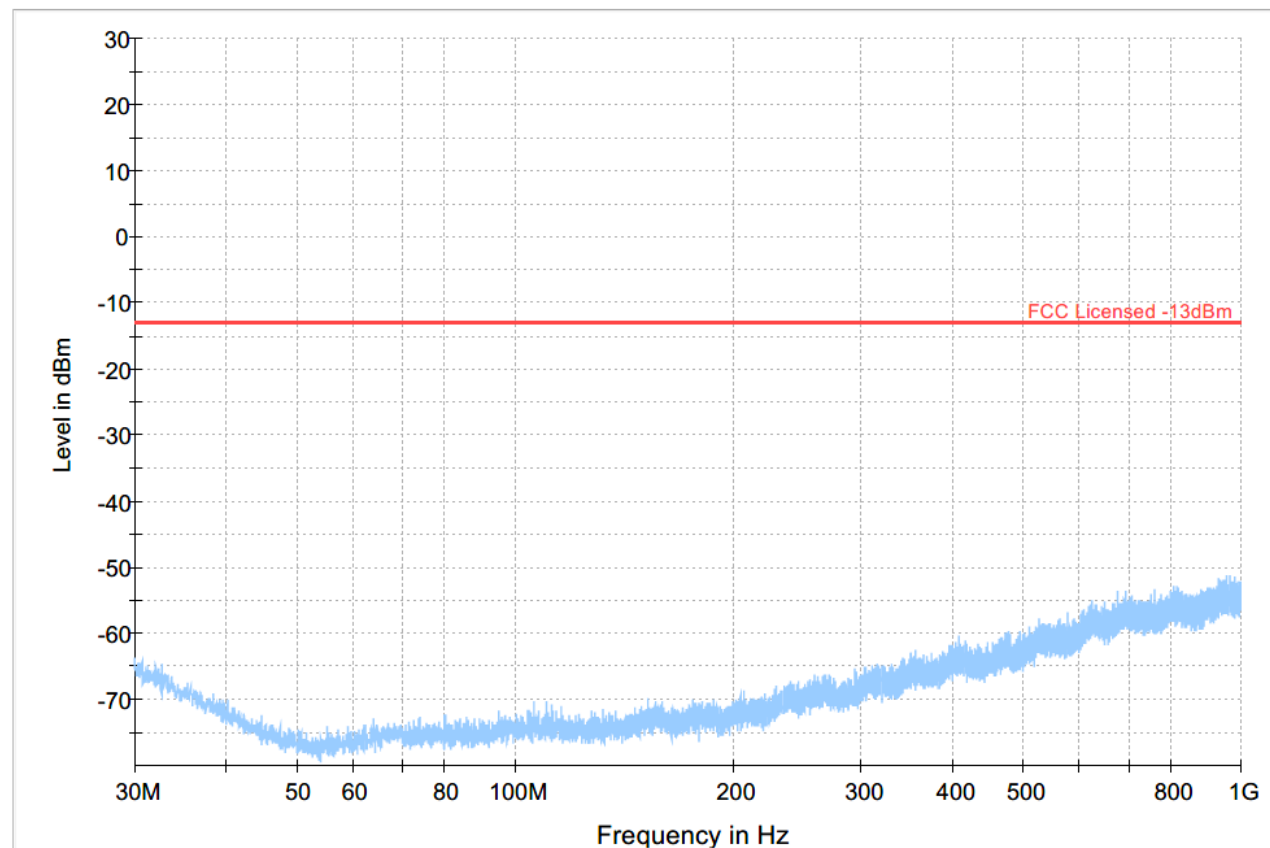


— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

UMTS Band II

Plot #46 Radiated Emissions: 30 MHz – 1GHz

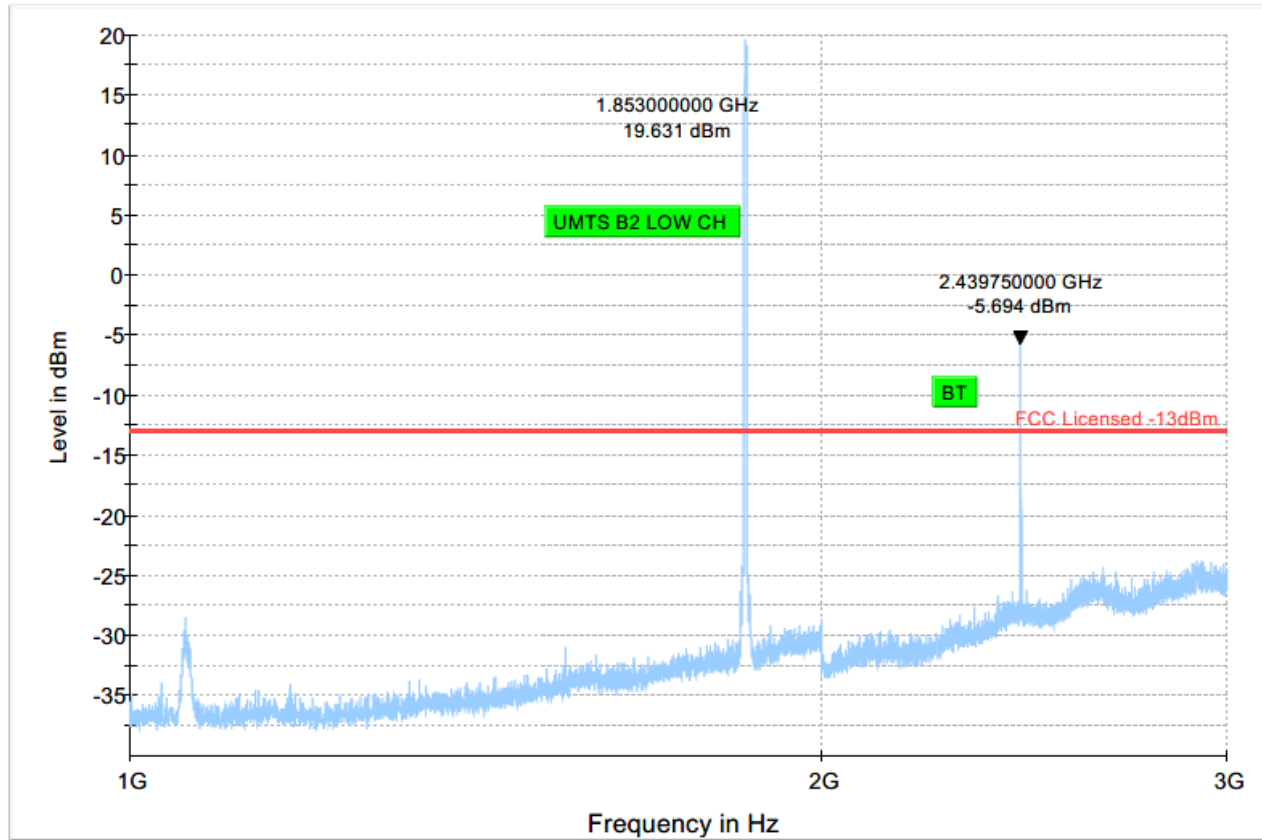
Channel: Low



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result R

Plot #47 Radiated Emissions: 1-3 GHz

Channel: Low



Preview Result 1-PK+

*

Critical_Freqs PK+

FCC Licensed -13dBm

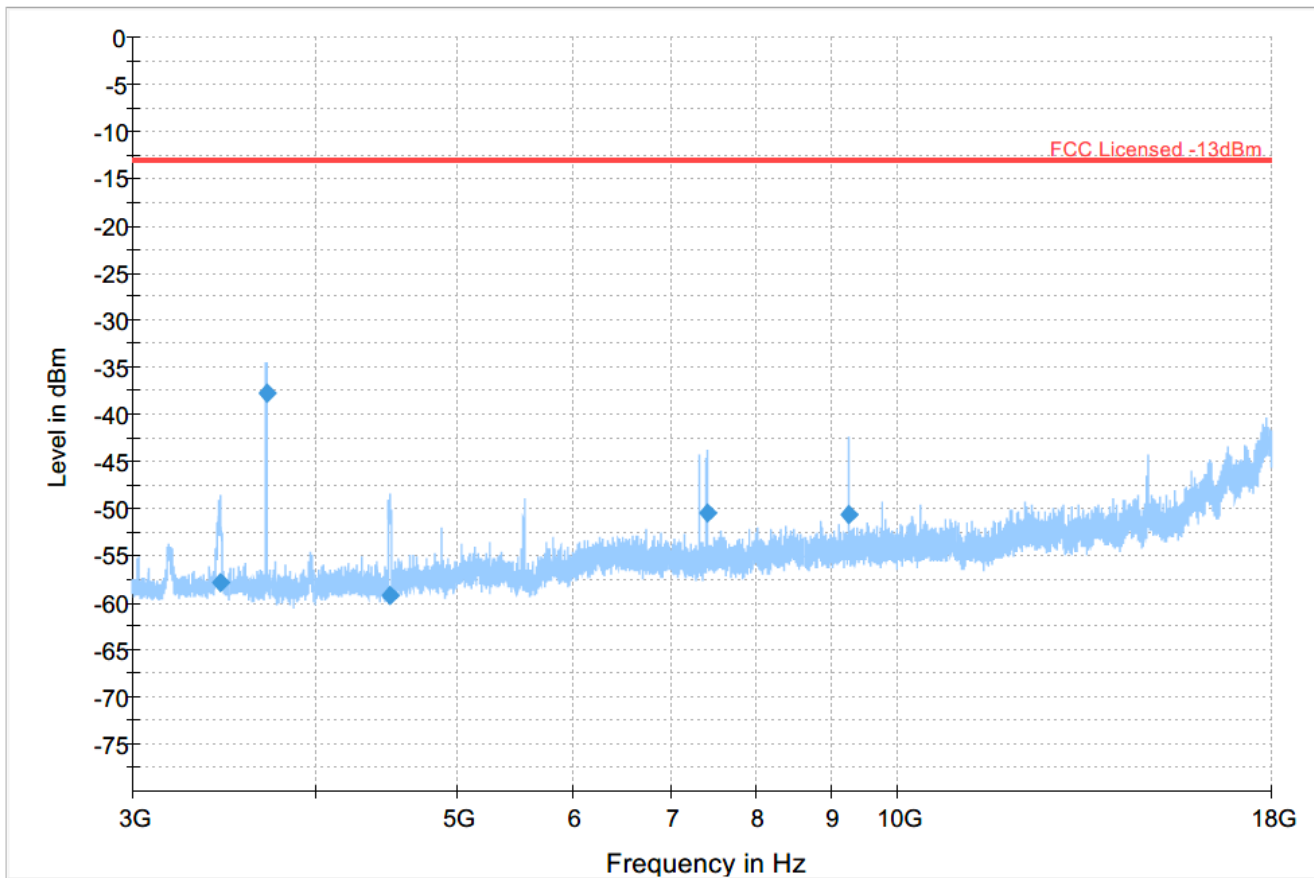
Final_Result RM

Plot #48 Radiated Emissions: 3-18 GHz

Channel: Low

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3445.500	-57.90	-13.00	44.90	500.0	1000.000	198.0	V	175.0	-103.2	
3706.500	-37.76	-13.00	24.76	500.0	1000.000	140.0	V	37.0	-101.6	
4495.500	-59.29	-13.00	46.29	500.0	1000.000	220.0	V	314.0	-100.6	
7412.500	-50.41	-13.00	37.41	500.0	1000.000	253.0	V	219.0	-95.5	
9260.000	-50.58	-13.00	37.58	500.0	1000.000	140.0	V	137.0	-93.8	



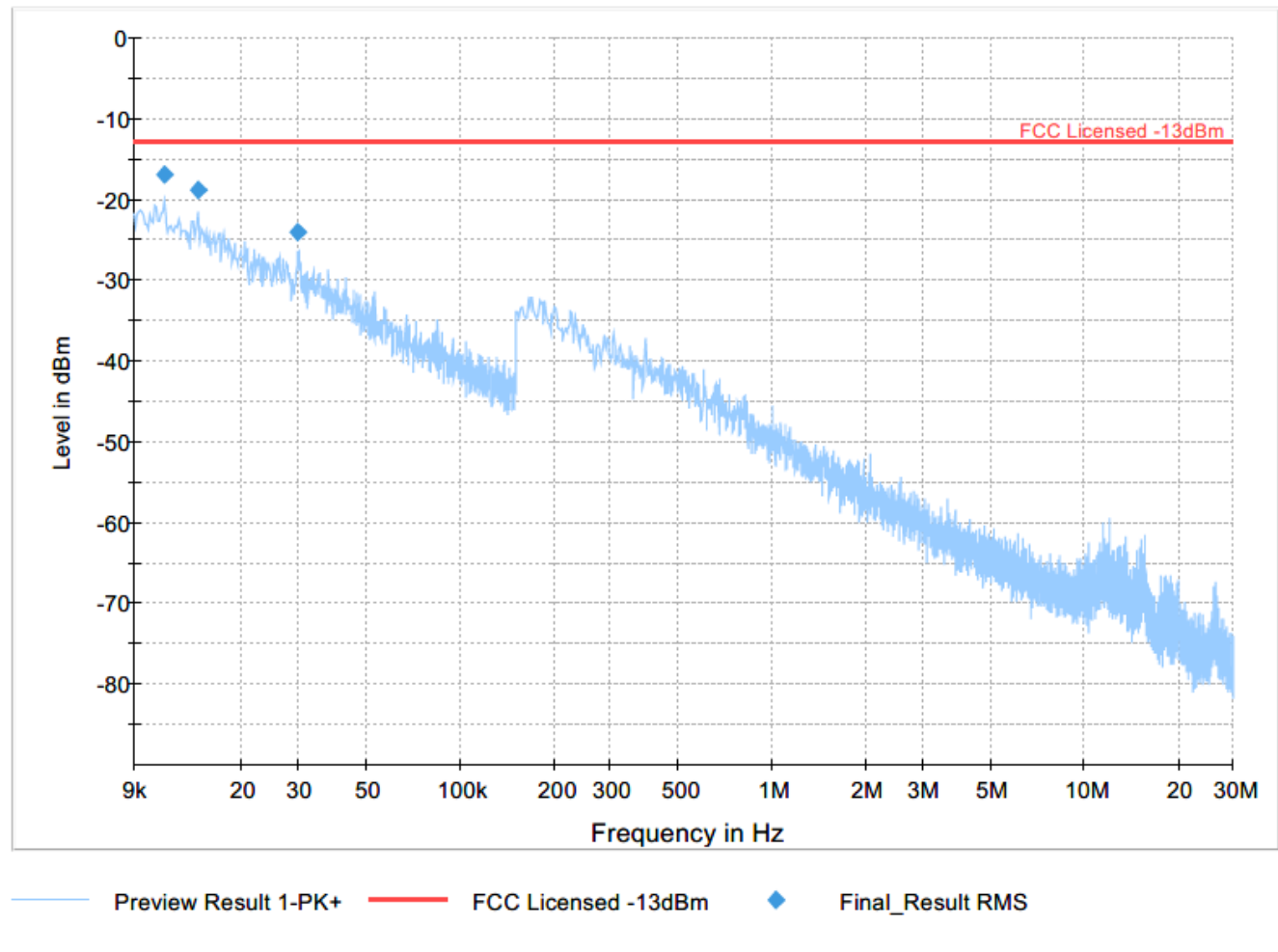
Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS

Plot #49 Radiated Emissions: 9 kHz – 30 MHz

Channel: Mid

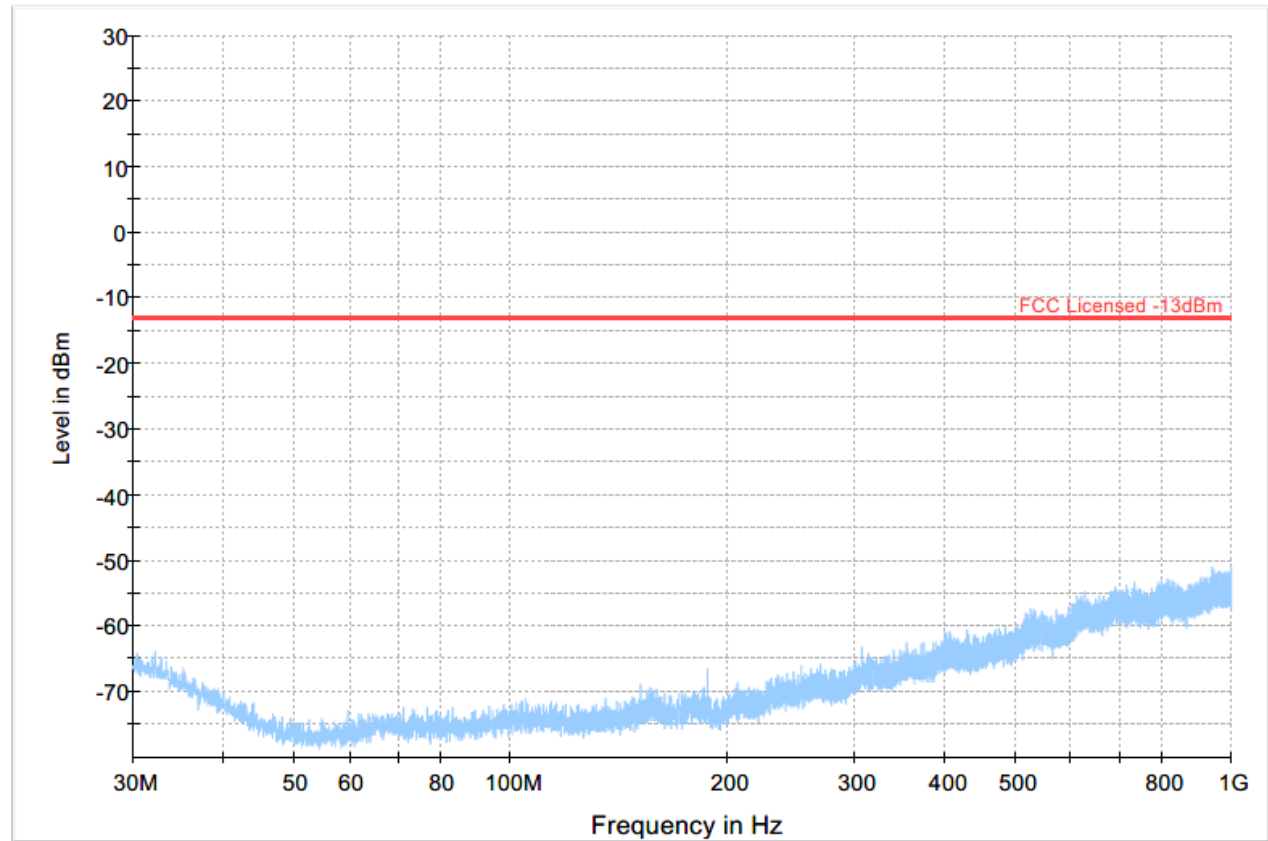
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.011	-16.95	-13.00	3.95	500.0	3.000	204.0	V	163.0	-65.9	
0.014	-18.85	-13.00	5.85	500.0	3.000	197.0	V	135.0	-67.6	
0.030	-24.15	-13.00	11.15	500.0	3.000	232.0	H	194.0	-72.1	



Plot #50 Radiated Emissions: 30 MHz – 1 GHz

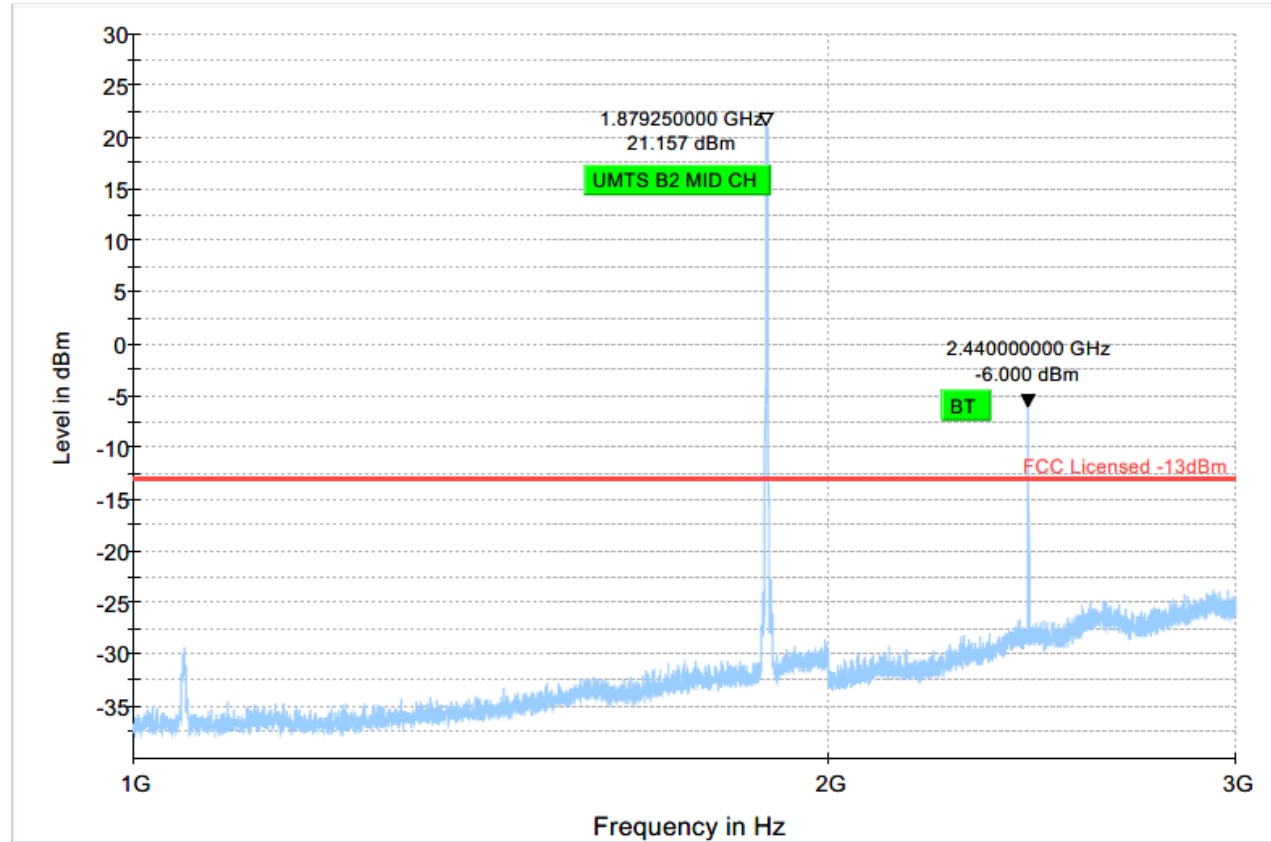
Channel: Mid



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #51 Radiated Emissions: 1-3 GHz

Channel: Mid



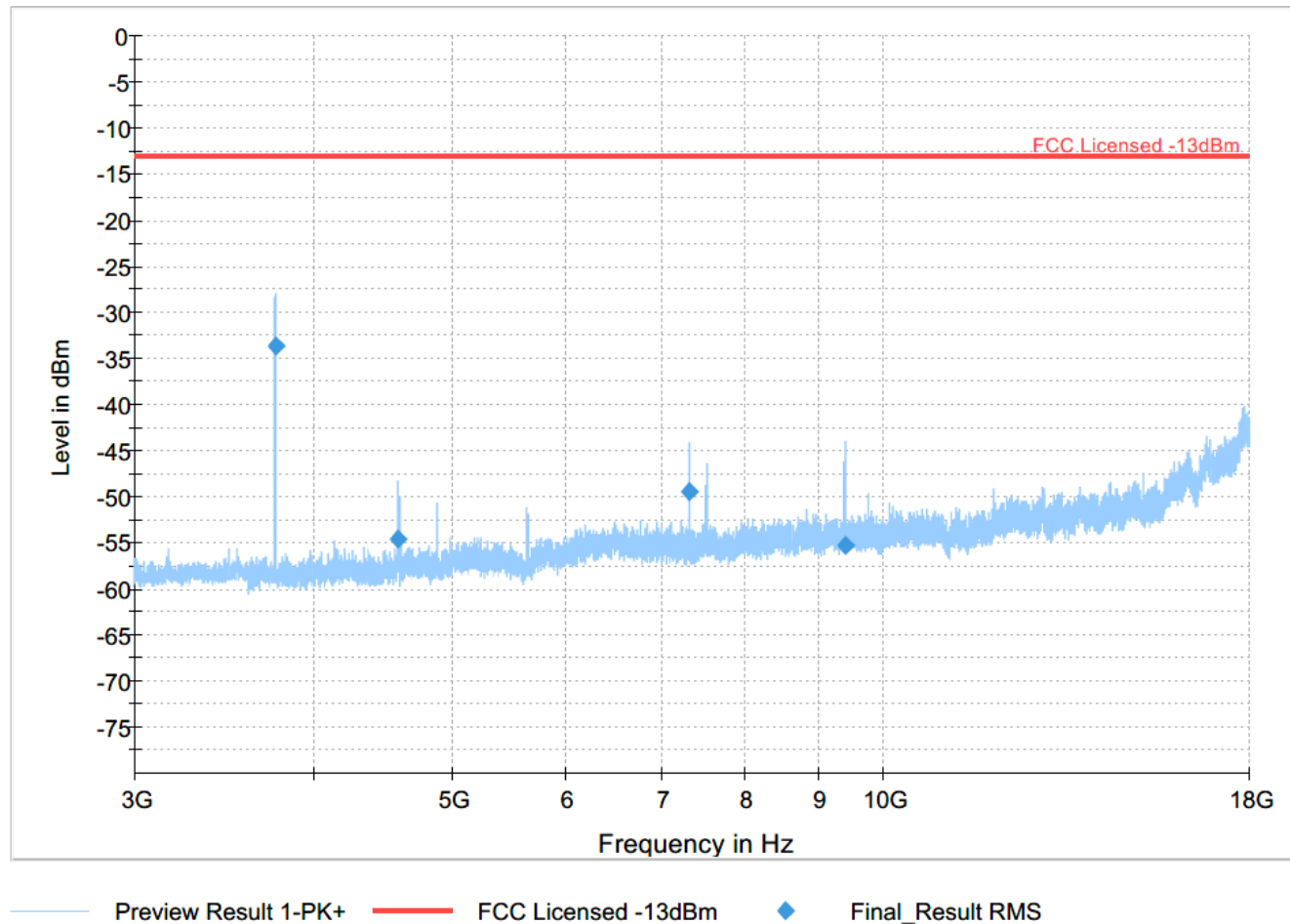
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #52 Radiated Emissions: 3-18 GHz

Channel: Mid

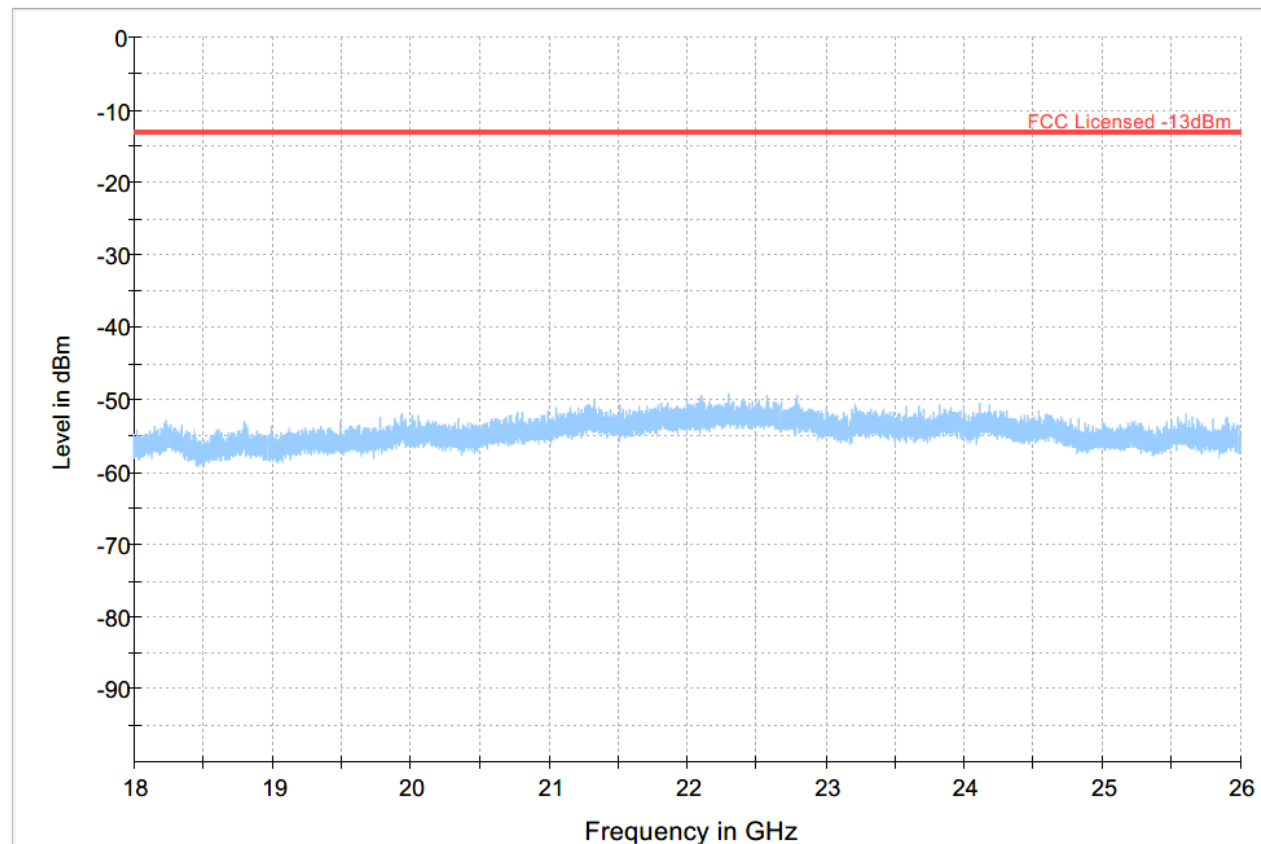
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3762.000	-33.65	-13.00	20.65	500.0	1000.000	164.0	H	181.0	-101.8	
4584.000	-54.58	-13.00	41.58	500.0	1000.000	200.0	V	146.0	-100.0	
7319.500	-49.43	-13.00	36.43	500.0	1000.000	140.0	V	128.0	-95.7	
9401.500	-55.34	-13.00	42.34	500.0	1000.000	153.0	H	205.0	-93.4	



Plot #53 Radiated Emissions: 18-26 GHz

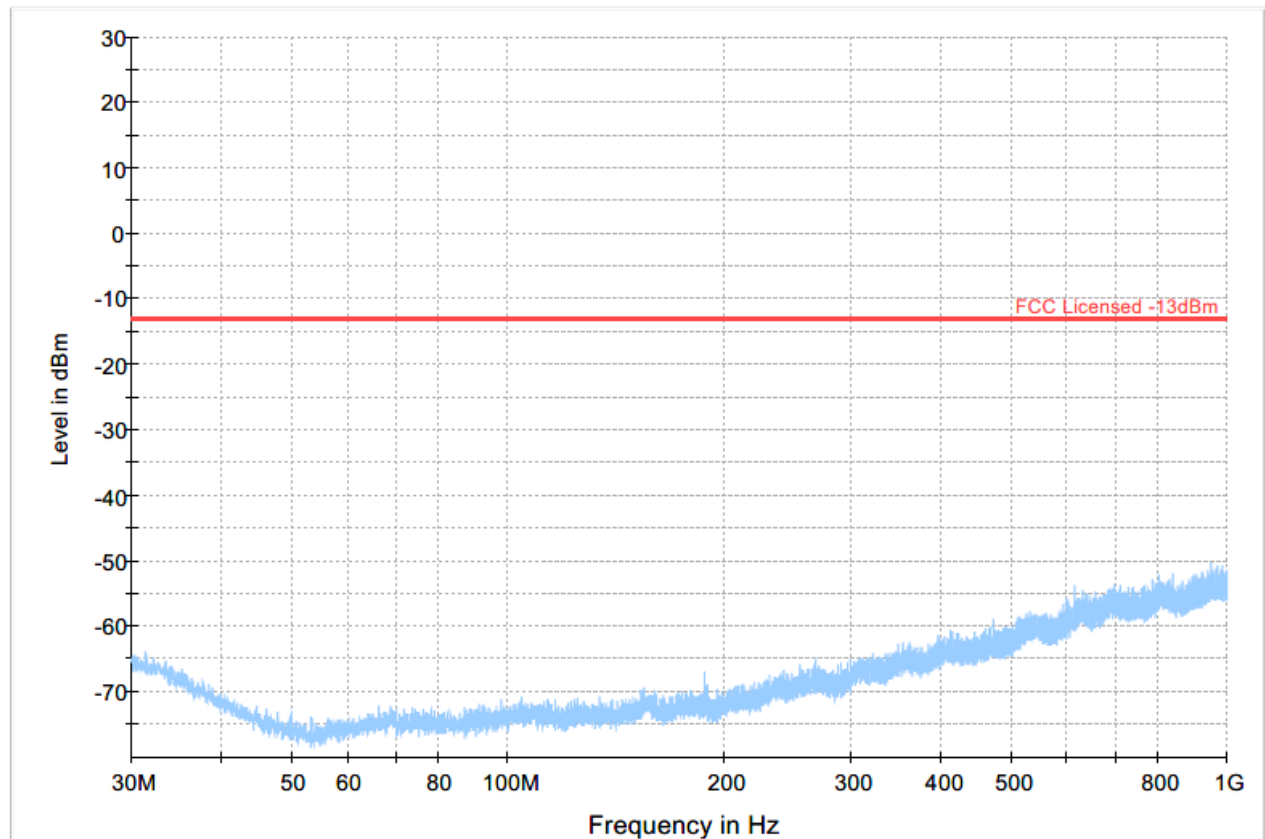
Channel: Mid



— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #54 Radiated Emissions: 30 MHz – 1 GHz

Channel: High



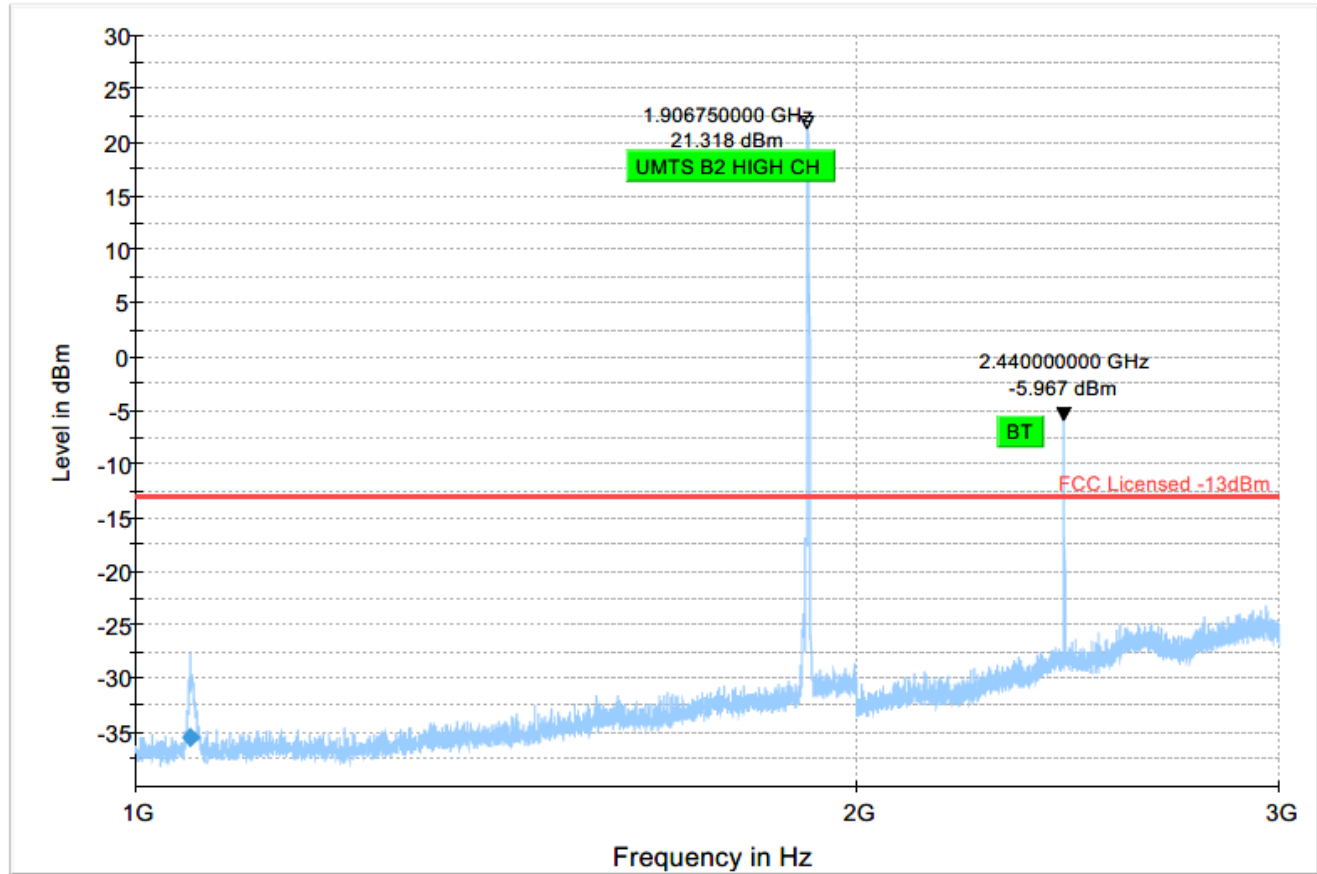
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #55 Radiated Emissions: 1-3 GHz

Channel: High

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
1053.750	-35.50	-13.00	22.50	500.0	1000.000	163.0	H	160.0	-65.4	

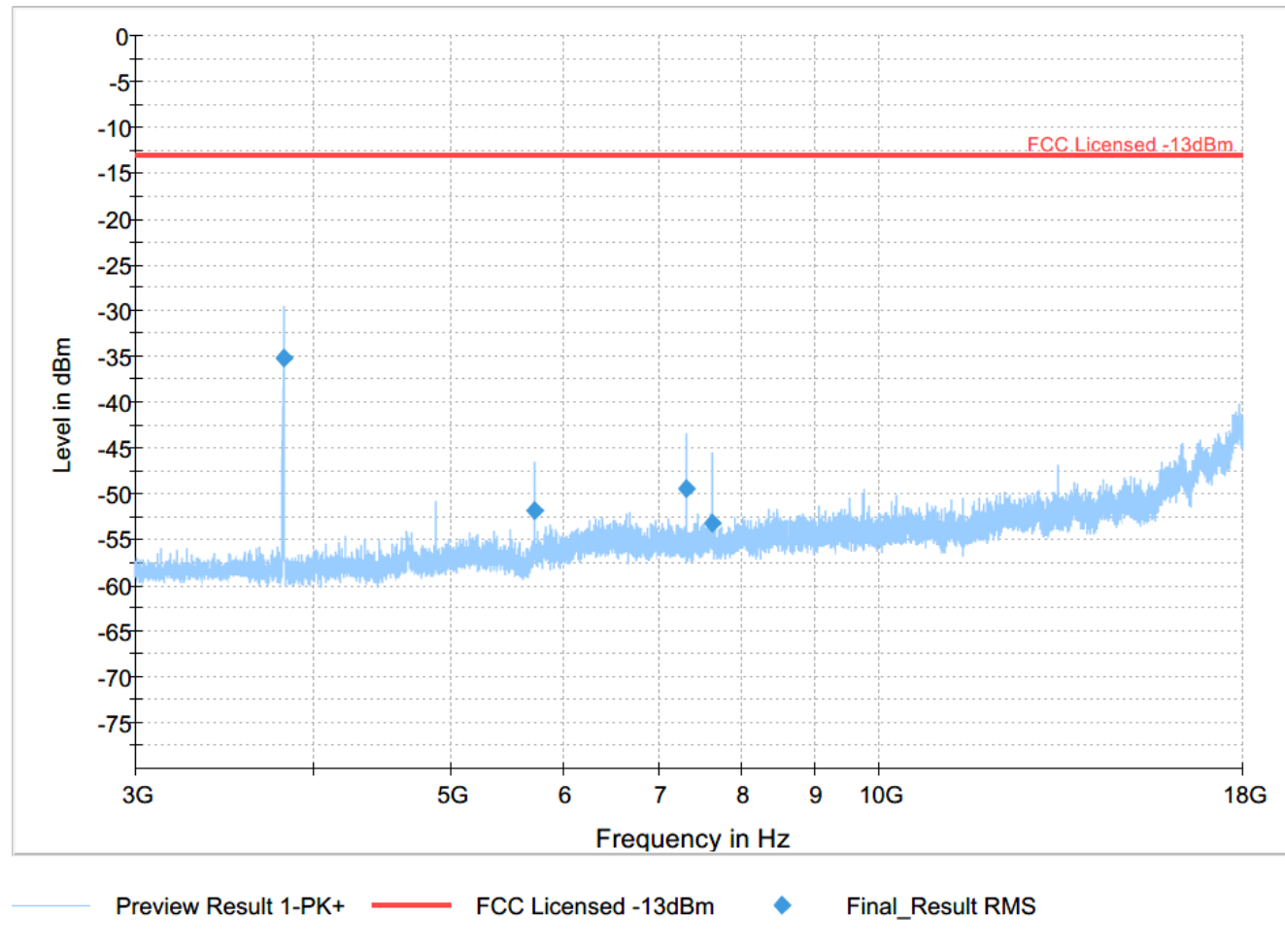


Plot #56 Radiated Emissions: 3-18 GHz

Channel: High

Final Result

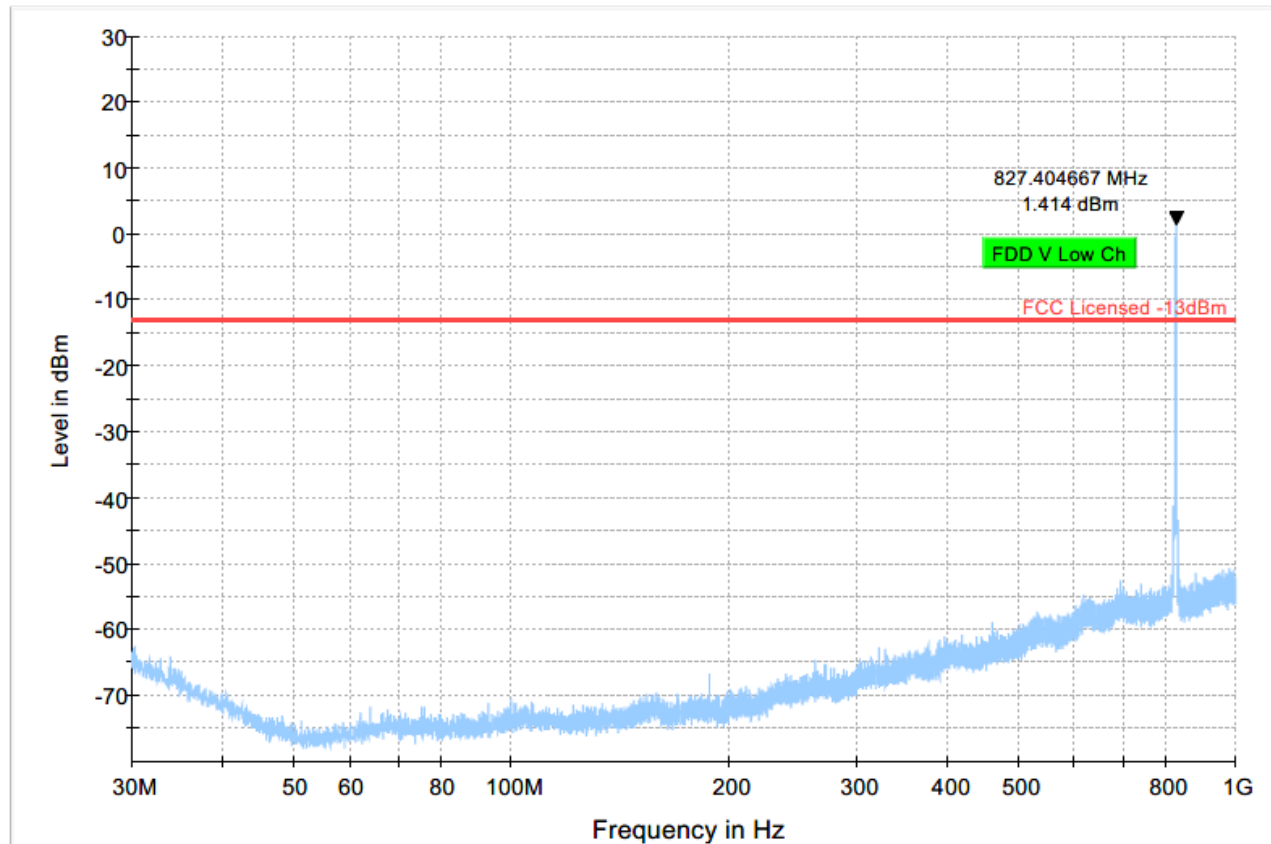
Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas._Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3813.000	-35.23	-13.00	22.23	500.0	1000.000	140.0	V	163.0	-101.6	
5720.500	-51.91	-13.00	38.91	500.0	1000.000	176.0	V	159.0	-98.7	
7320.000	-49.53	-13.00	36.53	500.0	1000.000	163.0	V	132.0	-95.7	
7631.500	-53.28	-13.00	40.28	500.0	1000.000	152.0	V	15.0	-95.6	



UMTS Band V

Plot #57 Radiated Emissions: 30 MHz – 1GHz

Channel: Low



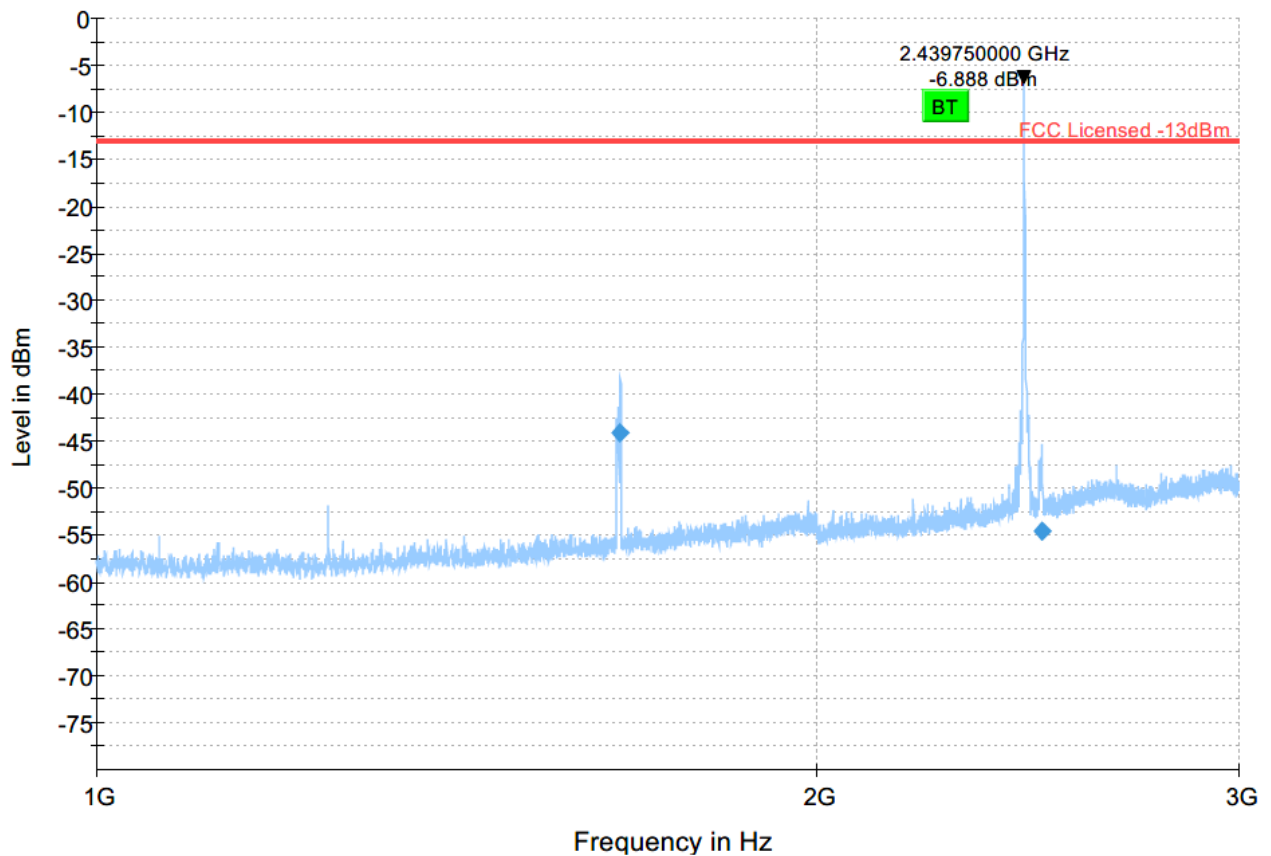
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #58 Radiated Emissions: 1-3 GHz

Channel: Low

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
1655.000	-44.17	-13.00	31.17	500.0	1000.000	151.0	H	135.0	-89.1	
2481.500	-54.56	-13.00	41.56	500.0	1000.000	140.0	V	-6.0	-85.6	



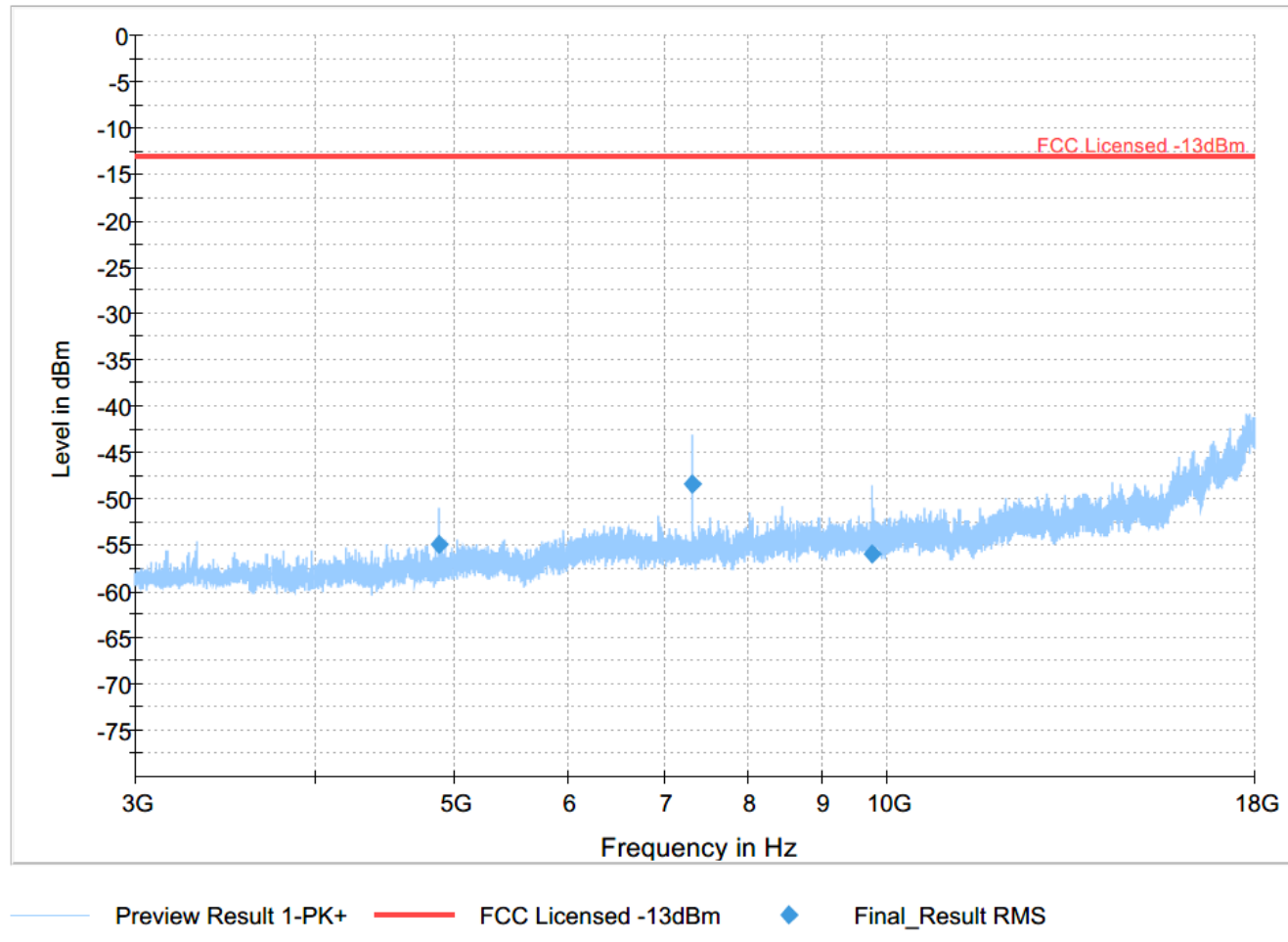
Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS

Plot #59 Radiated Emissions: 3-18 GHz

Channel: Low

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
4880.000	-54.87	-13.00	41.87	500.0	1000.000	152.0	V	149.0	-100.2	
7320.000	-48.40	-13.00	35.40	500.0	1000.000	140.0	V	138.0	-95.7	
9760.500	-55.88	-13.00	42.88	500.0	1000.000	140.0	V	248.0	-93.5	

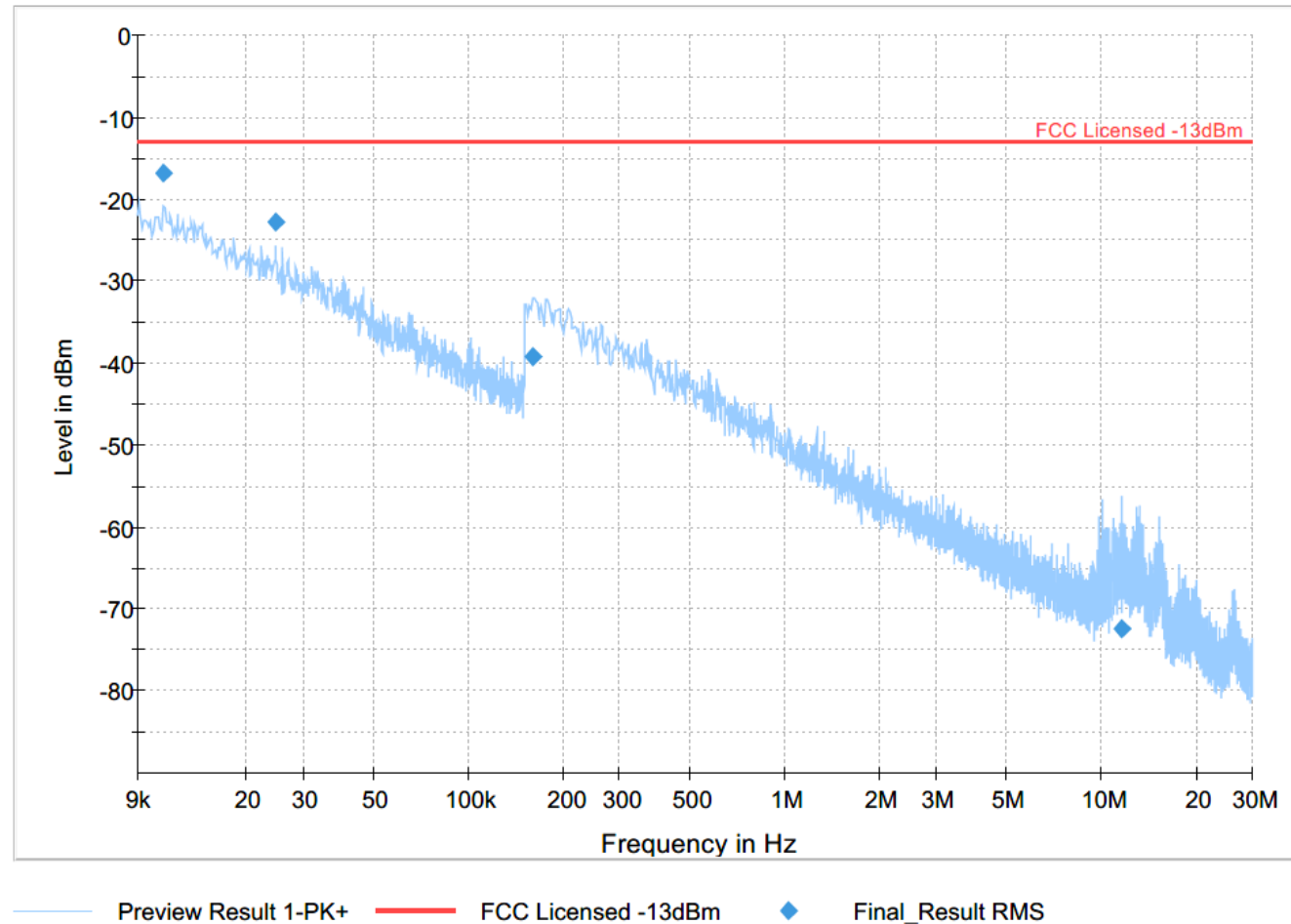


Plot #60 Radiated Emissions: 9 kHz – 30 MHz

Channel: Mid

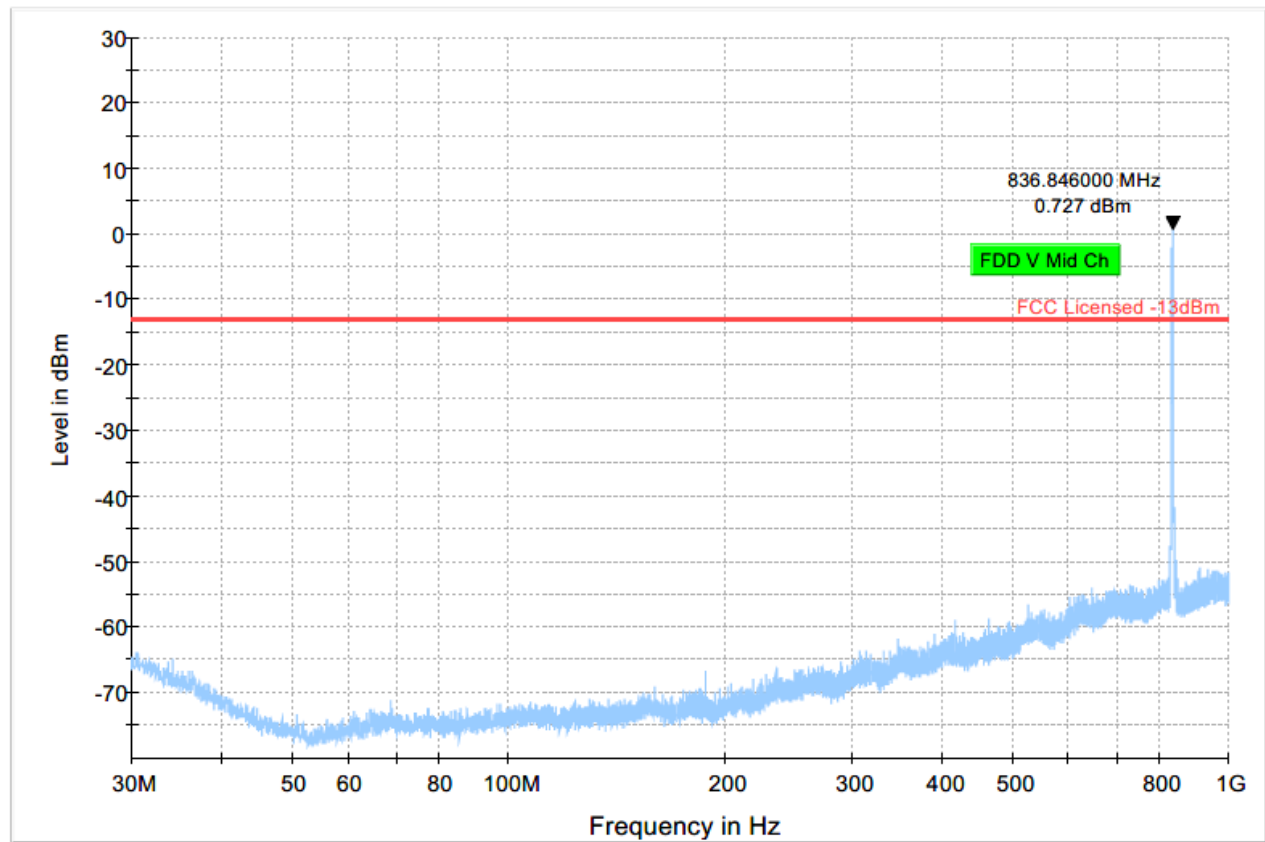
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.011	-16.75	-13.00	3.75	500.0	3.000	229.0	V	108.0	-65.7	
0.025	-22.75	-13.00	9.75	500.0	3.000	310.0	V	200.0	-71.3	
0.159	-39.30	-13.00	26.30	500.0	3.000	218.0	H	-36.0	-76.5	
11.616	-72.51	-13.00	59.51	500.0	3.000	176.0	V	45.0	-77.8	



Plot #61 Radiated Emissions: 30 MHz – 1 GHz

Channel: Mid



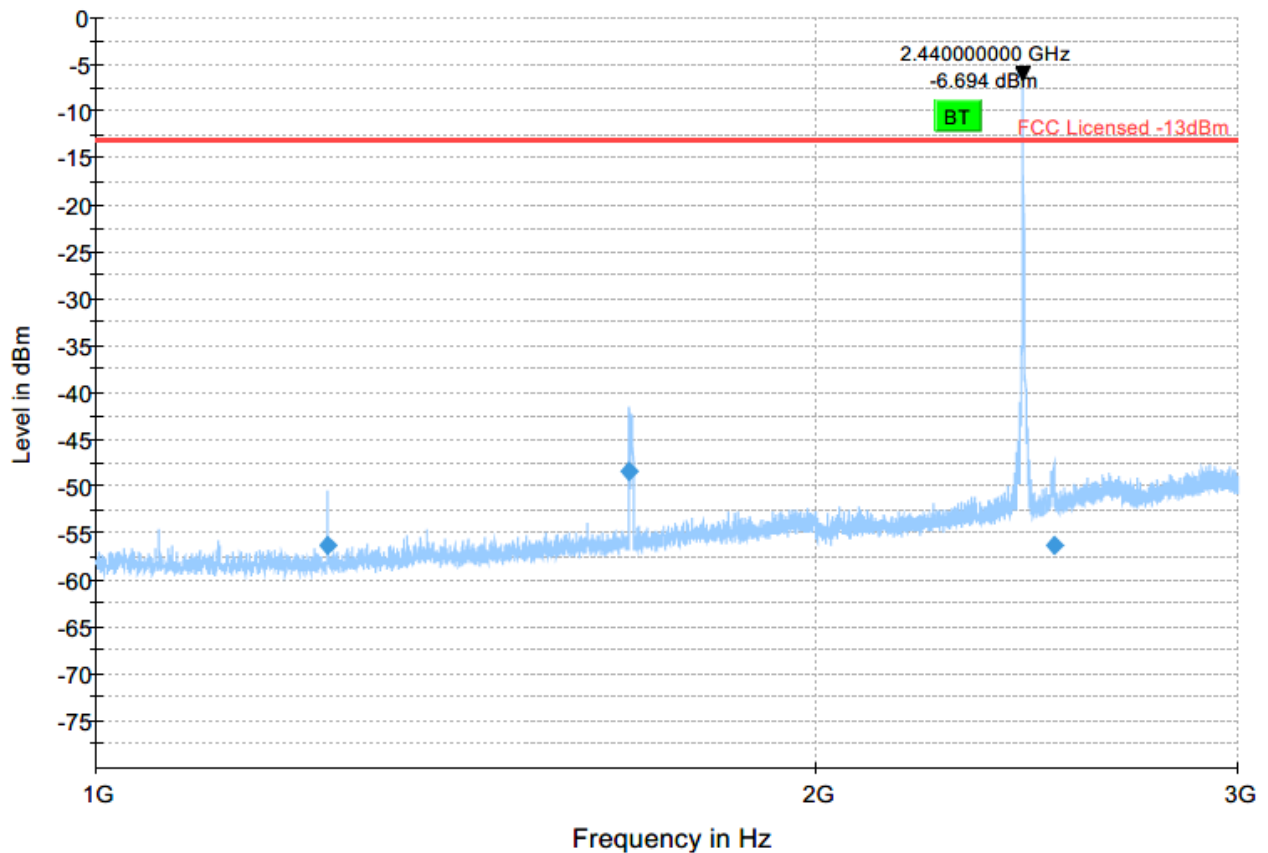
— Preview Result 1-PK+ * Critical_Freqs PK+ — FCC Licensed -13dBm ◆ Final_Result RM

Plot #62 Radiated Emissions: 1-3 GHz

Channel: Mid

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
1249.750	-56.25	-13.00	43.25	500.0	1000.000	184.0	V	65.0	-91.0	
1671.000	-48.41	-13.00	35.41	500.0	1000.000	152.0	H	355.0	-89.0	
2512.250	-56.38	-13.00	43.38	500.0	1000.000	152.0	V	11.0	-85.4	



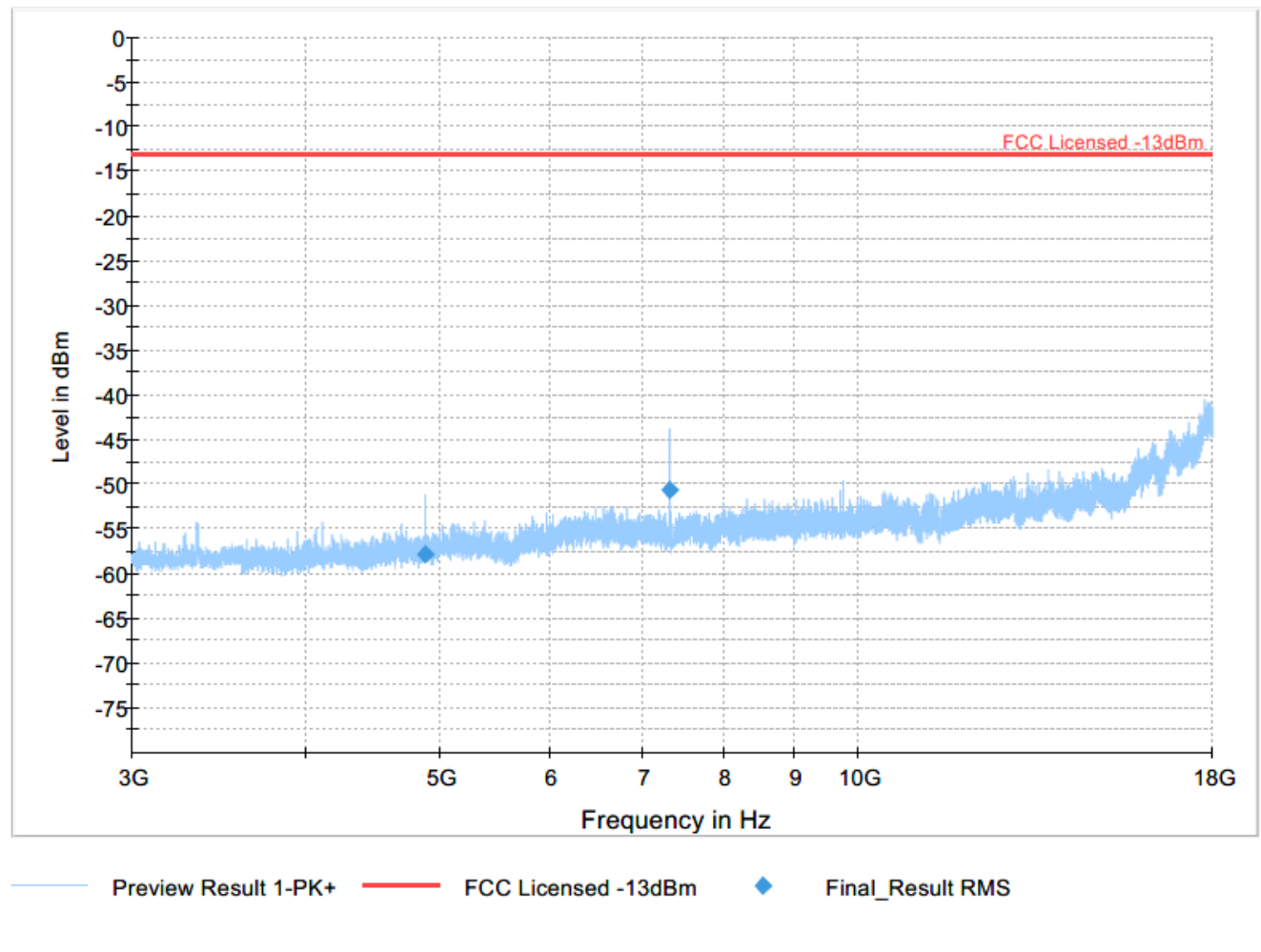
Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS

Plot #63 Radiated Emissions: 3-18 GHz

Channel: Mid

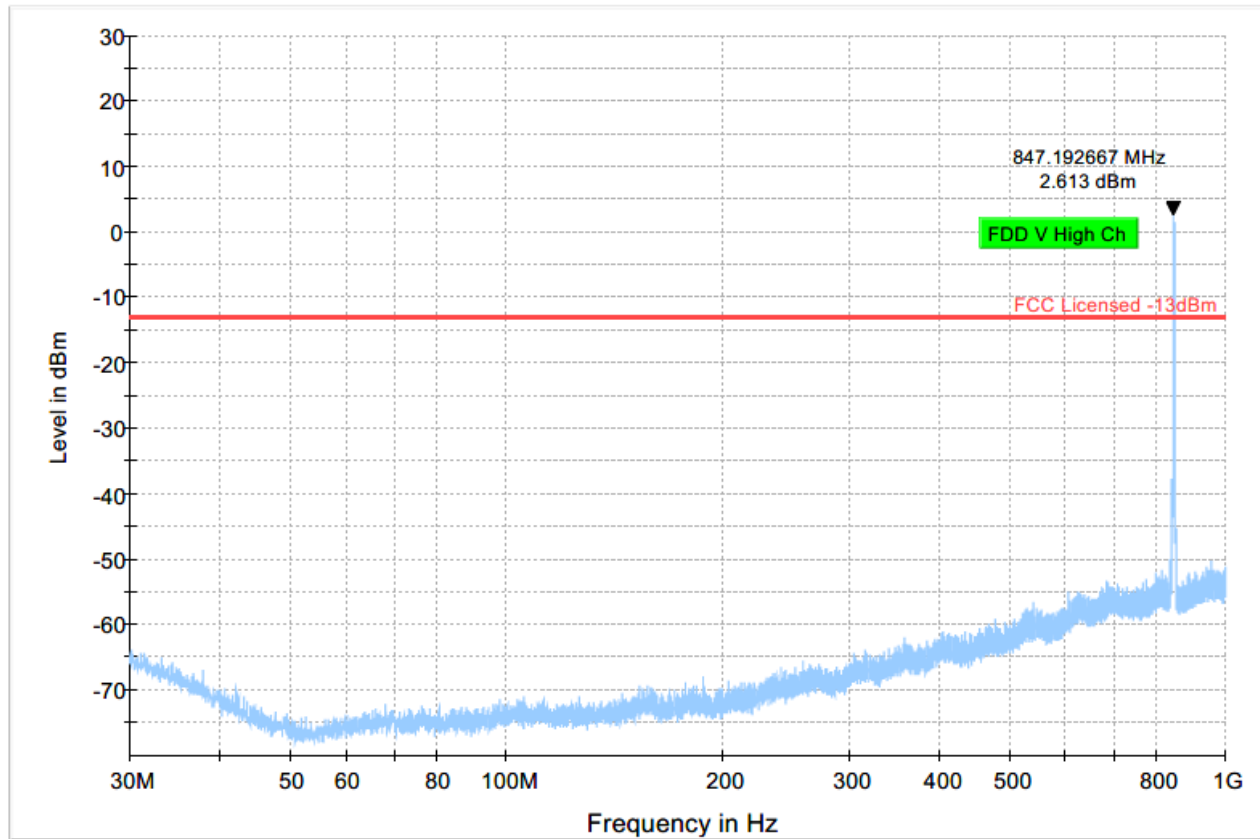
Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
4880.500	-57.91	-13.00	44.91	500.0	1000.000	153.0	V	154.0	-100.2	
7320.500	-50.56	-13.00	37.56	500.0	1000.000	140.0	H	167.0	-95.7	



Plot #64 Radiated Emissions: 30 MHz – 1 GHz

Channel: High



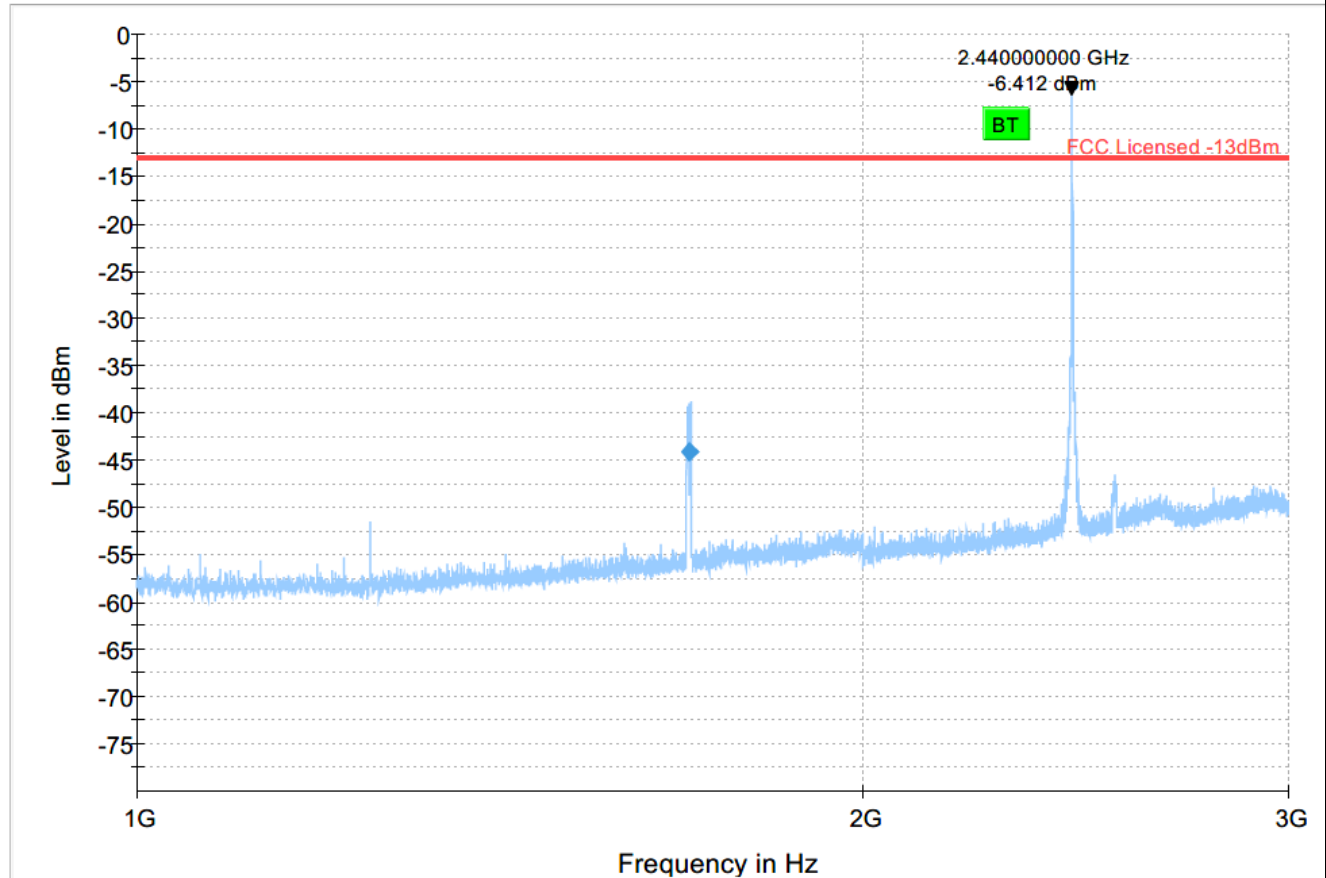
Preview Result 1-PK+ * Critical_Freqs PK+ FCC Licensed -13dBm Final_Result RM

Plot #65 Radiated Emissions: 1-3 GHz

Channel: High

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
1694.750	-44.13	-13.00	31.13	500.0	1000.000	263.0	H	144.0	-88.8	



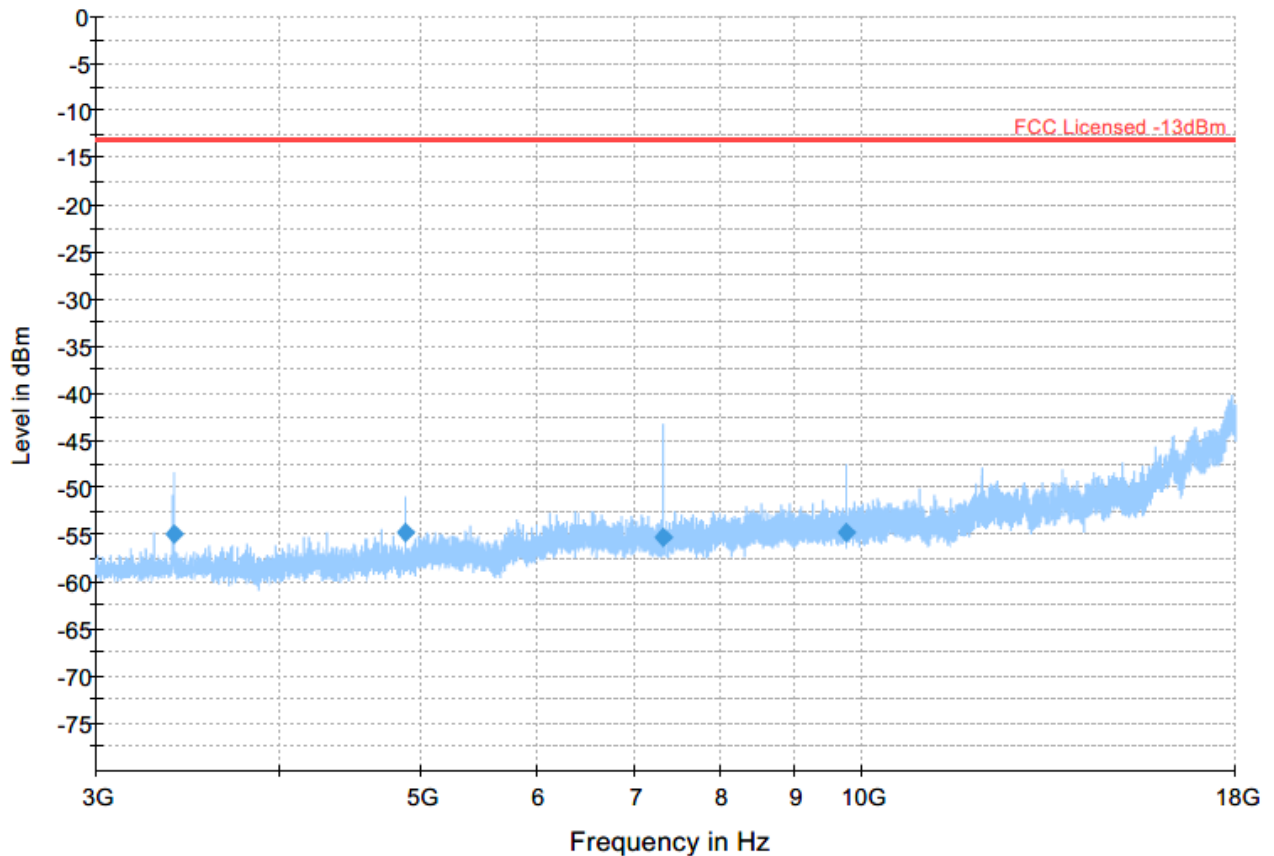
Preview Result 1-PK+ FCC Licensed -13dBm Final_Result RMS

Plot #66 Radiated Emissions: 3-18 GHz

Channel: High

Final Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Comment
3390.500	-55.00	-13.00	42.00	500.0	1000.000	152.0	V	174.0	-103.3	
4880.000	-54.77	-13.00	41.77	500.0	1000.000	175.0	V	149.0	-100.2	
7321.000	-55.33	-13.00	42.33	500.0	1000.000	140.0	V	137.0	-95.7	
9759.000	-54.84	-13.00	41.84	500.0	1000.000	140.0	V	250.0	-93.5	



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

8 Test setup photos

Setup photos are included in supporting file name: "EMC_CALAM-116-20001_FCC_Setup_photos.pdf"

9 Test Equipment And Ancillaries Used For Testing

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	03/12/2020
Magnetic Loop Antenna	Loop Antenna	ETS Lindgren	6507	161344	3 years	10/30/2020
Antenna Horn 3115 SN 35111	Horn Antenna	EMCO	3115	35111	3 years	04/17/2019
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	11/23/2020
Antenna Horn 3117	Horn Antenna	ETS Lindgren	3117-PA	169547	3 years	09/01/2020
EMI Receiver/Analyzer	EMI Receiver/Analyzer	R&S	ESU 40	1000251-KB	3 years	07/16/2019
Thermometer Humidity	Thermometer Humidity	Control Company	36934-164	191871994	2 Year	1/10/2019

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.

10 Revision History

Date	Template Revision	Changes to report	Prepared by
2020-12-08	EMC_CALAM-116-20001_FCC_22_24_27	Initial Version	Kevin Wang
2020-12-17	EMC_CALAM-116-20001_FCC_22_24_27_Rev1	Updated the antenna gain in section 3.1 and 7.1	Kevin Wang

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