FCC Test Report

For:
Rivian Automotive, LLC

Model #:
Telematics Control Module

Product Description:
The Telematics Control Module (TCM) is a connectivity module integrated into a vehicular application.

FCC ID: 2AW3A-1NAT20TCM

Applied Rules and Standards:
47 CFR Part 15.407 (UNII) & 5 GHz (UNII)

REPORT #: EMC_RIVIA-008-21001_FCC_15.407_Wi-Fi_UNII_Rev1

DATE: 5/21/2021

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.

No deviations were ascertained.

According to section 5 of this report, the overall result is Pass.

Company	Description	Model #
Rivian Automotive, LLC	The Telematics Control Module (TCM) is a connectivity module integrated into a vehicular application.	Telematics Control Module

Responsible for Testing Laboratory:

Date	Section	Name	Signature
5/21/2021	Compliance	Wang, Kevin (EMC Lab Manager)	kevin.wang@cetecom.com Digitally signed by: kevin.wang@cetecom.com DN: CN = kevin.wang@cetecom.com Date: 2021.05.24 10:17:12 -07'00'

Responsible for the Report:

Date	Section	Name	Signature
5/21/2021	Compliance	Ghanma, Issa (EMC Engineer)	Digitally signed by: Issa W Ghanma DN: CN = Issa W Ghanma email = issa.ghanma@cetecom.com C = US O = CETECOM Inc. OU = EMC Date: 2021.05.21 13:58:22 -07'00'

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:	Wang, Kevin
Responsible Project Leader:	Saman, Rami

2.2 Identification of the Client

Applicant's Name:	Rivian Automotive, LLC
Street Address:	607 Hansen Way
City/Zip Code	Palo Alto, CA 94304
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:	Telematics Control Module
FCC-ID :	2AW3A-1NAT20TCM
HW Version :	Rev. F
SW Version :	2.23
Product Description:	The Telematics Control Module (TCM) is a connectivity module integrated into a vehicular application.
Power Supply/ Rated Operating Voltage Range:	Low 9.9 V DC, Nominal 13.5 V DC, High 16.0 V DC
Operating Temperature Range:	Low -40º C, Nominal 20º C, High 85º C
Sample Revision	☐Prototype Unit; ☐Production Unit; ■Pre-Production
Antenna Information as declared:	❖ Antenna 1(Spoiler) • Type : External • Manufacturer : TE • Maximum Gain @ 5100 MHz : 3.9 dBi • Rivian part number : PT00039248 • TE part number : 955-012-201 ❖ Antenna 2 (Front) • Type : External • Manufacturer : TE • Maximum Gain @ 5400 MHz : 4.8 dBi • Rivian part number : PT00014349 • TE part number : 956-012-001

Wi-Fi Module information		
Name and number:	UBLOX JODY-W1	
FCC ID:	XPYJODYW167	
Frequency Range / number of channels:	Frequency Range (MHz)	Channel Number
	5150-5250	36-48 [4]
	5250-5350	52-64[4]
	5470-5725	100-140 [8]
	5725-5850	149-165 [5]
Modulation	802.11a/g/n/ac	OFDM
Supported data rates	IEEE Std. 802.11(xxxx)	Data Rate / MCS
	802.11a/g	6-54 Mbps
	802.11n SISO	MCS 0-7 (150 Mbps)
	802.11n 2x2 MIMO	MCS 8-15 (300 Mbps)
	802.11ac SISO	MCS 0-9 (433 Mbps)
	802.11ac 2x2 MIMO	MCS 0-9 (867 Mbps)
Supported channel bandwidth	20, 40, 80 MHz	
Other Radios included in the device:	❖ Bluetooth BR/EDR (Disabled) ❖ Bluetooth Low Energy 4.2 (Disabled) See Note 1 ❖ Wi-Fi 2.4 GHz b/g/n ❖ GPS/GNSS: • UBLOX NEO - M8L - 04A Standalone GNSS receiver • GEMALTO AIAS5 – GNSS receiver module integrated with the cellular modem	
EUT Dimensions:	13.5“ x 7.1“ x 1.1“	

Note 1: Referring to “TCM Operational Description_11May2021.pdf”; During TCM boot-up, the device does not load any Bluetooth drivers which means that the firmware is not downloaded.

3.2 EUT Sample details

EUT #	IMEI	HW Version	SW Version	Notes/Comments
1	35959910000118	Rev. F	2.23	Radiated measurement

3.3 Accessory Equipment (AE) details

AE #	Type	Rivian Part Number	TE Part Number	Manufacturer
1	External antenna LTE Main	PT00039249	955-922-501	TE
2	External antenna LTE Diversity	PT00039250	955-922-401	TE
3	Spoiler External antenna Wi-Fi/BT	PT00039248	955-012-201	TE
4	Front External antenna Wi-Fi/BT	PT00014349	956-012-001	TE
5	External antenna Aux GNSS	PT00014353	956-514-201	TE

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE#1, 2, 3, 4, 5	-

3.5 Mode of Operation details

Mode of Operation	Description of Operating modes	Additional Information
Op. 1	Wi-Fi 5 GHz UNII-1 + GSM850 Co-TX	❖ TeraTerm terminal used to communicate with the device, and sending commands provided by client, that will not available to end-user, to configure the Wi-Fi radio: • Power level : 15 dBm • Select TX paths : MIMO • Mode : 802.11ac • Transmit mode : Continuous TX • Duty cycle : ~ 100% • Hopping : No • Hopping Type : Single Frequency • Channel BW : 20 MHz • Channel : 36, 40, 48 • Data rate : MCS0 ❖ TeraTerm terminal used to communicate with the device, and sending AT commands to connect the Co-transmitter (GSM850) to the base station (CMW500).
Op. 2	Wi-Fi 5 GHz UNII-2a + GSM850 Co-TX	❖ TeraTerm terminal used to communicate with the device, and sending commands provided by client, that will not available to end-user, to configure the Wi-Fi radio: • Power level : 15 dBm • Select TX paths : MIMO • Mode : 802.11ac • Transmit mode : Continuous TX • Duty cycle : ~ 100% • Hopping : No • Hopping Type : Single Frequency • Channel BW : 20 MHz • Channel : 52, 60, 64 • Data rate : MCS0 ❖ TeraTerm terminal used to communicate with the device, and sending AT commands to connect the Co-transmitter (GSM850) to the base station (CMW500).

Op. 3	Wi-Fi 5 GHz UNII-2c + GSM850 Co-TX	❖ TeraTerm terminal used to communicate with the device, and sending commands provided by client, that will not available to end-user, to configure the Wi-Fi radio: • Power level : 15 dBm • Select TX paths : MIMO • Mode : 802.11n • Transmit mode : Continuous TX • Duty cycle : ~ 100% • Hopping : No • Hopping Type : Single Frequency • Channel BW : 20 MHz • Channel : 100, 116, 140 • Data rate : MCS8 ❖ TeraTerm terminal used to communicate with the device, and sending AT commands to connect the Co-transmitter (GSM850) to the base station (CMW500).
Op. 4	Wi-Fi 5 GHz UNII-3 + GSM850 Co-TX	❖ TeraTerm terminal used to communicate with the device, and sending commands provided by client, that will not available to end-user, to configure the Wi-Fi radio: • Power level : 15 dBm • Select TX paths : MIMO • Mode : 802.11n • Transmit mode : Continuous TX • Duty cycle : ~ 100% • Hopping : No • Hopping Type : Single Frequency • Channel BW : 40 MHz • Channel : 151,159 • Data rate : MCS8 ❖ TeraTerm terminal used to communicate with the device, and sending AT commands to connect the Co-transmitter (GSM850) to the base station (CMW500).

Note: Refer to “TCM Operational Description_11May2021.pdf” for Wi-Fi RF Power setting table.

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 possible duty cycle and output power.

For radiated measurements;

- All data in this report show the worst case of Wi-Fi radio in simultaneous transmission mode with GSM850, transmitting at the highest output power band representing worst case transmission mode.
- All data in this report show 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 15.407 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under:

- FCC ID: 2AW3A-1NAT20TCM

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.407(e)	Emission Bandwidth	Nominal	-	☐	☐	■	See Note 1 See Note 2
§15.407(a)	Power Spectral Density	Nominal	-	☐	☐	■	See Note 1 See Note 2
§15.407(a)	Maximum Output Power	Nominal	-	☐	☐	■	See Note 1 See Note 2
§15.407; 15.205	Band Edge Compliance	Nominal	-	☐	☐	■	See Note 1 See Note 2
§15.407(b); §15.209; 15.205	Radiated TX Spurious Emissions	Nominal	Op.1 Op.2 Op.3 Op.4	■	☐	☐	Complies
§15.207(a)	AC Conducted Emissions	Nominal	-	☐	■	☐	See Note 1 See Note 3

Note 1: NA= Not Applicable; NP= Not Performed.
Note 2: Leveraged from UBLOX JODY-W1 certification report # MDE_UBLOX_1828_FCCf under FCC: XPYJODYW167;
Note 3: The EUT is powered by a vehicular 12 V DC; hence this test does not apply.

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=1.

Radiated measurement

9 kHz to 30 MHz	±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)

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

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:

1/18/2021 – 1/28/2021

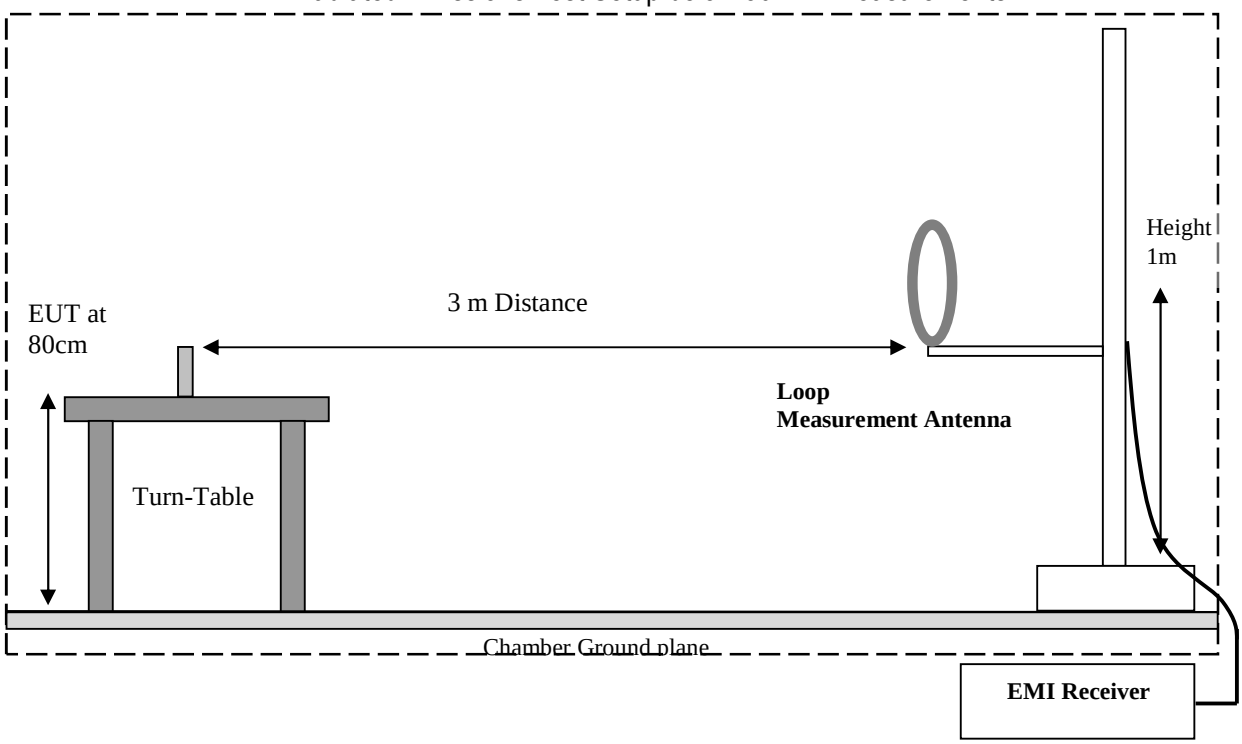
7 Measurement Procedures

7.1 Radiated Measurement

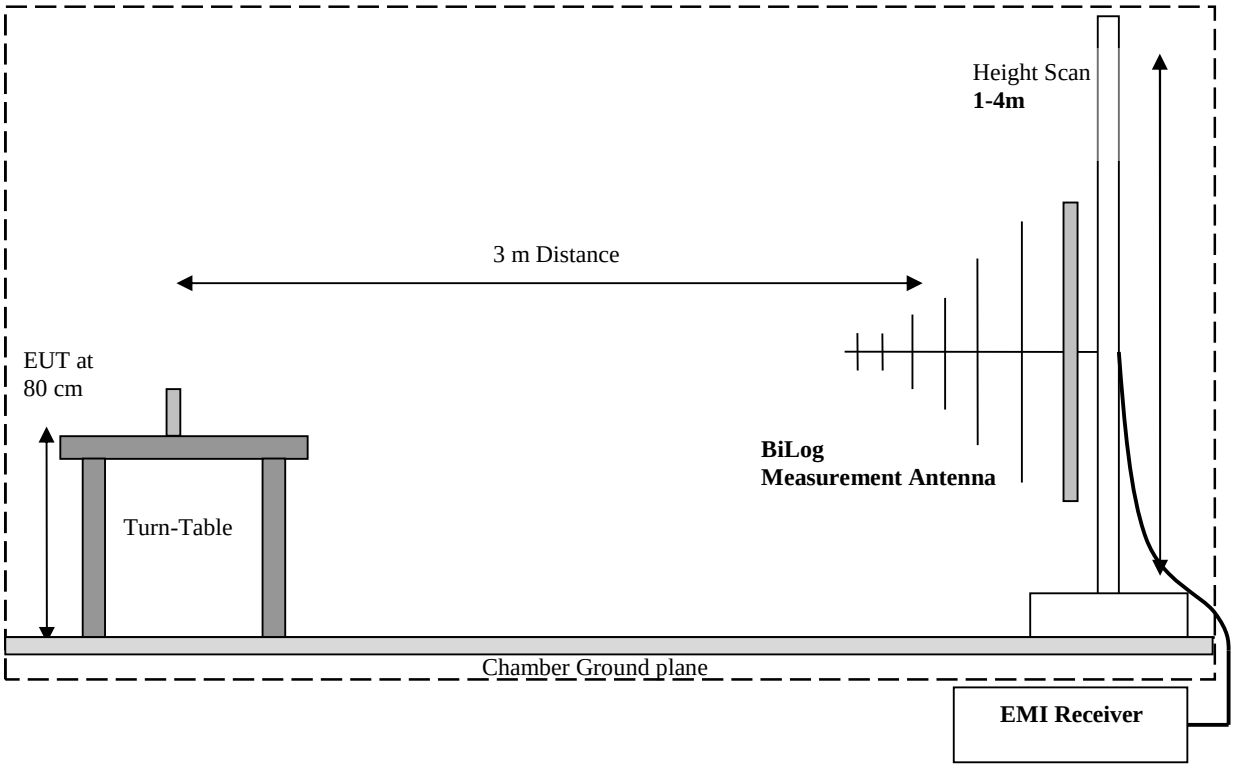
The radiated measurement is performed according to ANSI C63.10 (2013)

- 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 axes 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 the frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and all supported modulations.
- In case there are no emissions above the 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.

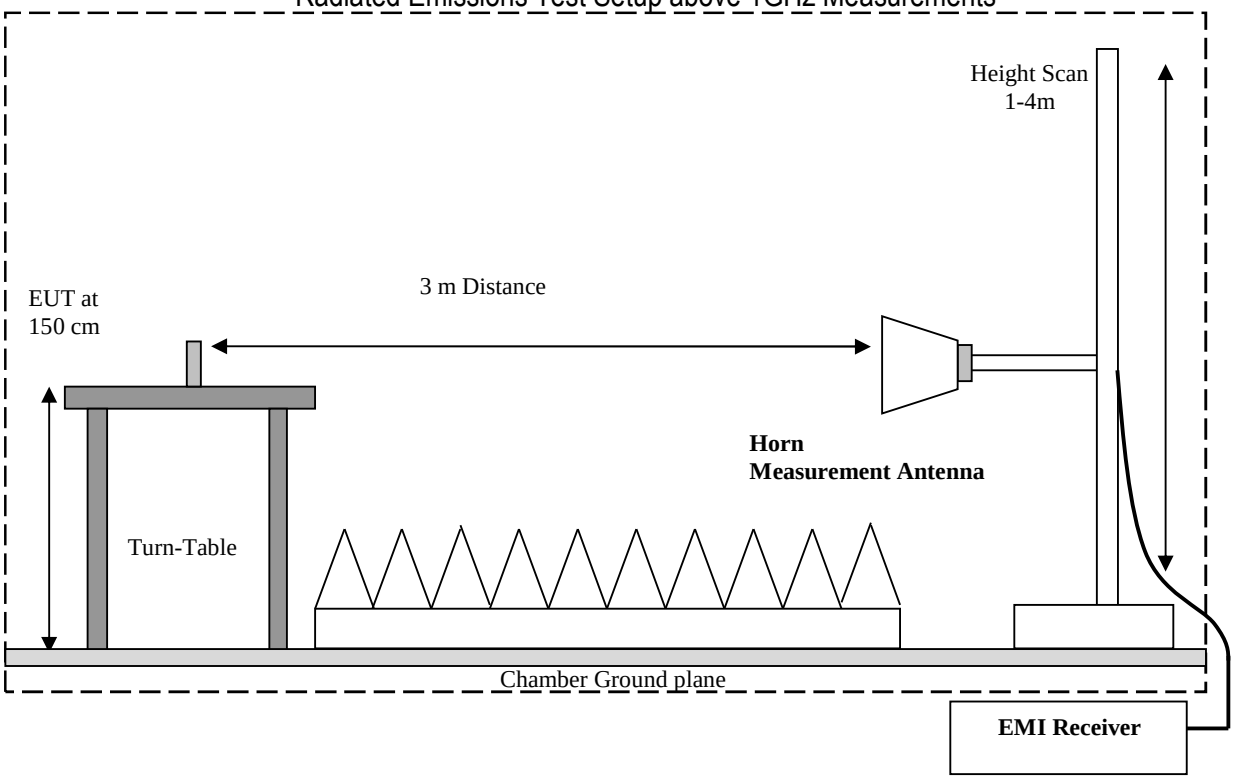
Radiated Emissions Test Setup below 30MHz Measurements



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 dBµV
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 (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

8 Test Result Data

8.1 Combining emissions and computing directional and array gain from devices with multiple outputs, and EIRP

8.1.1 According KDB 662911;

- E) 1) In-Band Power Measurements
  - The measure-and-sum technique shell be used for measuring in-band transmit power of a device. Total power is the sum of the conducted power levels measured at the various output ports.
- F) 2) Directional Gain Calculation for In-Band Measurements
  - d) Unequal antenna gains, with equal transmit power. For antenna gains given by G1, G2, …,$G_{N\ dBi}$
    - (i) If transmit signals are correlated then
      Directional gain = 10 log [(10^G_1 /20 + 10^G_2 /20 + … + 10^G_N /20)2 /N_{ANT}] dBi [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

Band Frequency (MHz)	EUT Operating Mode	MIMO RMS Output power (dBm\W)	FCC limit corrected for gain > 6 dBi (dBm\W)	EIRP Accounting for directional gain (dBm\W)	Result
UNII-1 5150 – 5250	802.11ac MIMO	16.5 \ 0.045	22.61 \ 0.182	23.87 \ 0.24	Pass
UNII-2a 5250 – 5230	802.11ac MIMO	16.70 \ 0.047	22.61 \ 0.182	24.07 \ 0.26	Pass
UNII-2c 5470 – 5725	802.11n MIMO	16.30 \ 0.043	22.61 \ 0.182	23.67 \ 0.23	Pass
UNII-3 5725 – 5850	802.11n MIMO	19.80 \ 0.095	28.63 \ 0.729	27.17 \ 0.52	Pass

- Directional gain = 10*Log_{10}[(10^(3.9 /20) + 10^(4.8 /20)^2 /2] → 7.37 dBi
- Limit corrected for gain > 6 dBi
  - UNII-1, UNII-2a, UNII-2c = 23.98-(7.37-6) → 22.61 dBm → 0.182 W
  - UNII-3 = 30-(7.37-6) → 28.63 dBm → 0.729 W

8.1.2 According KDB 905462 D06 802.11 Channel Plans New Rules V02;

- UNII-1 Additional rule for outdoor operation: Max_EIRP < 125 mW (21 dBm) at any elevation angel > 30° from horizon.

Band Frequency (MHz)	EUT Operating Mode	Antenna	MAX_EIRP Angel > 30° (dB)	EIRP Sum*1 (dBm)	Accounting for directional gain*2 (dBm)	Limit (dBm)	Result
UNII-1 5200	802.11ac MIMO	Spoiler External antenna	12.66	14.69	17.70	21	Pass
UNII-1 5200	802.11ac MIMO	Front External antenna	10.42				

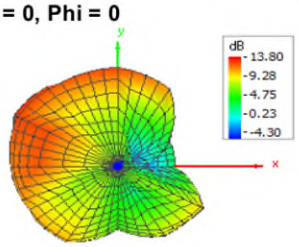
*1: $10*Log_{10}(10^{(12.66/10)} + 10^{(10.42/10)} = 14.69$ dBm
*2: $10*Log_{10}(N_{ANT})$ + Sum of EIRP → 3.01 + 14.69 =17.70 dBm

Plot # 1 EIRP elevation angel > 30 o		
Tx Frequency: 5200 MHz	Mode: 802.11ac	Spoiler antenna

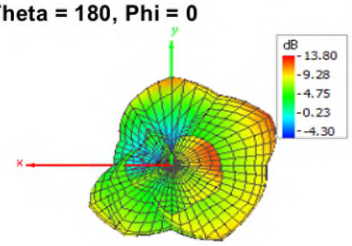
RP_5200.000_tot

Azimuth (deg)	Elevation 0 deg (dB)	Elevation 30 deg (dB)	Elevation 60 deg (dB)	Elevation 90 deg (dB)	Elevation 120 deg (dB)	Elevation 150 deg (dB)
0.00	6.33	-0.10	-3.00	3.25	2.86	6.18
30.00	6.33	-2.85	3.80	3.63	-2.13	3.88
60.00	6.33	0.63	11.05	8.07	2.18	4.53
90.00	6.33	7.23	12.66	11.73	-4.30	1.42
120.00	6.33	8.20	12.29	10.23	6.69	4.61
150.00	6.33	12.40	12.63	13.80	10.47	6.23
180.00	6.33	12.25	11.45	9.80	9.02	6.78
210.00	6.33	7.54	10.68	9.41	9.69	8.08
240.00	6.33	8.60	10.48	10.56	10.11	6.71
270.00	6.33	4.65	5.27	6.25	6.00	8.59
300.00	6.33	2.50	8.30	9.85	8.80	3.99
330.00	6.33	7.14	9.77	10.22	6.28	5.79
360.00	6.33	-0.10	-3.00	3.25	2.86	6.18

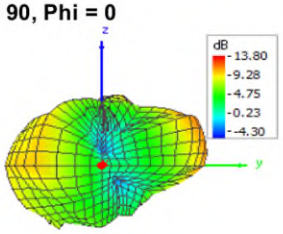
Theta = 0, Phi = 0



Theta = 180, Phi = 0



Theta = 90, Phi = 0



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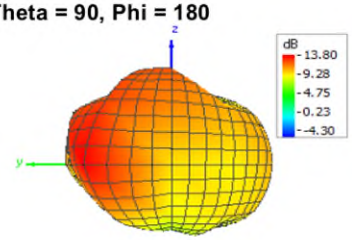

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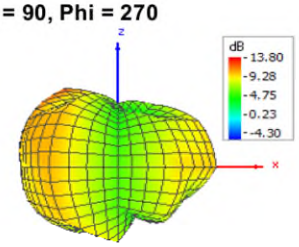

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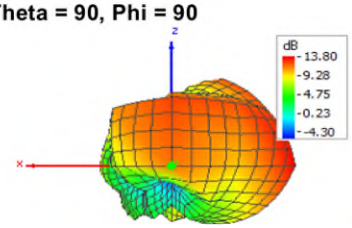
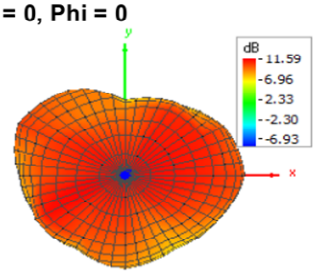


Plot # 2 EIRP elevation angel > 30 o		
Tx Frequency: 5200 MHz	Mode: 802.11ac	Front antenna

RP_5200.000_tot

Azimuth (deg)	Elevation 0 deg (dB)	Elevation 30 deg (dB)	Elevation 60 deg (dB)	Elevation 90 deg (dB)	Elevation 120 deg (dB)	Elevation 150 deg (dB)
0.00	11.59	10.87	10.01	6.58	5.27	1.68
30.00	11.59	11.02	9.31	5.25	1.42	3.44
60.00	11.59	10.82	6.81	2.78	-5.53	-5.40
90.00	11.59	9.19	5.17	4.00	-6.93	-4.07
120.00	11.59	9.33	9.38	7.64	1.00	1.19
150.00	11.59	10.51	10.42	7.22	3.32	3.14
180.00	11.59	10.15	8.07	5.69	2.90	0.82
210.00	11.59	11.34	7.28	6.09	4.42	0.60
240.00	11.59	10.06	6.90	5.59	2.08	2.54
270.00	11.59	9.82	8.53	6.06	0.36	0.63
300.00	11.59	8.81	7.21	5.41	1.86	1.11
330.00	11.59	10.22	8.21	6.95	7.16	0.91
360.00	11.59	10.87	10.01	6.58	5.27	1.68

Theta = 0, Phi = 0



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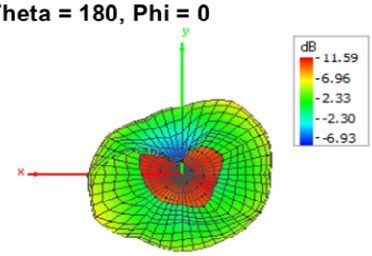

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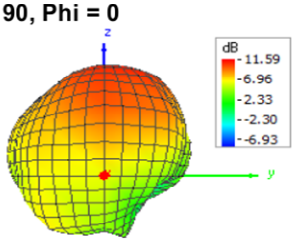
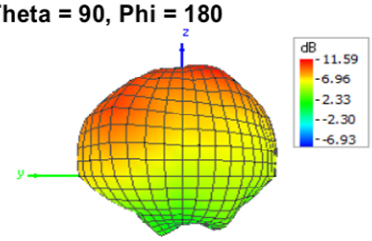
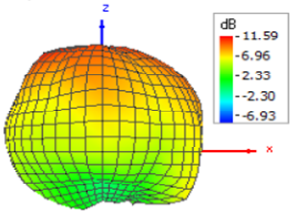


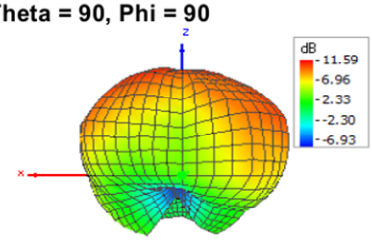
Theta = 90, Phi = 180



Theta = 90, Phi = 270



Theta = 90, Phi = 90



8.2 Band Edge Compliance

8.2.1 Unwanted Emissions in the Restricted Bands:

a) For all measurements, follow the requirements in II.G.3. "*General Requirements for Unwanted Emissions Measurements.*"
b) At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in II.G.5 and II.G.6., respectively, must satisfy the respective peak and average limits. If all peak measurements satisfy the average limit, then average measurements are not required.

❖ Measurement according to FCC 789033 D02 General UNII Test Procedures New Rules v02r01 and ANSI C63.10 (2013)

II.G.5 Procedure for Unwanted Maximum Emissions Measurements above 1000MHz:

a) Follow the requirements in II.G.3, "General Requirements for Unwanted Emissions Measurements."
b) Maximum emission levels are measured by setting the analyzer as follows:
   (i) RBW = 1 MHz.
   (ii) VBW ≥ 3 MHz.
   (iii) Detector = Peak.
   (iv) Sweep time = auto.
   (v) Trace mode = max hold.
   (vi) Allow sweeps to continue until the trace stabilizes. Note that if the transmission is not continuous, the time required for the trace to stabilize will increase by a factor of approximately 1/x, where x is the duty cycle. For example, at 50% duty cycle, the measurement time will increase by a factor of two relative to measurement time for continuous transmission.

II.G.6 Procedure for Unwanted Maximum Emissions Measurements above 1000MHz:

a) Follow the requirements in II.G.3. "General Requirements for Unwanted Emissions Measurements."
b) Average emission levels shall be measured using one of the following two methods.
c) Method AD (Average Detection): Primary method
   (i) RBW = 1 MHz.
   (ii) VBW ≥ 3 MHz.
   (iii) Detector = power averaging (rms), if span/(# of points in sweep) ≤ RBW/2. Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, the detector mode shall be set to peak.
   (iv) Averaging type = power averaging (rms)
   (v) Sweep time = auto.
   (vi) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, the number of traces shall be increased by a factor of 1/x, where x is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—rather than turning on and off with the transmit cycle, at least 100 traces shall be averaged.)

8.2.2 Unwanted Emissions that fall Outside of the Restricted Bands:

a) For all measurements, follow the requirements in II.G.3. "*General Requirements for Unwanted Emissions Measurements.*"

b) At frequencies above 1000 MHz, use the procedure for maximum emissions described in II.G.5 "*Procedure for Unwanted Emissions Measurements Above 1000 MHz.*"

(i) Sections 15.407(b)(1-3) specifies the unwanted emissions limit for the U-NII-1 and U-NII-2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz/

(ii) Section 15.407(b)(4) specifies the unwanted emissions limit for the U-NII-3, A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are based on the use of a peak detector.

8.2.3 Limits non-restricted band:

FCC§15.407 (b); RSS-247 6

- For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
- For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
- For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.
- For transmitters operating in the 5.725-5.85 GHz band: All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

8.2.4 Limits for restricted band §15.407/15.209/15.205 and RSS-Gen 8.9/8.10

- *PEAK LIMIT= 74 dBµV/m @3m =-21.23 dBm
- *AVG. LIMIT= 54 dBµV/m @3m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205

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			

8.2.5 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	Power Input
23.8°C	1	12 V dc

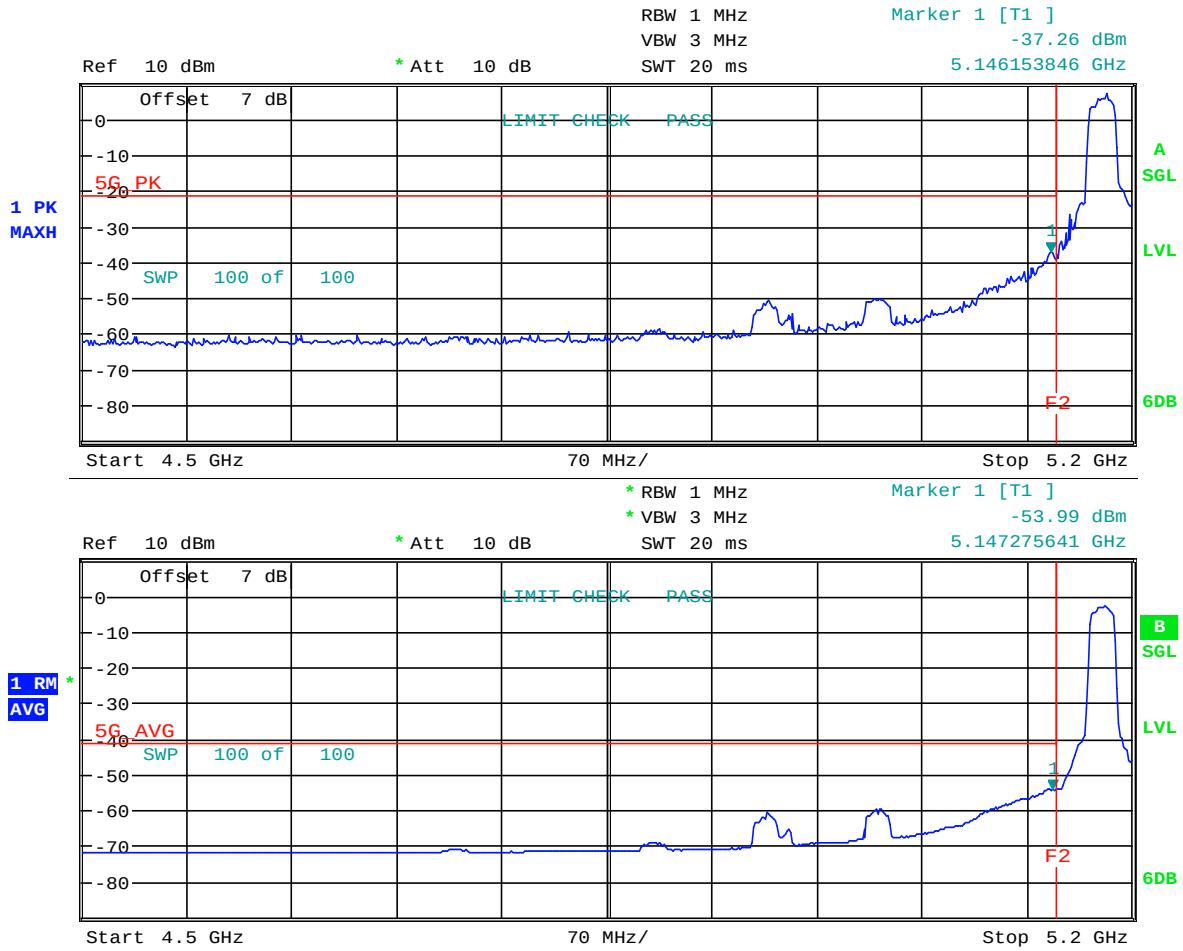
8.2.6 Measurement result:

8.2.6.1 Combining emissions and computing directional and array gain from devices with multiple outputs

According KDB 662911;

- E) 3) Out-of-Band and Spurious Emission Measurements
  - a) Absolute Emission Limits
    When performing measurements outside of the band of operation of a transmitter (i.e., out-of-band and spurious emissions), any of the three techniques below may be used to combine the emission measurements from multiple outputs prior to comparing to the emission limit. The first is the most accurate method. The second and third techniques are offered as simpler alternatives, but they may lead to overestimates of the total emission level when emission levels differ between outputs; consequently, if measurements performed using methods (ii) or (iii) exceed the emission limit, the test lab may wish to retest using method (i) before declaring that the device fails the emission test. With any of the methods, existing rules and guidance shall be applied in performing the measurements on the individual outputs and in determining the maximum permitted emission level for the device.
    - (iii) Measure and add 10 log(NANT) dB, where NANT is the number of outputs, as described in section E)2)c).
  - F) 3) Directional Gain Calculation for Conducted Out-of-Band and Spurious Measurements
  - c) Directional gain for out-of-band and spurious emissions shall be computed in the same way as for in-band signals.
    - Directional gain = $10*\text{Log}_{10}[(10\text{^}(3.9/20) + 10\text{^}(4.8/20)\text{^}2/2]$ → 7.37 dBi

4500MHz – 5150 MHz Restricted band-edge							
EUT operating mode	Band Edge	Channel #	Measured Peak/AVG Value (dBm)		EIRP Accounting for directional gain (dBm)	Limit (dBm)	Result
			Primary	Add 10Log(NANT)			
802.11n_HT20	Lower Restricted	36	Peak: -37.26	3.01	-26.88	Peak: -21.23	Pass
			AVG: -53.99	3.01	-43.61	AVG: -41.23	



low

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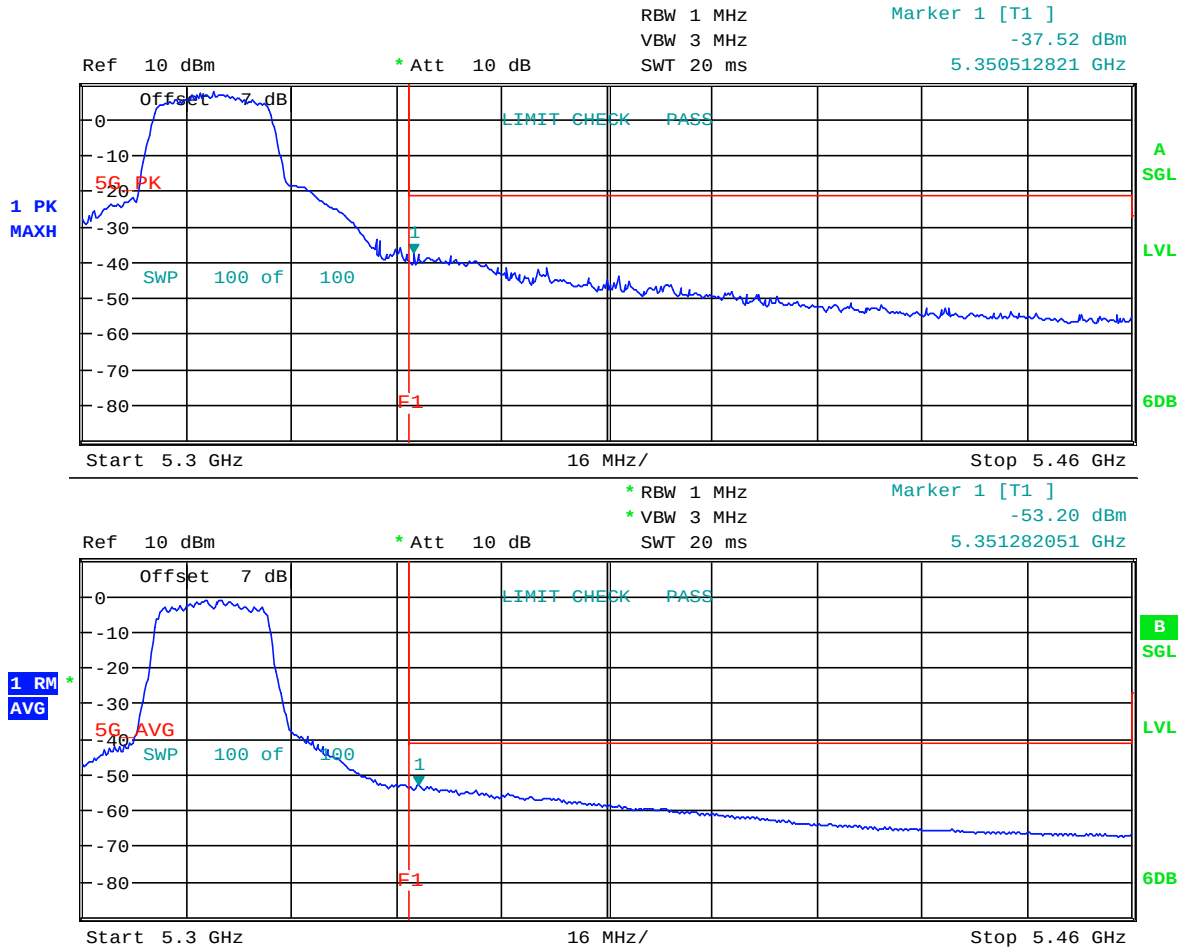
5350MHz – 5460 MHz Restricted band-edge							
EUT operating mode	Band Edge	Channel #	Measured Peak/AVG Value (dBm)		EIRP Accounting for directional gain (dBm)	Limit (dBm)	Result
			Primary	Add 10Log(NANT)			
802.11n_HT20	Upper Restricted	64	Peak: -37.52	3.01	-27.14	Peak: -21.23	Pass
			AVG: -53.20	3.01	-28.49	AVG: -41.23	



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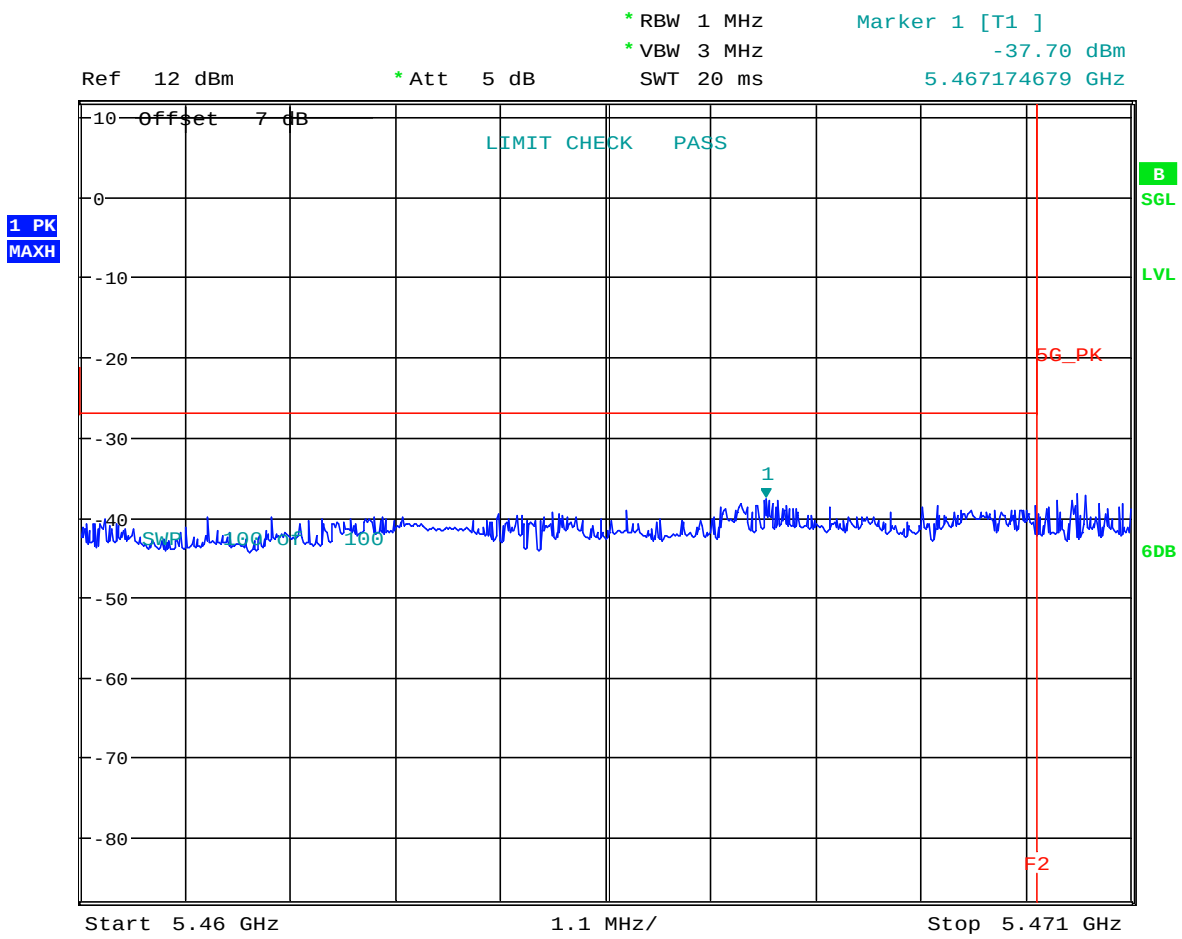
5460 – 5470 MHz Non-Restricted band-edge

EUT operating mode	Band Edge	Channel #	Measured Peak/AVG Value (dBm)		EIRP Accounting for directional gain (dBm)	Limit (dBm)	Result
			Primary	Add 10Log(NANT)			
802.11n_HT20	Lower Non-Restricted	100	-37.70	3.01	-27.32	-27	Pass



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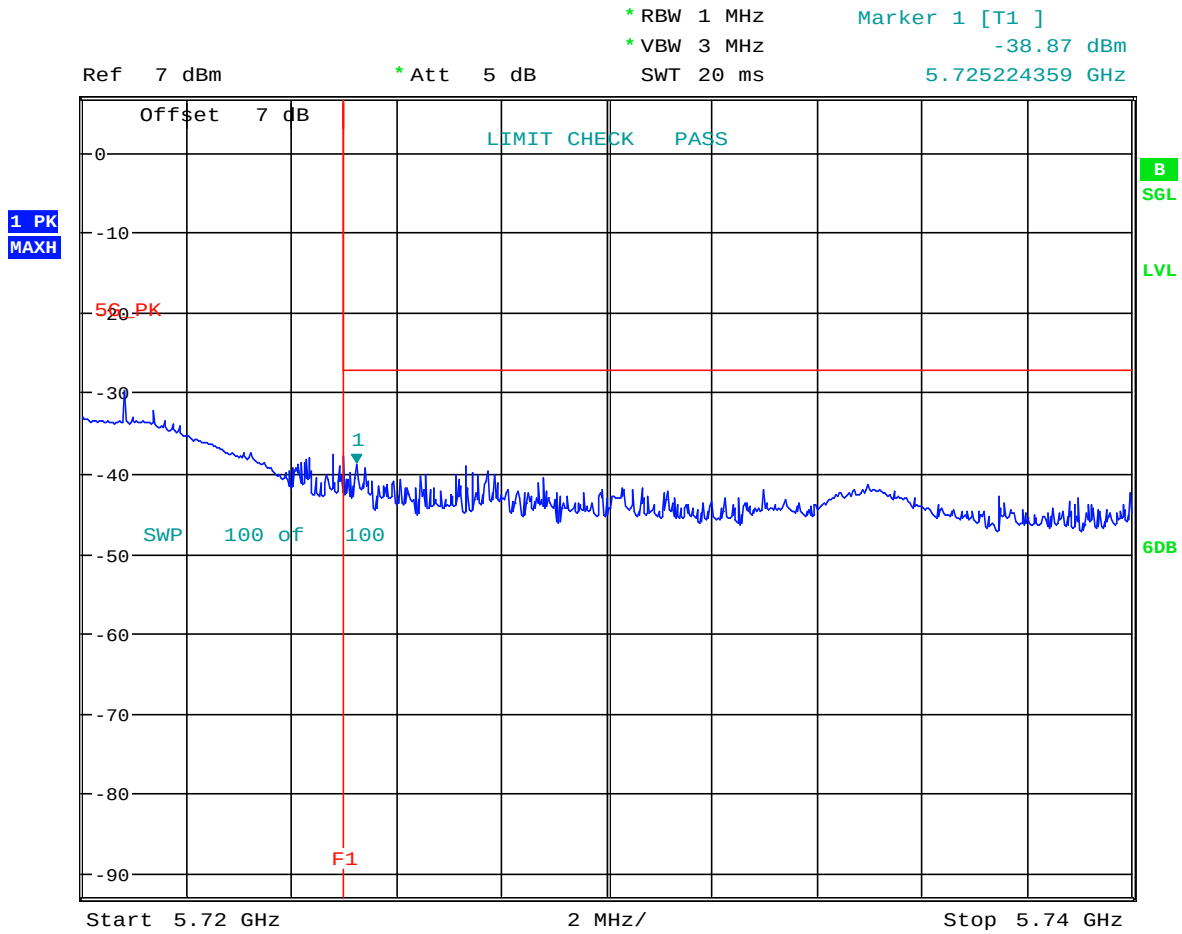
5725 – 5740 MHz Non-Restricted band-edge

EUT operating mode	Band Edge	Channel #	Measured Peak/AVG Value (dBm)		EIRP Accounting for directional gain (dBm)	Limit (dBm)	Result
			Primary	Add 10Log(NANT)			
802.11n_HT20	Lower Non-Restricted	140	-38.87	3.01	-28.49	-27	Pass



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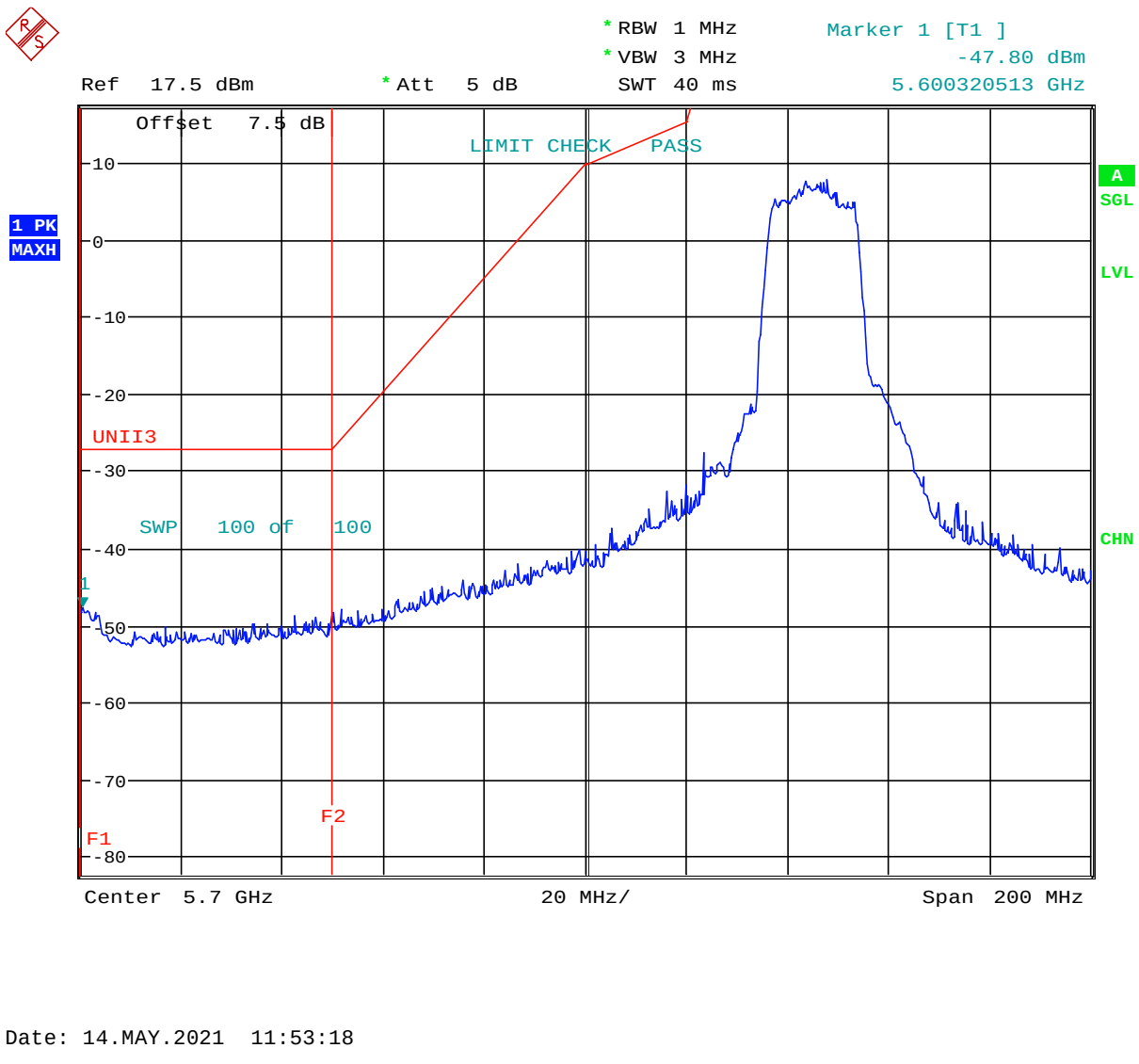
802.11n_HT20				5725 – 5850 MHz Emission mask		
Channel #	Mask frequency (MHz)	Measured AVG Value (dBm)		EIRP Accounting for directional gain (dBm)	Limit*1 (dBm)	Result
		Primary	Add 10Log(NANT)			
149	5600 – 5650	-47.80	3.01	-37.42	-27.0	Pass
149	5650 – 5700	-40.18	3.01	-29.80	8.52	Pass
149	5700 – 5720	-31.85	3.01	-21.47	15.44	Pass
149	5720 - 5725	-27.49	3.01	-17.11	23.4	Pass
149	> 5725	7.99	3.01	18.37	27.0	Pass
165	< 5850	7.35	3.01	17.73	27.0	Pass
165	5850 – 5855	-34.55	3.01	-24.17	26.64	Pass
165	5855 – 5875	-39.55	3.01	-29.17	13.7	Pass
165	5875 – 5925	-42.85	3.01	-32.47	10.0	Pass
165	5925 – 6000	-46.31	3.01	-35.93	-27.0	Pass

*1: Calculated limit using Liner Interpolation equation $y= y_1 + (x-x_1) * [(y_2-y_1)/(x_2-x_1)]$.

8.2.7 Measurement Plots:

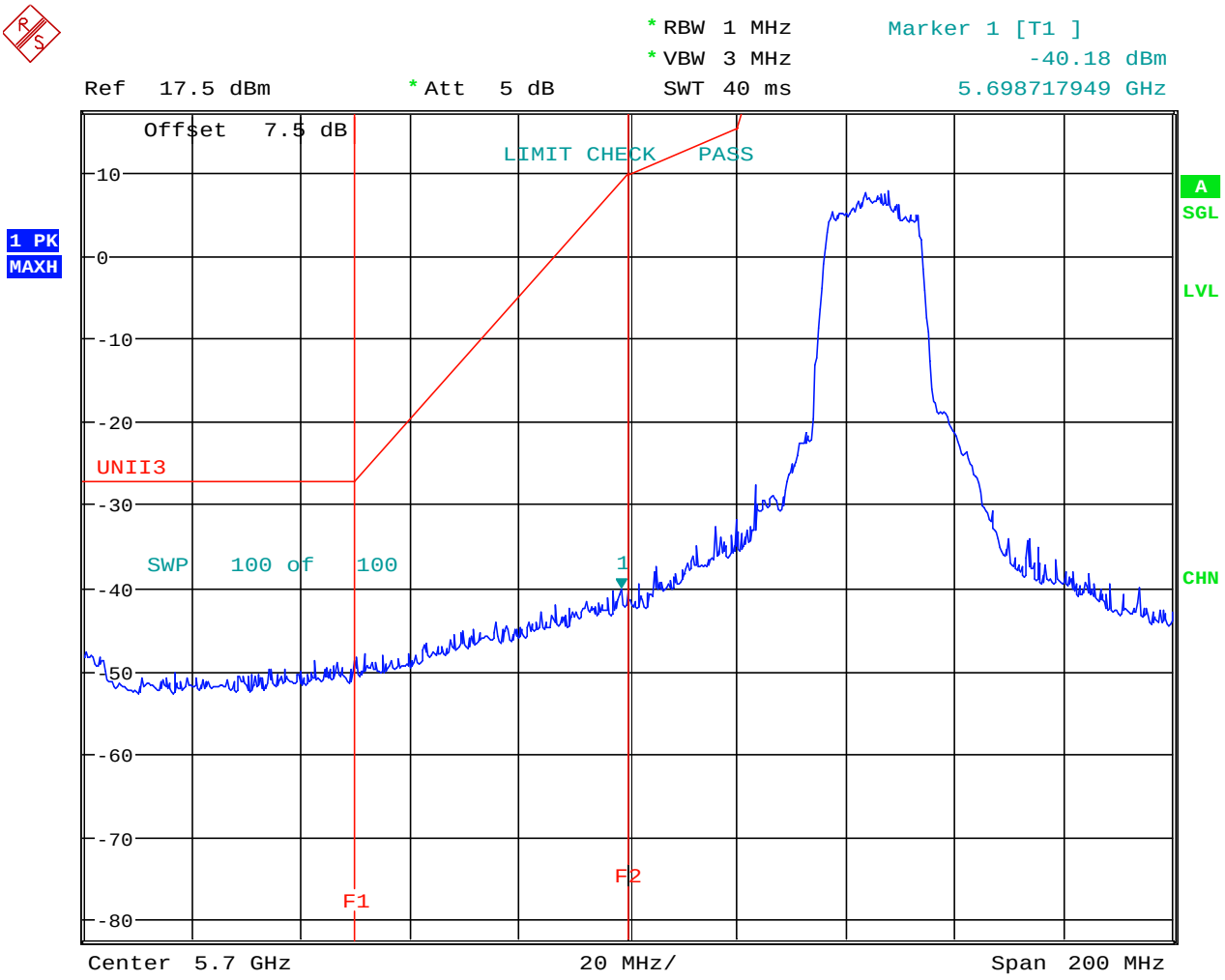
Channel: 149	Mode: 802.11n

5600 – 5650 MHz Mask



Date: 14.MAY.2021 11:53:18

5650 – 5700 MHz Mask



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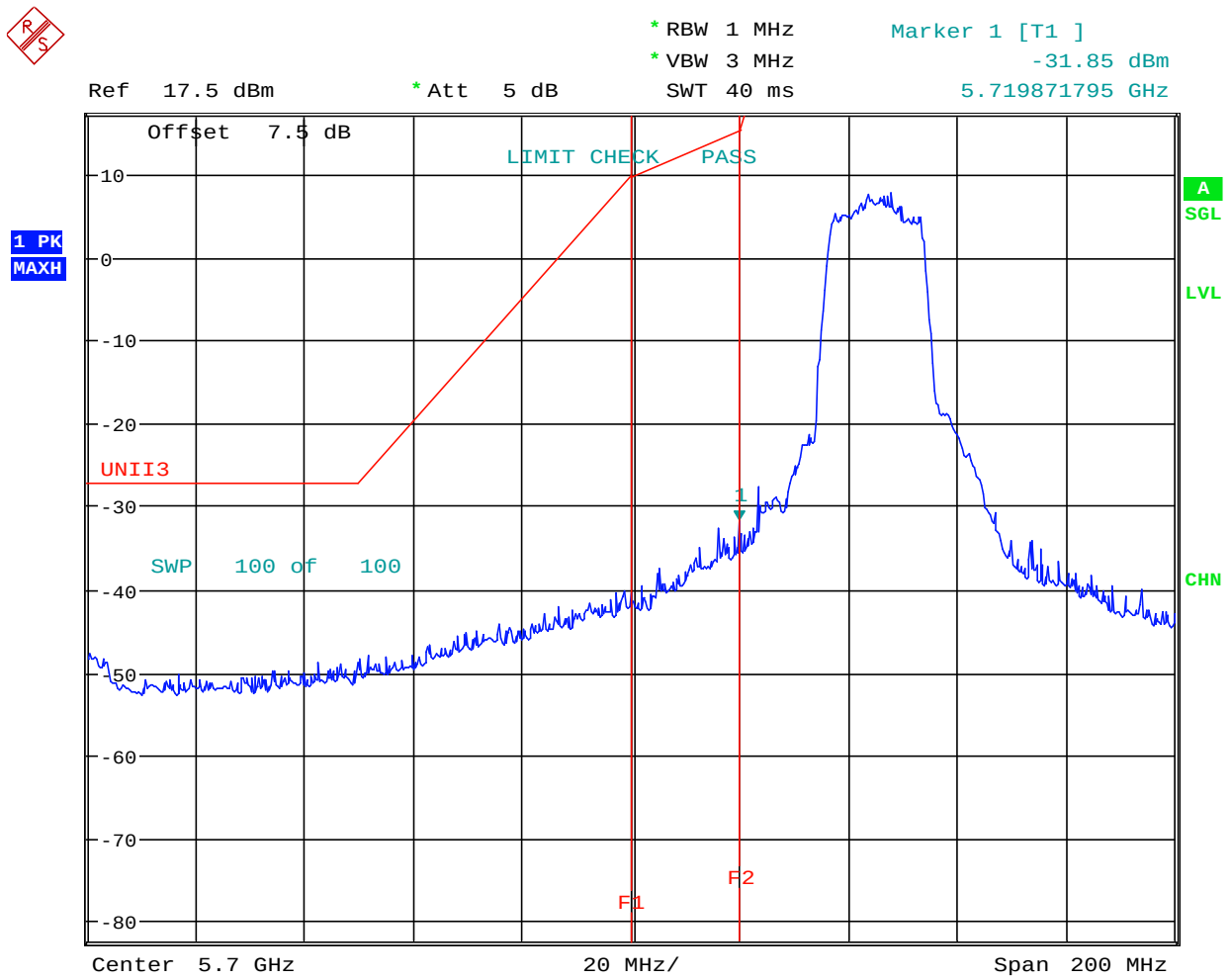
5700 – 5720 MHz Mask



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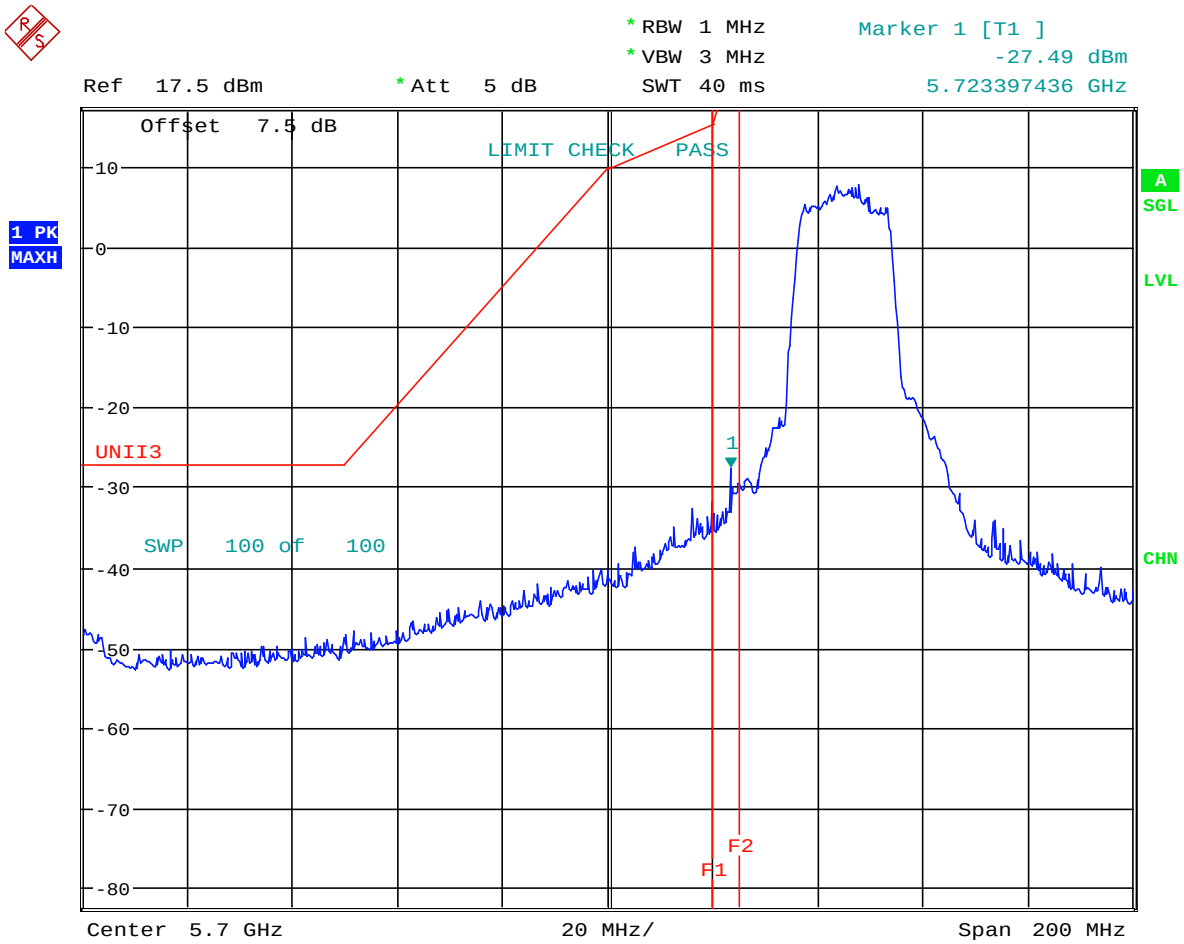
5720 – 5725 MHz Mask



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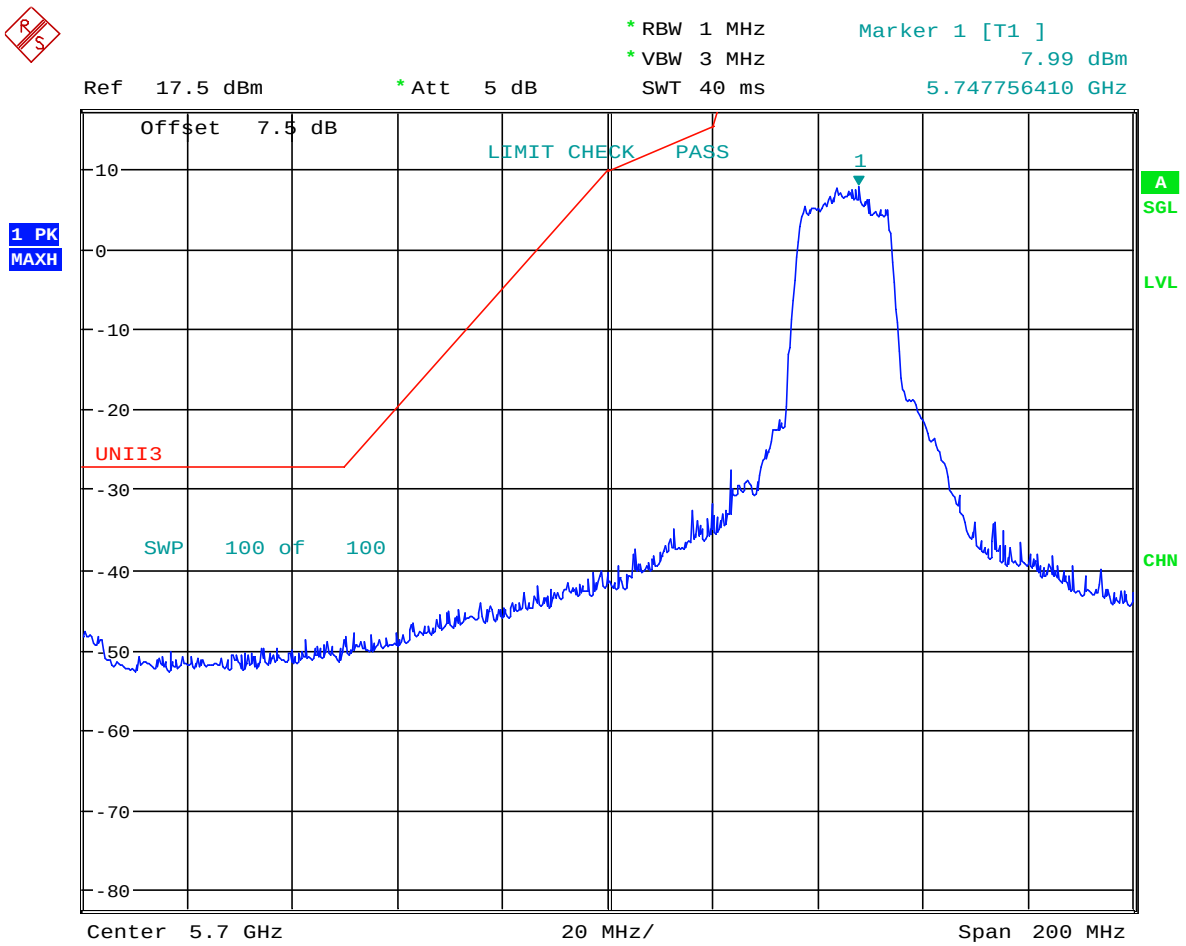
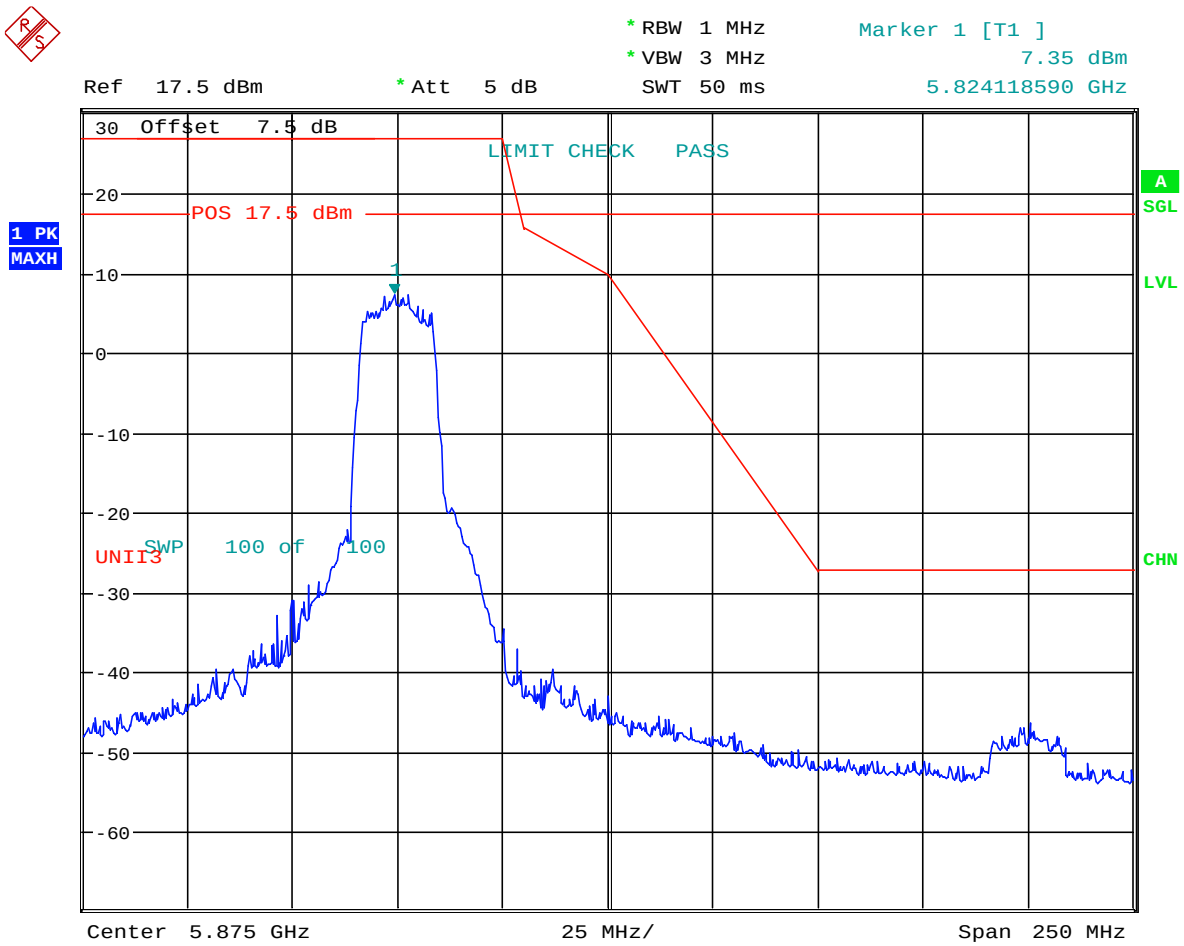
> 5725 MHz Mask



Date: 14.MAY.2021 12:02:02

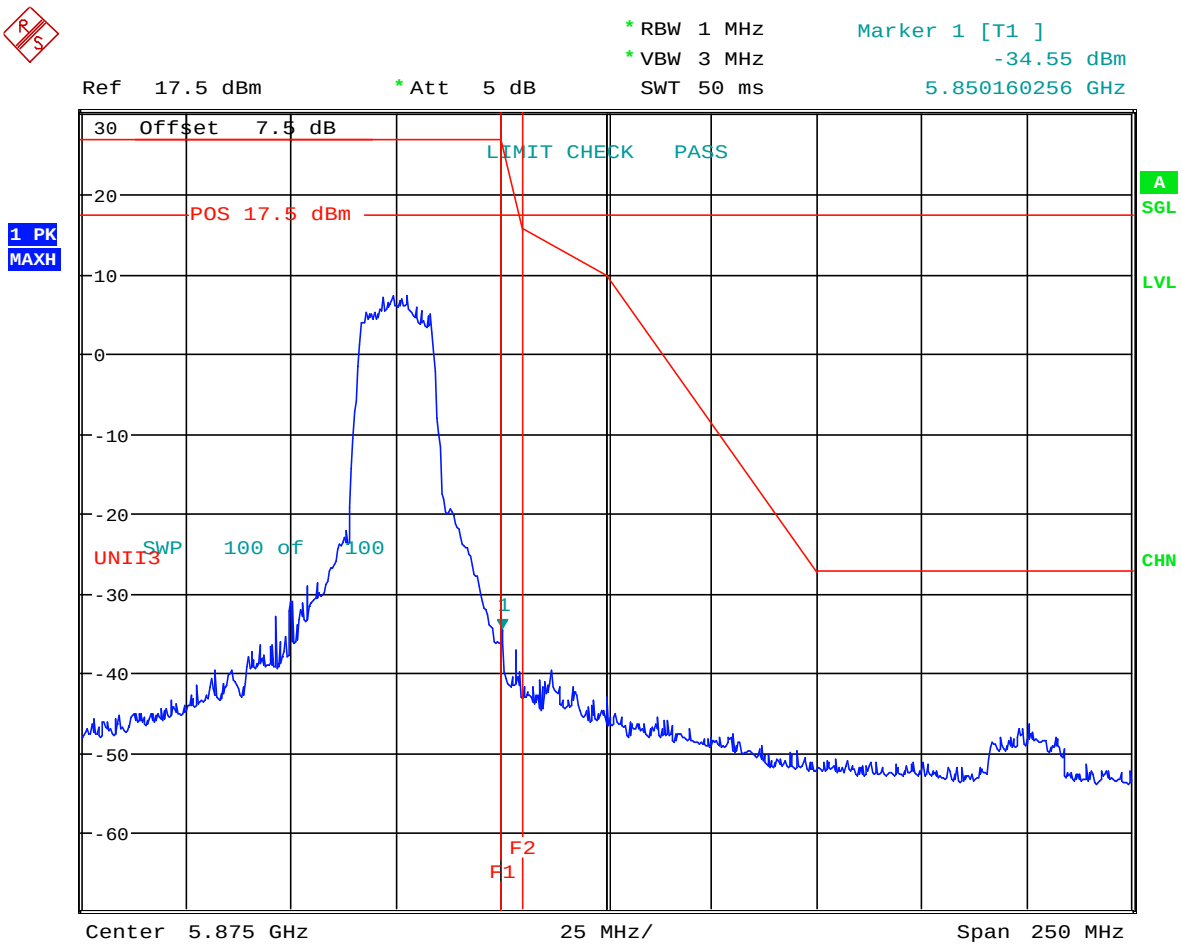
Channel: 165	Mode: 802.11n

< 5850 MHz Mask



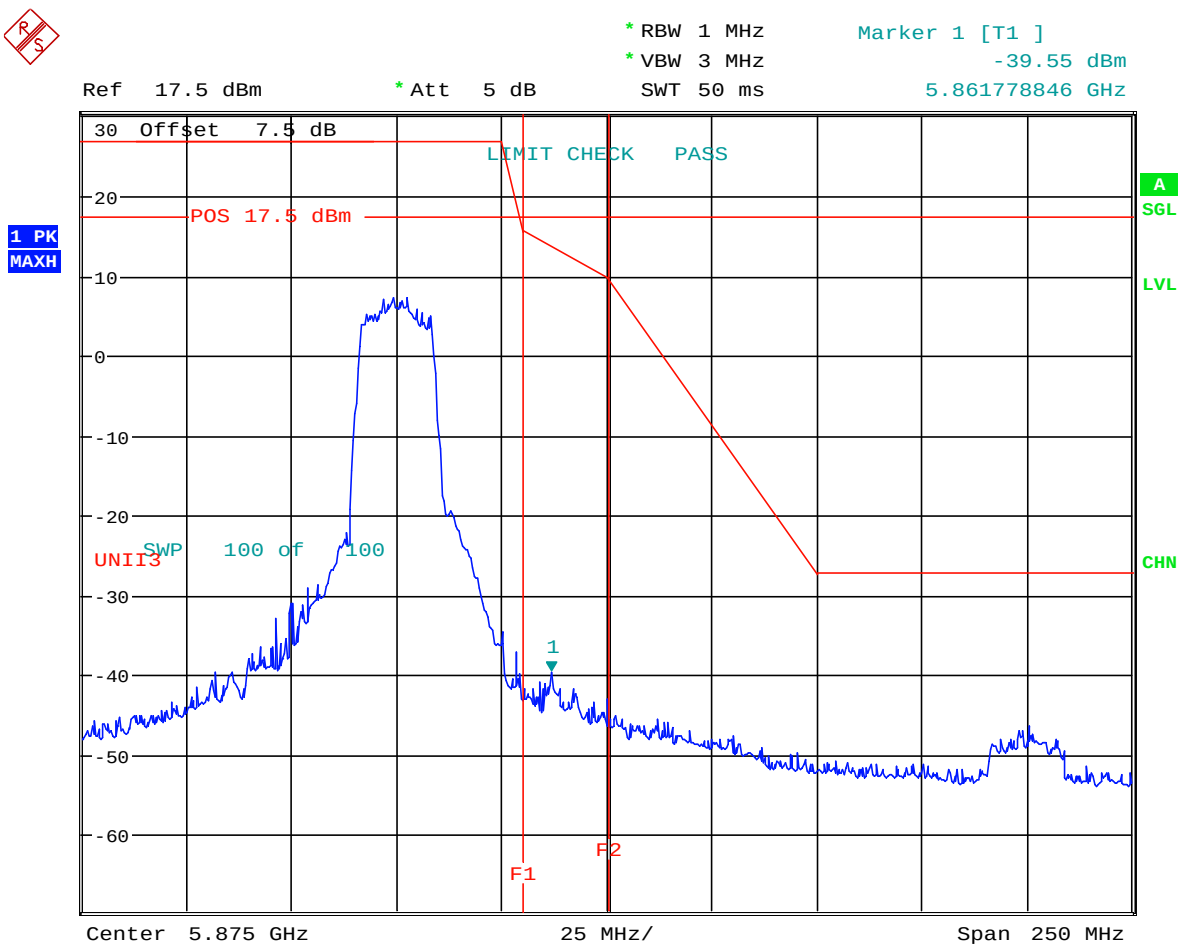
Date: 14.MAY.2021 12:10:41

5850 – 5855 MHz Mask



Date: 14.MAY.2021 12:12:56

5855 – 5875 MHz Mask



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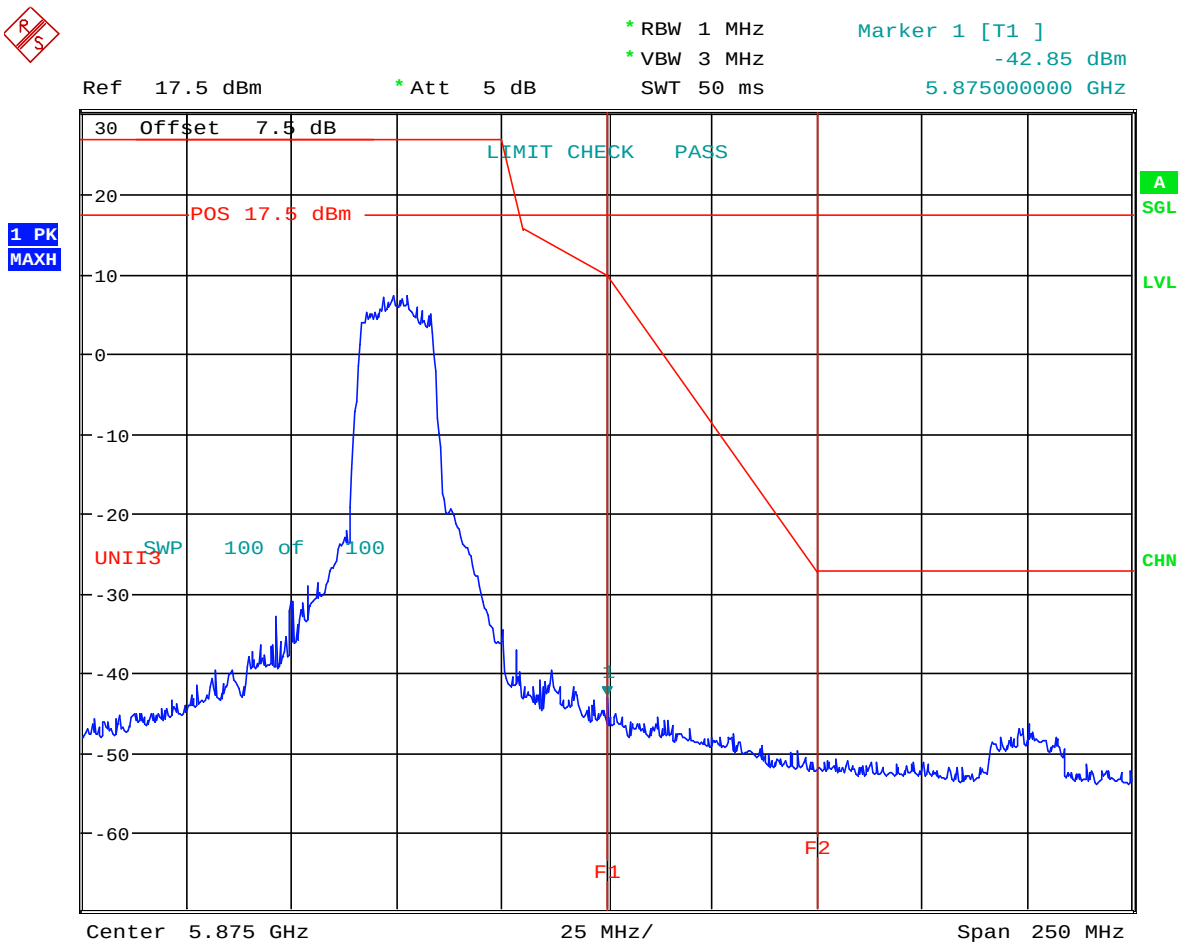
5875 – 5925 MHz Mask



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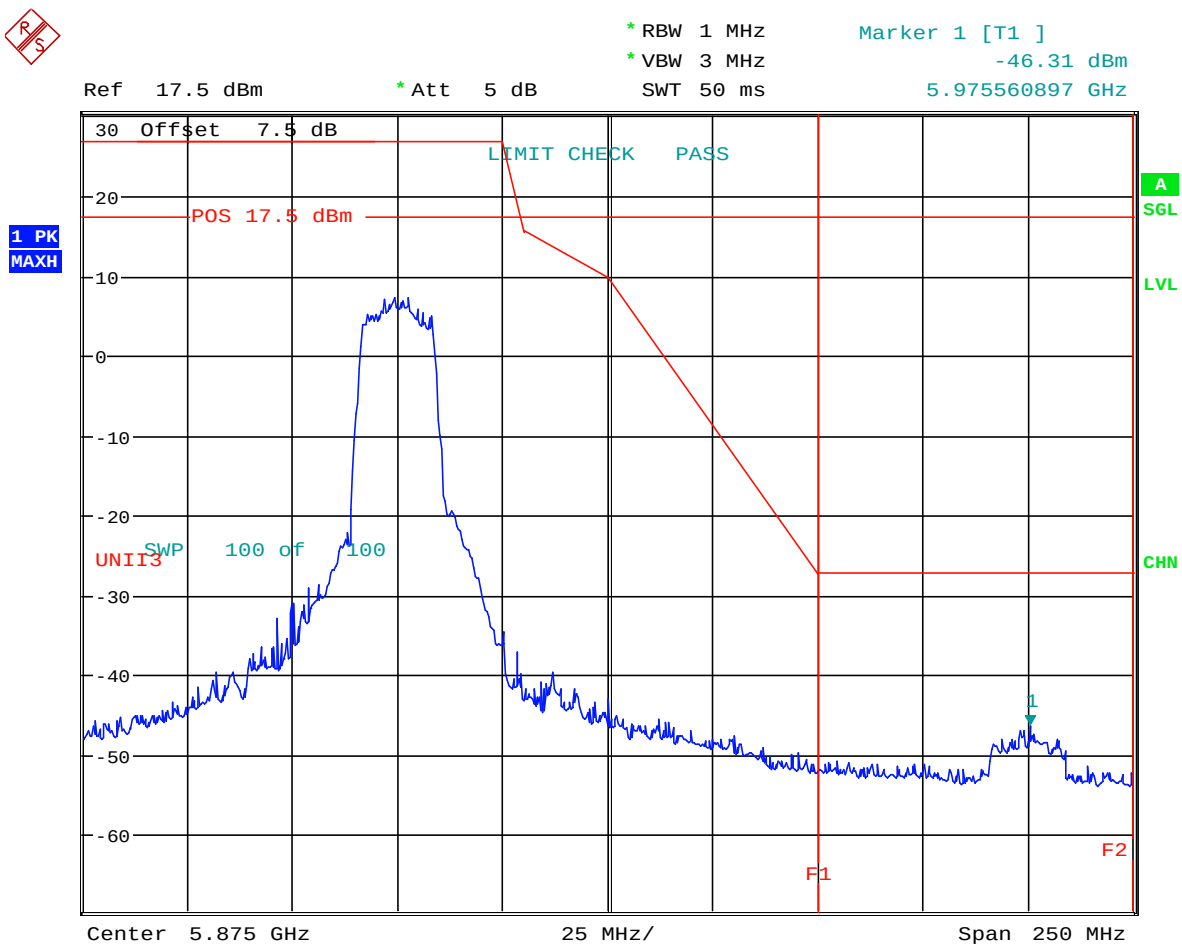
5925 – 6000 MHz Mask



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8.3 Radiated Transmitter Spurious Emissions

8.3.1 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.

8.3.2 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

- 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

- 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
[1]0.495-0.505	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

8.3.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23.8°C	1	Op.1, Op.2, Op.3, Op.4	12 V DC

8.3.4 Measurement result:

Plot #	Scan Frequency	Channel #	Op.#	Lowest margin emissions (dBµV/m)	Limit	Result
1 – 3	30 MHz – 18 GHz	Low (36)	Op.1	43.10	See section 8.1.2	Pass
4 – 8	9 kHz – 40 GHz	Mid (40)	Op.1	63.10	See section 8.1.2	Pass
9 – 11	30 MHz – 18 GHz	High (48)	Op.1	42.95	See section 8.1.2	Pass
12 – 14	30 MHz – 18 GHz	Low (52)	Op.2	40.48	See section 8.1.2	Pass
15 - 19	9 kHz – 40 GHz	Mid (60)	Op.2	40.70	See section 8.1.2	Pass
20 – 22	30 MHz – 18 GHz	High (64)	Op.2	40.60	See section 8.1.2	Pass
23 – 25	30 MHz – 18 GHz	Low (100)	Op.3	40.49	See section 8.1.2	Pass
26 – 30	9 kHz – 40 GHz	Mid (116)	Op.3	41.10	See section 8.1.2	Pass
31 - 33	30 MHz – 18 GHz	High (140)	Op.3	39.66	See section 8.1.2	Pass
34 – 36	30 MHz – 18 GHz	Low (151)	Op.4	42.90	See section 8.1.2	Pass
37 – 41	9 kHz – 40 GHz	High (159)	Op.4	54.78	See section 8.1.2	Pass

8.3.5 Measurement Plots:

8.3.5.1 UNII-1

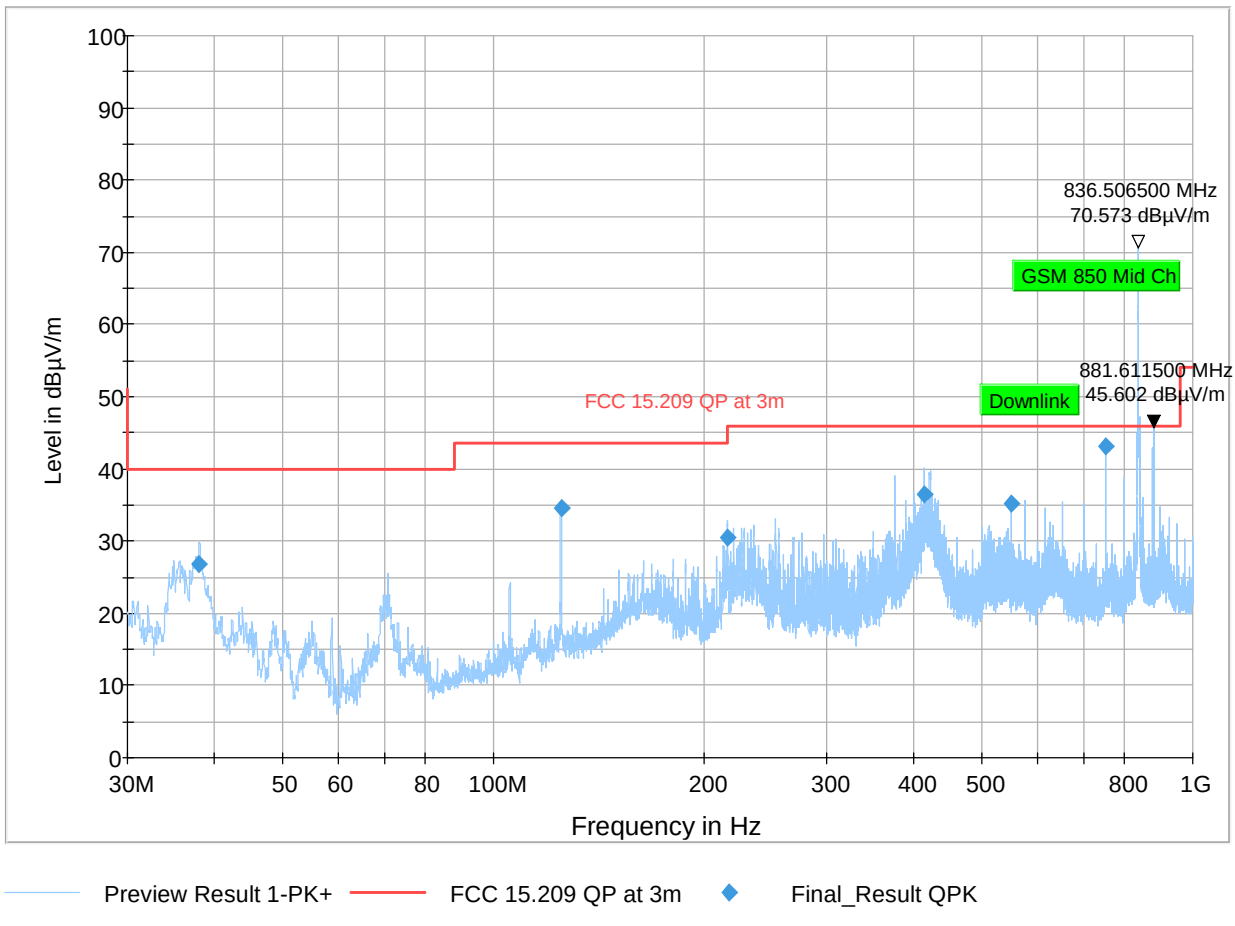
CH 36

Plot # 1 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5180 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
38.003	26.76	40.00	13.24	500.0	120.000	100.0	V	21.0	-21.2
124.963	34.59	43.50	8.91	500.0	120.000	100.0	V	117.0	-17.6
215.901	30.40	43.50	13.10	500.0	120.000	163.0	H	2.0	-22.6
413.635	36.49	46.02	9.53	500.0	120.000	100.0	H	196.0	-16.5
549.969	35.10	46.02	10.92	500.0	120.000	100.0	H	34.0	-14.0
749.983	43.10	46.02	2.92	500.0	120.000	107.0	H	203.0	-10.4

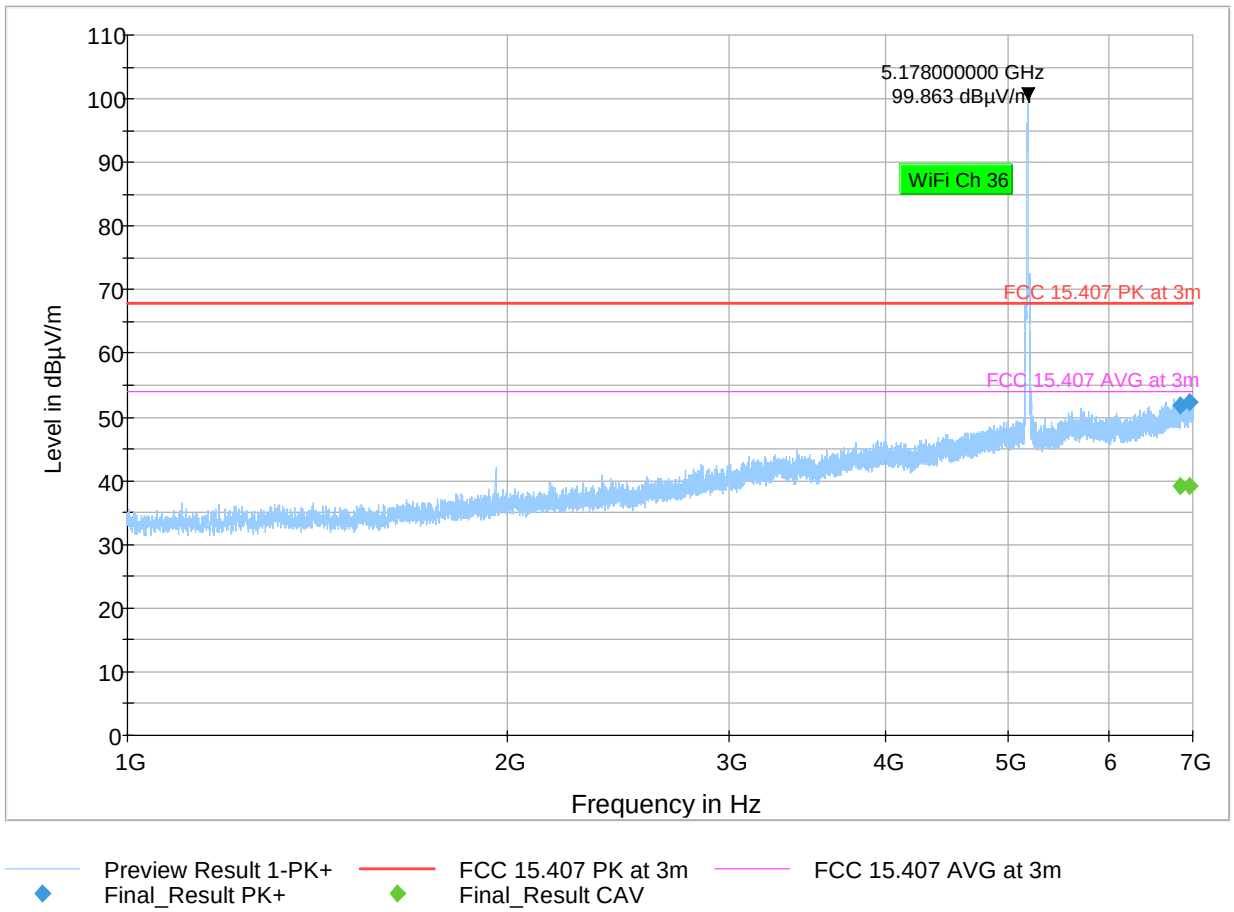


Plot # 2 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5180 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
6838.000	---	39.10	53.98	14.88	500.0	1000.000	107.0	V	136.0	18.9
6838.000	51.89	---	68.00	16.11	500.0	1000.000	107.0	V	136.0	18.9
6964.500	---	39.09	53.98	14.89	500.0	1000.000	185.0	V	278.0	19.3
6964.500	52.22	---	68.00	15.78	500.0	1000.000	185.0	V	278.0	19.3

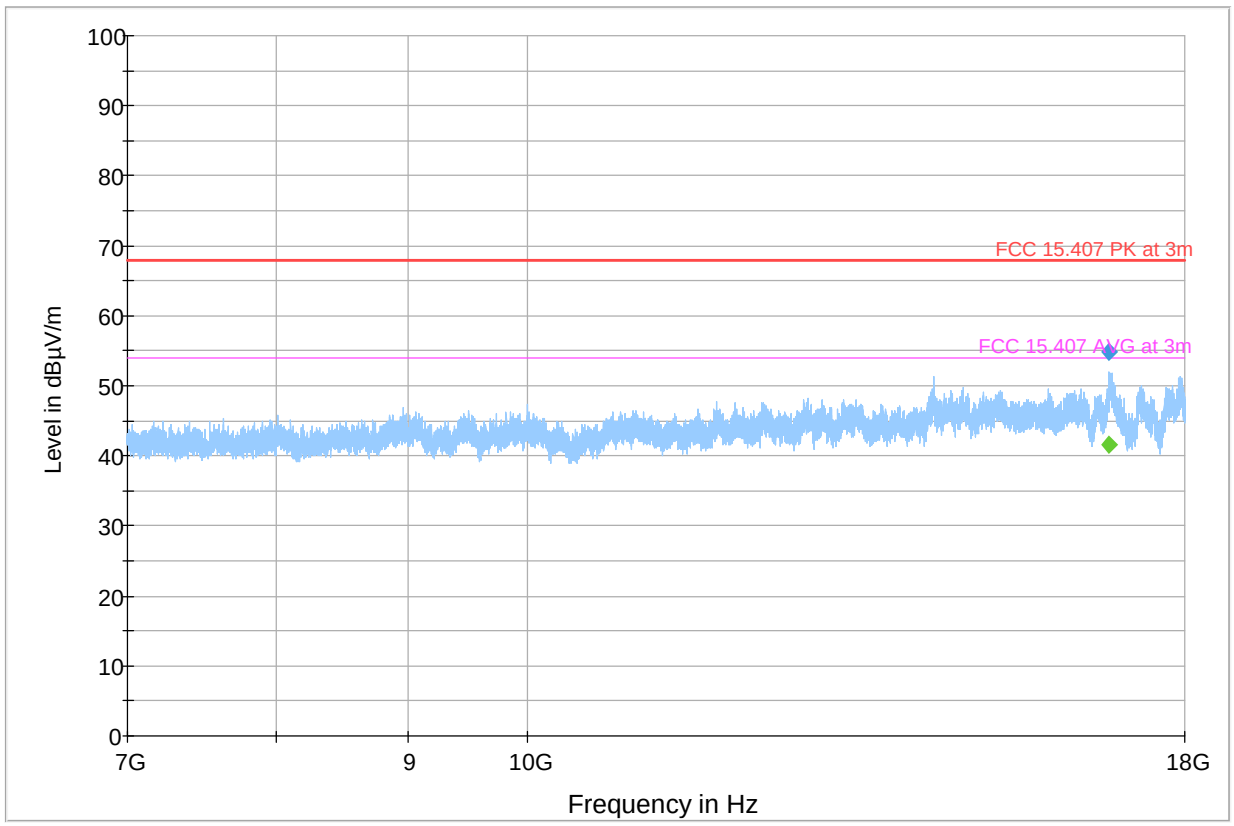


Plot # 3 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5180 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
16827.889	---	41.69	53.98	12.29	500.0	1000.000	250.0	V	139.0	14.4
16827.889	54.88	---	68.00	13.12	500.0	1000.000	250.0	V	139.0	14.4



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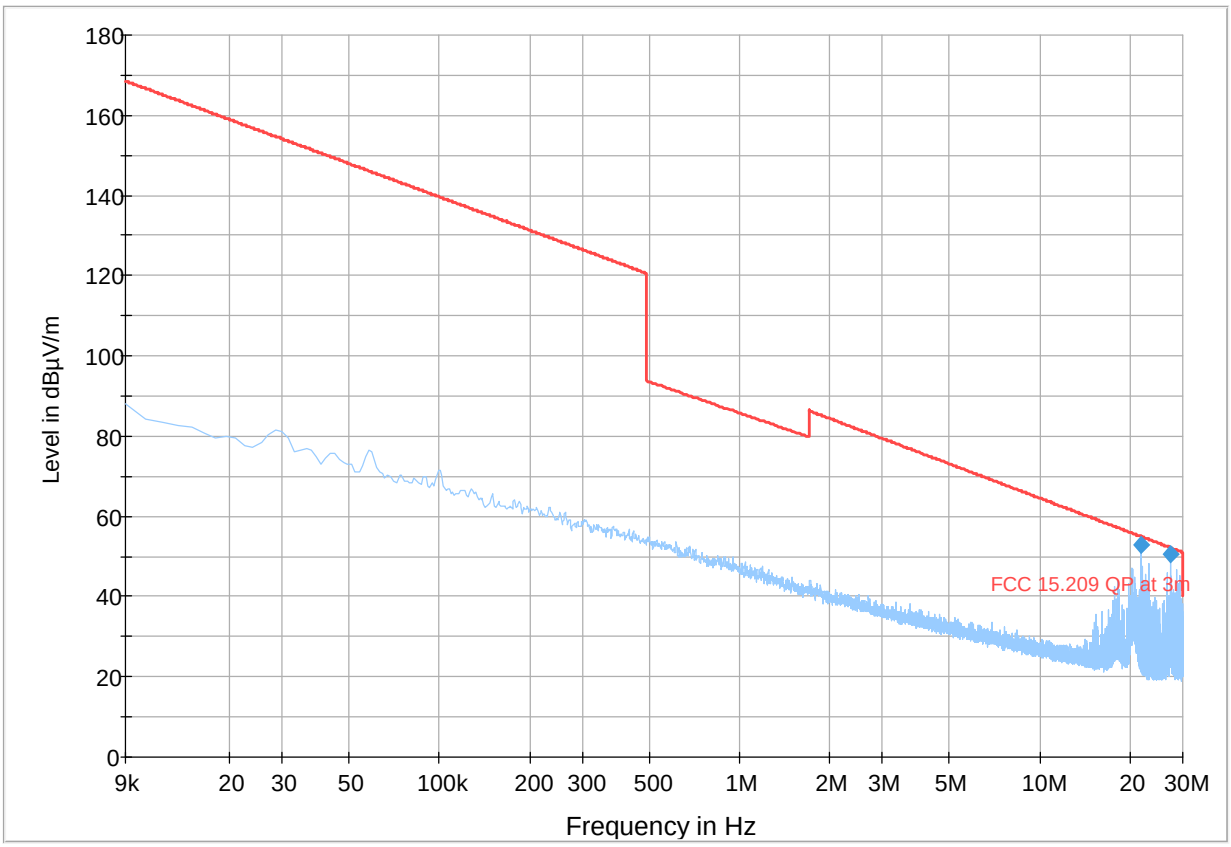
Plot # 4 Radiated Emissions: 9 KHz – 30 MHz

Tx Frequency: 5200 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
21.663	52.98	55.05	2.07	500.0	3.000	100.0	V	-22.0	16.8
27.161	50.47	52.26	1.79	500.0	3.000	100.0	V	-45.0	16.4

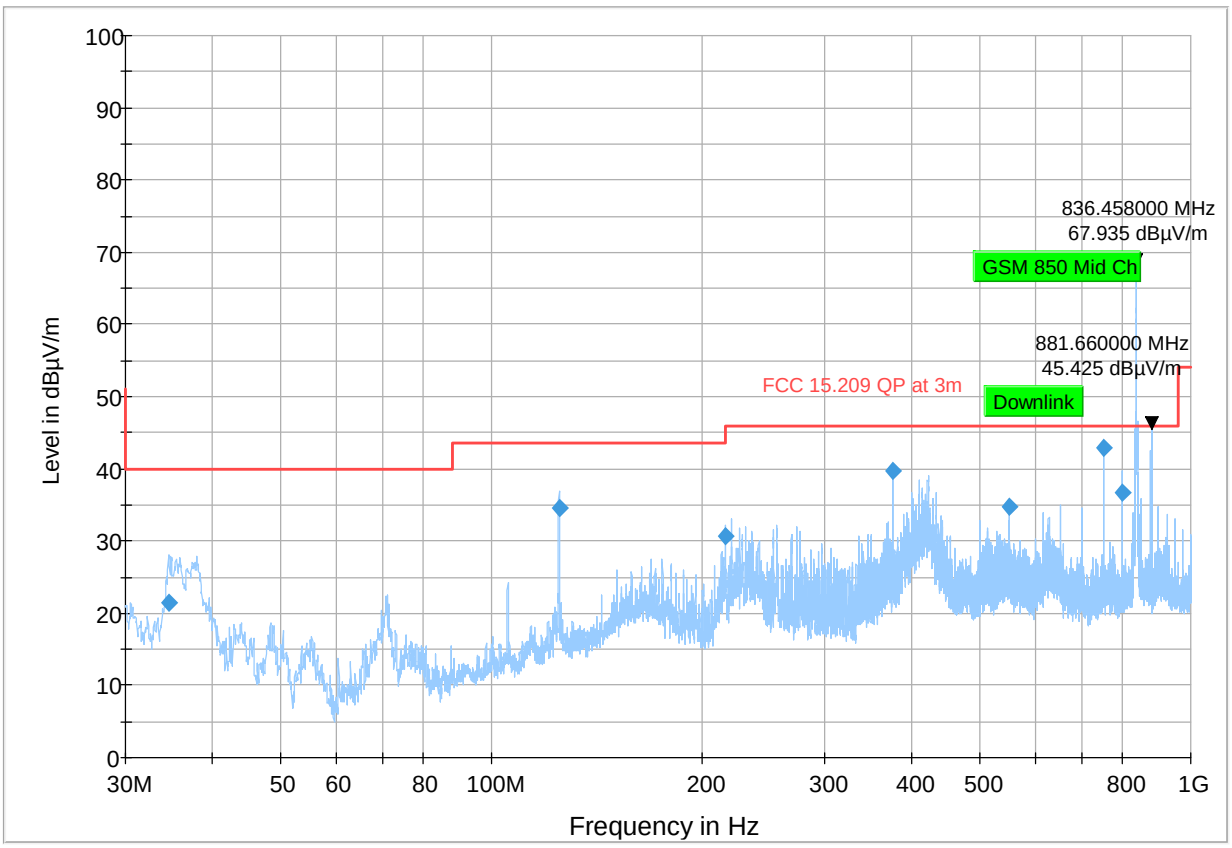


Plot # 5 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5200 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
34.559	21.56	40.00	18.44	500.0	120.000	134.0	V	120.0	-19.6
124.963	34.54	43.50	8.96	500.0	120.000	100.0	V	97.0	-17.6
215.998	30.71	43.50	12.79	500.0	120.000	168.0	H	-6.0	-22.6
374.981	39.78	46.02	6.24	500.0	120.000	100.0	H	36.0	-17.8
549.969	34.74	46.02	11.28	500.0	120.000	100.0	H	40.0	-14.0
749.983	42.87	46.02	3.15	500.0	120.000	107.0	H	200.0	-10.4
799.938	36.79	46.02	9.23	500.0	120.000	100.0	H	341.0	-9.9

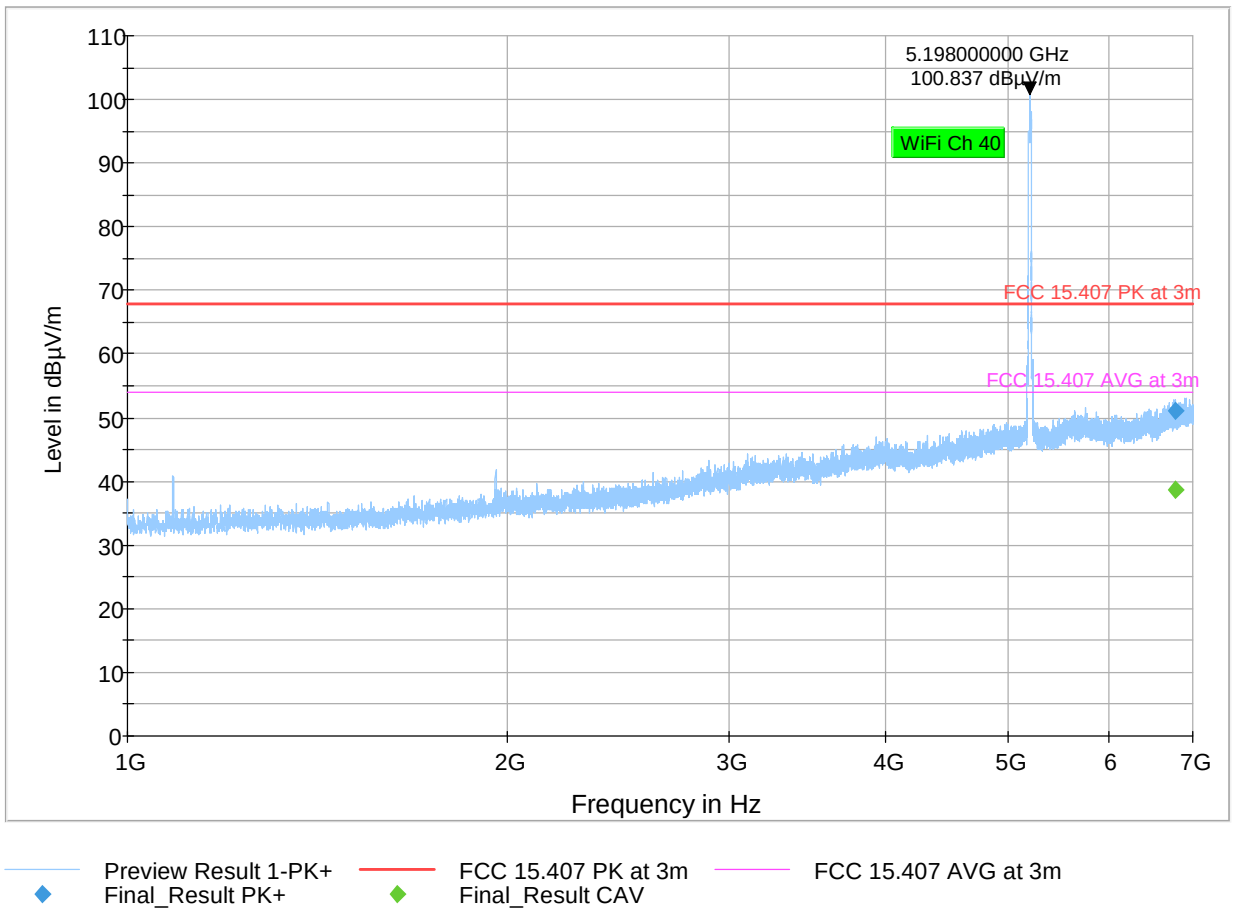


Plot # 6 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5200 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
6793.000	---	38.75	53.98	15.23	500.0	1000.000	100.0	H	190.0	18.4
6793.000	51.10	---	68.00	16.90	500.0	1000.000	100.0	H	190.0	18.4

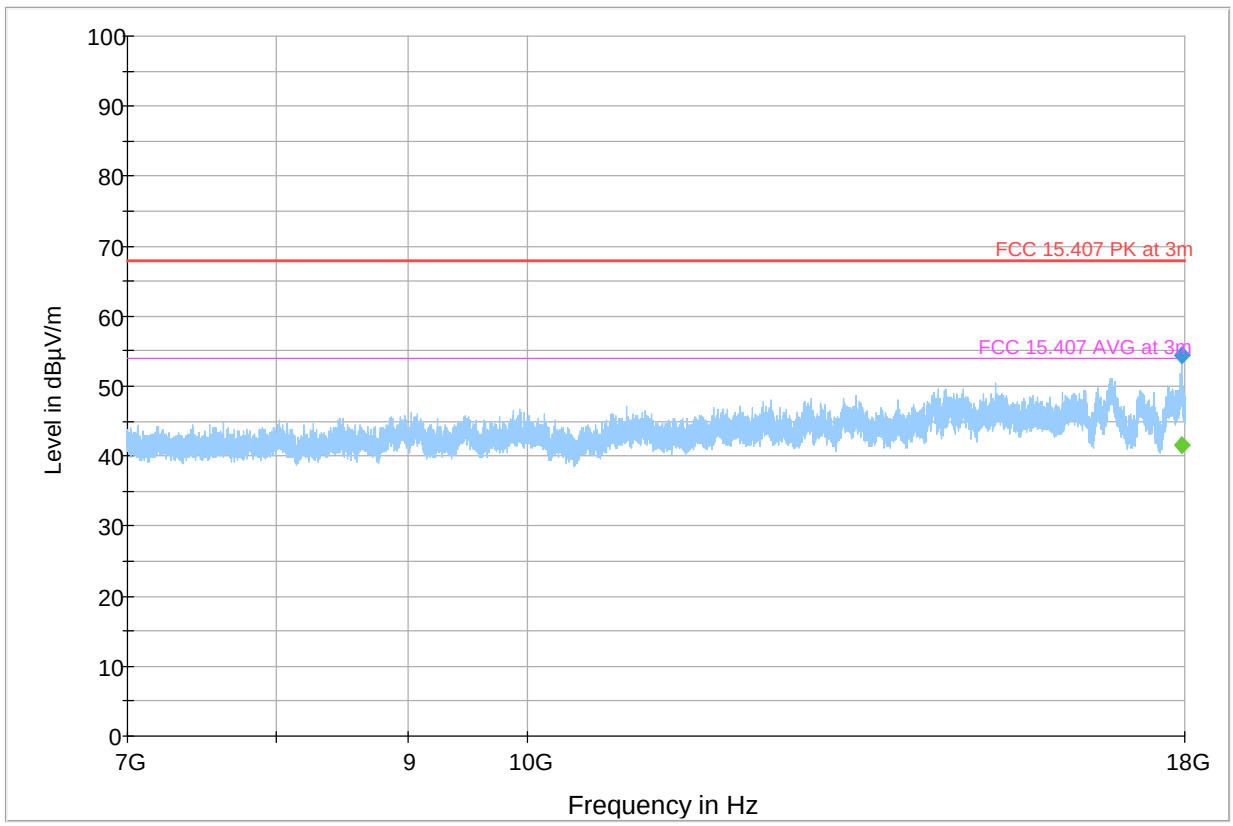


Plot # 7 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5200 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17941.089	---	41.62	53.98	12.36	500.0	1000.000	142.0	H	114.0	17.6
17941.089	54.38	---	68.00	13.62	500.0	1000.000	142.0	H	114.0	17.6

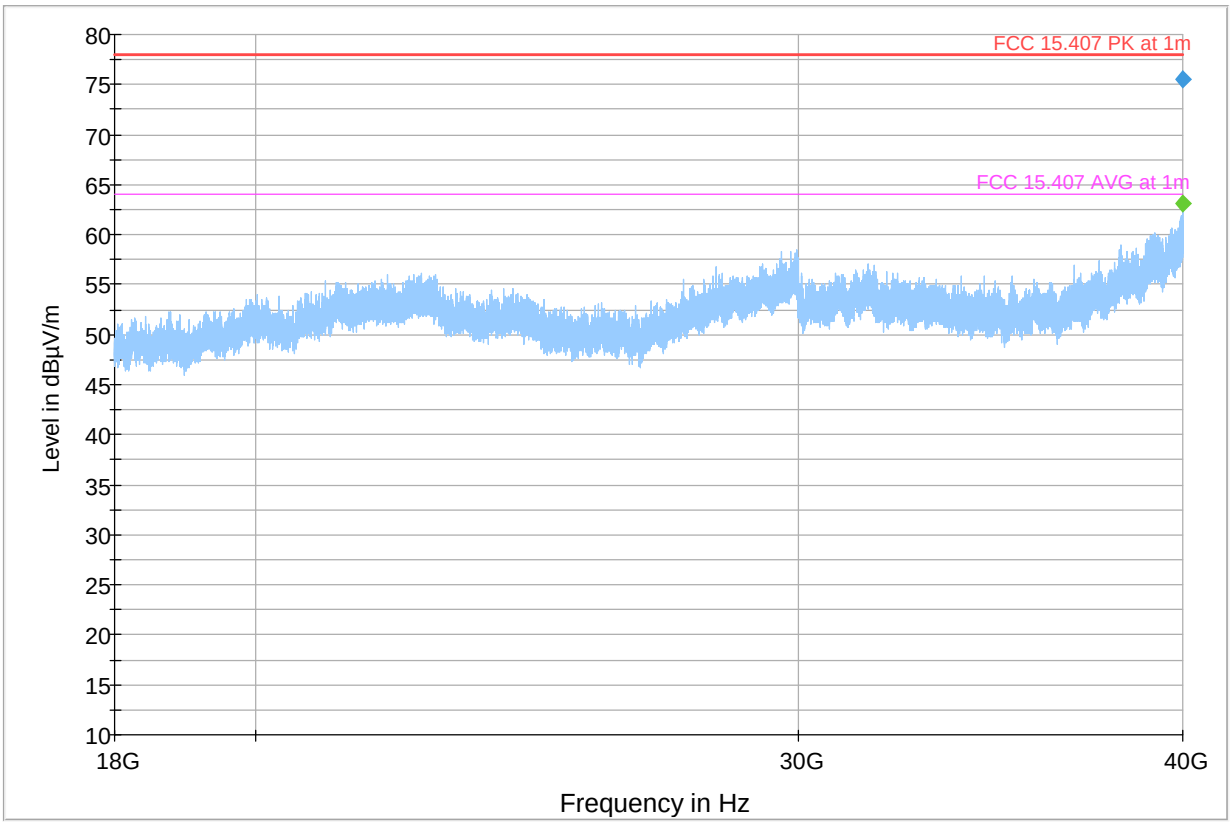


Plot # 8 Radiated Emissions: 18 – 40 GHz

Tx Frequency: 5200 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
39985.313	---	63.10	63.98	0.88	500.0	1000.000	197.0	V	23.0	24.9
39985.313	75.58	---	78.00	2.42	500.0	1000.000	197.0	V	23.0	24.9



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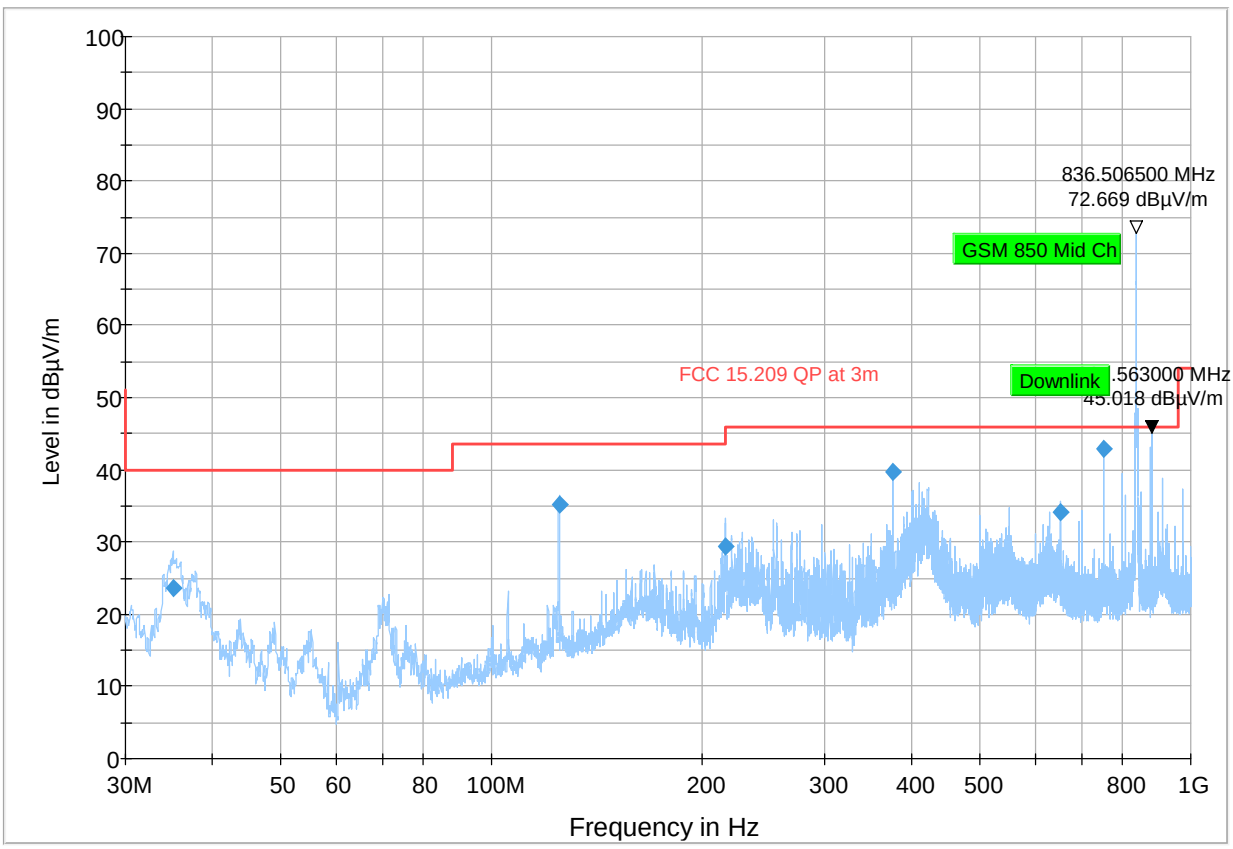
Plot # 9 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5240 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.093	23.68	40.00	16.32	500.0	120.000	100.0	V	81.0	-19.9
124.963	35.11	43.50	8.39	500.0	120.000	100.0	V	123.0	-17.6
215.901	29.43	43.50	14.07	500.0	120.000	168.0	H	-2.0	-22.6
374.981	39.65	46.02	6.37	500.0	120.000	100.0	H	30.0	-17.8
649.976	34.06	46.02	11.96	500.0	120.000	116.0	H	-15.0	-12.1
749.983	42.95	46.02	3.07	500.0	120.000	117.0	H	207.0	-10.4

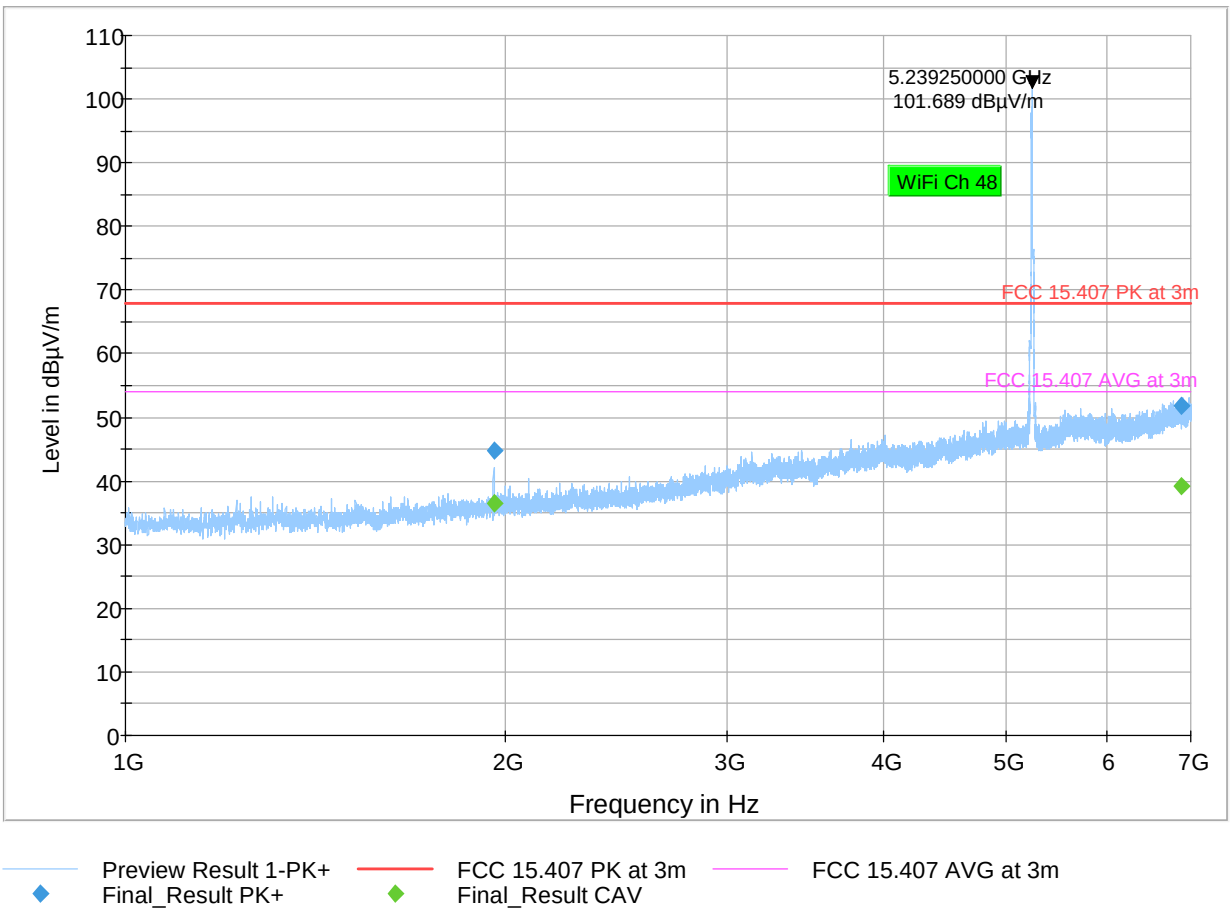


Plot # 10 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5240 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1959.750	44.79	---	68.00	23.21	500.0	1000.000	107.0	H	316.0	4.7
1959.750	---	36.44	53.98	17.54	500.0	1000.000	107.0	H	316.0	4.7
6872.750	51.92	---	68.00	16.08	500.0	1000.000	226.0	H	10.0	19.1
6872.750	---	39.24	53.98	14.74	500.0	1000.000	226.0	H	10.0	19.1

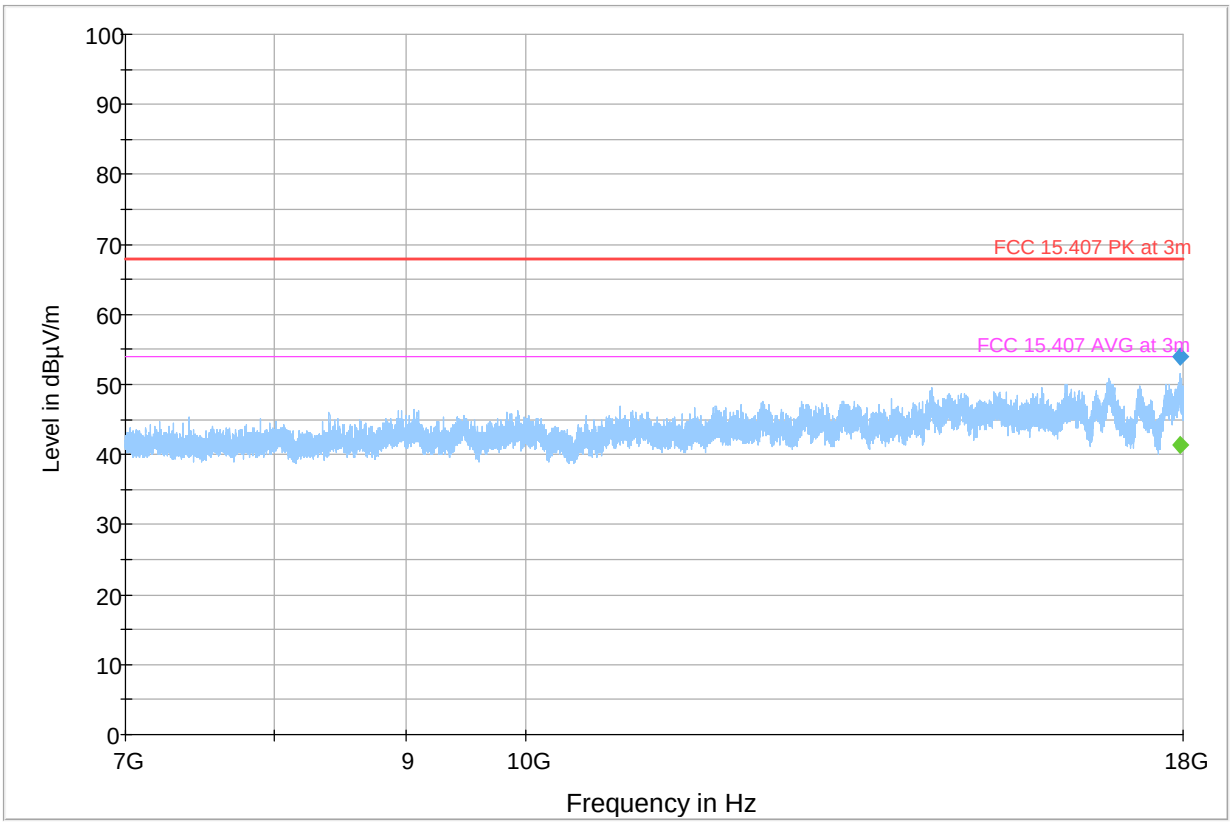


Plot # 11 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5240 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17947.200	---	41.27	53.98	12.71	500.0	1000.000	283.0	H	237.0	17.5
17947.200	53.90	---	68.00	14.10	500.0	1000.000	283.0	H	237.0	17.5



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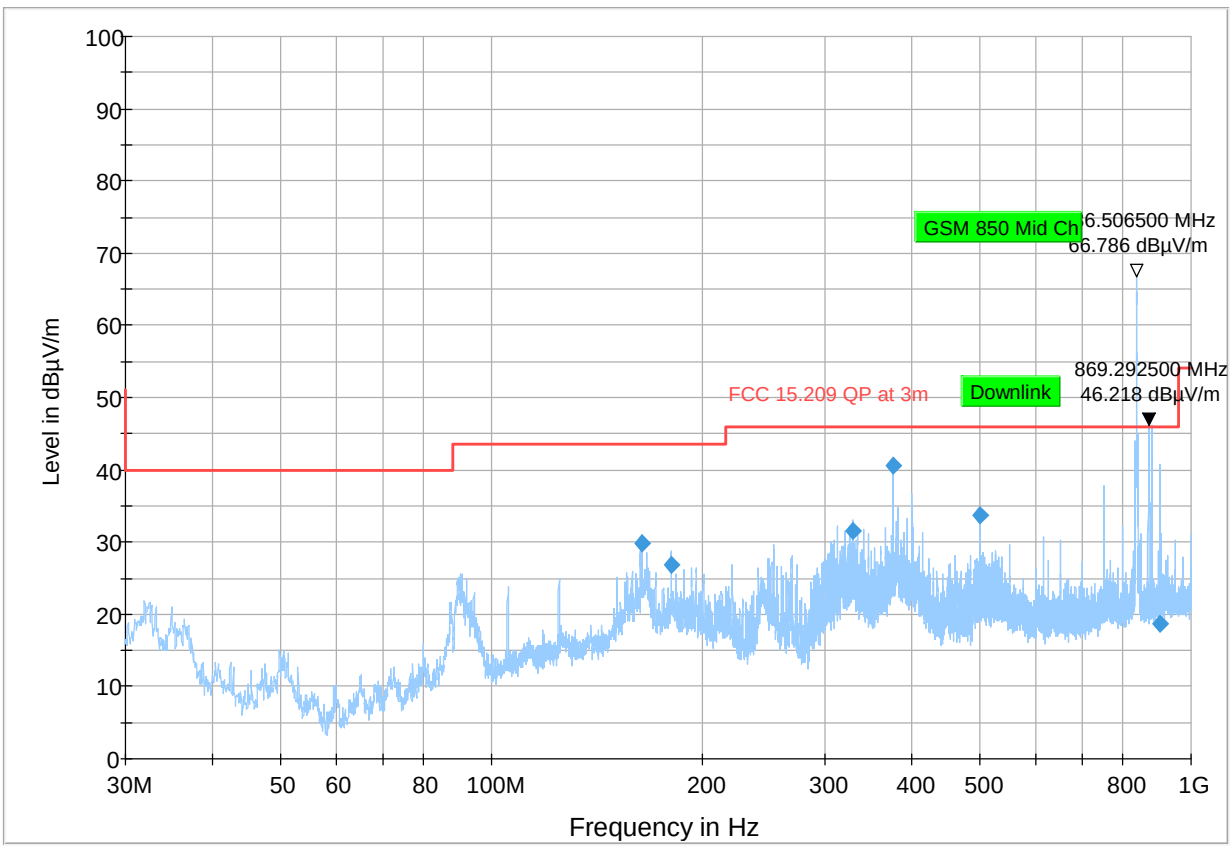
Plot # 12 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5260 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
164.006	29.74	43.50	13.76	500.0	120.000	142.0	H	21.0	-17.2
180.835	26.89	43.50	16.61	500.0	120.000	100.0	H	352.0	-21.1
329.148	31.44	46.02	14.58	500.0	120.000	100.0	H	190.0	-18.8
374.981	40.48	46.02	5.54	500.0	120.000	142.0	H	255.0	-17.8
499.965	33.74	46.02	12.28	500.0	120.000	100.0	H	348.0	-14.8
902.612	18.69	46.02	27.33	500.0	120.000	134.0	V	69.0	-9.0

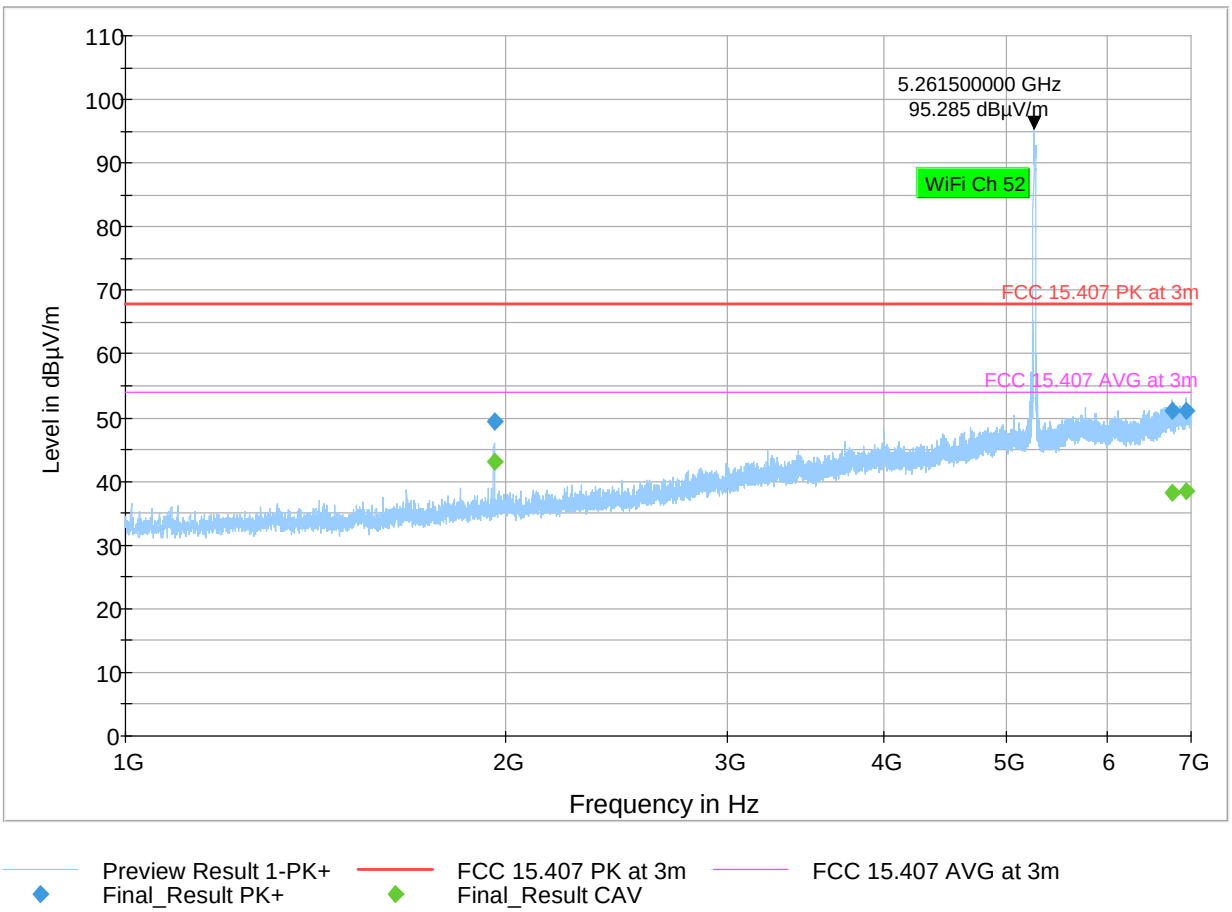


Plot # 13 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5260 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1959.750	49.44	---	68.00	18.56	500.0	1000.000	252.0	V	272.0	4.7
1959.750	---	43.03	53.98	10.94	500.0	1000.000	252.0	V	272.0	4.7
6768.500	---	38.16	53.98	15.82	500.0	1000.000	275.0	H	20.0	18.4
6768.500	51.05	---	68.00	16.95	500.0	1000.000	275.0	H	20.0	18.4
6942.500	50.99	---	68.00	17.01	500.0	1000.000	157.0	H	216.0	19.3
6942.500	---	38.39	53.98	15.59	500.0	1000.000	157.0	H	216.0	19.3

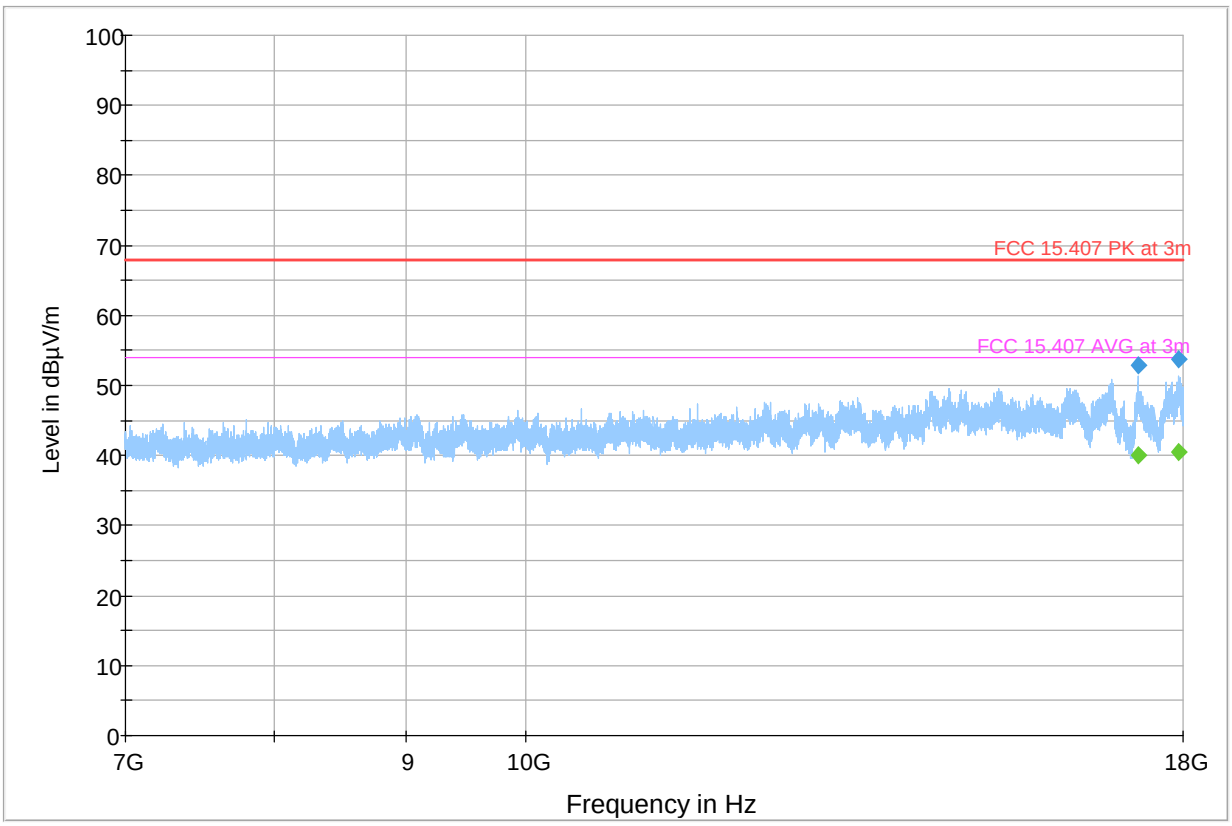


Plot # 14 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5260 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17291.600	---	40.15	53.98	13.83	500.0	1000.000	194.0	H	279.0	15.4
17291.600	52.92	---	68.00	15.08	500.0	1000.000	194.0	H	279.0	15.4
17918.600	---	40.58	53.98	13.40	500.0	1000.000	194.0	V	-15.0	18.0
17918.600	53.81	---	68.00	14.19	500.0	1000.000	194.0	V	-15.0	18.0



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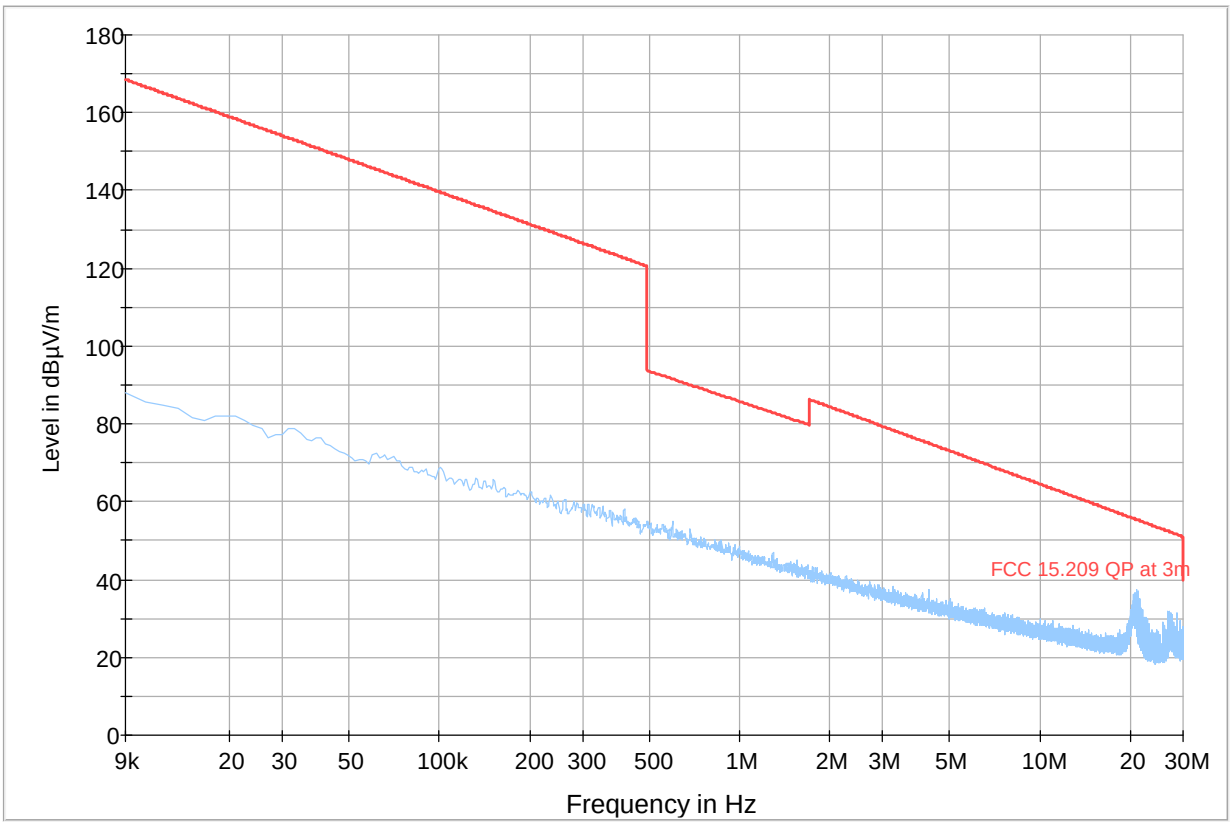
Plot # 15 Radiated Emissions: 9 KHz – 30 MHz	
Tx Frequency: 5300 MHz	**Mode: 802.11ac**

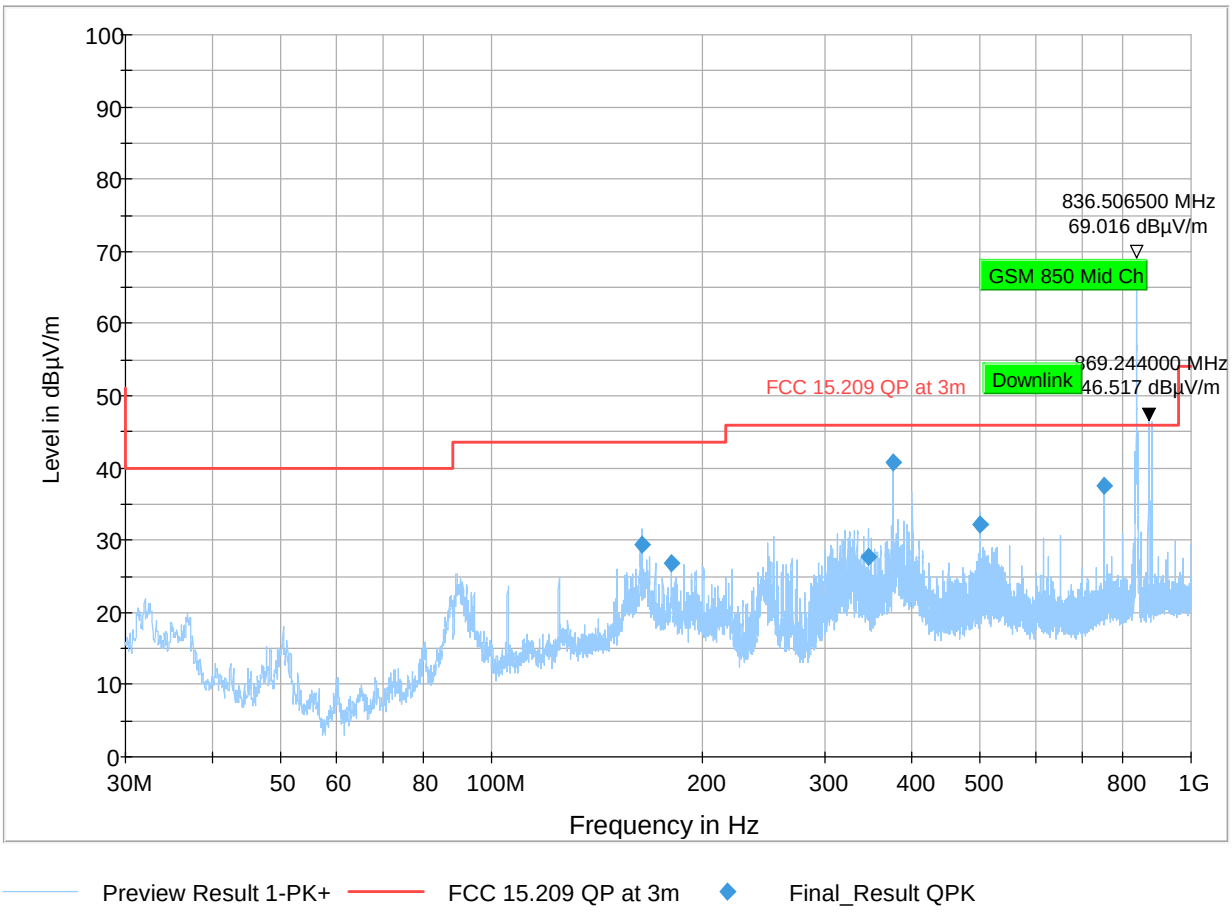


Plot # 16 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5300 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
163.957	29.43	43.50	14.07	500.0	120.000	125.0	H	26.0	-17.1
180.738	26.84	43.50	16.66	500.0	120.000	141.0	H	-2.0	-21.1
345.590	27.75	46.02	18.27	500.0	120.000	100.0	V	276.0	-19.2
374.981	40.70	46.02	5.32	500.0	120.000	142.0	H	245.0	-17.8
499.965	32.26	46.02	13.76	500.0	120.000	100.0	H	-13.0	-14.8
749.983	37.60	46.02	8.42	500.0	120.000	100.0	H	138.0	-10.4

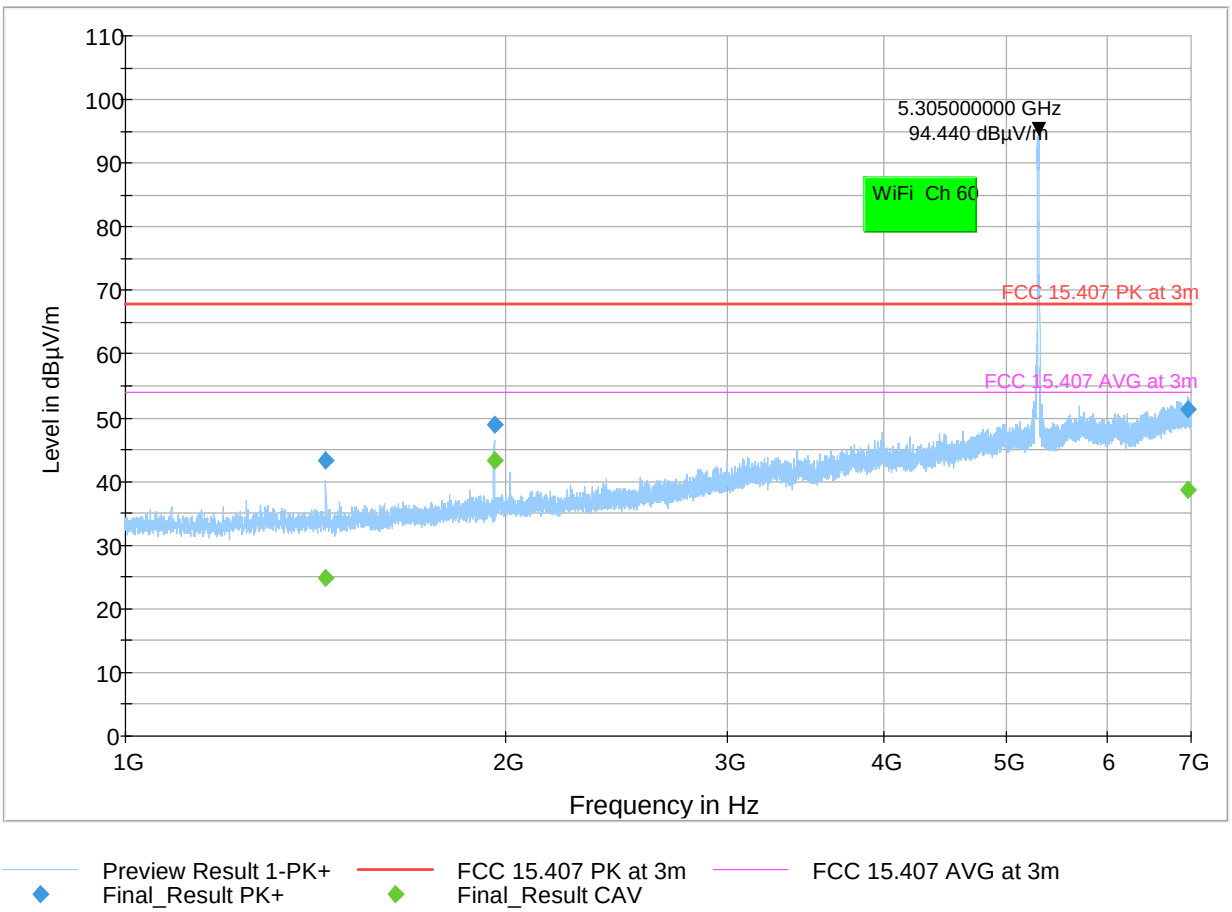


Plot # 17 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5300 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1442.750	---	24.76	53.98	29.22	500.0	1000.000	191.0	H	11.0	2.5
1442.750	43.24	---	68.00	24.76	500.0	1000.000	191.0	H	11.0	2.5
1960.000	48.84	---	68.00	19.16	500.0	1000.000	219.0	V	247.0	4.7
1960.000	---	43.29	53.98	10.69	500.0	1000.000	219.0	V	247.0	4.7
6962.750	51.33	---	68.00	16.67	500.0	1000.000	260.0	V	284.0	19.3
6962.750	---	38.68	53.98	15.30	500.0	1000.000	260.0	V	284.0	19.3

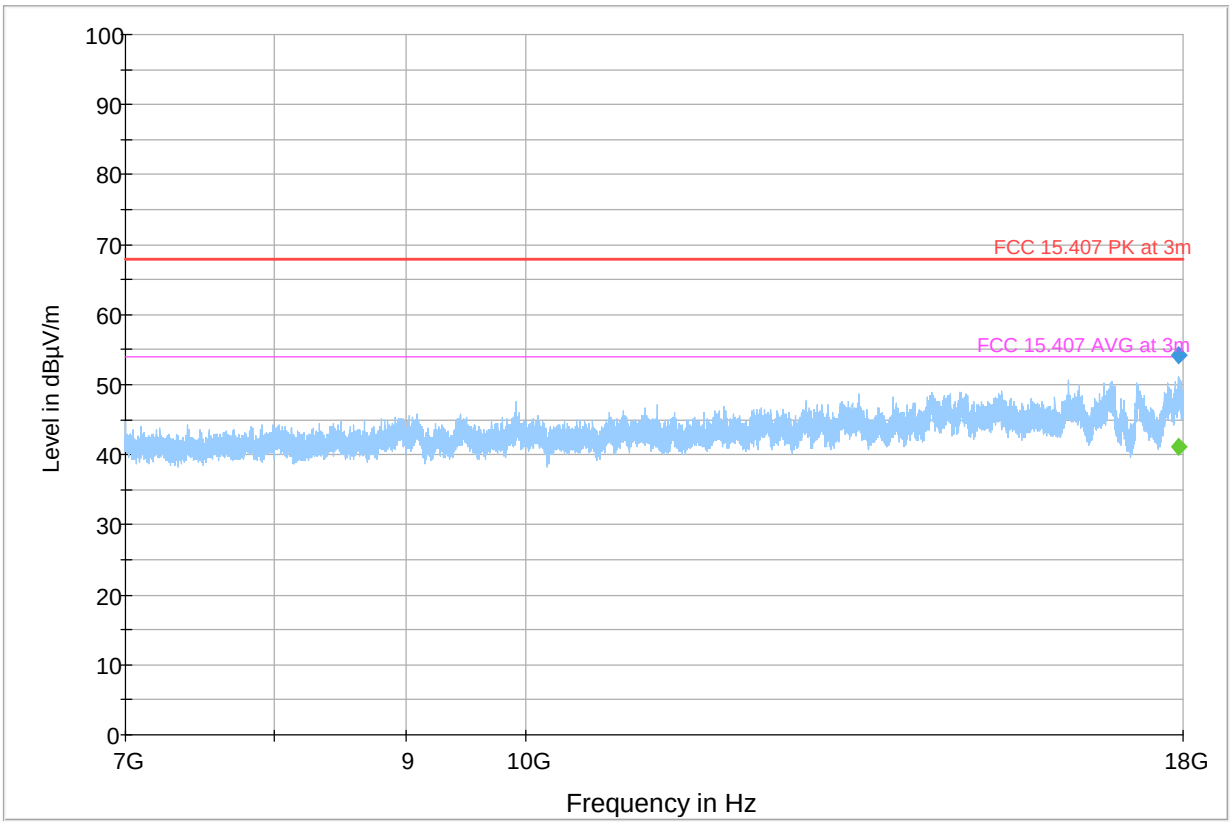


Plot # 18 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5300 MHz | **Mode: 802.11ac**

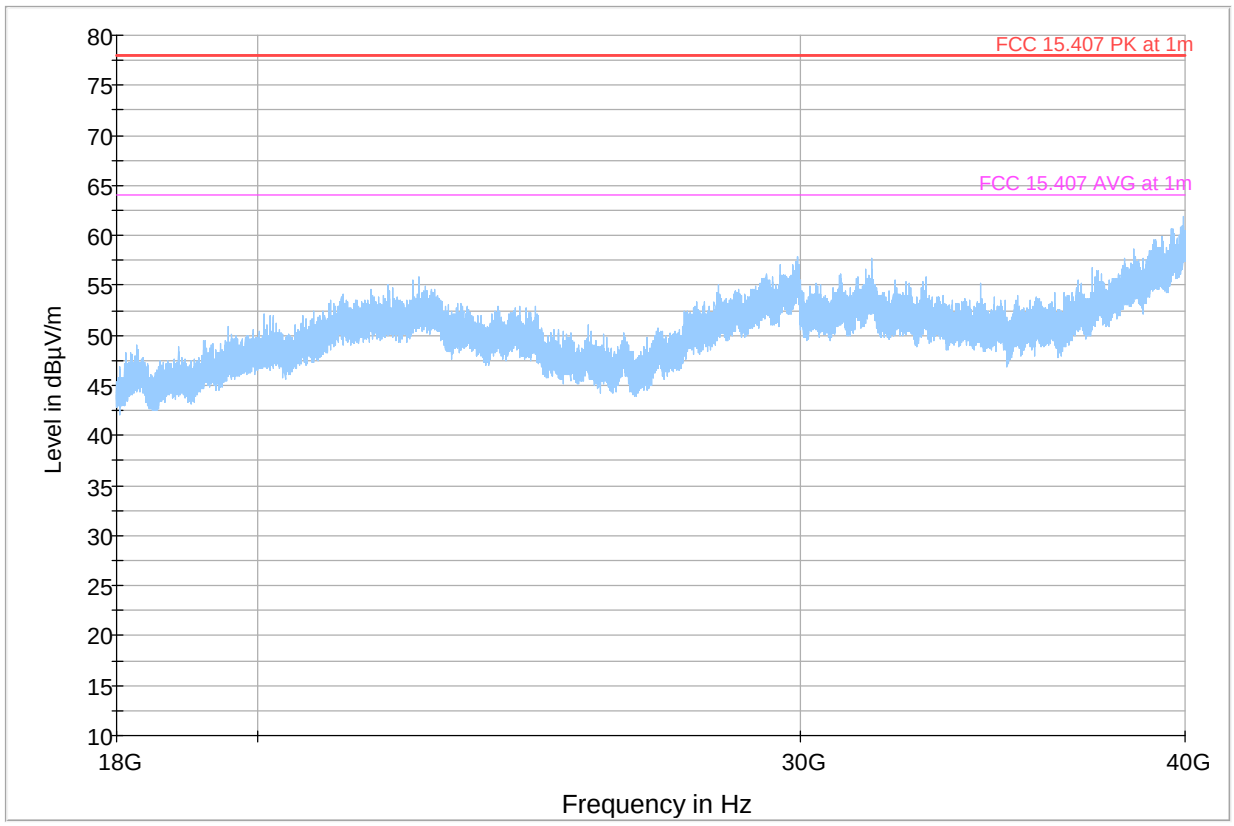
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17933.511	---	41.22	53.98	12.76	500.0	1000.000	317.0	V	56.0	17.7
17933.511	54.21	---	68.00	13.79	500.0	1000.000	317.0	V	56.0	17.7



Plot # 19 Radiated Emissions: 18 – 40 GHz

Tx Frequency: 5300 MHz	Mode: 802.11ac



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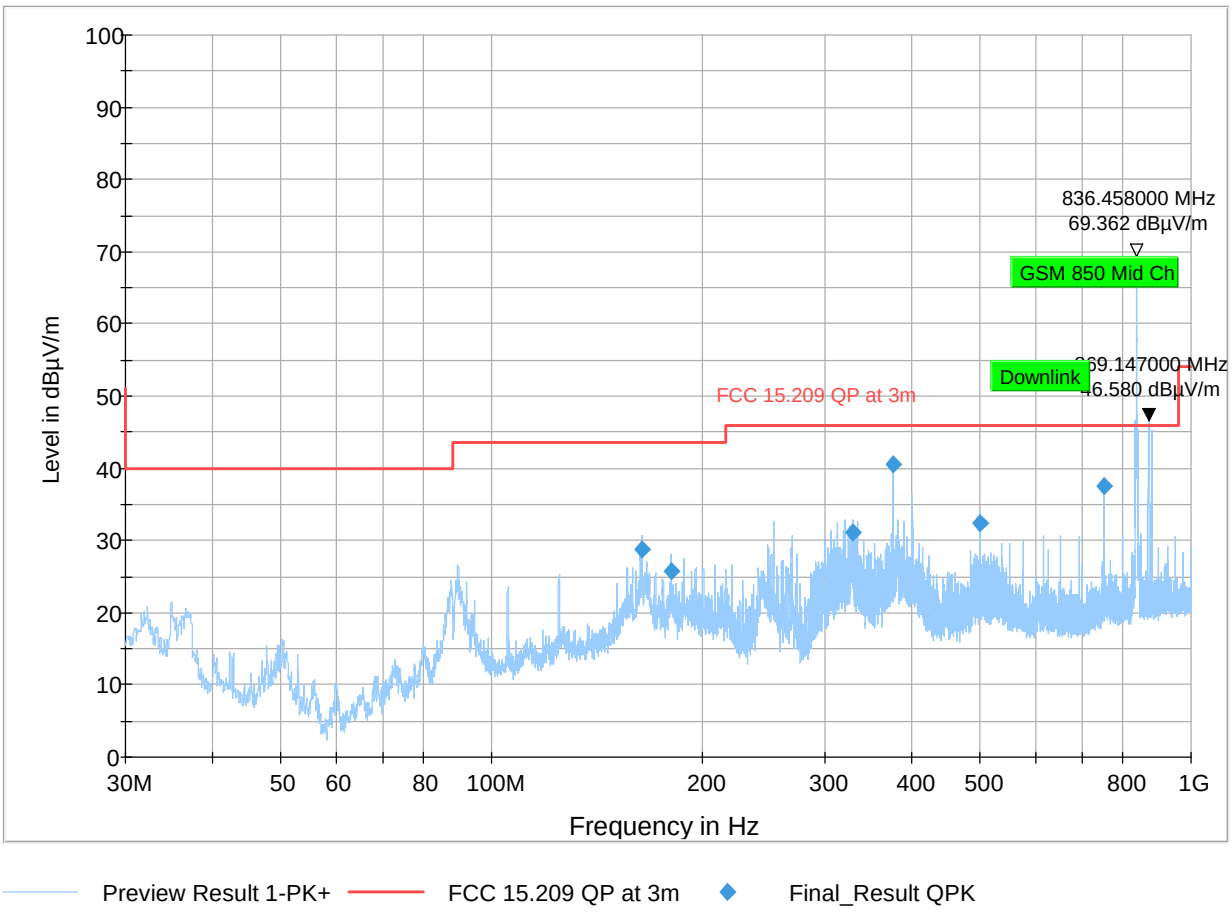
Plot # 20 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5320 MHz	Mode: 802.11ac

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
163.957	28.78	43.50	14.72	500.0	120.000	133.0	H	0.0	-17.1
180.932	25.75	43.50	17.75	500.0	120.000	241.0	H	-7.0	-21.1
329.148	31.10	46.02	14.92	500.0	120.000	100.0	H	198.0	-18.8
374.981	40.60	46.02	5.42	500.0	120.000	142.0	H	242.0	-17.8
499.965	32.41	46.02	13.61	500.0	120.000	100.0	H	339.0	-14.8
749.983	37.48	46.02	8.54	500.0	120.000	100.0	H	137.0	-10.4

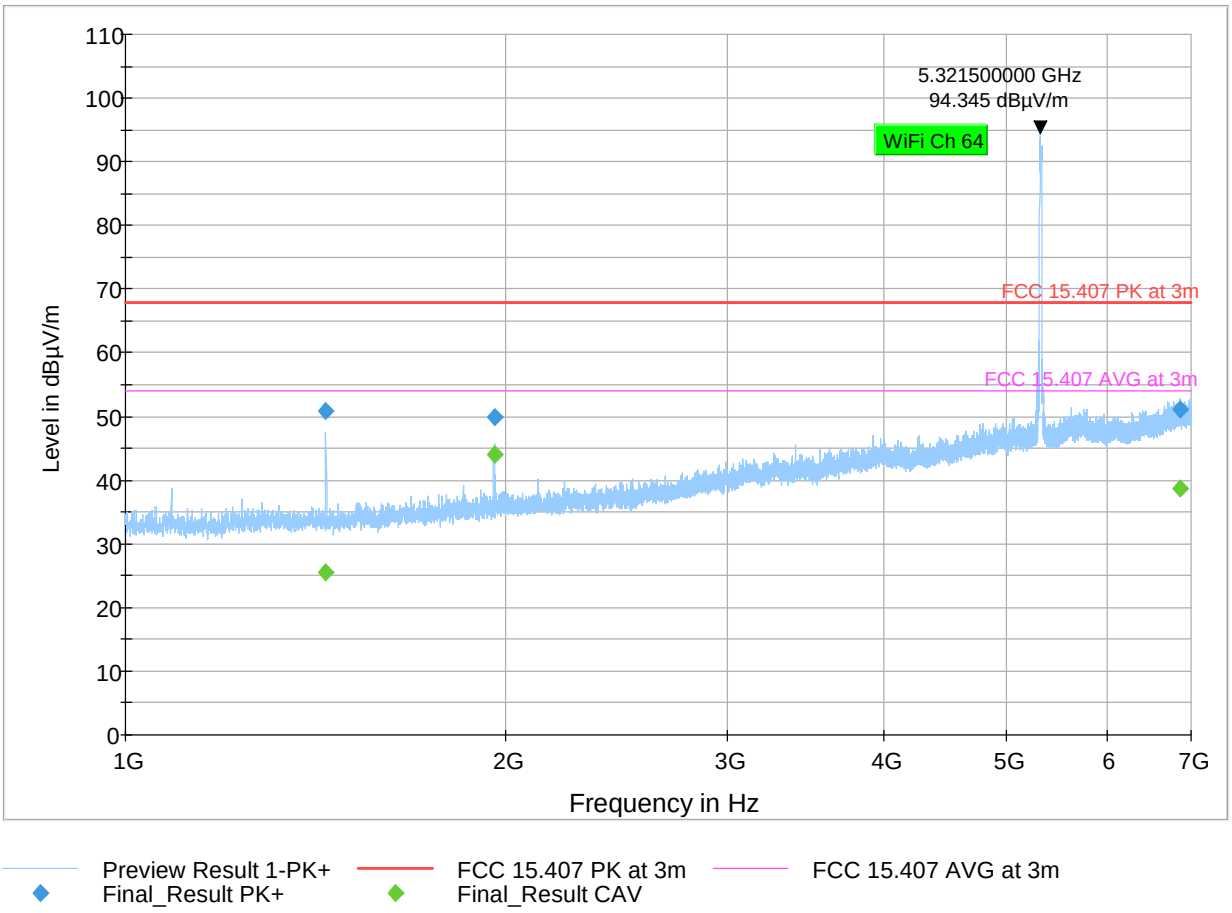


Plot # 21 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5320 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1442.750	50.85	---	68.00	17.15	500.0	1000.000	202.0	V	280.0	2.5
1442.750	---	25.61	53.98	28.37	500.0	1000.000	202.0	V	280.0	2.5
1960.000	49.88	---	68.00	18.12	500.0	1000.000	227.0	V	247.0	4.7
1960.000	---	44.05	53.98	9.93	500.0	1000.000	227.0	V	247.0	4.7
6857.500	---	38.74	53.98	15.24	500.0	1000.000	211.0	H	-35.0	19.0
6857.500	51.04	---	68.00	16.96	500.0	1000.000	211.0	H	-35.0	19.0

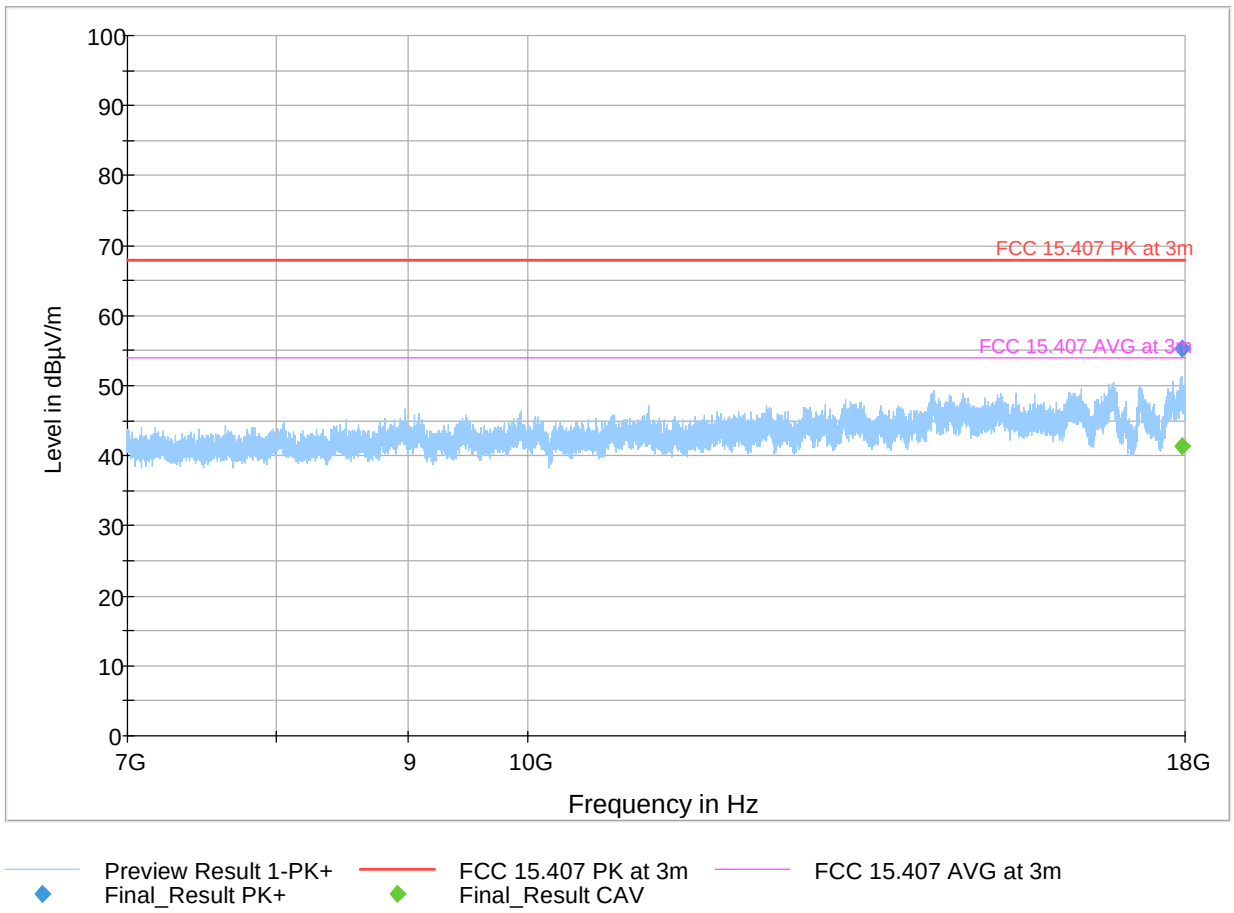


Plot # 22 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5320 MHz | **Mode: 802.11ac**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17942.556	---	41.32	53.98	12.66	500.0	1000.000	249.0	H	75.0	17.6
17942.556	55.41	---	68.00	12.59	500.0	1000.000	249.0	H	75.0	17.6



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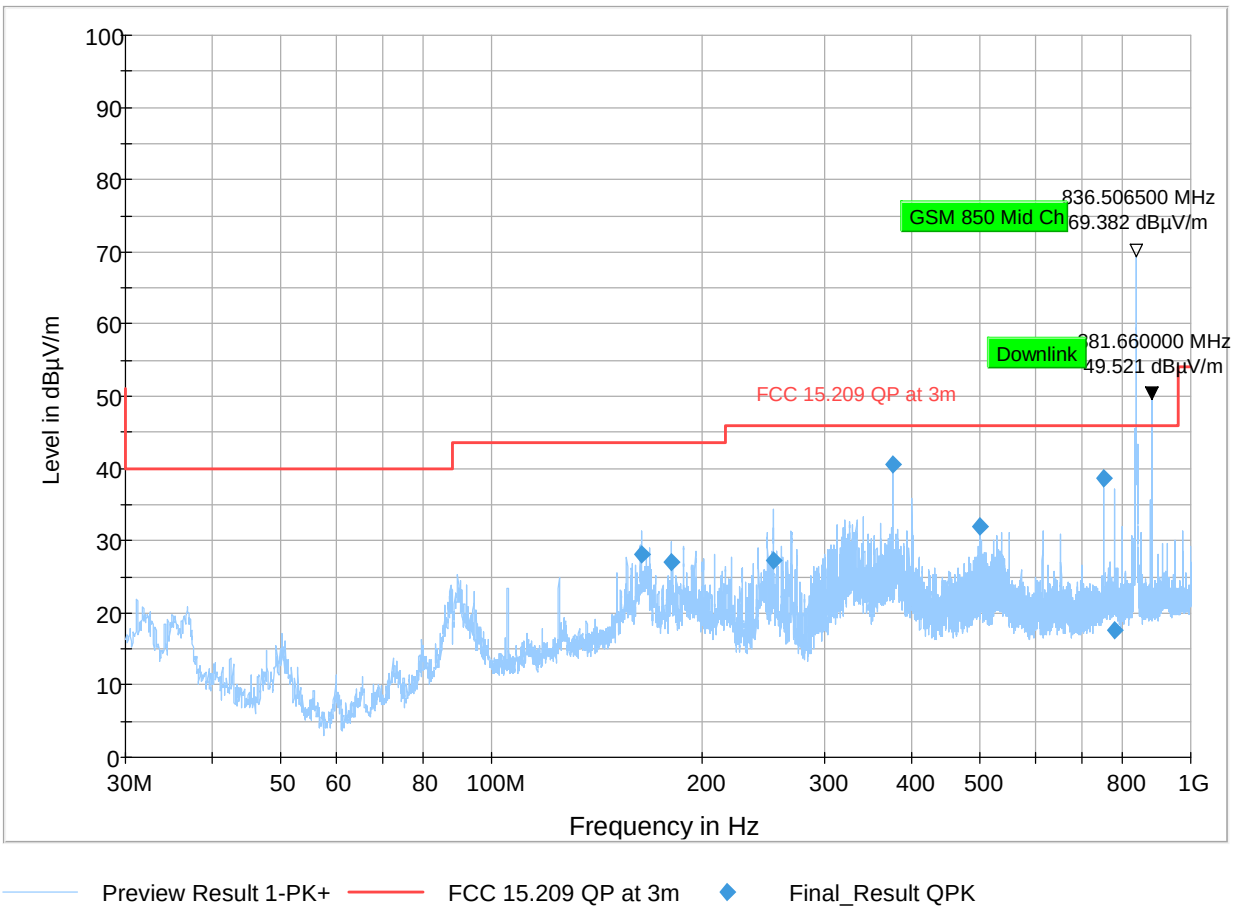
Plot # 23 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5500 MHz	Mode: 802.11n

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
163.909	28.16	43.50	15.34	500.0	120.000	125.0	H	20.0	-17.1
180.884	27.11	43.50	16.39	500.0	120.000	141.0	H	0.0	-21.1
253.537	27.36	46.02	18.66	500.0	120.000	222.0	H	-3.0	-16.6
374.981	40.49	46.02	5.53	500.0	120.000	149.0	H	247.0	-17.8
499.965	31.96	46.02	14.06	500.0	120.000	100.0	H	162.0	-14.8
749.983	38.53	46.02	7.49	500.0	120.000	253.0	H	57.0	-10.4
777.288	17.67	46.02	28.35	500.0	120.000	226.0	V	248.0	-10.4

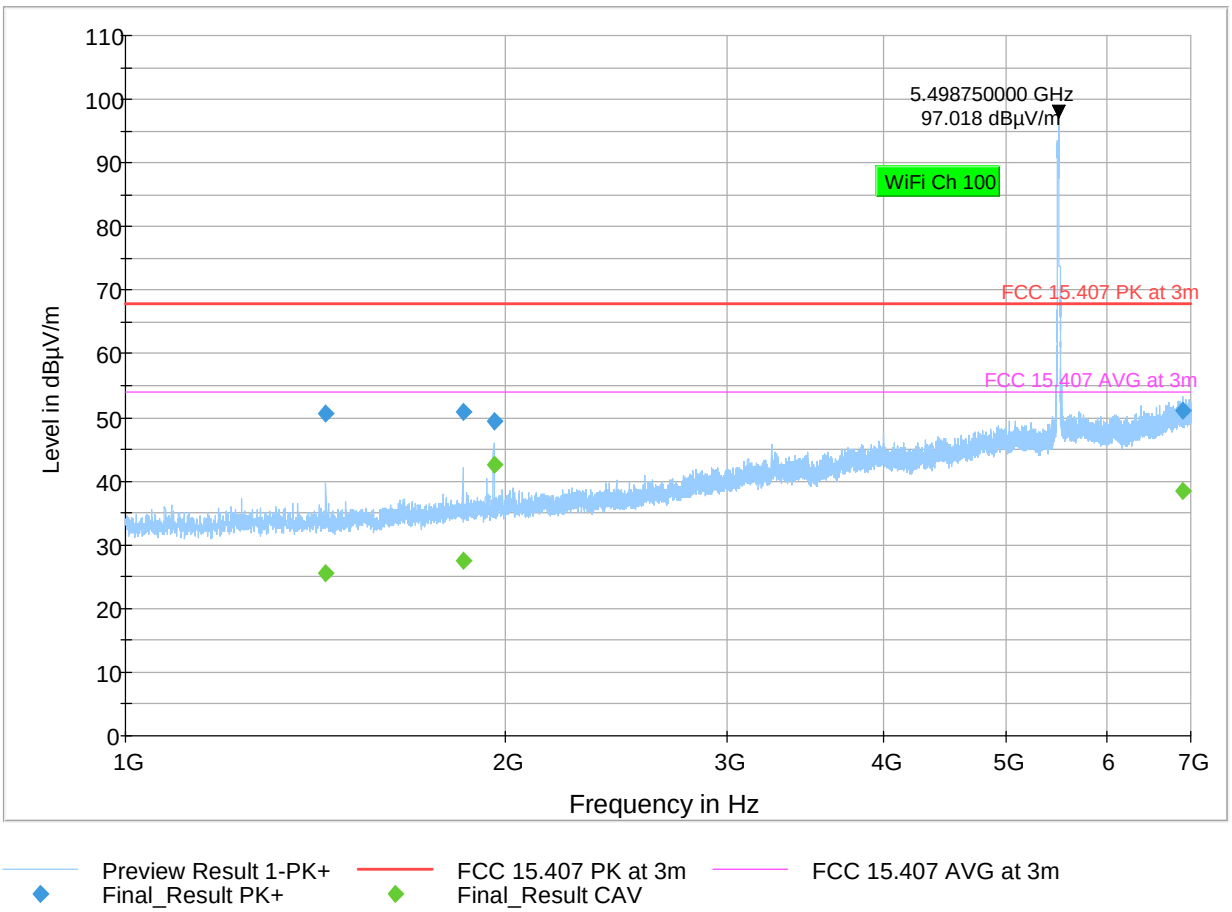


Plot # 24 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5500 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1442.750	50.56	---	68.00	17.44	500.0	1000.000	244.0	V	277.0	2.5
1442.750	---	25.56	53.98	28.42	500.0	1000.000	244.0	V	277.0	2.5
1852.000	---	27.45	53.98	26.53	500.0	1000.000	243.0	V	274.0	4.5
1852.000	50.82	---	68.00	17.18	500.0	1000.000	243.0	V	274.0	4.5
1959.750	---	42.56	53.98	11.42	500.0	1000.000	244.0	V	269.0	4.7
1959.750	49.33	---	68.00	18.67	500.0	1000.000	244.0	V	269.0	4.7
6894.250	51.13	---	68.00	16.87	500.0	1000.000	208.0	H	246.0	19.1
6894.250	---	38.53	53.98	15.45	500.0	1000.000	208.0	H	246.0	19.1

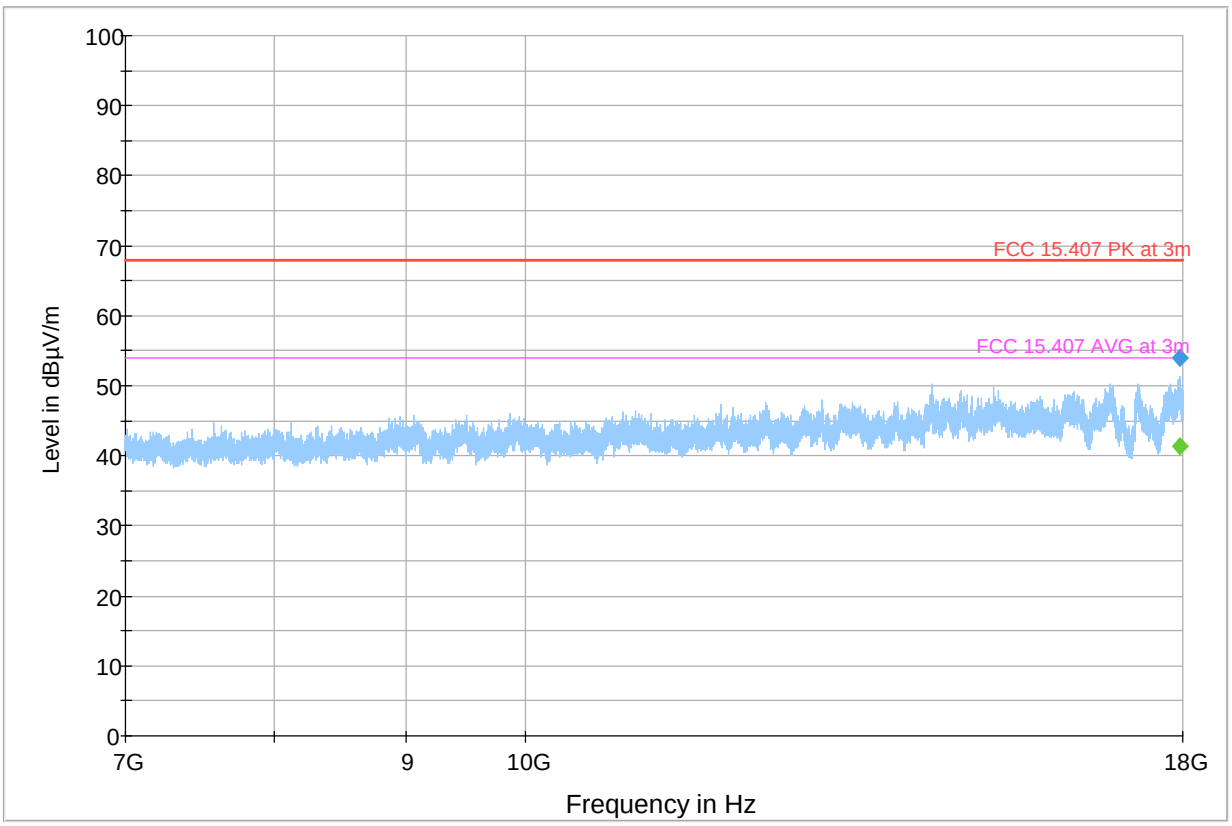


Plot # 25 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5500 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17941.333	---	41.30	53.98	12.68	500.0	1000.000	116.0	V	220.0	17.6
17941.333	53.95	---	68.00	14.05	500.0	1000.000	116.0	V	220.0	17.6



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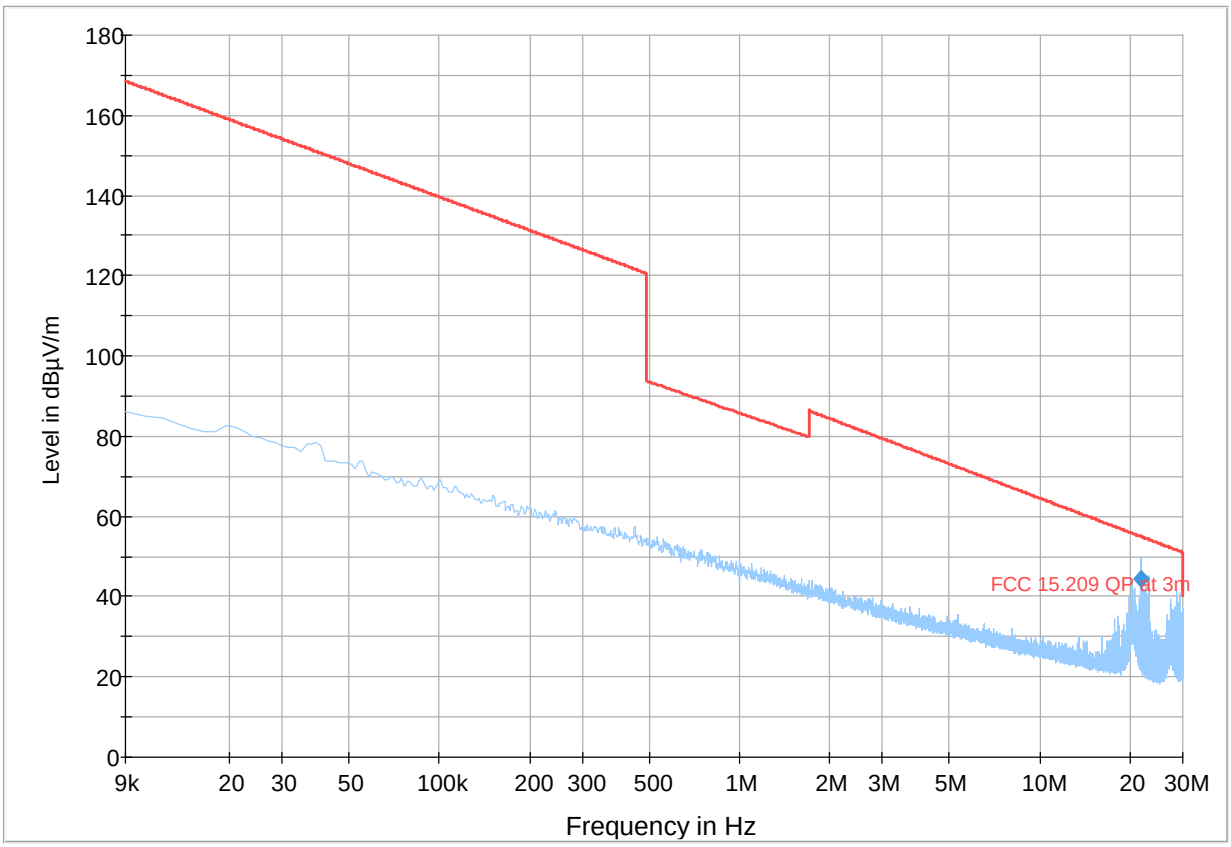
Plot # 26 Radiated Emissions: 9 KHz – 30 MHz

Tx Frequency: 5580 MHz	Mode: 802.11n

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
21.663	44.48	55.05	10.57	500.0	3.000	100.0	V	247.0	16.8

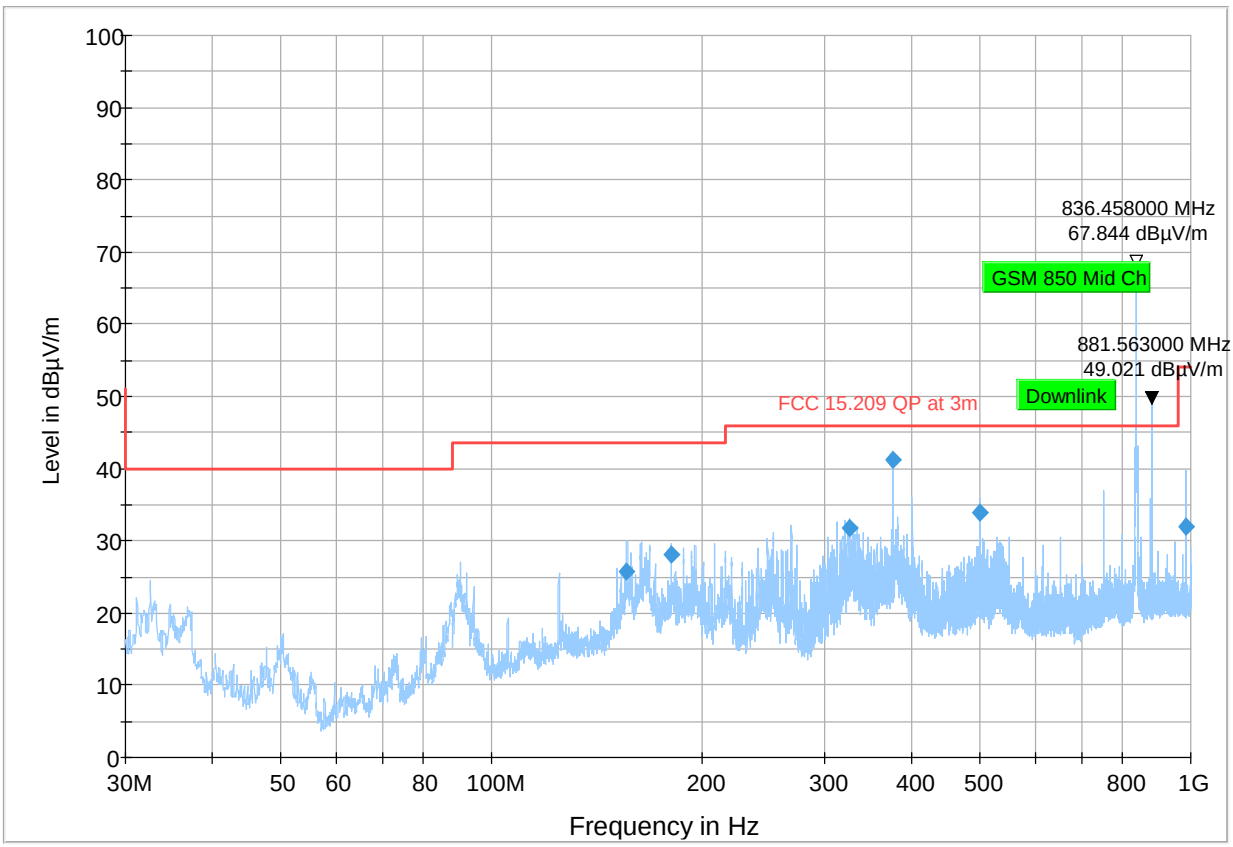


Plot # 27 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5580 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
156.391	25.79	43.50	17.71	500.0	120.000	158.0	H	27.0	-16.0
180.932	28.07	43.50	15.43	500.0	120.000	116.0	H	358.0	-21.1
325.365	31.73	46.02	14.29	500.0	120.000	107.0	H	192.0	-18.9
374.981	41.10	46.02	4.92	500.0	120.000	150.0	H	-13.0	-17.8
499.965	33.81	46.02	12.21	500.0	120.000	100.0	H	346.0	-14.8
986.711	31.87	53.98	22.11	500.0	120.000	107.0	V	257.0	-8.1

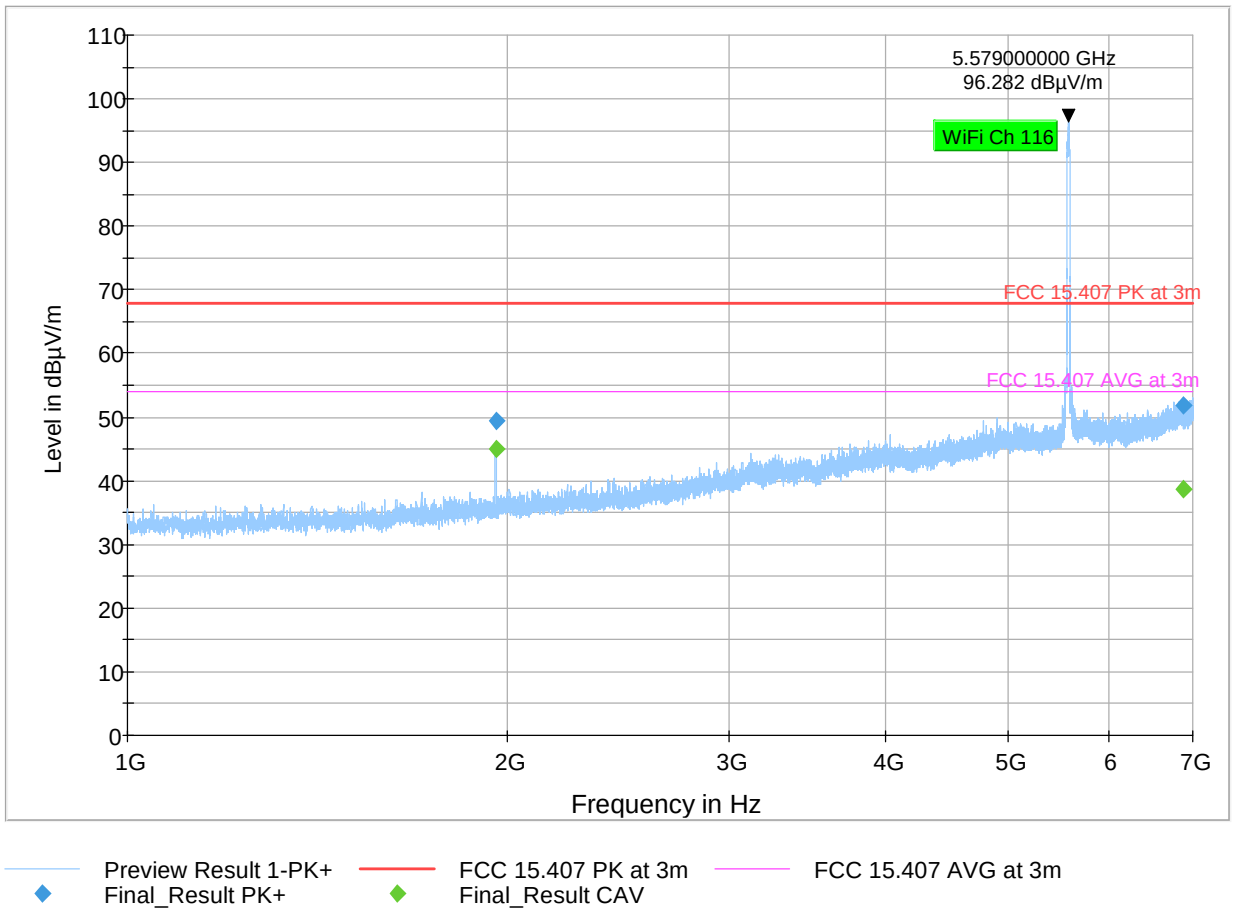


Plot # 28 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5580 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1959.750	49.31	---	68.00	18.69	500.0	1000.000	224.0	V	247.0	4.7
1959.750	---	44.94	53.98	9.04	500.0	1000.000	224.0	V	247.0	4.7
6877.250	51.88	---	68.00	16.12	500.0	1000.000	220.0	V	158.0	19.1
6877.250	---	38.73	53.98	15.25	500.0	1000.000	220.0	V	158.0	19.1

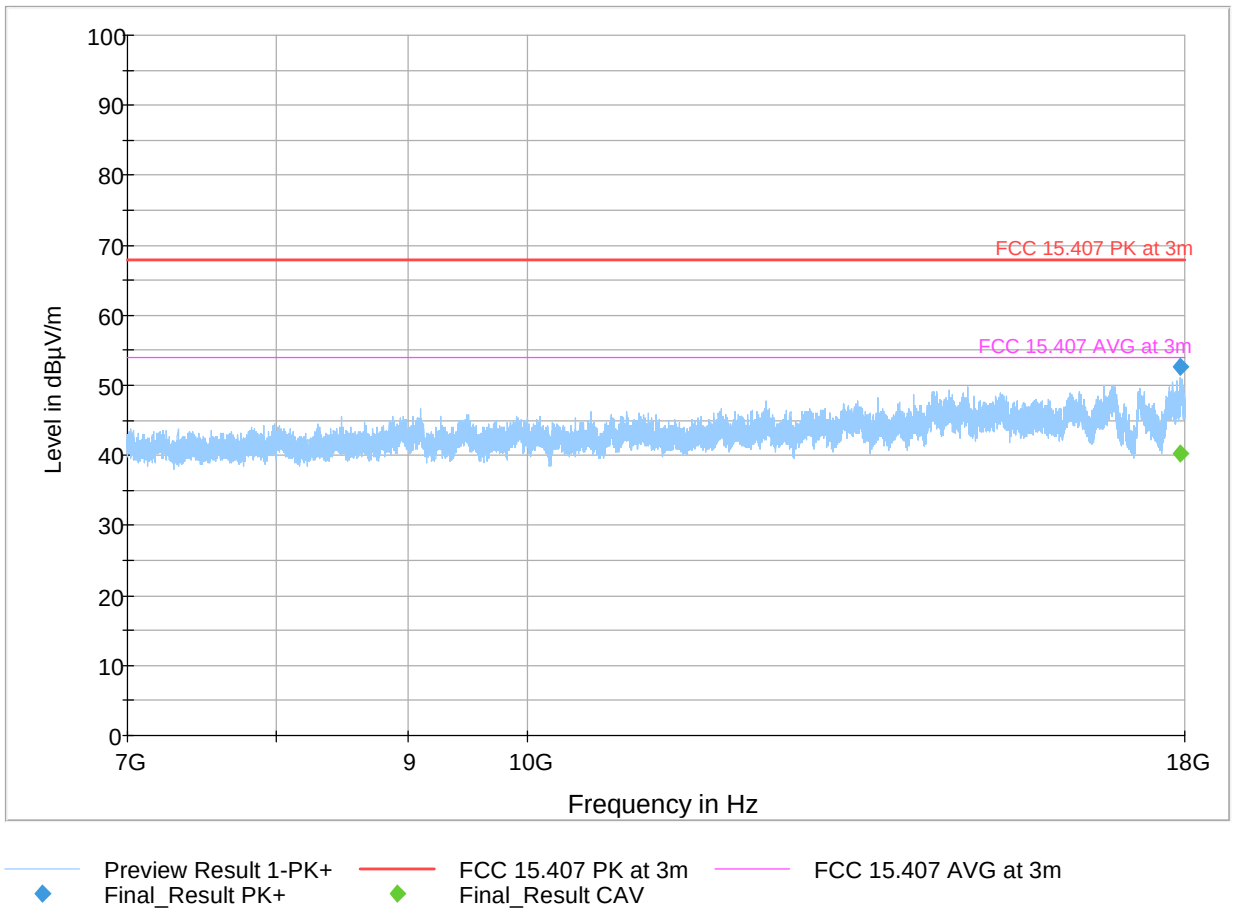


Plot # 29 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5580 MHz	Mode: 802.11n

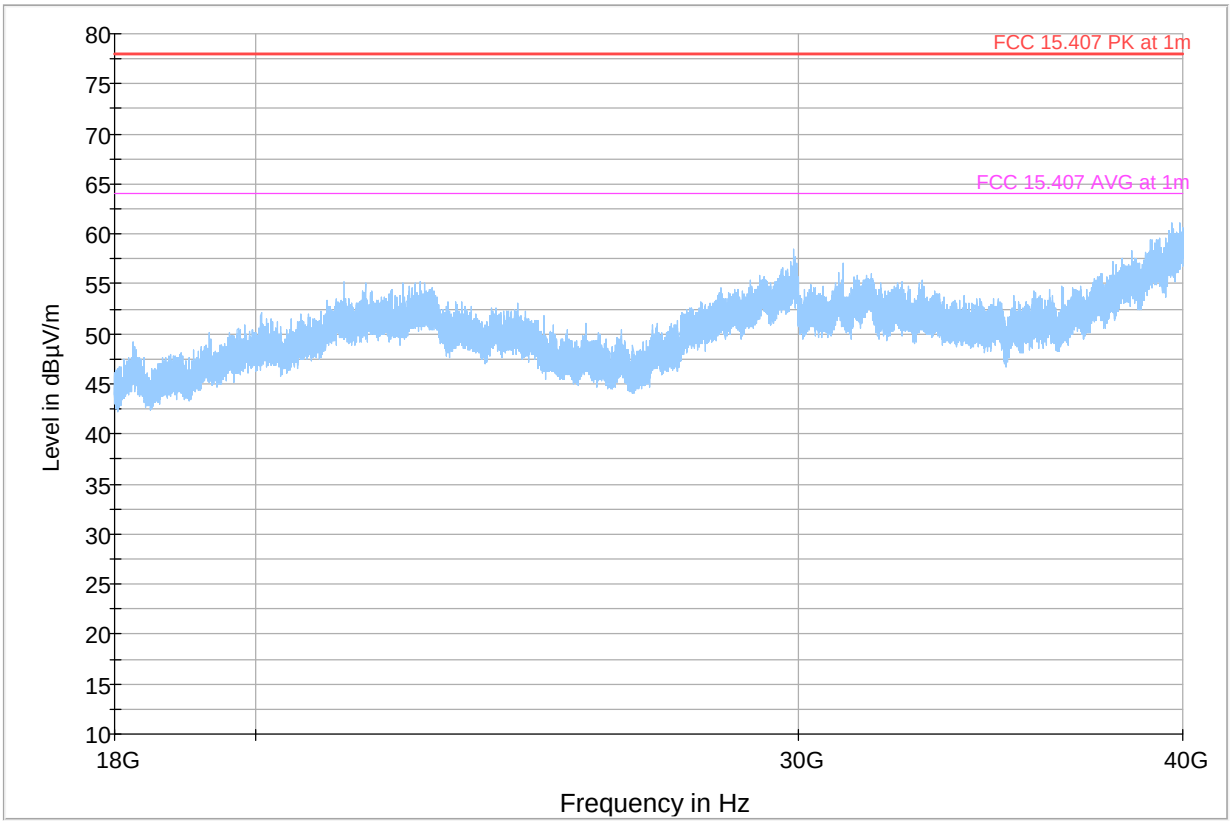
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17918.844	---	40.34	53.98	13.64	500.0	1000.000	125.0	H	275.0	18.0
17918.844	52.72	---	68.00	15.28	500.0	1000.000	125.0	H	275.0	18.0



Plot # 30 Radiated Emissions: 18 – 40 GHz

Tx Frequency: 5580 MHz	Mode: 802.11n



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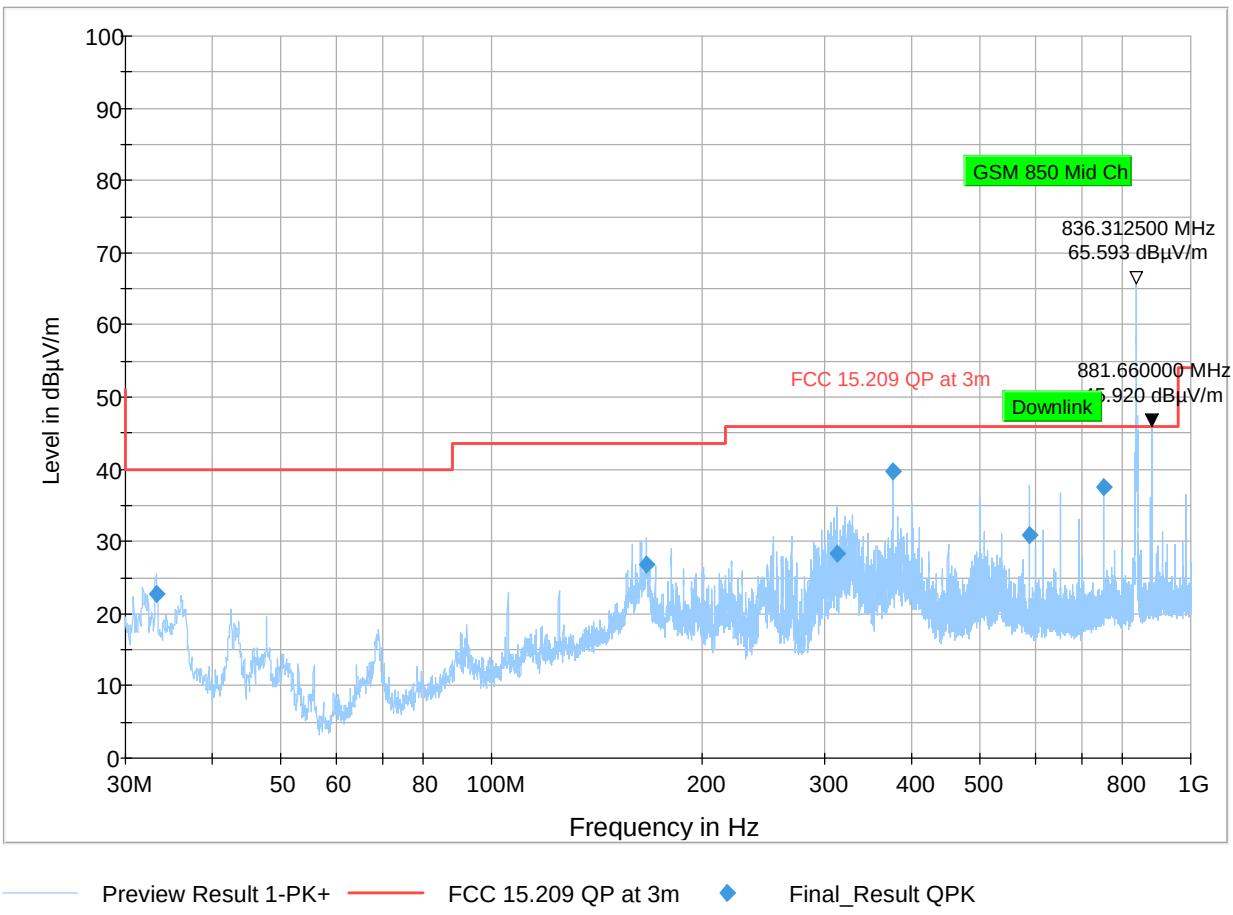
Plot # 31 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5700 MHz	Mode: 802.11n

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.201	22.75	40.00	17.25	500.0	120.000	116.0	V	45.0	-18.9
166.528	26.87	43.50	16.63	500.0	120.000	125.0	H	243.0	-17.8
312.707	28.23	46.02	17.79	500.0	120.000	107.0	H	202.0	-19.1
374.981	39.66	46.02	6.36	500.0	120.000	107.0	H	217.0	-17.8
587.459	30.95	46.02	15.07	500.0	120.000	100.0	V	262.0	-13.6
749.983	37.55	46.02	8.48	500.0	120.000	100.0	H	136.0	-10.4

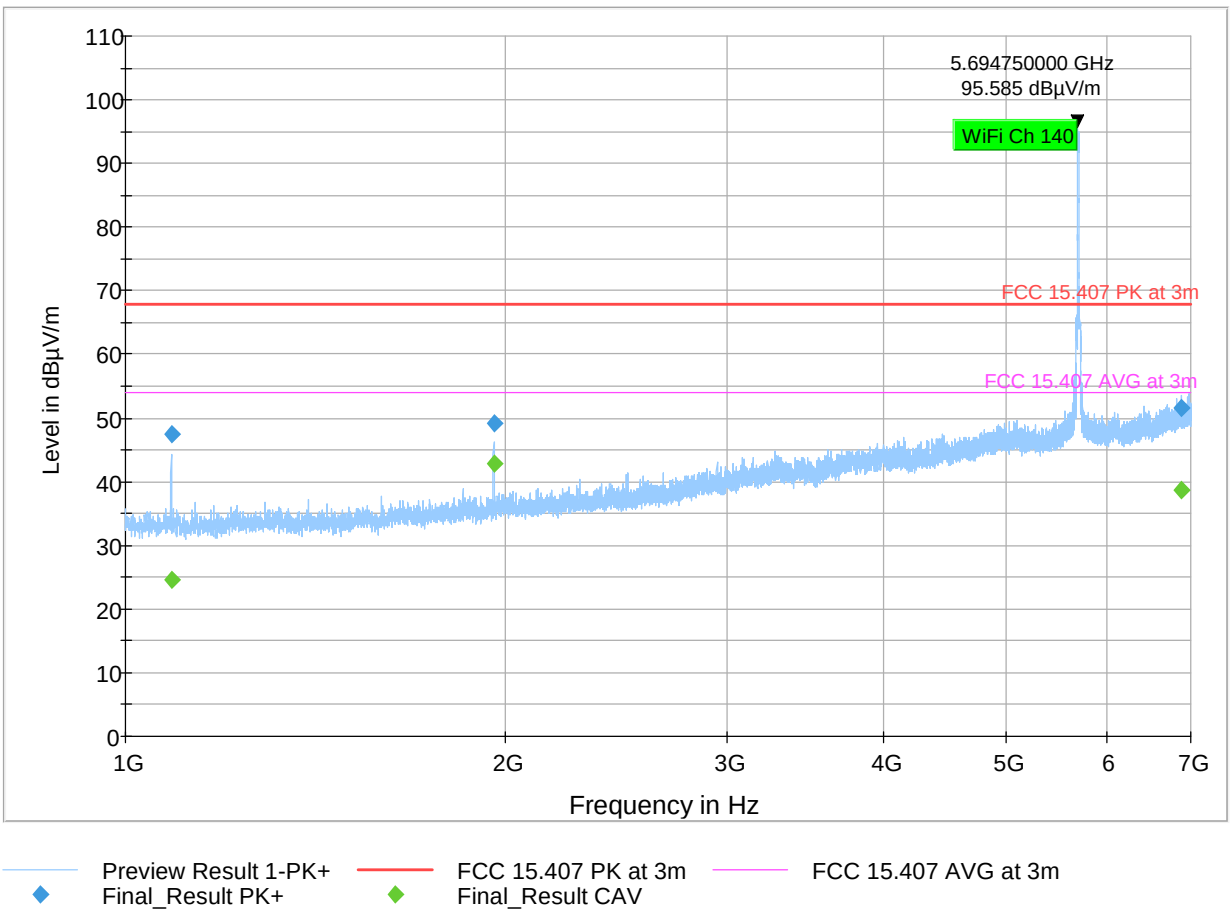


Plot # 32 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5700 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1087.250	47.54	---	68.00	20.46	500.0	1000.000	100.0	V	256.0	2.0
1087.250	---	24.51	53.98	29.47	500.0	1000.000	100.0	V	256.0	2.0
1959.750	49.07	---	68.00	18.93	500.0	1000.000	259.0	V	271.0	4.7
1959.750	---	42.89	53.98	11.09	500.0	1000.000	259.0	V	271.0	4.7
6879.500	---	38.62	53.98	15.36	500.0	1000.000	149.0	V	37.0	19.1
6879.500	51.50	---	68.00	16.50	500.0	1000.000	149.0	V	37.0	19.1

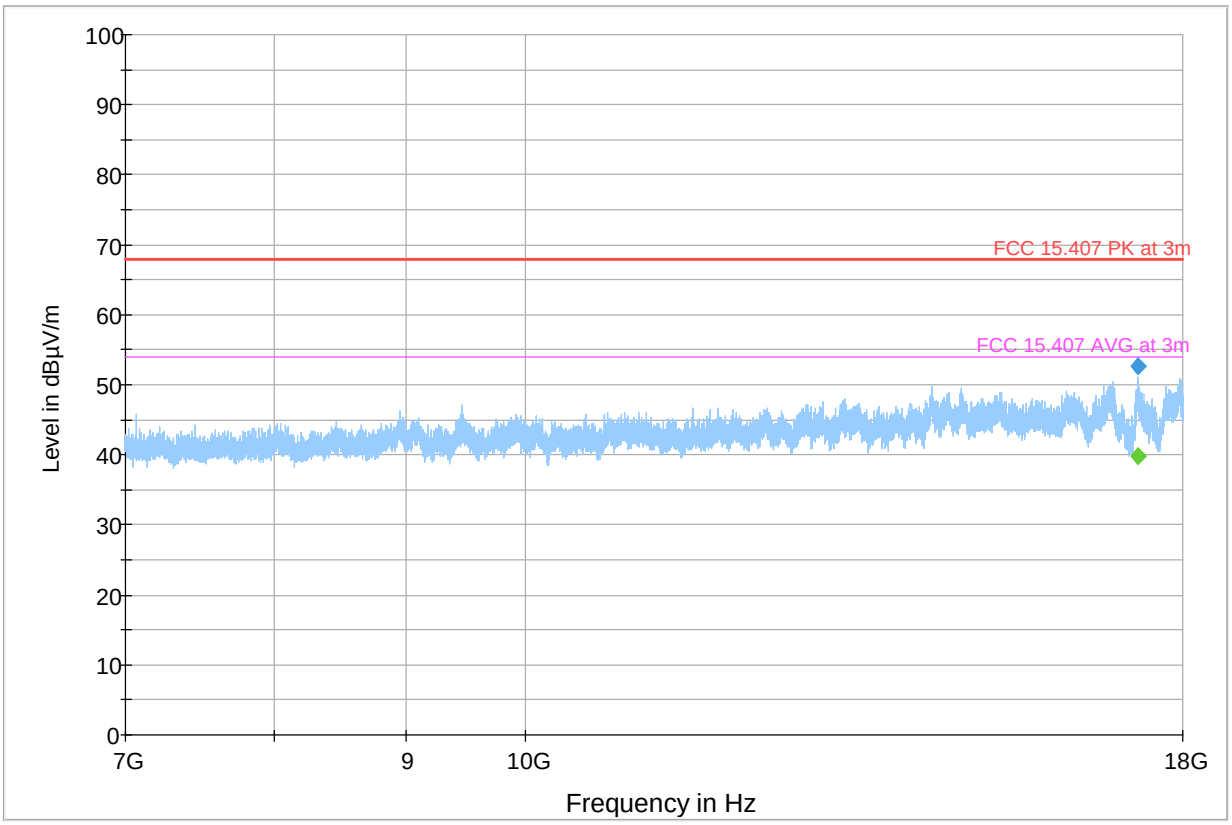


Plot # 33 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5700 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
17303.333	---	39.89	53.98	14.09	500.0	1000.000	133.0	V	143.0	15.6
17303.333	52.68	---	68.00	15.32	500.0	1000.000	133.0	V	143.0	15.6



8.3.5.4 UNII-3

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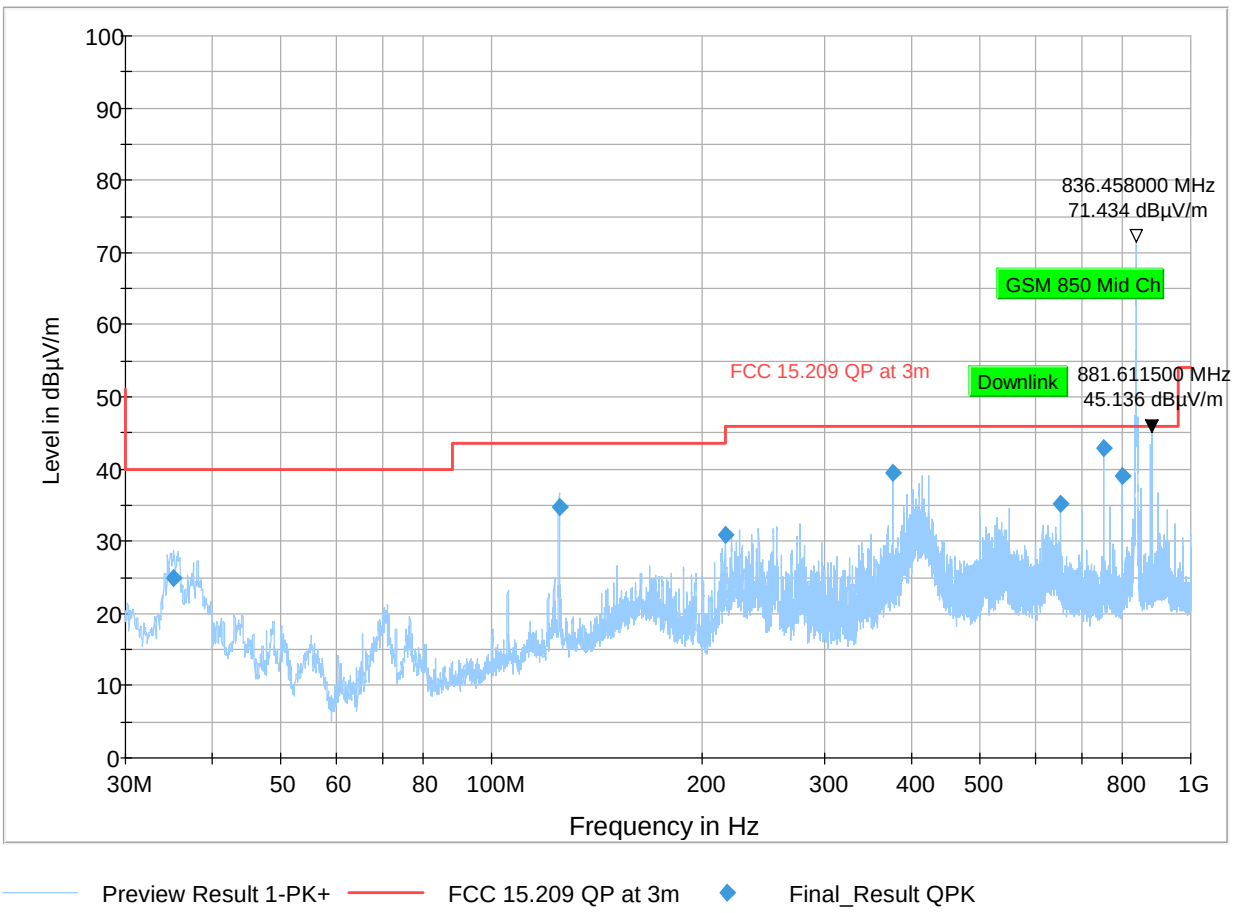
Plot # 34 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5745 MHz	Mode: 802.11n

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.190	24.86	40.00	15.14	500.0	120.000	107.0	V	18.0	-19.9
124.963	34.75	43.50	8.75	500.0	120.000	100.0	V	120.0	-17.6
215.998	30.97	43.50	12.53	500.0	120.000	159.0	H	-2.0	-22.6
374.981	39.56	46.02	6.46	500.0	120.000	100.0	H	31.0	-17.8
649.976	35.09	46.02	10.93	500.0	120.000	107.0	V	82.0	-12.4
749.983	42.90	46.02	3.12	500.0	120.000	107.0	H	202.0	-10.4
799.986	38.99	46.02	7.03	500.0	120.000	100.0	H	342.0	-9.9

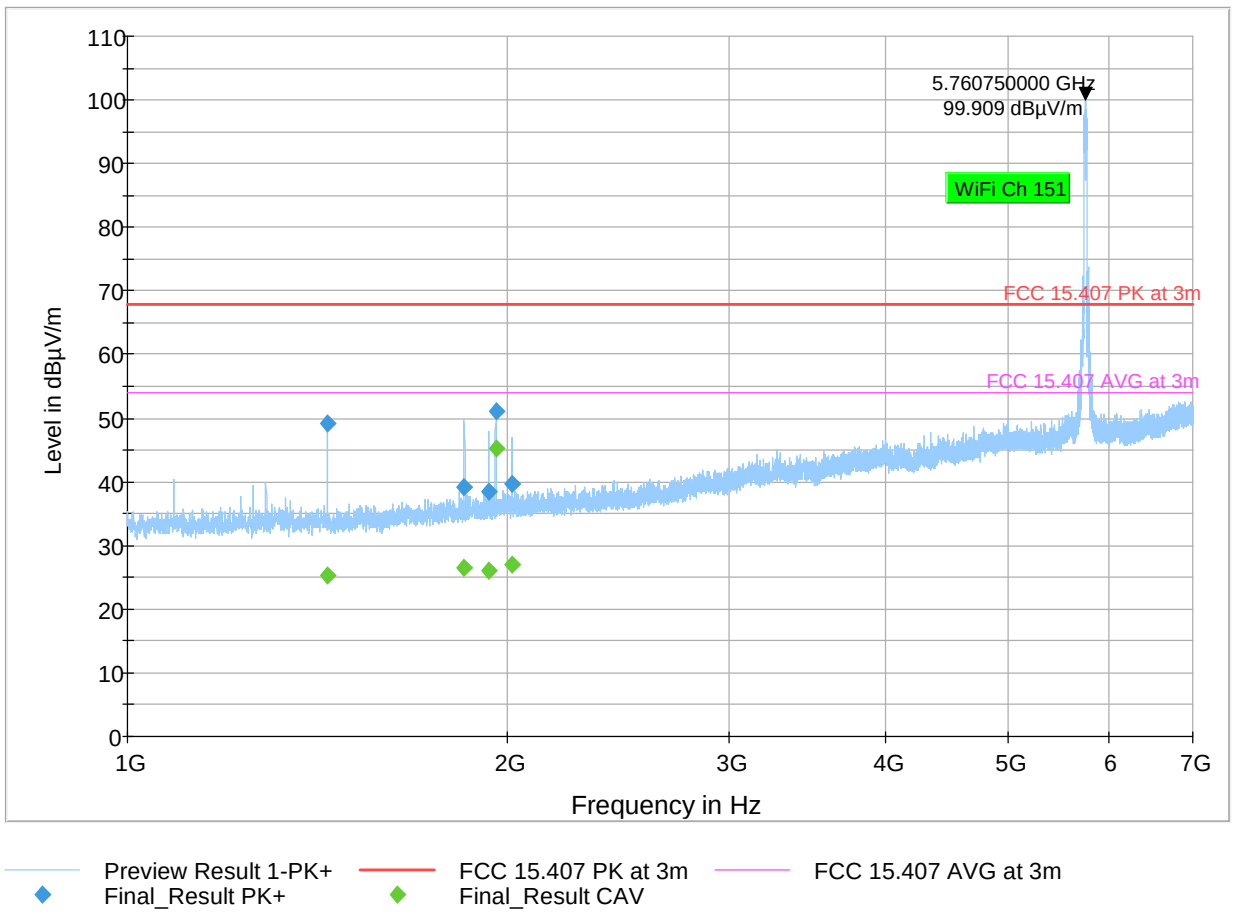


Plot # 35 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5745 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1442.000	---	25.19	53.98	28.79	500.0	1000.000	142.0	V	151.0	2.5
1442.000	49.10	---	68.00	18.90	500.0	1000.000	142.0	V	151.0	2.5
1851.250	39.08	---	68.00	28.92	500.0	1000.000	134.0	V	238.0	4.5
1851.250	---	26.45	53.98	27.53	500.0	1000.000	134.0	V	238.0	4.5
1933.750	38.55	---	68.00	29.45	500.0	1000.000	275.0	V	210.0	4.5
1933.750	---	25.96	53.98	28.02	500.0	1000.000	275.0	V	210.0	4.5
1959.750	---	45.34	53.98	8.64	500.0	1000.000	235.0	V	273.0	4.7
1959.750	51.13	---	68.00	16.87	500.0	1000.000	235.0	V	273.0	4.7
2018.750	---	27.02	53.98	26.96	500.0	1000.000	120.0	V	263.0	5.1
2018.750	39.59	---	68.00	28.41	500.0	1000.000	120.0	V	263.0	5.1

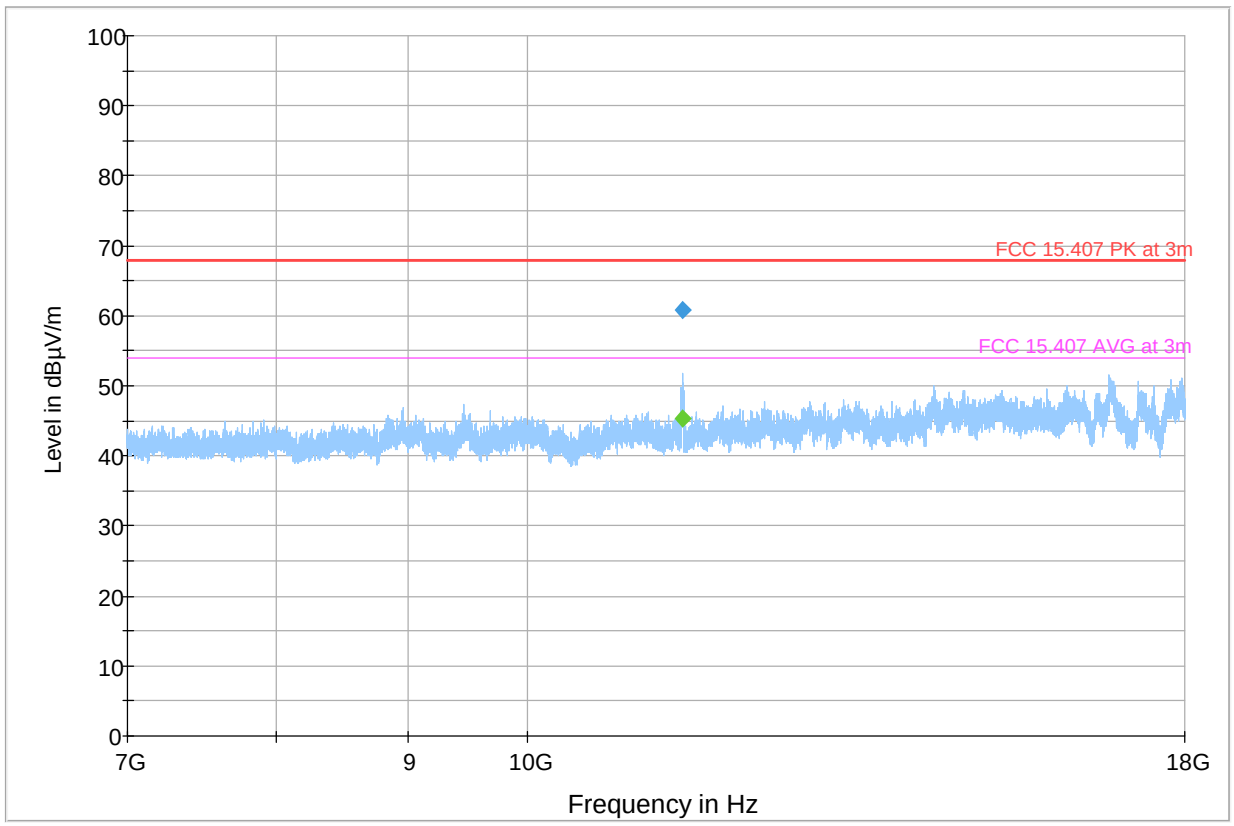


Plot # 36 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5745 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
11486.778	---	45.26	53.98	8.71	500.0	1000.000	313.0	V	233.0	3.2
11486.778	60.92	---	68.00	7.08	500.0	1000.000	313.0	V	233.0	3.2



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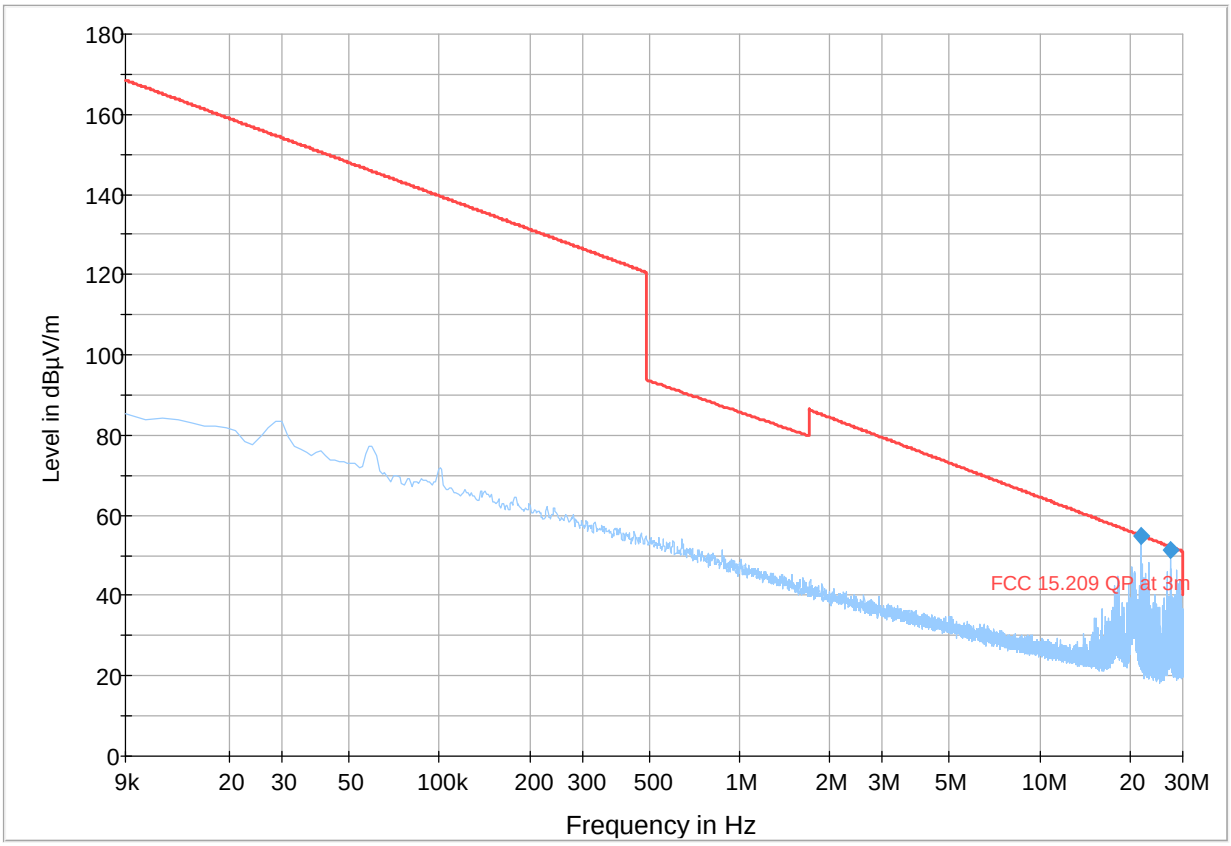
Plot # 37 Radiated Emissions: 9 KHz – 30 MHz

Tx Frequency: 5785 MHz	Mode: 802.11n

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
21.664	54.78	55.05	0.27	500.0	3.000	100.0	V	241.0	16.8
27.160	51.34	52.26	0.92	500.0	3.000	107.0	V	42.0	16.4

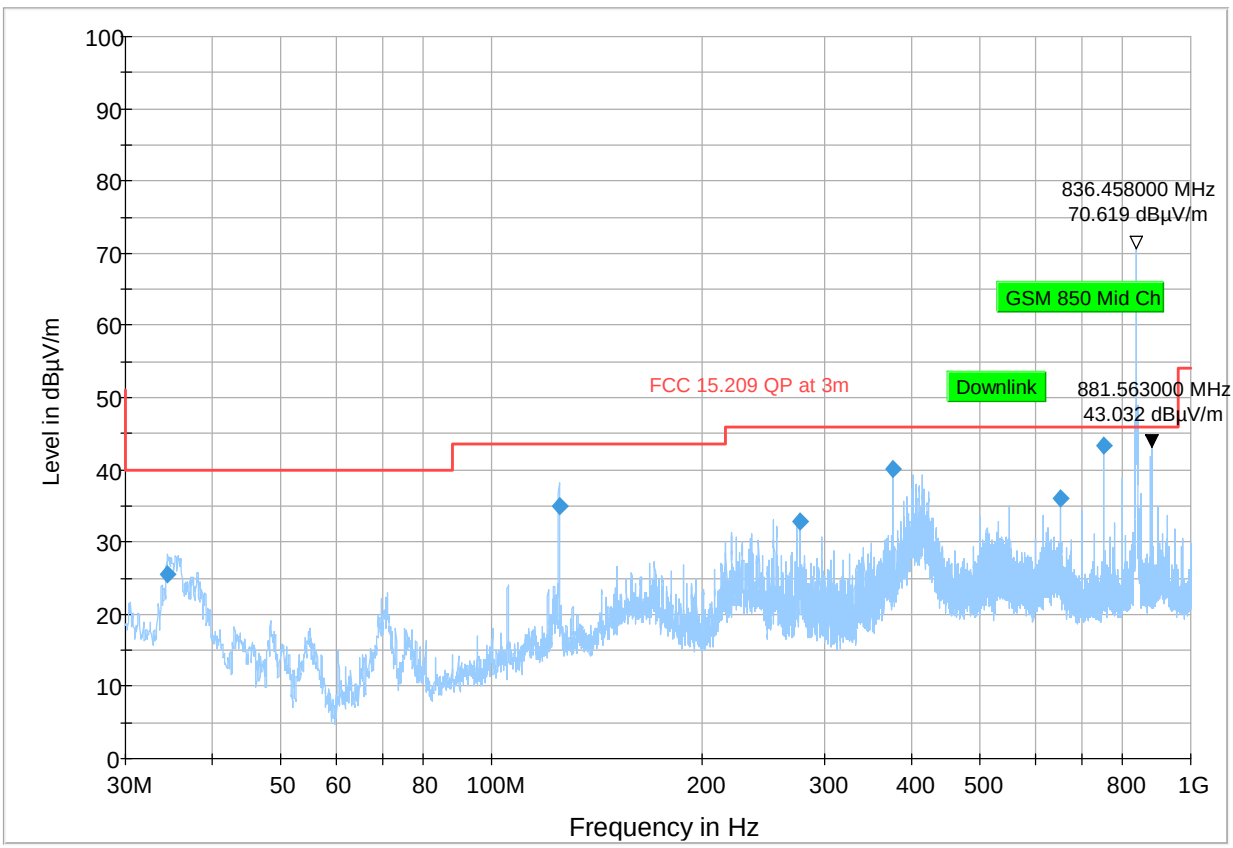


Plot # 38 Radiated Emissions: 30 MHz – 1 GHz

Tx Frequency: 5785 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
34.511	25.44	40.00	14.56	500.0	120.000	100.0	V	53.0	-19.6
124.963	34.92	43.50	8.58	500.0	120.000	100.0	V	119.0	-17.6
276.429	32.77	46.02	13.25	500.0	120.000	116.0	H	355.0	-20.2
374.981	40.02	46.02	6.00	500.0	120.000	100.0	H	36.0	-17.8
649.976	36.16	46.02	9.86	500.0	120.000	116.0	H	200.0	-12.1
749.983	43.31	46.02	2.71	500.0	120.000	107.0	H	201.0	-10.4

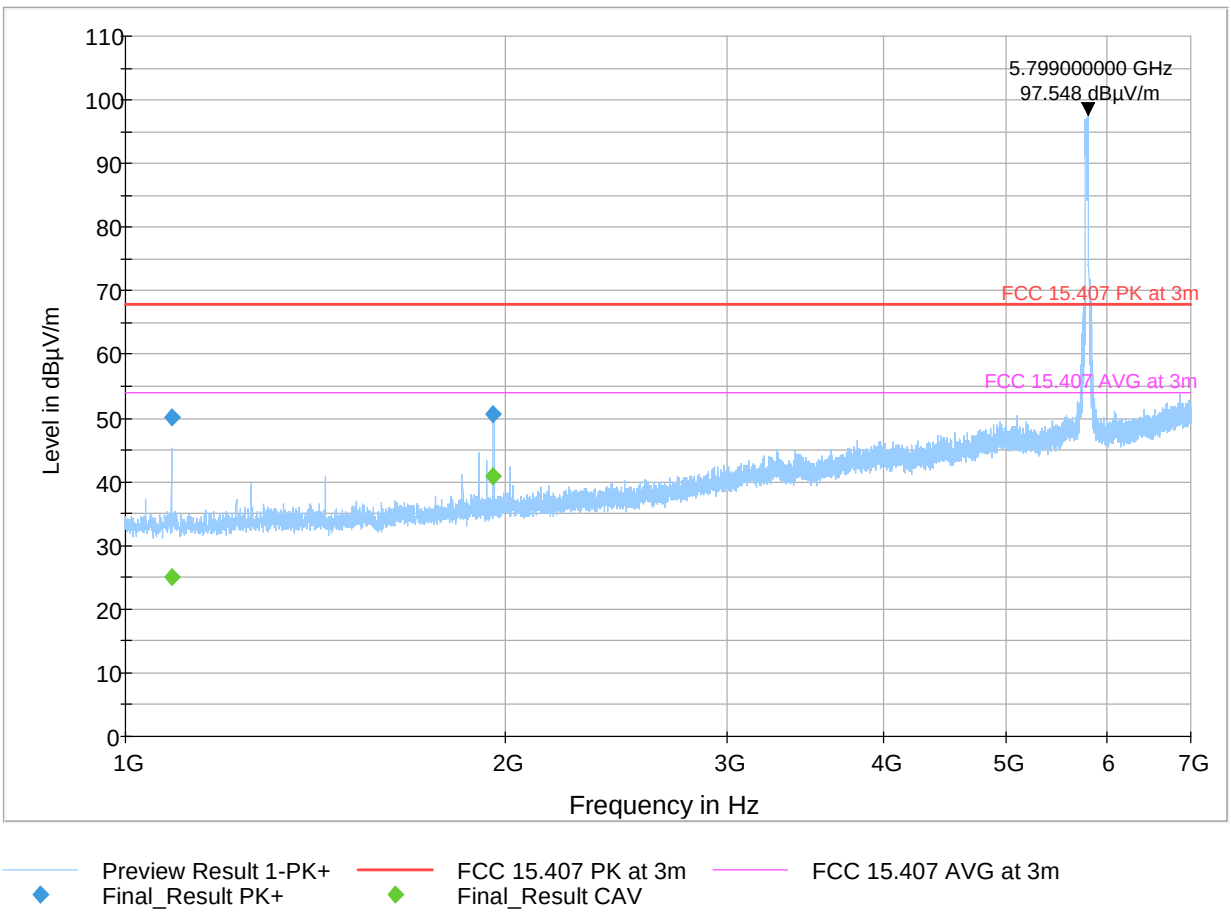


Plot # 39 Radiated Emissions: 1 – 7 GHz

Tx Frequency: 5785 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1087.500	50.09	---	68.00	17.91	500.0	1000.000	116.0	V	266.0	2.0
1087.500	---	25.10	53.98	28.88	500.0	1000.000	116.0	V	266.0	2.0
1959.500	50.73	---	68.00	17.27	500.0	1000.000	232.0	V	273.0	4.7
1959.500	---	40.99	53.98	12.99	500.0	1000.000	232.0	V	273.0	4.7

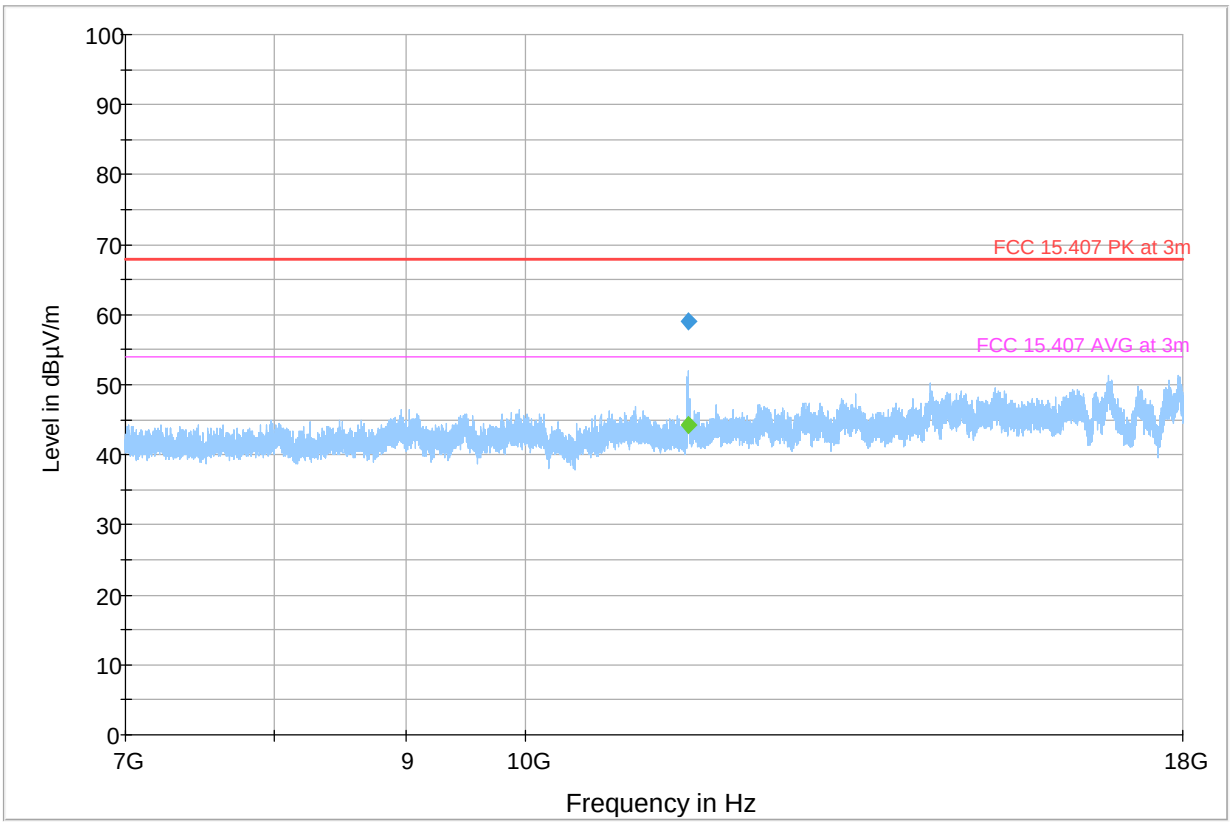


Plot # 40 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5785 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
11564.756	---	44.22	53.98	9.76	500.0	1000.000	200.0	V	247.0	3.9
11564.756	59.08	---	68.00	8.92	500.0	1000.000	200.0	V	247.0	3.9

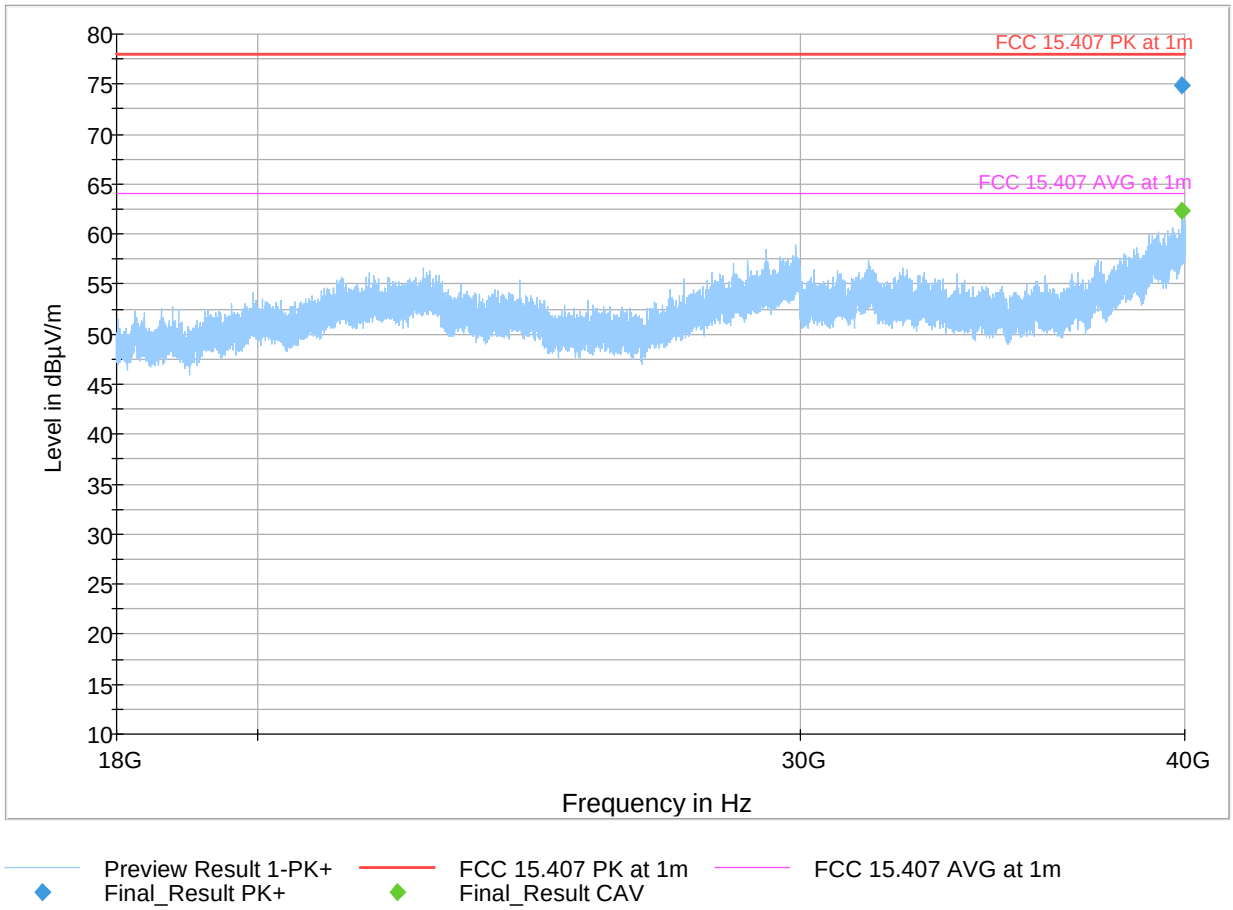


Plot # 41 Radiated Emissions: 18 – 40 GHz

Tx Frequency: 5785 MHz | **Mode: 802.11n**

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
39922.813	---	62.29	63.98	1.69	500.0	1000.000	315.0	V	130.0	24.7
39922.813	74.95	---	78.00	3.05	500.0	1000.000	315.0	V	130.0	24.7



9 Test setup photos

Setup photos are included in supporting file name: "EMC_RIVIA-008-21001_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
Biconilog ANTENNA	ETS LINDGREN	3142E	00166067	3 YEARS	3/20/2020
HORN ANTENNA	ETS LINDGREN	3115	00035114	3 YEARS	10/10/2020
HORN ANTENNA	ETS LINDGREN	3117-PA	00215984	3 YEARS	1/31/2021
HORN ANTENNA	ETS LINDGREN	3116C	00070497	3 YEARS	11/23/2020
EMI RECEIVER	R&S	ESU40	100251	3 YEARS	7/16/2019
Digital Thermometer/Chilled Mirror Hygrometer	Control Company	36934-164	191872028	3 years	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.

11 History

Date	Report Name	Changes to report	Report prepared by
5/6/2021	EMC_RIVIA-008-21001_FCC_15.407_WIFI_UNII	Initial Version	Ghanma, Issa
5/21/2021	EMC_RIVIA-008-21001_FCC_15.407_Wi-Fi_UNII_Rev1	❖ Add section 8.1.2 ❖ Add section 8.2	Ghanma, Issa

<<< The End >>>