FCC / ISED Test Report

For:
Rivian Automotive

Brand: Rivian Automotive

Marketing Name: Autonomy Experience Module 2.0/ AXM 2.0

Model Name: AXM 2.0

Product Description: Autonomy Experience Module

FCC ID: 2AW3A-2NAT23AXM
IC: 26958-2NAT23AXM

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

REPORT #: EMC_RIVIA_058_23001_15_407_UNII_Rev1

DATE: 2024-04-16

A2LA Accredited

IC recognized # 3462B

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.407 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Rivian Automotive	Autonomy Experience Module	AXM 2.0

Responsible for the Report:

Date	Section	Name	Signature
2024-04-16	Compliance	Art Thammanavarat (Senior EMC Engineer)	art. thammanavarat @cetecom.com Digitally signed by: art. thammanavarat@cetecom.com DN: CN = art. thammanavarat@cetecom.com Date: 2024.04.16 17:29:10 -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:	Issa Ghama
Responsible Project Leader:	Rami Saman

2.2 Identification of the Client

Client Firm/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:	AXM 2.0
HW Version :	D
SW Version :	42
FCC-ID :	2AW3A-2NAT23AXM
IC:	26958-2NAT23AXM
FWIN:	N/A
HVIN:	AXM 2.0
PMN:	Autonomy Experience Module 2.0
Product Description:	Autonomy Experience Module
Frequency Range / number of channels:	Frequency Range (MHz) / Channel Number 5150-5250 / 36-48 [4] 5725-5850 / 149-165 [5]
Modes of Operation / Channel Bandwidths:	IEEE Std. 802.11 / Data Rate / MCS a / 6-54 Mbps n: HT20 & HT40 / MCS 0-7 ac: VHT20; VHT40; VHT80 / MCS 0-9 ax: HE20; HE40; HE80 / MCS 0-11
Transmit Chains(NTX)	1 & 2
Radio Information:	FCC ID VPYLB2AJ and IC: 772C-LB2AJ :Wi-Fi 2.4GHz, 5GHz - UNII-1 and UNII- 3, EDR/BDR, BLE, Wi-Fi
Power Supply/ Rated Operating Voltage Range:	9 VDC – 16 VDC
Operating Temperature Range	-30º to 45º C
Other Radios included in the device:	Cell, GPS, BT
Sample Revision	☒Production Unit; ☐Pre-Production
Note: The information of the EUT specifications in the table above is provided by the client.	

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	LIP-55352 AXM2-D PEGA	D	42	Radiated and Conducted Measurements

3.3 Accessory Equipment (AE) details

AE #	Type	Part Number	Manufacturer	Serial Number
1	Camera	PT00463985 A	RIVIAN	22287A000000000017
2	Camera	PT00463985 A	RIVIAN	22287A000000000016
3	Camera	PT00463985 A	RIVIAN	22287A000000000078
4	Camera	PT00463984 A	RIVIAN	22329A000000000011
5	Camera	PT00463986 A	RIVIAN	22840A000000000028
6	Camera	PT00463986 A	RIVIAN	22840A000000000044
7	Display	PT00000503-F Rev 01	RIVIAN	22328A0010B1026427
8	Display	PT00055883-E Rev 02	RIVIAN	22213A0010B1001322
9	Display	CLUSTER DISPLAY	RIVIAN	CLUS-008
10	Internal Wi-Fi Antenna	PT00001507	RIVIAN	20268000135
11	Internal Wi-Fi Antenna	PT00001507	RIVIAN	20268000120
12	Internal Wi-Fi Antenna	PT00001507	RIVIAN	N/A
13	External Wi-Fi Antenna	PT00039250	RIVIAN	22342
14	CELL Antenna	PT00039248	RIVIAN	22223
15	Spoiler	5093407	RIVIAN	00051
16	Chiller	LM61GX1A110C	PolyScience	2108-02177
17	Laptop	20S1S97U00	ThinkPad	PF23ZGQM

3.4 Test Sample Configuration

Set-up #	EUT / AE used for set-up	Comments
1	EUT#1+AE#1~17	Radiated RF measurements were performed with EUT configured via customer provided GUE and instructions. Powered by 12 VDC Car battery

3.5 Mode of Operation details

Mode of Operation	Description of Operating modes	Additional Information
Op. 1	Internal Wi-Fi 802.11ax HE20/80 MIMO + Cellular + External Wi-Fi 802.11ax HE20 MIMO and Bluetooth LE Co-Transmission	Internal WiFi radio was configured to 802.11ax HE20 and HE80 Mid channel using special commands through command window provided by the client that will not be available to the end user Cellular was tested on Mid Channels at maximum power in a co-transmission mode External WiFi radio was configured to 802.11ax HE20 Mid channel using special commands through command window provided by the client that will not be available to the end user Bluetooth LE radio was configured to a fixed channel transmission with highest possible duty cycle using confidential test software and scripts provided by the applicant.

3.6 Justification for Worst Case Mode of Operation

During the testing process the EUT was tested with transmitter sets on mid channels at the maximum power simultaneous transmission with Internal WiFi radio 802.11ax HE20/80 Mid channel + External WiFi radio 802.11ax HE20 Mid channel and 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 assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.407 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

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

- FCC ID: VPYLB2AJ
- IC: 772C-LB2AJ

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.407(e) RSS-247 6.2.4.1	Emission Bandwidth	Nominal	802.11a/n/ ac/ax	☐	☐	■	See Note 4
§15.407(a) RSS-247 6.2.1	Power Spectral Density	Nominal	802.11a/n/ ac/ax	☐	☐	■	See Note 5
§15.407(a) RSS-247 6.2.1	Maximum Output Power	Nominal	802.11a/n/ ac/ax	■	☐	☐	See Note 3,6
§15.407; 15.205 RSS-247 6.2.1; RSS-Gen 8.10	Band Edge Compliance	Nominal	802.11a/n/ ac/ax	☐	☐	■	See Note 7
§15.407(b); §15.209; 15.205 RSS-247 6; RSS-Gen 8.9; 8.10	Radiated TX Spurious Emissions	Nominal	802.11a/n/ ac/ax	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	802.11a/n/ ac/ax	☐	☐	■	See Note 1,2

Note 1: NA= Not Applicable, NP= Not Performed.
Note 2: This device does not connect to AC mains network
Note 3: Power verification testing was conducted only on middle channel.
Note 4: Leveraged from report # ER/2020/B0047 Section 8 (FCC ID: VPYLB2AJ)
Note 5: Leveraged from report # ER/2020/B0047, Section 10 (FCC ID: VPYLB2AJ)
Note 6: Leveraged from report # ER/2020/B0047, Section 9 (FCC ID: VPYLB2AJ)
Note 7: Leveraged from report # ER/2020/B0047, Section 11 (FCC ID: VPYLB2AJ)

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=2.

Measurement System		EMC 1	EMC 2
Conducted emissions (mains port)		1.12 dB	0.46 dB
Radiated emissions	(< 30 MHz)	3.66 dB	3.88 dB
	(30 MHz – 1GHz)	3.17 dB	3.34 dB
	(1 GHz – 3 GHz)	5.01 dB	4.45 dB
	(>3 GHz)	4.0 dB	4.79 dB

6.1 Environmental Conditions during Testing:

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

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

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

6.2 Date of Testing:

2023-12-11 – 2023-12-22

6.3 Decision Rule:

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

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

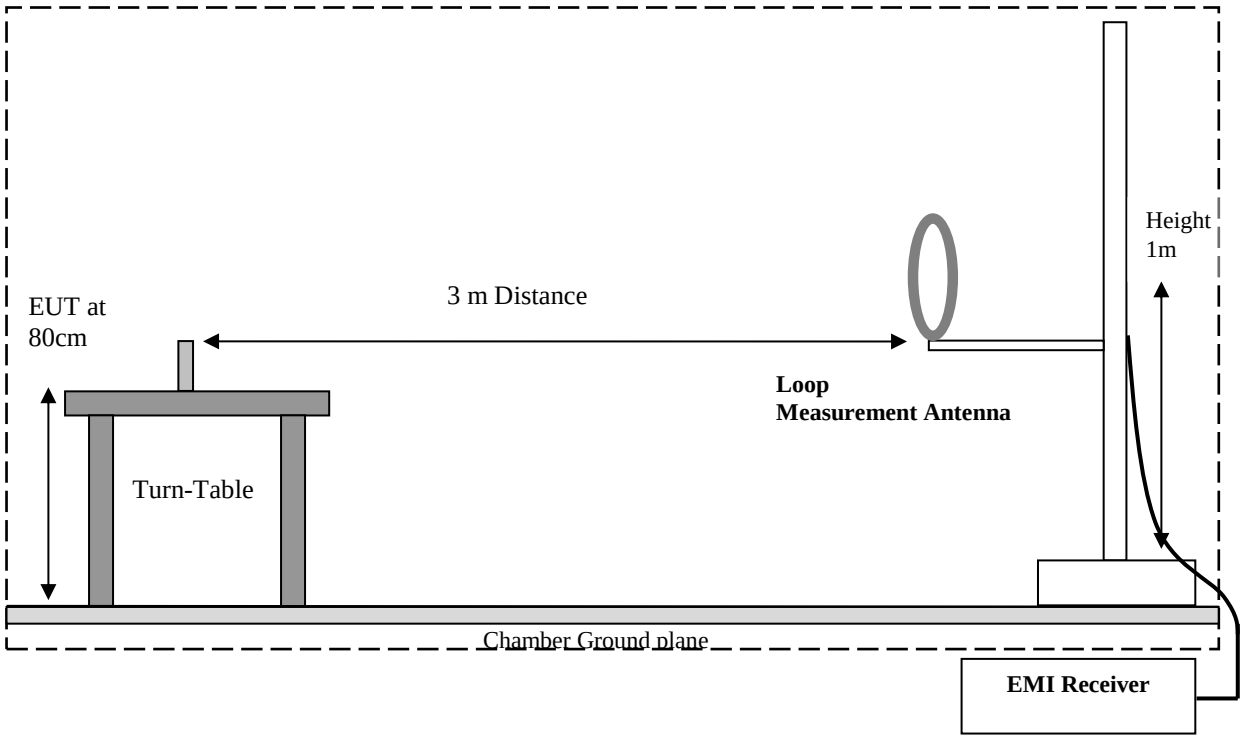
7 Measurement Procedures

7.1 Radiated Measurement

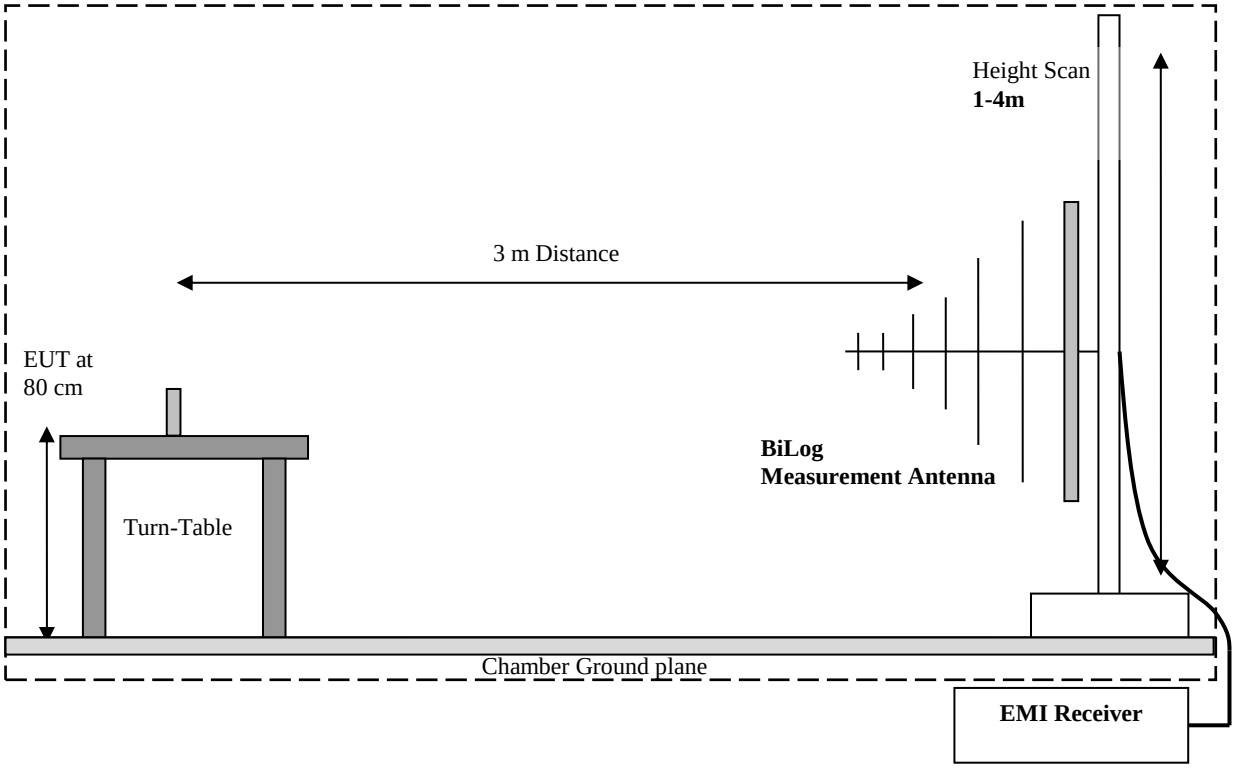
The radiated measurement is performed according to ANSI C63.10 (2013)

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

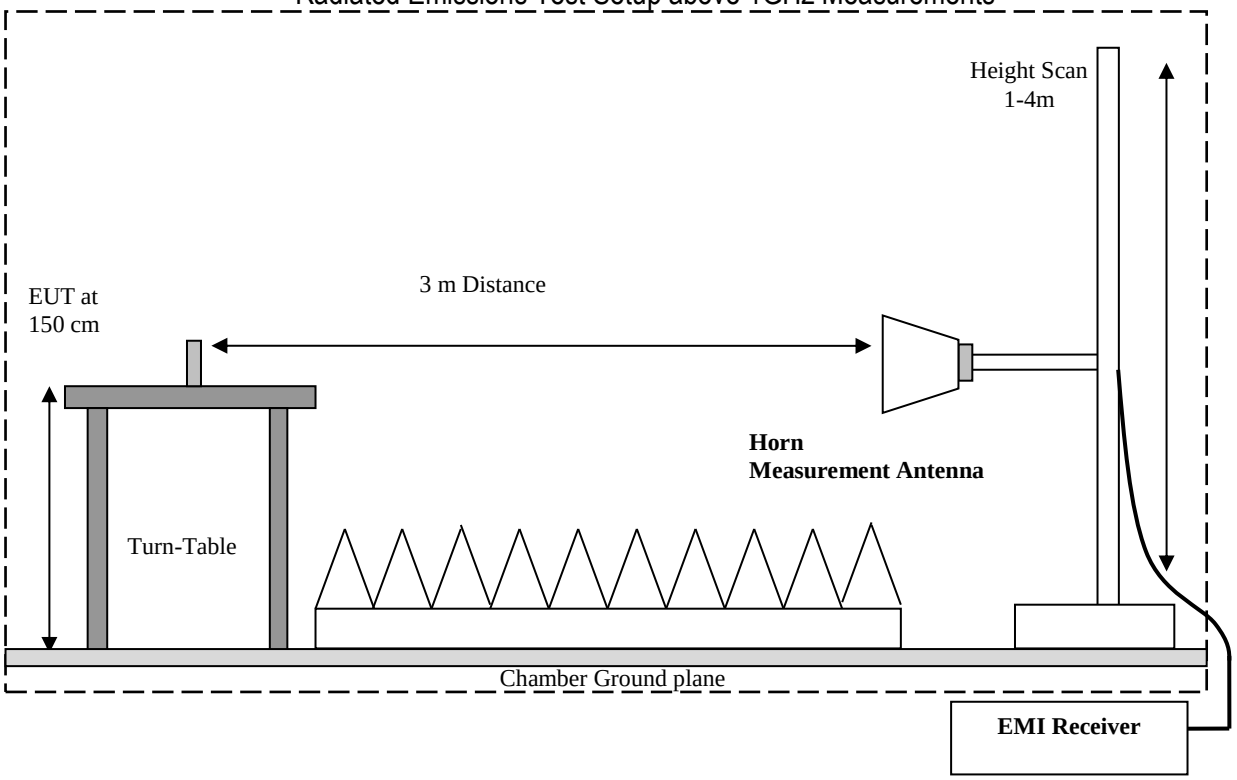
Radiated Emissions Test Setup below 30MHz Measurements



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:

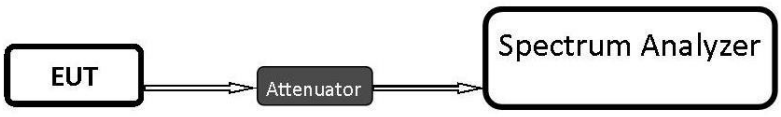
Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

7.2 Power Line Conducted Measurement Procedure

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

7.3 RF Conducted Measurement Procedure

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



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

8 Test Result Data

8.1 EIRP Measurement Results:

SISO

Radio	Modulation	Data Rate	CH	Frequency	Avg. Output Power CH 0	Avg. Output Power CH 1	Cable Loss	Ant-Gain	EIRP	FCC Limit EIRP
				(MHz)	(dBm)	(dBm)	(dBm)	(dBi)	(W)	(W)
Wi-Fi 5GHz U-NII-1	802.11a	6	36	5180	12.99		6.20	3.76	0.0114	0.125
	802.11n HT20	MCS0	36	5180	12.98		6.20	3.76	0.0113	0.125
		MCS0	44	5220		12.82	6.20	3.76	0.0109	0.125
	802.11n HT40	MCS0	46	5230	12.78		6.20	3.76	0.0108	0.125
		MCS0	46	5230		12.76	6.20	3.76	0.0108	0.125
	802.11ac VHT80	MCS0	42	5210	12.80		6.20	3.76	0.0109	0.125
		MCS0	42	5210		12.74	6.20	3.76	0.0107	0.125
	802.11ax HE20	MCS0	44	5220	12.99		6.20	3.76	0.0114	0.125
		MCS0	36	5180		12.97	6.20	3.76	0.0006	0.125
	802.11ax HE40	MCS0	38	5190	12.98		6.20	3.76	0.0113	0.125
		MCS0	38	5190		12.96	6.20	3.76	0.0113	0.125
	802.11ax HE80	MCS0	42	5210	12.88		6.20	3.76	0.0111	0.125
		MCS0	42	5210		12.88	6.20	3.76	0.0006	0.125

Radio	Modulation	Data Rate	CH	Frequency	Avg. Output Power CH 0	Avg. Output Power CH 1	Cable Loss	Ant-Gain	EIRP	FCC Limit EIRP
				(MHz)	(dBm)	(dBm)	(dBm)	(dBi)	(W)	(W)
Wi-Fi 5GHz U-NII-3	802.11a	6	165	5825	12.99		6.60	1.84	0.0067	4
	802.11n HT20	MCS0	165	5825	12.99		6.60	1.84	0.0067	4
		MCS0	165	5825		12.67	6.60	1.84	0.0062	4
	802.11n HT40	MCS0	151	5755	12.98		6.60	1.84	0.0066	4
		MCS0	159	5795		12.84	6.60	1.84	0.0064	4
	802.11ac VHT80	MCS0	155	5775	12.98		6.60	1.84	0.0066	4
		MCS0	155	5775		12.75	6.60	1.84	0.0063	4
	802.11ax HE20	MCS0	149	5745	12.99		6.60	1.84	0.0067	4
		MCS0	149	5745		12.99	6.60	1.84	0.0003	4
	802.11ax HE40	MCS0	159	5795	12.98		6.60	1.84	0.0066	4
		MCS0	159	5795		12.99	6.60	1.84	0.0067	4
	802.11ax HE80	MCS0	155	5775	12.99		6.60	1.84	0.0067	4
		MCS0	155	5775		12.88	6.60	1.84	0.0003	4

Note 1: Power Conducted (dBm) leveraged from test report "ER/2020/B0047" prepared by SGS Taiwan Ltd. The module Model # LBEE6ZZ2AJ (FCC ID: VPYLB2AJ, IC: 772C-LB2AJ).
Note 2: EIRP are based on calculations from Power Conducted by adding the declared maximum gain of the utilized antenna per operational description

MIMO

Radio	Modulation	Data Rate	CH	Frequency	Total Avg. Output Power	Cable Loss	Ant-Gain	EIRP	FCC Limit EIRP
				(MHz)	(dBm)	(dBm)	(dBi)	(W)	(W)
Wi-Fi 5GHz U-NII-1	802.11n HT20	MCS0	36	5180	15.94	6.20	6.77	0.0448	0.125
	802.11n HT40	MCS0	38	5190	15.83	6.20	6.77	0.0437	0.125
	802.11ac VHT80	MCS0	42	5210	15.54	6.20	6.77	0.0408	0.125
	802.11ax HE20	MCS0	36	5180	15.97	6.20	6.77	0.0451	0.125
	802.11ax HE40	MCS0	38	5190	15.99	6.20	6.77	0.0453	0.125
	802.11ax HE80	MCS0	42	5210	**15.99**	6.20	6.77	0.0453	0.125
Wi-Fi 5GHz U-NII-3	802.11n HT20	MCS0	149	5745	15.76	6.60	4.85	0.0252	4
	802.11n HT40	MCS0	151	5755	15.95	6.60	4.85	0.0263	4
	802.11ac VHT80	MCS0	155	5775	15.97	6.60	4.85	0.0264	4
	802.11ax HE20	MCS0	165	5825	**15.98**	6.60	4.85	0.0265	4
	802.11ax HE40	MCS0	151	5755	15.89	6.60	4.85	0.0259	4
	802.11ax HE80	MCS0	155	5775	15.96	6.60	4.85	0.0264	4

MIMO for ISED

Radio	Modulation	Data Rate	CH	Frequency	Total Avg. Output Power	Cable Loss	Ant-Gain	EIRP	ISED Limit EIRP
				(MHz)	(dBm)	(dBm)	(dBi)	(W)	(W)
Wi-Fi 5GHz U-NII-1	802.11ax HE80	MCS0	42	5210	***8.00****	6.20	6.77	*0.0072*	0.030
Wi-Fi 5GHz U-NII-3	802.11ax HE20	MCS0	165	5825	**15.98**	6.60	4.85	0.0265	4

Note 1: Power Conducted (dBm) leveraged from test report "ER/2020/B0047" prepared by SGS Taiwan Ltd. The module Model # LBEE6ZZ2AJ (FCC ID: VPYLB2AJ, IC: 772C-LB2AJ).
Note 2: EIRP are based on calculations from Power Conducted by adding the declared maximum gain of the utilized antenna per operational description
Note 3: The DUT will load a different power calibration file which will reduce the transmit power (conducted) to 8dBm to comply with Canadian regulatory limits. When the GPS on board the vehicle detects that it has entered Canadian territory. Please refer to operation description.

8.2 Maximum Output Power Verification

8.2.1 Measurement according to FCC 789033 D02 General UNII Test Procedures New Rules v02r01

Spectrum Analyzer settings for method SA-1:

- Set span to encompass the entire emission bandwidth (EBW) (or, alternatively, the entire 99% occupied bandwidth) of the signal.
- Set RBW = 1 MHz
- Set the VBW ≥ 3 MHz
- Detector = RMS
- Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = Auto Couple
- Trace mode = Trace average at least 100 traces in power averaging (i.e., RMS mode).
- If transmit duty cycle < 98%, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run."
- Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the spectrum.

8.2.2 Limits:

FCC§15.407

Sub-band 5150-5250 MHz

- For AP the maximum conducted output power over the frequency band of operation shall not exceed 1 W
- For Client Devices the maximum conducted output power over the frequency band of operation shall not exceed 250 mW

Sub-band 5250-5350 MHz and 5470-5725 MHz and

- The maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26 dB emission bandwidth in megahertz

Sub-band 5725-5850 MHz

- The maximum conducted output power over the frequency band of operation shall not exceed 1 W

RSS-247

Sub-band 5150-5250 MHz

- For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 log10B, dBm, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.

- For other devices, the maximum e.i.r.p. shall not exceed 200 mW or 10 + 10 log10B, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz.

Sub-band 5250-5350 MHz

- For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 mW or 1.76 + 10 log10B, dBm, whichever is less. Devices shall implement TPC in order to have the capability to operate at least 3 dB below the maximum permitted e.i.r.p. of 30 mW.
  - Devices, other than devices installed in vehicles, shall comply with the following:
    a) The maximum conducted output power shall not exceed 250 mW or 11 + 10 log10B, dBm, whichever is less.
    b) b.The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

- Additional requirements

  In addition to the above requirements, devices shall comply with the following, where applicable:

  a) Outdoor fixed devices with a maximum e.i.r.p. greater than 200 mW shall comply with the following e.i.r.p. at different elevations, where θ is the angle above the local horizontal plane (of the Earth) as shown below:

i. -13 dBW/MHz	for $0^\circ \leq \theta < 8^\circ$
ii. -13 − 0.716 (θ-8) dBW/MHz	for $8^\circ \leq \theta < 40^\circ$
iii. -35.9 − 1.22 (θ-40) dBW/MHz	for $40^\circ \leq \theta \leq 45^\circ$
iv. -42 dBW/MHz	for $\theta > 45^\circ$

  The measurement procedure defined in Annex A of this document shall be used to verify the compliance to the e.i.r.p. at different elevations.

  b) Devices, other than outdoor fixed devices, having an e.i.r.p. greater than 200 mW shall comply with either i. or ii. below:

  i. devices shall comply with the e.i.r.p. elevation mask in 6.2.2.3(a); or

  ii. devices shall implement a method to permanently reduce their e.i.r.p. via a firmware feature in the event that the Department requires it. The test report must demonstrate how the device's power table can be updated to meet this firmware requirement. The manufacturer shall provide this firmware to update all systems automatically incompliance with the directions received from the Department.

Sub-band 5470-5600 MHz and 5650-5725 MHz

- The maximum conducted output power shall not exceed 250 mW or 11 + 10 log10B, dBm, whichever is less.
- The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

Sub-band 5725-5850 MHz

- The maximum conducted output power shall not exceed 1 W.

Note: All limits are conducted. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain
22.8° C	1	1	12 VDC	U-NII-1 ~ 6.77 dBi U-NII-3 ~ 4.85 dBi

8.2.4 Measurement result for FCC

Mode	Channel	Frequency (MHz)	Total Avg. Output Power	Cable Loss	EIRP		Limit	Result
				(dBm)	(dBm)	(W)		
802.11ax HE 80	42	5210	14.41	6.20	14.98	0.032	See Section 8.2.2	Pass

Mode	Channel	Frequency (MHz)	Total Avg. Output Power	Cable Loss	EIRP		Limit	Result
				(dBm)	(dBm)	(W)		
802.11ax HE 20	165	5825	14.04	6.60	12.29	0.017	See Section 8.2.2	Pass

8.2.5 Measurement result for ISED

Mode	Channel	Frequency (MHz)	Total Avg. Output Power	Cable Loss	EIRP		Limit	Result
				(dBm)	(dBm)	(W)		
802.11ax HE 80	42	5210	10.5	6.20	11.07	0.0128	See Section 8.2.2	Pass

Note: Please refer to operation description for power reduction.

Mode	Channel	Frequency (MHz)	Total Avg. Output Power	Cable Loss	EIRP		Limit	Result
				(dBm)	(dBm)	(W)		
802.11ax HE 20	165	5825	14.04	6.60	12.29	0.017	See Section 8.2.2	Pass

8.3 Emission Bandwidth and 99% Verification

8.3.1 Measurement according to FCC 789033 D02 General UNII Test Procedures New Rules v02r01

- For the band 5.150-5.250 GHz the 99% EBW is measured

Spectrum Analyzer Settings for 99% Occupied Bandwidth

- Set center frequency to the nominal EUT channel center frequency
- Set span = 1.5 times to 5.0 times the OBW
- Set RBW = 1% to 5% of the OBW
- Set VBW ≥ 3 x RBW
- Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used
- Use the 99% power bandwidth function of the instrument (if available)
- If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies

8.3.2 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22.8° C	1	1	12 VDC

8.3.3 Measurement result:

Mode	Channel	Frequency (MHz)	99% Occupied Bandwidth (MHz)
802.11ax HE 80	42	5210	77.56

Note: Testing was done to verify that 99% OBW will not change due to power reduction. Please refer to operation description for power reduction.

8.4 Radiated Transmitter Spurious Emissions

8.4.1 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.

8.4.2 Limits:

FCC §15.407

- Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209.
- The provisions of §15.205 apply to intentional radiators operating under this section.

FCC §15.209 & RSS-Gen 8.9

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength @ 3m (dBµV/m)
0.009–0.490	2400/F(kHz) / ---------	300	-
0.490–1.705	24000/F(kHz) / --------	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBµV/m
88–216	150	3	43.5 dBµV/m
216–960	200	3	46 dBµV/m
Above 960	500	3	54 dBµV/m

FCC §15.205 & RSS-Gen 8.10

- Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[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

8.4.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22.8° C	1	1	12 VDC

8.4.4 Measurement result:

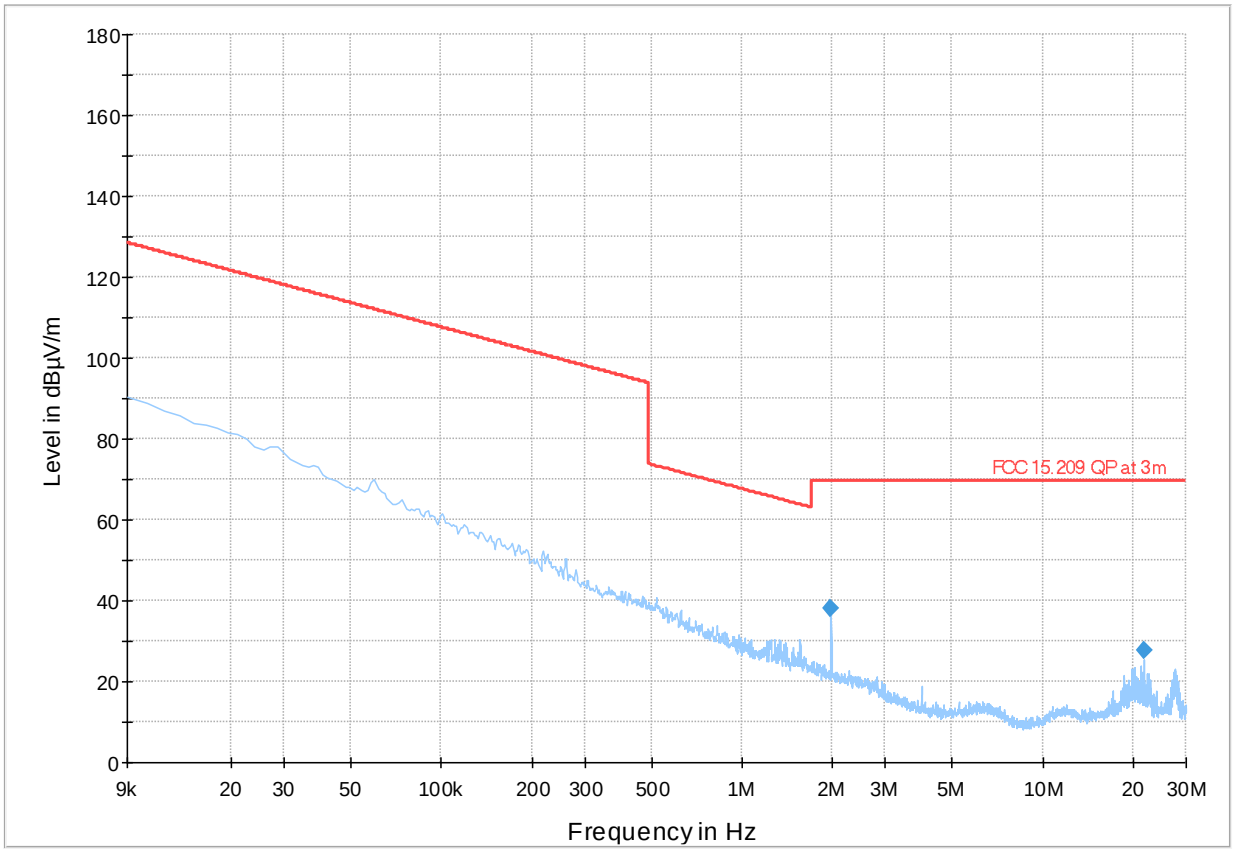
Plot #	Channel #	Scan Frequency	Lowest margin emission (dBµV/m)	Limit	Result
1-6	Mid (42)	9 kHz – 40 GHz	39.61	See section 8.4.2	Pass
7-12	Mid (165)	9 kHz – 40 GHz	39.57	See section 8.4.2	Pass

***Note:** Co-Transmission was determined by the worst case combination of the following:
Cellular + BTLE+ Internal Wi-Fi 5GHz + External Wi-Fi 5GHz.

8.4.5 Measurement Plots:

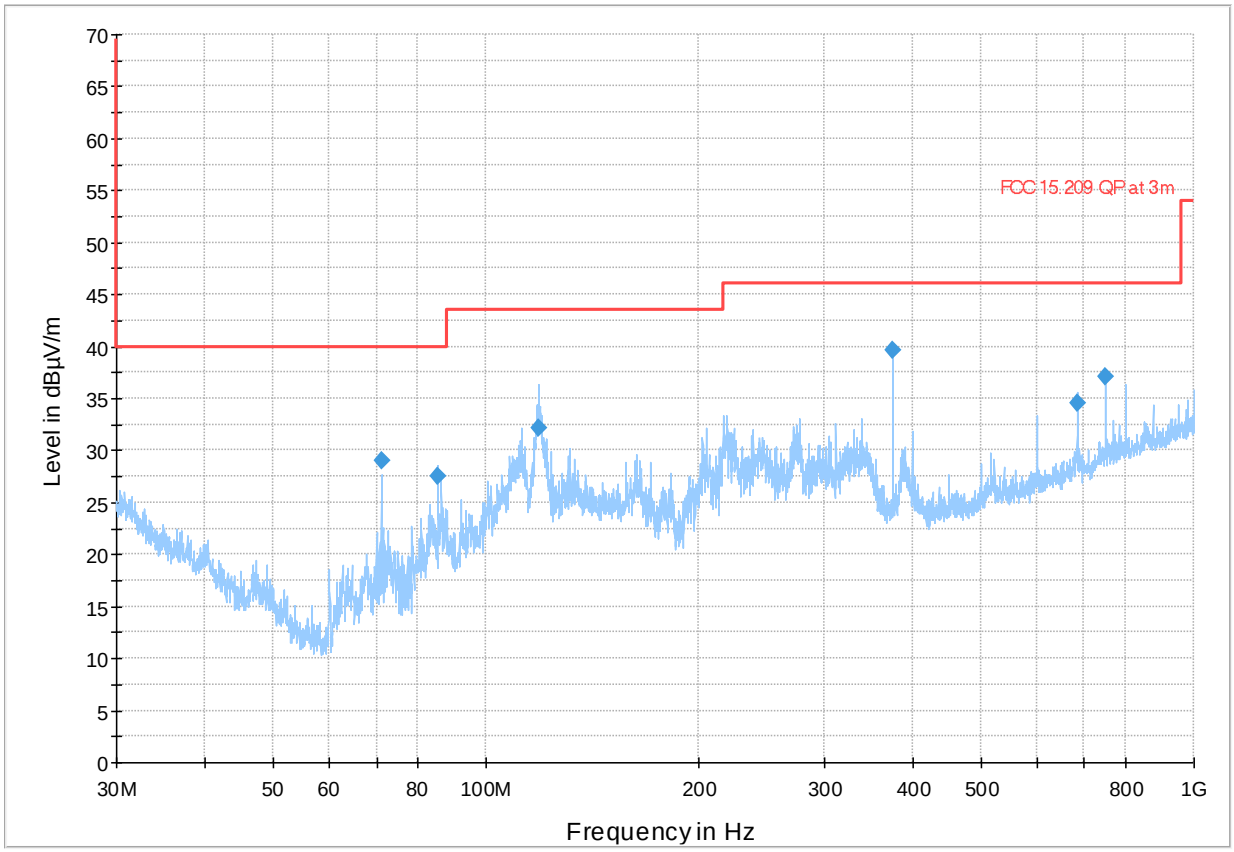
Plot # 1 Radiated Emissions: 9 kHz – 30 MHz

Tx Frequency: 5210 MHz							802.11ax-HE80							
Frequency	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
1.978	38.02	---	69.50	31.48	500.0	9.000	100.0	H	-15.0	13.8	0.1	-28.2	41.9	24.3
21.663	27.78	---	69.50	41.72	500.0	9.000	100.0	H	152.0	6.1	0.2	-28.0	34.0	21.6



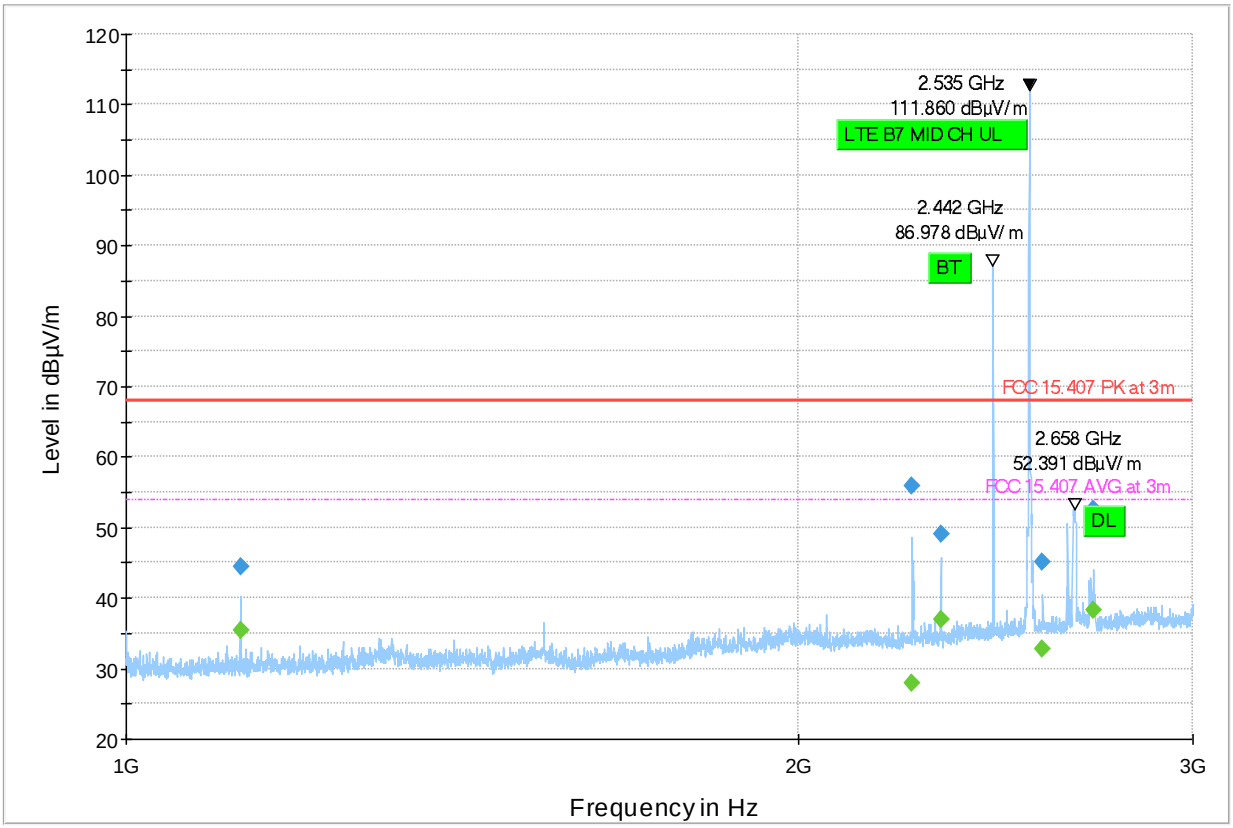
Plot # 2 Radiated Emissions: 30 – 1000 MHz

Tx Frequency: 5210 MHz								802.11ax-HE80					
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
71.007	29.04	40.00	10.96	500.0	120.000	253.0	H	287.0	13.7	0.4	0.0	13.3	15.4
85.363	27.50	40.00	12.50	500.0	120.000	206.0	H	122.0	16.6	0.5	0.0	16.1	10.9
118.585	32.15	43.50	11.35	500.0	120.000	100.0	V	347.0	23.9	0.6	0.0	23.3	8.3
374.981	39.61	46.02	6.41	500.0	120.000	100.0	H	17.0	23.1	1.5	0.0	21.6	16.6
685.429	34.50	46.02	11.52	500.0	120.000	138.0	V	188.0	28.7	2.2	0.0	26.5	5.8
749.958	37.11	46.02	8.91	500.0	120.000	100.0	H	61.0	29.7	2.3	0.0	27.4	7.4



Plot # 3 Radiated Emissions: 1 – 3 GHz

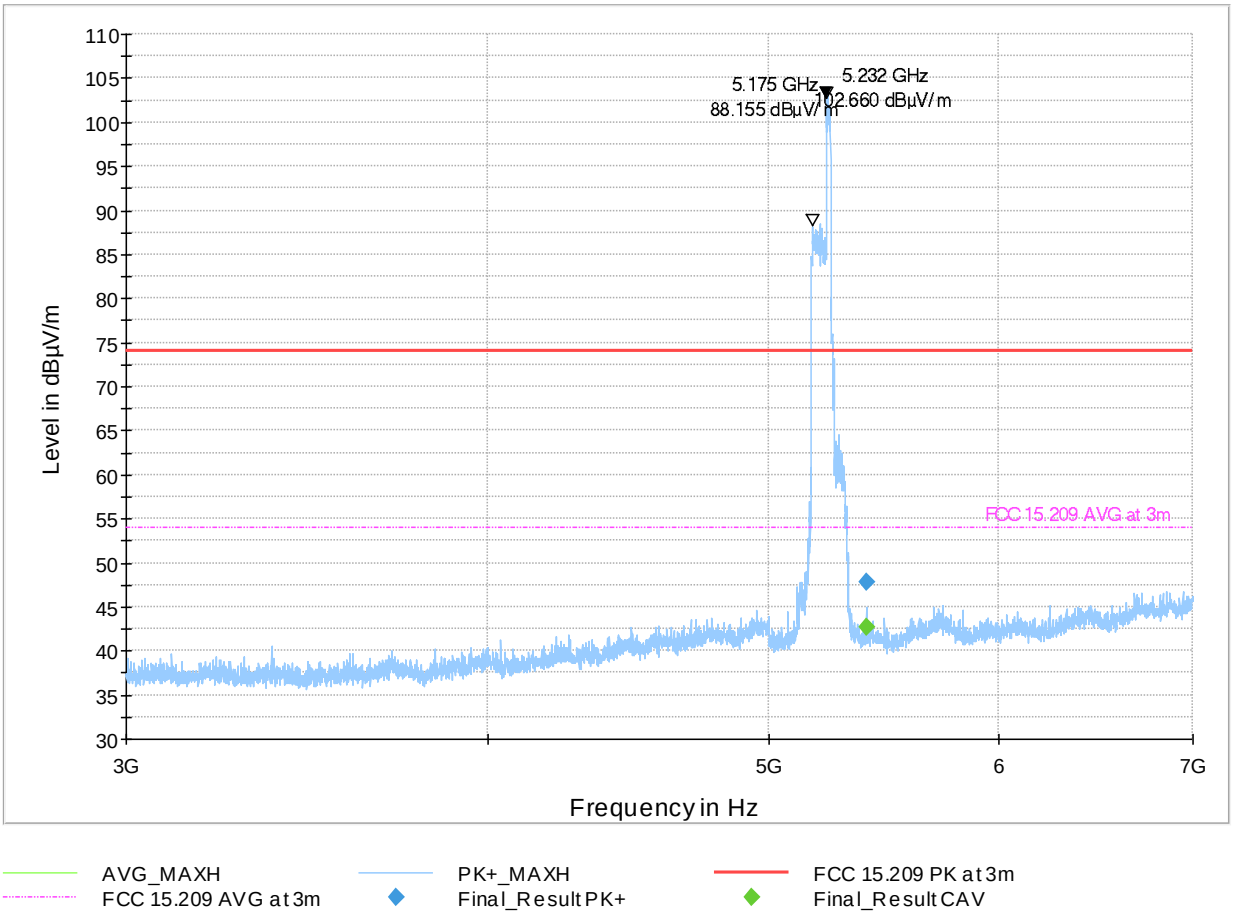
Tx Frequency: 5210 MHz									802.11ax-HE80					
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
1125.000	44.41	---	68.00	23.59	500.0	1000.000	253.0	V	102.0	1.6	-	0.0	24.9	42.8
1125.000	---	35.35	53.98	18.63	500.0	1000.000	253.0	V	102.0	1.6	-	0.0	24.9	33.7
2246.650	55.80	---	68.00	12.20	500.0	1000.000	143.0	V	269.0	5.0	-	0.0	27.6	50.8
2246.650	---	28.01	53.98	25.97	500.0	1000.000	143.0	V	269.0	5.0	-	0.0	27.6	23.1
2313.850	---	36.93	53.98	17.05	500.0	1000.000	225.0	H	136.0	5.2	-	0.0	27.8	31.7
2313.850	49.09	---	68.00	18.91	500.0	1000.000	225.0	H	136.0	5.2	-	0.0	27.8	43.9
2570.000	---	32.69	53.98	21.29	500.0	1000.000	150.0	V	45.0	6.3	-	0.0	28.6	26.4
2570.000	45.10	---	68.00	22.90	500.0	1000.000	150.0	V	45.0	6.3	-	0.0	28.6	38.8
2706.850	---	38.30	53.98	15.68	500.0	1000.000	142.0	V	218.0	6.7	-	0.0	28.9	31.6
2706.850	52.56	---	68.00	15.44	500.0	1000.000	142.0	V	218.0	6.7	-	0.0	28.9	45.9



Plot # 4 Radiated Emissions: 3 – 7 GHz

Tx Frequency: 5210 MHz	802.11ax-HE80

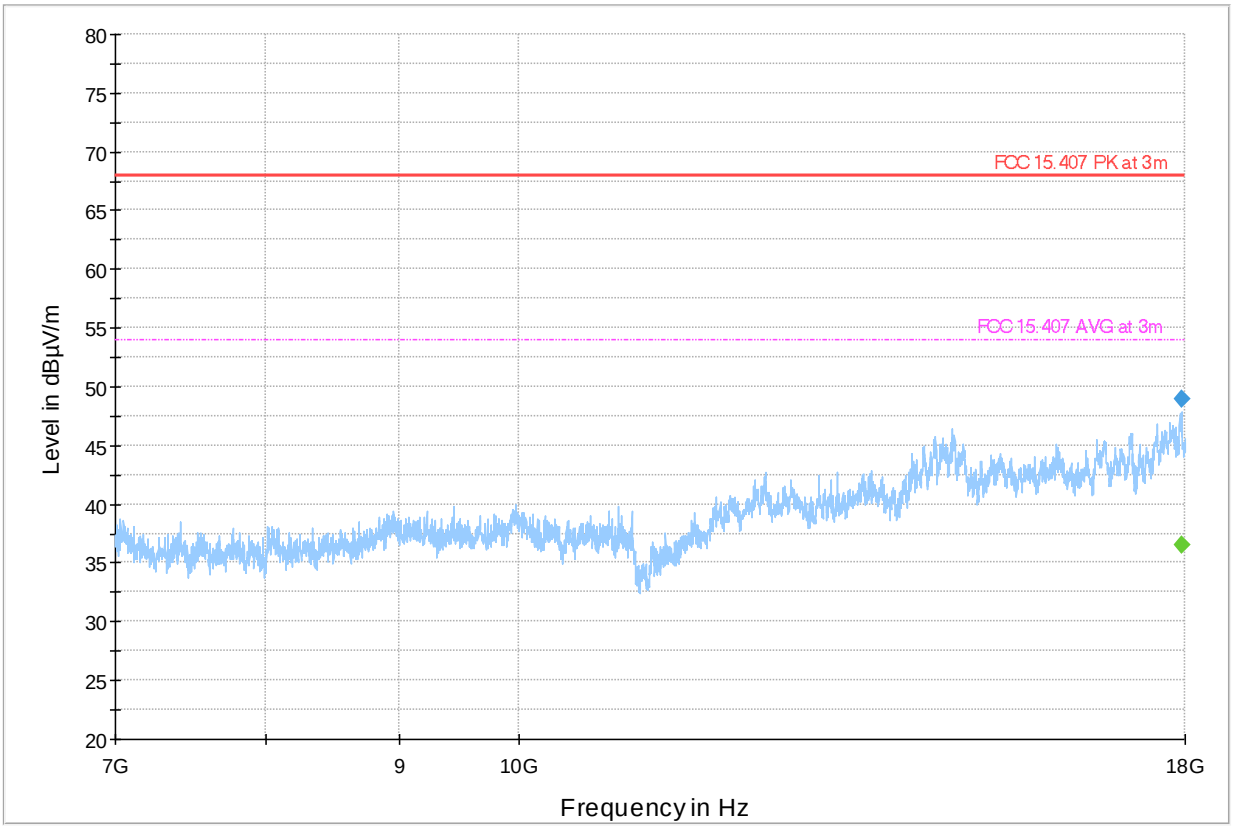
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
5400.267	---	42.73	53.98	11.25	500.0	1000.000	141.0	V	235.0	-2.8	8.2	-45.7	34.7	45.5
5400.267	47.76	---	73.98	26.22	500.0	1000.000	141.0	V	235.0	-2.8	8.2	-45.7	34.7	50.5



Plot # 5 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5210 MHz | **802.11ax-HE80**

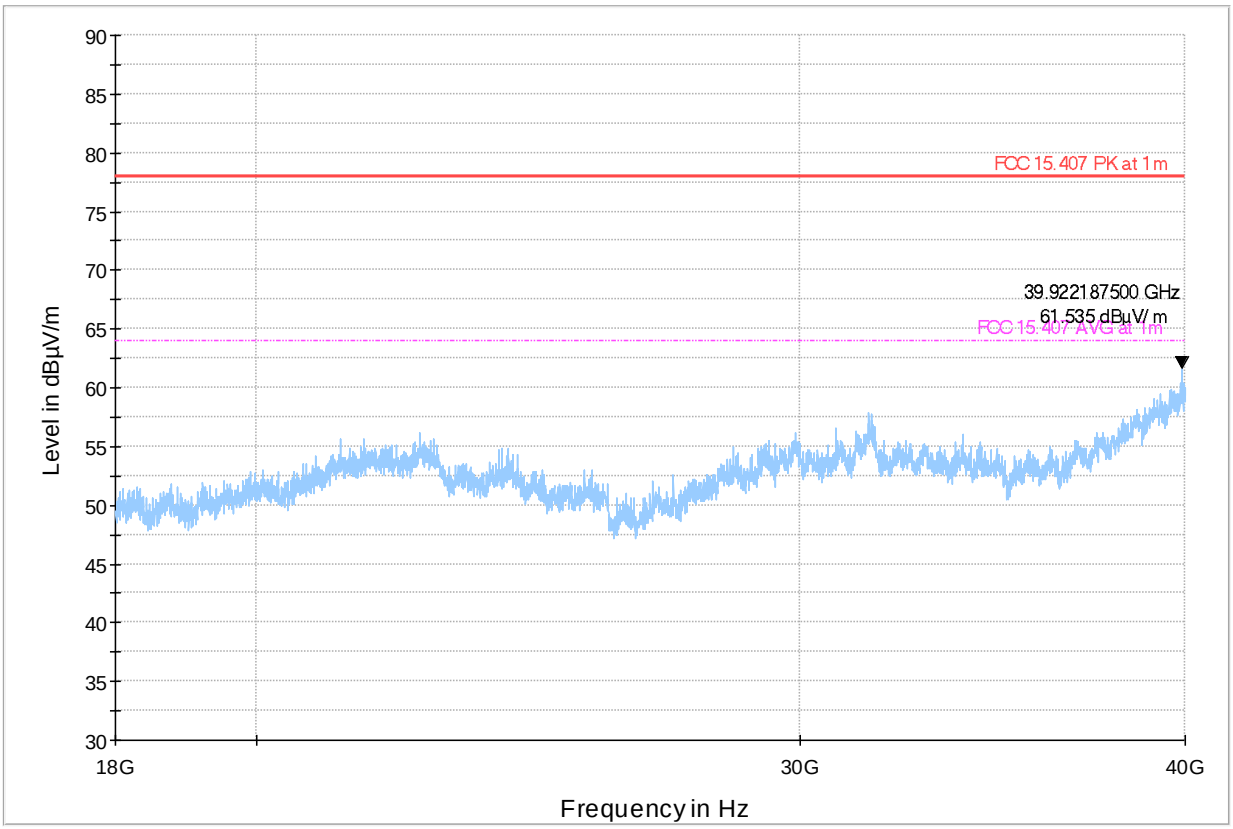
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
17939.427	---	36.47	53.98	17.51	500.0	1000.000	280.0	H	5.0	15.6	16.3	-42.3	41.6	20.8
17939.427	48.93	---	68.00	19.07	500.0	1000.000	280.0	H	5.0	15.6	16.3	-42.3	41.6	33.3



Plot # 6 Radiated Emissions: 18 – 40 GHz

Tx Frequency: 5210 MHz	802.11ax-HE80

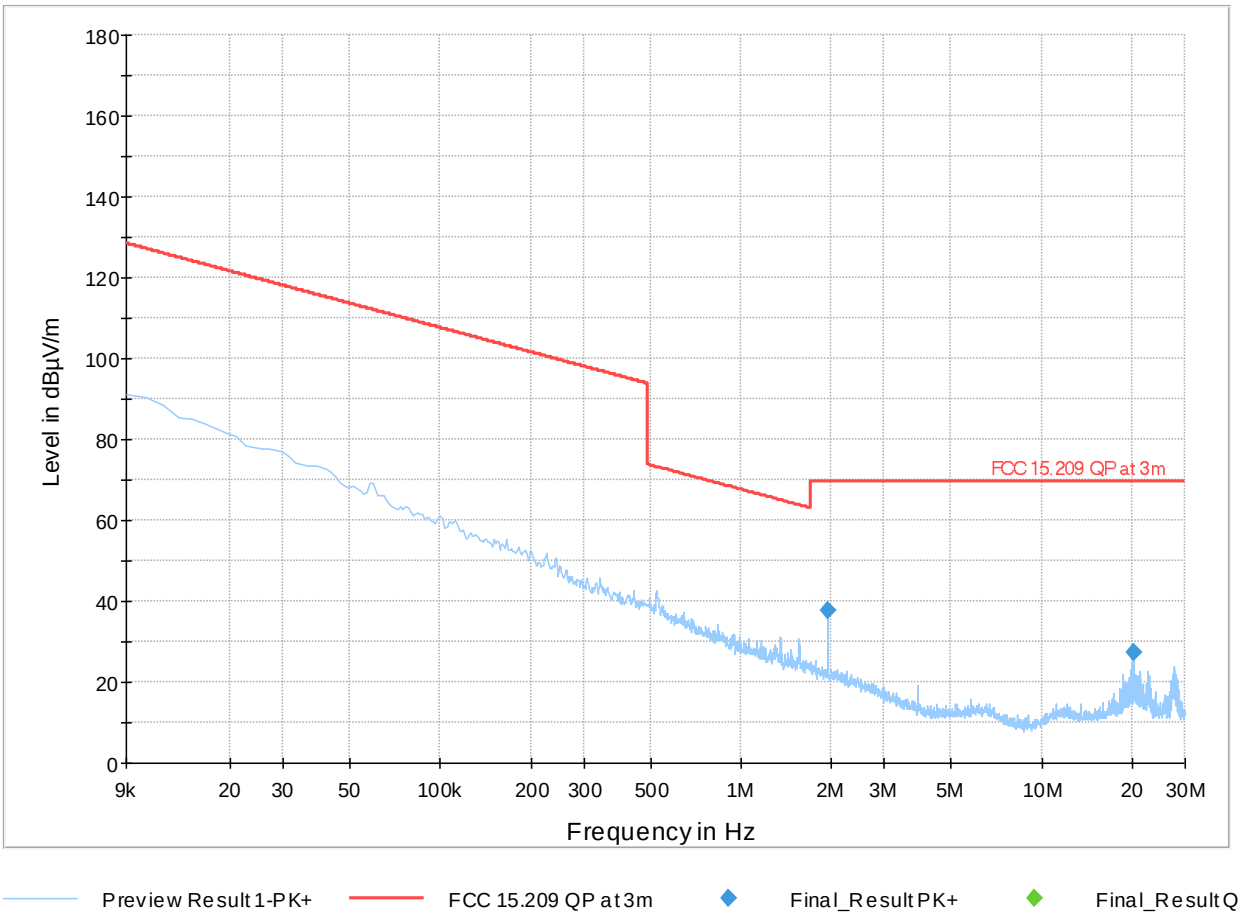
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
---	---	---	---	---	---	---	---		---	---	---	---	---	---



Plot # 7 Radiated Emissions: 9 kHz – 30 MHz

Tx Frequency: 5825 MHz | **802.11ax-HE20**

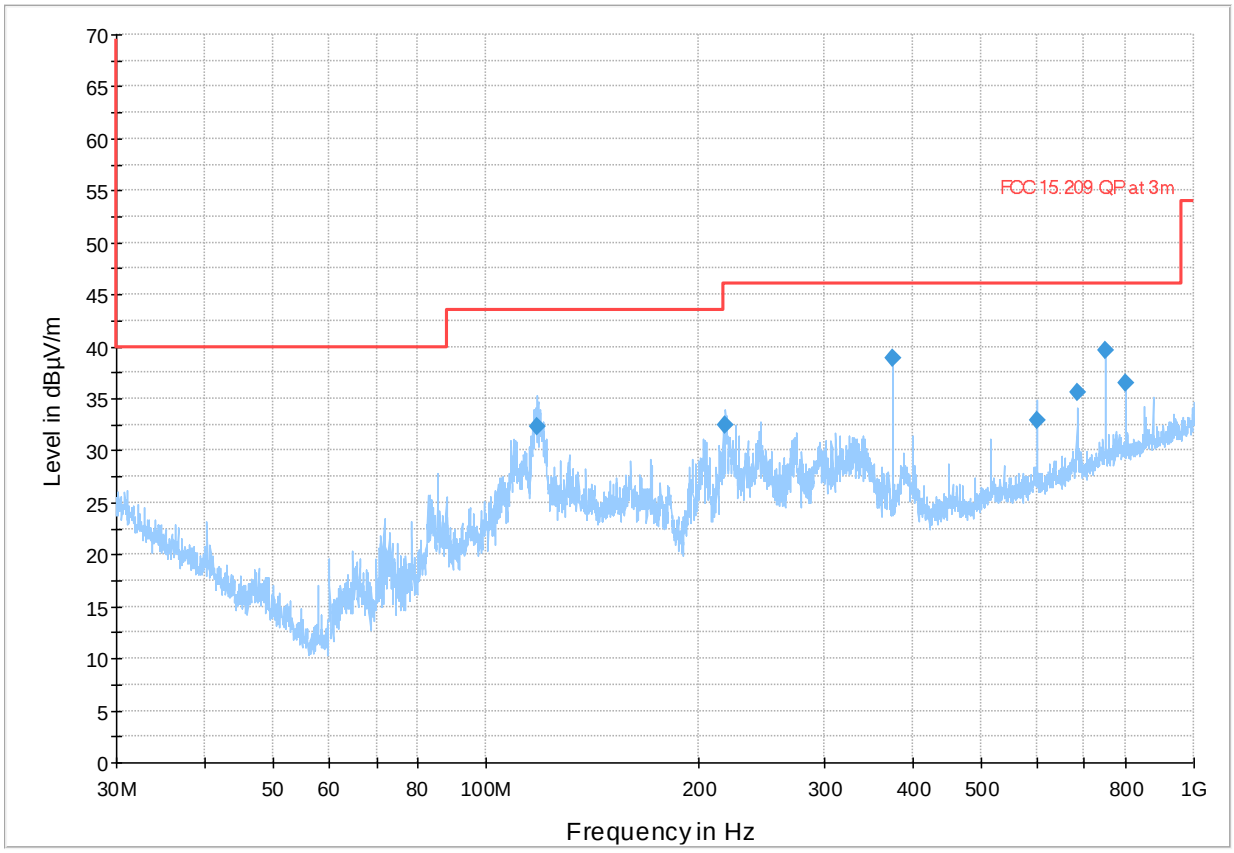
Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
1.943	37.54	---	69.50	31.96	500.0	9.000	100.0	H	158.0	13.9	0.1	-28.2	42.0	23.6
20.197	27.19	---	69.50	42.31	500.0	9.000	100.0	V	117.0	6.2	0.2	-28.0	34.0	21.0



Plot # 8 Radiated Emissions: 30 – 1000 MHz

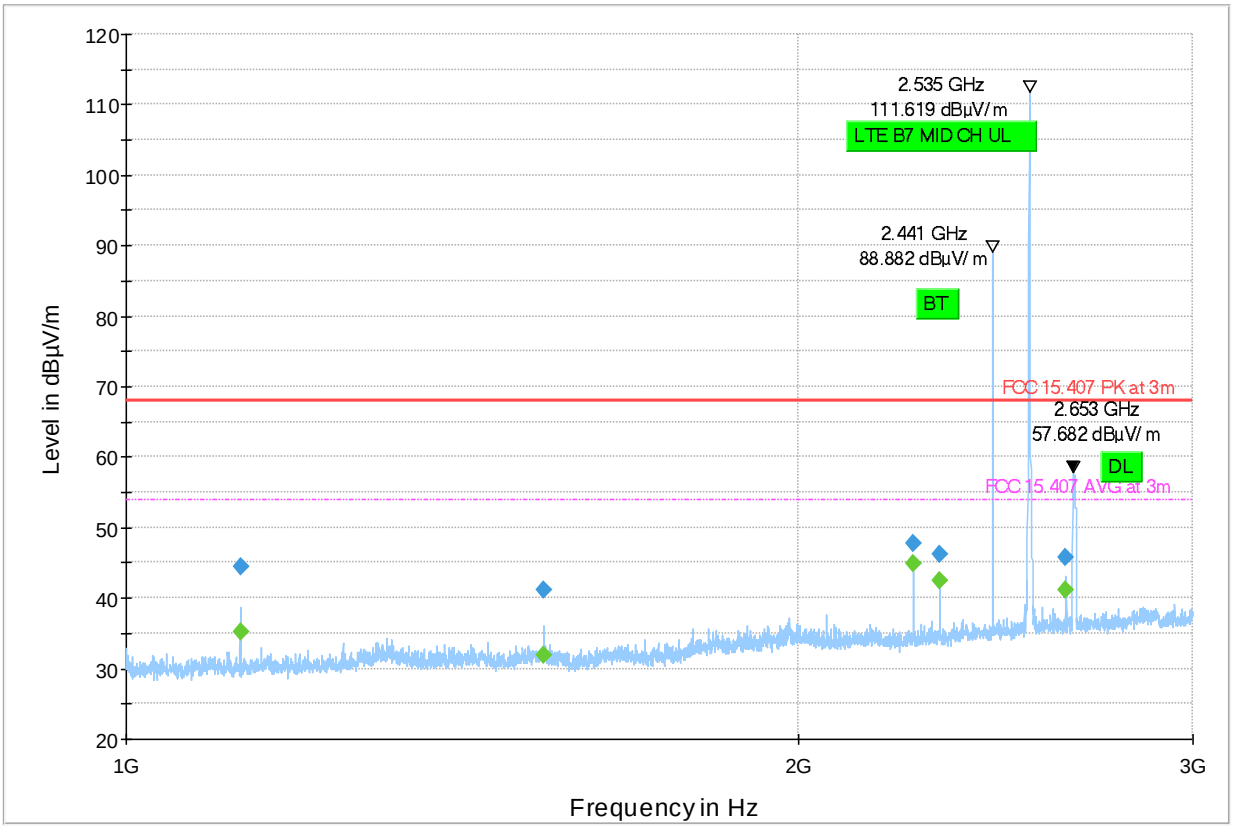
Tx Frequency: 5825 MHz | **802.11ax-HE20**

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
117.712	32.35	43.50	11.15	500.0	120.000	100.0	V	333.0	24.1	0.6	0.0	23.5	8.3
217.889	32.45	46.02	13.57	500.0	120.000	100.0	H	172.0	18.8	1.1	0.0	17.7	13.7
374.981	38.83	46.02	7.19	500.0	120.000	142.0	V	274.0	22.8	1.5	0.0	21.3	16.0
599.972	32.84	46.02	13.18	500.0	120.000	100.0	V	345.0	27.4	2.0	0.0	25.4	5.4
685.478	35.52	46.02	10.50	500.0	120.000	117.0	V	180.0	28.7	2.2	0.0	26.5	6.8
749.958	39.57	46.02	6.45	500.0	120.000	100.0	H	55.0	29.7	2.3	0.0	27.4	9.8
799.962	36.55	46.02	9.47	500.0	120.000	107.0	H	111.0	30.3	2.4	0.0	27.9	6.3



Plot # 9 Radiated Emissions: 1 – 3 GHz

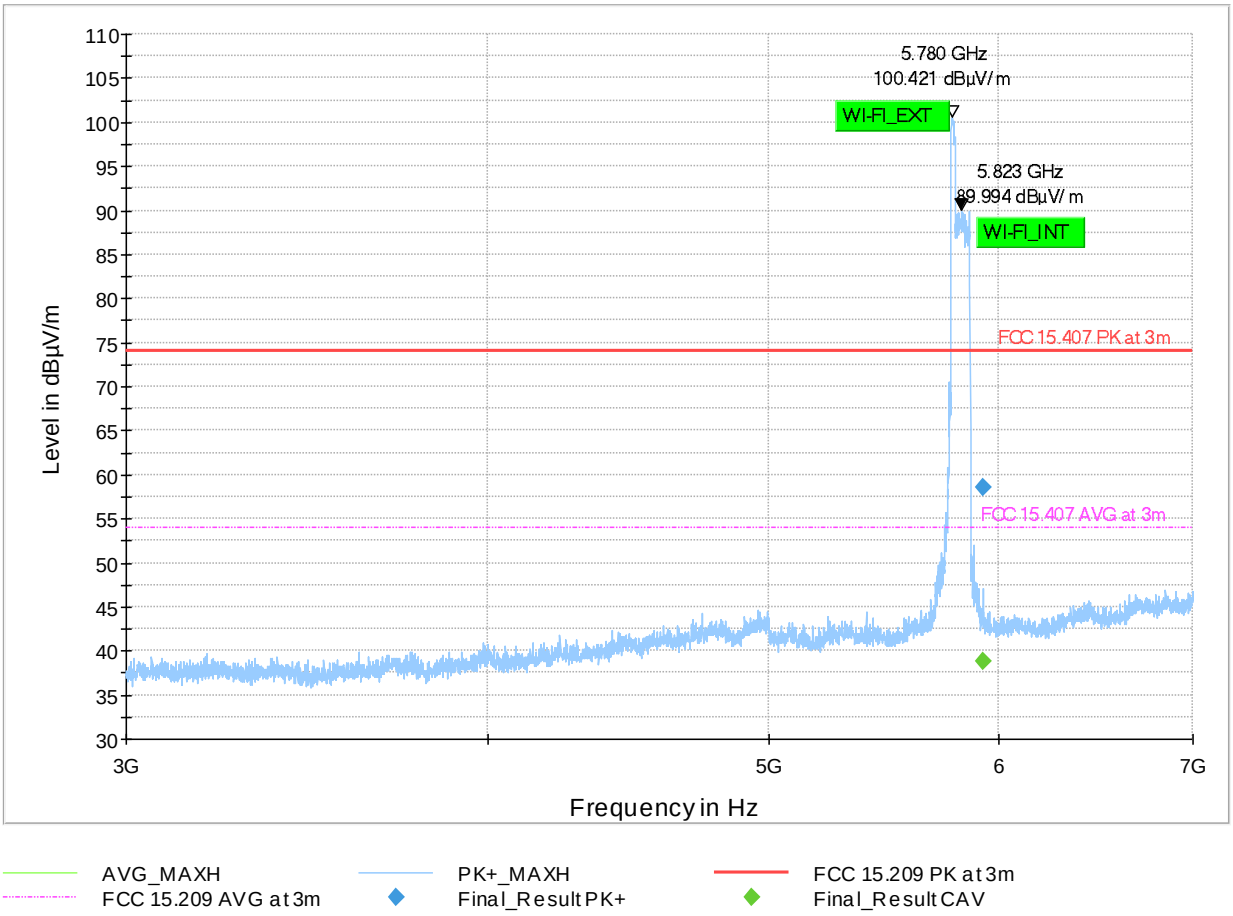
Tx Frequency: 5825 MHz									802.11ax-HE20					
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
1124.950	---	35.20	53.98	18.78	500.0	1000.000	255.0	V	98.0	1.6	-	0.0	24.9	33.6
1124.950	44.45	---	68.00	23.55	500.0	1000.000	255.0	V	98.0	1.6	-	0.0	24.9	42.8
1537.300	---	31.80	53.98	22.18	500.0	1000.000	107.0	V	180.0	2.2	-	0.0	25.3	29.6
1537.300	41.04	---	68.00	26.96	500.0	1000.000	107.0	V	180.0	2.2	-	0.0	25.3	38.8
2249.000	---	44.86	53.98	9.12	500.0	1000.000	269.0	H	136.0	4.9	-	0.0	27.6	39.9
2249.000	47.70	---	68.00	20.30	500.0	1000.000	269.0	H	136.0	4.9	-	0.0	27.6	42.8
2313.000	46.27	---	68.00	21.73	500.0	1000.000	228.0	H	135.0	5.2	-	0.0	27.8	41.1
2313.000	---	42.52	53.98	11.46	500.0	1000.000	228.0	H	135.0	5.2	-	0.0	27.8	37.3
2632.900	45.69	---	68.00	22.31	500.0	1000.000	107.0	H	137.0	6.3	-	0.0	28.6	39.4
2632.900	---	41.13	53.98	12.85	500.0	1000.000	107.0	H	137.0	6.3	-	0.0	28.6	34.8



Plot # 10 Radiated Emissions: 3 – 7 GHz

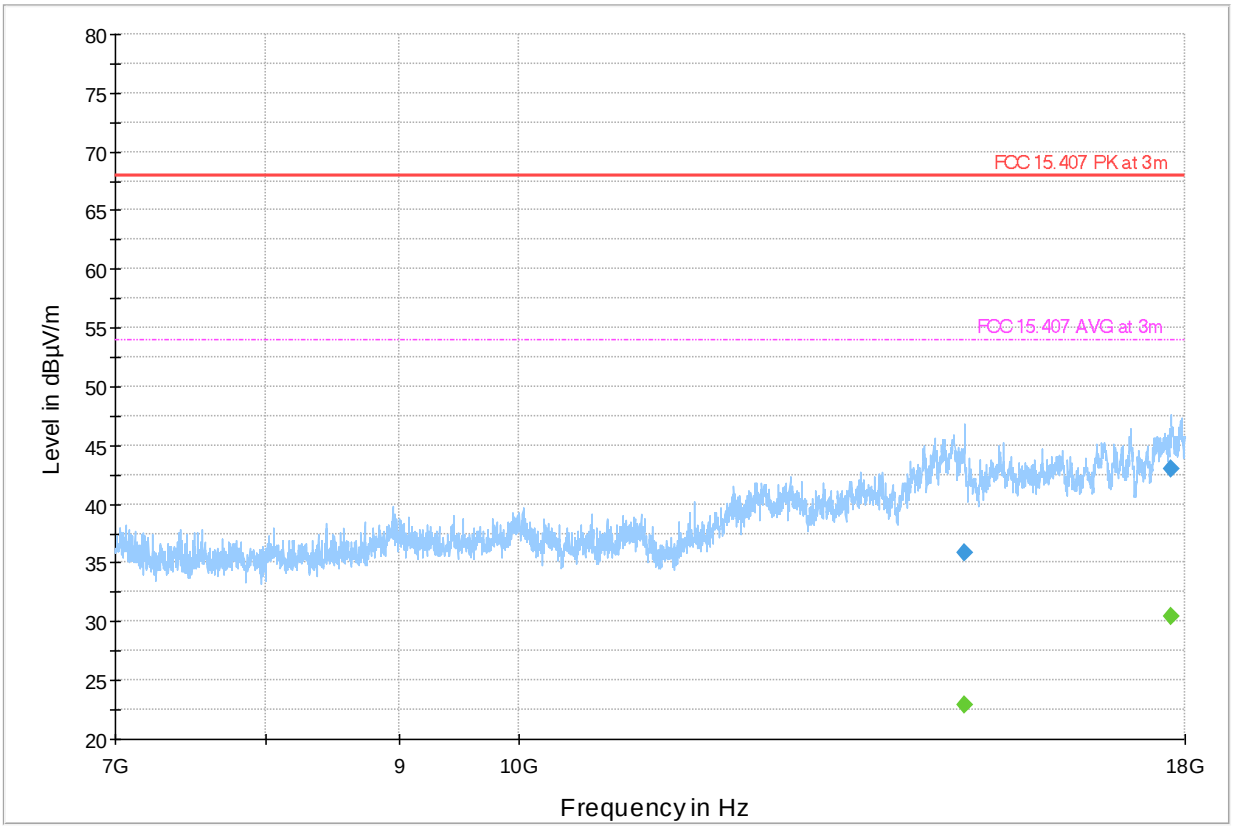
Tx Frequency: 5825 MHz	802.11ax-HE20

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
5924.133	---	38.79	53.98	15.19	500.0	1000.000	298.0	V	106.0	-2.6	8.5	-46.2	35.1	41.4
5924.133	58.60	---	73.98	15.38	500.0	1000.000	298.0	V	106.0	-2.6	8.5	-46.2	35.1	61.2



Plot # 11 Radiated Emissions: 7 – 18 GHz

Tx Frequency: 5825 MHz									802.11ax-HE20					
Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
14810.587	---	22.92	53.98	31.06	500.0	1000.000	184.0	V	311.0	9.7	14.5	-46.0	41.2	13.2
14810.587	35.81	---	68.00	32.19	500.0	1000.000	184.0	V	311.0	9.7	14.5	-46.0	41.2	26.1
17787.333	---	30.41	53.98	23.57	500.0	1000.000	334.0	V	52.0	15.0	16.1	-42.6	41.5	15.4
17787.333	43.00	---	68.00	25.00	500.0	1000.000	334.0	V	52.0	15.0	16.1	-42.6	41.5	28.0



Plot # 12 Radiated Emissions: 18 – 40 GHz

Tx Frequency: 5825 MHz	802.11ax-HE20

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path	Preamp (dB)	Trd Corr.	Raw Rec
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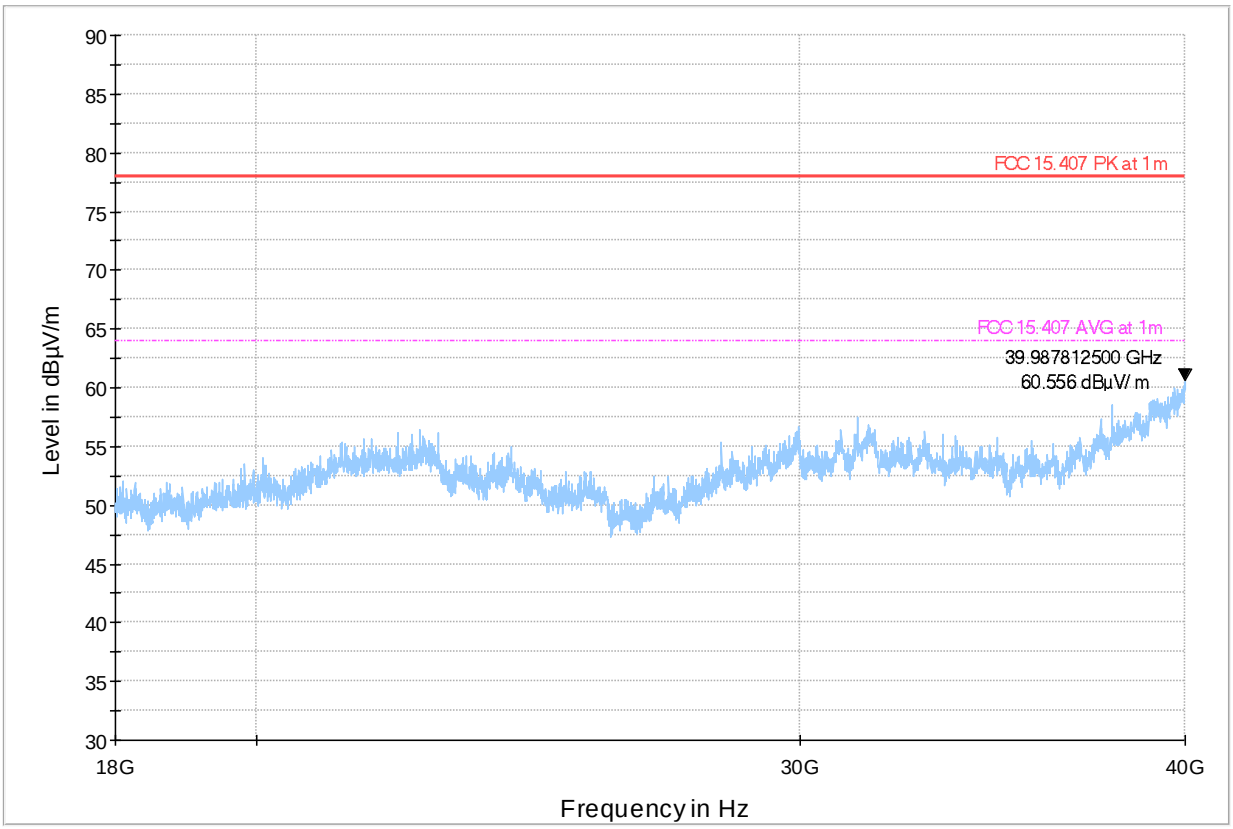

9 Test setup photos

Setup photos are included in supporting file name: "EMC_RIVIA_058_23001_15_407_FCC_Setup_Photos.pdf"

10 Test Equipment And Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
BILOG ANTENNA	A.H. SYSTEMS	BiLA2G	569	3 YEARS	10/30/2023
HORN ANTENNA	EMCO	3115	00035111	3 YEARS	10/26/2023
HORN ANTENNA	ETS LINDGREN	3117-PA	00167061	3 YEARS	9/25/2023
HORN ANTENNA	ETS LINDGREN	3116C-PA	00166821	3 YEARS	10/26/2023
ESW.EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	101715	3 YEARS	10/24/2023
DIGITAL THRMOMETER	Control Company	4410,90080-03	230712972	3 YEARS	10/18/2023
Software	EMC32	Version 10.50.40	-	-	-

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.
Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

11 History

Date	Template Revision	Changes to report	Prepared by
2024-02-23	EMC_RIVIA_058_23001_15_407_UNII	Initial Version	Art Thammanavarat
2024-04-16	EMC_RIVIA_058_23001_15_407_UNII_Rev1	Report Revised base on TCB's review. 1. Sections 1: Corrected typo. And Removed report reviewer 2. Title Page, Secs 1 & 3.1: Updated Product Description. 3. Section 3.1: Updated Table. 4. Section 8.1: Added EIRP Measurement results and Added note. 5. Section 8.2.4: Updated Table and Added Note. 6. Section 8.3: Added OBW verification.	Art Thammanavarat

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