Radio Frequency Exposure Evaluation 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:
CFR Part Part1 (1.1307 &1.1310), Part 2 (2.1091),
FCC KDB 447498 D01 General RF Exposure Guidance v06
ISED RSS-102 Issue 5

Report number: EMC_RIVIA_058_23001_RF_Exposure_Rev2

DATE: 2024-04-04

ACCREDITED
TESTING LABORATORY
Certificate #2135.01

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1 Assessment

This RF Exposure evaluation report provides evidence for compliance of the below identified device with the RF Exposure limits for mobile devices as defined in FCC CFR Part 1 (1.1307 &1.1310), Part 2 (2.1091) and ISED standard RSS-102 issue 5 under worst case conditions (measured or rated RF output power, antenna gain, distance towards human body, multiple transmitter information as presented by the applicant).
In addition, maximum antenna gain or minimum distance towards the human body is calculated respectively, where relevant.

The device meets the limits as stipulated by the above given FCC and ISED rule parts based on available specifications for worst-case conditions at 20 cm distance to the body.

Company	Description	Host Model #	Module Model #
Rivian Automotive	Autonomy Experience Module	AXM 2.0	-

Responsible for the Report:

Date	Section	Name	Signature
2024-04-04	Compliance	Art Thammanavarat (Senior EMC Engineer)	art. thammanavarat @cetecom.com Digitally signed by: art. thammanavarat@cetecom.com DN: CN = art. thammanavarat@cetecom.com Date: 2024.04.04 17:12:37 -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
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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 Assessment

3.1 EUT Specifications

Product Description:	Autonomy Experience Module
Model Name :	AXM 2.0
HW Version :	D
SW Version :	42
FCC-ID :	2AW3A-2NAT23AXM
IC:	26958-2NAT23AXM
Contains FCC ID :	N/A
Contains IC:	N/A
Bands/Modes Supported	**Cell QIPALAS5-AM:** GSM: 850MHz, 1900MHz UMTS: II, IV, V LTE 2, 4, 5, 7, 12, 13, 66
	Wi-Fi & Bluetooth Modules **VPYLB2AJ internal:** Wi-Fi 2.4GHz, 5GHz - UNII-1 and UNII- 3, EDR/BDR, BLE. **2VPYLB1TA External:** Wi-Fi 2.4GHz, 5GHz - UNII-1/2A,C /3
	GPS Modules **Model Name** : u-blox M8 concurrent GNSS module **Model Number :** NEO-M8
Other Radios included in the device	N/A
Power Supply/ Rated Operating Voltage Range	9 VDC – 16 VDC
Operating Temperature Range	-30º to 45º C
Sample Revision	☒Production ☐ Pre-Production
EUT Dimensions	280mm x 230mm x 150mm
Weight	5400 grams
EUT Diameter	■ < 60 cm ☐ Other _____
Note: The information of the EUT specifications in the table above is provided by the client.	

4 RF Exposure Limits and FCC and ISED Basic Rules

FCC

4.1.1 § 2.1093(c)(1)

Evaluation of compliance with the exposure limits in § 1.1310 of this chapter, and preparation of an EA if the limits are exceeded, is necessary for mobile devices with single RF sources having either more than an available maximum time-averaged power of 1 mW or more than the ERP listed in Table 1 to § 1.1307(b)(3)(i)(C), whichever is greater. For mobile devices not exempt by § 1.1307(b)(3)(i)(C) at distances from 20 centimeters to 40 centimeters and frequencies from 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in § 1.1310 of this chapter is necessary if the ERP of the device is greater than ERP20cm in the formula below. If the ERP of a single RF source at distances from 20 centimeters to 40 centimeters and frequencies from 0.3 GHz to 6 GHz is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP) in comparison with the following formula only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

$$P_{th}(\text{mW}) = ERP_{20\,cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

4.1.2 § 2.1093(c)(2)

For multiple mobile or portable RF sources within a device operating in the same time averaging period, routine environmental evaluation is required if the formula in § 1.1307(b)(3)(ii)(B) of this chapter is applied to determine the exemption ratio and the result is greater than 1.

4.1.3 § 1.1307(b)(3)(ii)(B)

in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \le 1$$

ISED RSS 102

4.1.4 Clause 2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 4.49/f0.5 W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1.31 x 10-2 f0.6834 W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived

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5 Evaluations

5.1 Analysis of RF Exposure

Duty Cycle

The table below illustrates the highest possible duty cycle for each type of radio during operation.

Mode	Duty Cycle	Duty Cycle Correction [dBm]
LTE	1:1	0
WCDMA	1:1	0
GSM	1:2	-3
WLAN	1:1	0

5.2 FCC RF Exposure (Standalone)

Radio	Tech-Band	Freq-Low$_{[GHz]}$	Pwr$_{[dBm]}$	Pwr$_{[dBm]}$ corrected by Duty Cycle	Cable Loss (dBm)	Ant-G$_{[dBi]}$	EIRP$_{[W]}$	ERP$_{[W]}$	FCC 2.1093(c)(1) Pth$_{[mW]}$ = ERP$_{20cm}$
Cellurlar	LTE 5	0.8290	23.19	23.19	2.30	2.52	0.219	0.134	1691.16
	GSM850	0.8242	32.38	29.37	2.30	2.52	0.910	0.555	1681.37
	UMTS V	0.8264	24.41	24.41	2.30	2.52	0.290	0.177	1685.86
	LTE 2	1.8550	23.22	23.22	3.56	3.59	0.211	0.129	3060.00
	GSM1900	1.8502	29.64	26.63	3.56	3.59	0.463	0.282	3060.00
	UMTS II	1.8524	24.45	24.45	3.56	3.59	0.281	0.171	3060.00
	LTE 4	1.7150	23.07	23.07	3.47	3.33	0.196	0.120	3060.00
	UMTS IV	1.7124	24.35	24.35	3.47	3.33	0.264	0.161	3060.00
	LTE 7	2.5050	23.29	23.29	4.34	4.63	0.228	0.139	3060.00
	LTE 12	0.7040	23.41	23.41	2.13	1.54	0.191	0.117	1436.16
	LTE 13	0.7820	23.18	23.18	2.30	1.37	0.168	0.102	1595.28
	LTE 66	1.7150	23.16	23.16	3.47	3.33	0.200	0.122	3060.00
Radio	**Tech-Band**	**Freq-Low$_{[GHz]}$**	**Pwr$_{[dBm]}$**	**Pwr$_{[dBm]}$ corrected by Duty Cycle**	**Cable Loss (dBm)**	**Ant-G$_{[dBi]}$**	**EIRP$_{[W]}$**	**ERP$_{[W]}$**	**FCC 2.1093(c)(1) Pth$_{[mW]}$ = ERP$_{20cm}$**
BT	EDR	2.4020	-1.14	-1.14	3.80	2.19	0.0005	0.0003	3060.00
	LE	2.4020	-1.13	-1.13	3.80	2.19	0.0005	0.0003	3060.00
WLAN (Internal)	802.11n HT20	2.4120	21.87	21.87	3.80	5.20	0.2123	0.1294	3060.00
	802.11ax HE80	5.1800	10.50	10.50	6.20	6.77	0.0128	0.0078	3060.00
	802.11ax HE20	5.7450	15.98	15.98	6.60	4.85	0.0265	0.0161	3060.00
Radio	**Tech-Band**	**Freq-Low$_{[GHz]}$**	**Pwr$_{[dBm]}$**	**Pwr$_{[dBm]}$ corrected by Duty Cycle**	**Cable Loss (dBm)**	**Ant-G$_{[dBi]}$**	**EIRP$_{[W]}$**	**ERP$_{[W]}$**	**FCC 2.1093(c)(1) Pth$_{[mW]}$ = ERP$_{20cm}$**
WLAN (External)	802.11b	2.4020	18.93	18.93	3.50	5.17	0.1148	0.0700	3060.00
	802.11ax HE20	5.1800	11.70	11.70	5.49	7.58	0.0239	0.0146	3060.00
	802.11ax HE20	5.2600	11.50	11.50	5.40	7.58	0.0233	0.0142	3060.00
	802.11ax HE20	5.5000	18.99	18.99	5.90	8.75	0.1528	0.0931	3060.00
	802.11ax HE20	5.7450	18.99	18.99	5.75	8.43	0.1469	0.0895	3060.00

Conclusion:

- The maximum RF emissions from this equipment fulfills the RF exclusion threshold limits for separation distance between the antenna and the human body greater than 20 cm. No RF Exposure evaluation is required.

5.3 ISED RF Exposure (Standalone)

								RF Exposure	
								RSS-102 2.5.2 D>20 cm (300 ≤ Freq < 6000 MHz)	
Radio	**Tech-Band**	**Freq-Low [MHZ]**	**$Pwr_{[dBm]}$**	**$Pwr_{[dBm]}$ corrected by Duty Cycle**	**Cable Loss (dBm)**	**Ant-G [dBi]**	**$EIRP_{[W]}$**	**Exemption limit for Routine Evaluation**	**Exemption (Y/N)**
Cellular	LTE 5	829.00	23.19	23.19	2.30	2.52	0.22	1.29	Yes
	GSM850	824.20	32.38	29.37	2.30	2.52	0.91	1.29	Yes
	UMTS V	826.40	24.41	24.41	2.30	2.52	0.29	1.29	Yes
	LTE 2	1855.00	23.22	23.22	3.56	3.59	0.21	2.24	Yes
	GSM1900	1850.20	29.64	26.63	3.56	3.59	0.46	2.24	Yes
	UMTS II	1852.40	24.45	24.45	3.56	3.59	0.28	2.24	Yes
	LTE 4	1715.00	23.07	23.07	3.47	3.33	0.20	2.13	Yes
	UMTS IV	1712.40	24.35	24.35	3.47	3.33	0.26	2.12	Yes
	LTE 7	2505.00	23.29	23.29	4.34	4.63	0.23	2.75	Yes
	LTE 12	704.00	23.41	23.41	2.13	1.54	0.19	1.16	Yes
	LTE 13	782.00	23.18	23.18	2.30	1.37	0.17	1.24	Yes
	LTE 66	1715.00	23.16	23.16	3.47	3.33	0.20	2.13	Yes
Radio	**Tech-Band**	**Freq-Low [MHZ]**	**$Pwr_{[dBm]}$**	**$Pwr_{[dBm]}$ corrected by Duty Cycle**	**Cable Loss (dBm)**	**Ant-G [dBi]**	**$EIRP_{[W]}$**	**Exemption limit for Routine Evaluation**	**Exemption (Y/N)**
BT	EDR	2402.00	-1.14	-1.14	3.80	2.19	0.001	2.68	Yes
	LE	2402.00	-1.13	-1.13	3.80	2.19	0.001	2.68	Yes
WLAN	802.11n HT20	2412.00	21.87	21.87	3.80	5.20	0.212	2.68	Yes
	802.11ax HE80	5180.00	10.50	10.50	6.20	6.77	0.013	4.53	Yes
	802.11ax HE20	5745.00	15.98	15.98	6.60	4.85	0.026	4.86	Yes

Radio	**Tech-Band**	**Freq-Low [MHZ]**	**$Pwr_{[dBm]}$**	**$Pwr_{[dBm]}$ corrected by Duty Cycle**	**Cable Loss (dBm)**	**Ant-G [dBi]**	**$EIRP_{[W]}$**	**Exemption limit for Routine Evaluation**	**Exemption (Y/N)**
WLAN	802.11b	2402.00	18.93	18.93	3.50	5.17	0.115	2.68	Yes
	802.11ax HE20	5180.00	11.70	11.70	5.49	7.58	0.024	4.53	Yes
	802.11ax HE20	5260.00	11.50	11.50	5.40	7.58	0.023	4.57	Yes
	802.11ax HE20	5500.00	18.99	18.99	5.90	8.75	0.153	4.71	Yes
	802.11ax HE20	5745.00	18.99	18.99	5.75	8.43	0.147	4.86	Yes

Conclusion:

- The maximum RF emissions from this equipment fulfills the RF exclusion threshold limits for separation distance between the antenna and the human body greater than 20 cm. No RF Exposure evaluation is required.

5.4 RF Exposure Test Exemptions for Simultaneous Transmission Sources

- Theoretically, the worst case of simultaneous transmission operating at the highest output power mode, within the nearest frequency bands.
- The worst case of simultaneous transmission calculation :
  GSM850 + (Internal) WLAN 802.11ax HE20 (2.45 GHz) + (External) WLAN 802.11ax HE20 (5GHz) + Bluetooth LE:
  (554.6/1681.37) + (129.4/3060) + (93.1/3060) + (0.324/3060) = 0.403

Applicable Simultaneous Transmission Sources	Sum of the ratios of the applicable terms	Limit	RF Exclusion No evaluation required
GSM850 + (Internal) Wi-Fi 2.4GHz + (External) Wi-Fi 5GHz+ BLE	0.330 + 0.0423 + 0.0304 + 0.0001 = 0.403	≤ 1	Yes

Conclusion:

- The sum of the fractional contributions to the applicable thresholds is less than or equal to 1, hence the multiple RF sources are exempt

6 Revision History

Date	Report Name	Changes to report	Report prepared by
2024-02-23	EMC_RIVIA_058_23001_RF_Exposure	Initial Version	Art Thammanavarat
2024-04-01	EMC_RIVIA_058_23001_RF_Exposure_Rev1	Report Revised base on TCB's review. 1. Sections 1: Corrected typo. 2. Title Page, Secs 1 & 3.1: Updated Product Description. 3. Section 5.2, 5.3& 5.4: Updated table.	Art Thammanavarat
2024-04-04	EMC_RIVIA_058_23001_RF_Exposure_Rev2	Report Revised base on TCB's review. 1. Sections 5.1, 5.2 & 5.3: Updated table. 2. Section 5.4: Updated Worst case.	Art Thammanavarat

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