RF Exposure Evaluation Report

FCC 47 CFR § 2.1091

for

Vehicle Gateway

Model Name.: 010-00008, 010-00006

Prepared for:

Samsara Inc.

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Prepared by

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Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	March 20, 2024	Initial Issue	ALL	Allison Chen
01	March 27, 2024	See the following Note Rev.(01)	P.7, 12, 13	Allison Chen
02	April 2, 2024	See the following Note Rev.(02)	P.7, 13-14	Allison Chen

Note:
Rev.(01)
1. Evaluate co-transmission with WIFI/BT module and modify antenna model.
Rev.(02)
1. Modify LTE module information.

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1 Attestation of Test Results

Applicant Name	Samsara Inc.
Model Name	Vehicle Gateway
Applicable Standards	FCC 47 CFR § 2.1091 FCC 47 CFR § 1.1307 FCC 47 CFR § 1.1310 Published RF exposure KDB procedures
Receive EUT Date:	December 11, 2023
Compliance Certification Services Inc. , tested the above equipment in accordance with the requirements set forth in the above standards. Determination of compliance is based on the results of the compliance measurement,not taking into account measurement instrumentation uncertainy.All indications of Pass/Fail in this report are opinions expressed by Compliance Certification Services Inc, based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.	
Approved & Released By: 	
Sky Zhou Asst. Supervisor Compliance Certification Services Inc.	

2 Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1091, the following FCC Published RF exposure KDB procedures:

- 447498 D04 Interim General RF Exposure Guidance v01
- 865664 D02 RF Exposure Reporting v01r02

3 Device Under Test (DUT) Information

3.1 DUT Description

<table>
<tr><td>Product</td><td>Vehicle Gateway</td></tr>
<tr><td>Trade Name</td><td>Samsara</td></tr>
<tr><td>Model No.</td><td>010-00008, 010-00006</td></tr>
<tr><td>Model Discrepancy</td><td>For detailed description of the differences between series models, please see the table below:
<table>
<tr><th>Model name</th><th>Difference</th></tr>
<tr><td>010-00008</td><td>LTE Band: 2,4,5,12,14</td></tr>
<tr><td>010-00006</td><td>LTE Band: 2,4,5,12,13</td></tr>
</table></td></tr>
<tr><td>Hardware Version</td><td>02-04:23</td></tr>
<tr><td>Serial number</td><td>010-00008: GHBE-HW6-JBR
010-00006: GYYV-DEB-3SR</td></tr>
<tr><td>Sample Stage</td><td>Identical prototype</td></tr>
</table>

3.2 Wireless Technologies

Frequency bands

☒ Bluetooth: (1Mbps) 2402MHz-2480MHz
(2Mbps) 2404MHz-2478MHz
☒ 802.11b/g/n HT20: 2412MHz ~ 2462 MHz
☐ 802.11n HT40: 2422MHz ~ 2452MHz
☐ 802.11a/n HT20: 5180MHz ~ 5240MHz / 5260MHz ~ 5320MHz / 5500MHz ~ 5700MHz / 5745MHz ~ 5825MHz
☐ 802.11ac VHT20: 5180MHz ~ 5240MHz / 5260MHz ~ 5320MHz / 5500MHz ~ 5700MHz / 5745MHz ~ 5825MHz
☐ 802.11n HT40: 5190MHz ~ 5230MHz / 5270MHz ~ 5310MHz / 5510MHz ~ 5670MHz / 5755MHz ~ 5795MHz
☐ 802.11ac VHT 40: 5190MHz ~ 5230MHz / 5270MHz ~ 5310MHz / 5510MHz ~ 5670MHz / 5755MHz ~ 5795MHz
☐ 802.11ac VHT80: 5210MHz / 5290MHz / 5530MHz ~ 5610MHz / 5775MHz
☐ Others

Exposure classification

☐ Occupational/Controlled exposure
☒ General Population/Uncontrolled exposure

Maximum tune up power

BLE 2M	18.50 dBm	(70.795 mW)

2.4GHz

IEEE 802.11b	20.50 dBm	(112.202 mW)
IEEE 802.11g	19.50 dBm	(89.125 mW)
IEEE 802.11n HT20	19.50 dBm	(89.13 mW)

Antenna Specification

Type: PIFA Antenna, Brand: Sercomm, Model: 6172001NWA

BT:	Antenna Gain : 2.40 dBi	(Numeric gain: 1.74)	Worst
2.4GHz:	Antenna Gain: 2.40 dBi	(Numeric gain: 1.74)	Worst

Type: PIFA Antenna, Brand: Sercomm, Model: 6172001KWA
Model: 010-00008

WCDMA Band II	Antenna Gain : 1.50 dBi	(Numeric gain: 1.41)	Worst
WCDMA Band V	Antenna Gain: 1.20 dBi	(Numeric gain: 1.32)	Worst
LTE Band 2	Antenna Gain : 1.50 dBi	(Numeric gain: 1.41)	Worst
LTE Band 4	Antenna Gain: 1.60 dBi	(Numeric gain: 1.45)	Worst
LTE Band 5	Antenna Gain : 1.20 dBi	(Numeric gain: 1.32)	Worst
LTE Band 12	Antenna Gain: 0.90 dBi	(Numeric gain: 1.23)	Worst
LTE Band 14	Antenna Gain: 1.50 dBi	(Numeric gain: 1.41)	Worst

Model: 010-00006

WCDMA Band II	Antenna Gain : 1.50 dBi	(Numeric gain: 1.41)	Worst
WCDMA Band V	Antenna Gain: 1.20 dBi	(Numeric gain: 1.32)	Worst
LTE Band 2	Antenna Gain : 1.50 dBi	(Numeric gain: 1.41)	Worst
LTE Band 4	Antenna Gain: 1.60 dBi	(Numeric gain: 1.45)	Worst
LTE Band 5	Antenna Gain : 1.20 dBi	(Numeric gain: 1.32)	Worst
LTE Band 12	Antenna Gain: 0.90 dBi	(Numeric gain: 1.23)	Worst
LTE Band 13	Antenna Gain : 1.40 dBi	(Numeric gain: 1.38)	Worst

Notes:

1. For more details, please refer to the User's manual of the EUT.
2. Disclaimer: Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.
3. Disclaimer: The variant model numbers / trademarks are assessed as identical in hardware and software to each other, hence all variants are fully covered by the test results in this test report without further verification test.
4. The tune up power referred the AVG power of the test report TMWK2312004665KR and TMWK2312004666KR for RF Exposure assessment purpose.

4 Maximum Permissible Exposure

4.1 Limits for Maximum Permissible Exposure (MPE)

Table 1 - Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	* 100	6
3.0-30	1842/f	4.89/f	* $900/f^2$	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* 100	30
1.34-30	824/f	2.19/f	* $180/f^2$	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

4.2 MPE Calculation Method

Calculation

Given $E = \frac{\sqrt{30 \times P \times G}}{d}$ & $S = \frac{E^2}{377}$

Where E = Field strength in Volts / meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{377 d^2}$$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and

d (cm) = d(m) / 100

Yields

$$S = \frac{30 \times (P/1000) \times G}{377 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2}$$ **Equation 1**

Where d = Distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power density in mW / cm^2

If, Substituting the MPE safe distance using d = 20 cm into Equation 1:

$$S = 0.000199 \times P \times G$$

4.3 MPE EXEMPTION

(A) The available maximum time-averaged power is no more than 1 mW

(B) The available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold *Pth* (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). *Pth* is given by:

$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^{x} & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

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

d = the separation distance (cm);

(C) Using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP 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).

Single RF Sources Subject to Routine Environmental Evaluation	
RF Source frequency (MHz)	**Threshold ERP (watts)**
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 R^2f.
1,500-100,000	19.2R^2.
Note: R is in meters, f is in MHz.	

4.4 Multiple RF sources

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),

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

5 MPE Exemption Option B

Bluetooth

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
BLE_2M	2476.00	0.2	18.5	2.40	20.90	18.75	74.989	3060	Complies

WIFI 2.4GHz

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
IEEE 802.11b	2457.00	0.2	20.5	2.40	22.90	20.75	118.850	3060	Complies
IEEE 802.11g	2457.00	0.2	19.5	2.40	21.90	19.75	94.406	3060	Complies
IEEE 802.11n HT 20	2457.00	0.2	19.5	2.40	21.90	19.75	94.406	3060	Complies

WWAN

1. Model: 010-00008 (Contains FCC ID: NKRM18QAG)

Mode	Frequency (MHz)	R(m)	Max conducted power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
WCDMA Band II	1852.40	0.2	24.18	1.50	25.68	23.53	225.424	3060	Complies
WCDMA Band V	826.40	0.2	24.85	1.20	26.05	23.90	245.471	1686	Complies
LTE Band 2	1908.50	0.2	23.94	1.50	25.44	23.29	213.304	3060	Complies
LTE Band 4	1720.00	0.2	23.85	1.60	25.45	23.30	213.796	3060	Complies
LTE Band 5	836.50	0.2	24.28	1.20	25.48	23.33	215.278	1706	Complies
LTE Band 12	704.00	0.2	24.07	0.90	24.97	22.82	191.426	1436	Complies
LTE Band 14	795.50	0.2	23.81	1.50	25.31	23.16	207.014	1623	Complies

2. Model: 010-00006 (Contains FCC ID: NKRM18QF)

Mode	Frequency (MHz)	R(m)	Max conducted power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
WCDMA Band II	1852.40	0.2	24.53	1.50	26.03	23.88	244.343	3060	Complies
WCDMA Band V	826.40	0.2	25.26	1.20	26.46	24.31	269.774	1686	Complies
LTE Band 2	1908.50	0.2	22.97	1.50	24.47	22.32	170.608	3060	Complies
LTE Band 4	1720.00	0.2	23.02	1.60	24.62	22.47	176.604	3060	Complies
LTE Band 5	836.50	0.2	24.25	1.20	25.45	23.30	213.796	1706	Complies
LTE Band 12	704.00	0.2	24.49	0.90	25.39	23.24	210.863	1436	Complies
LTE Band 13	779.50	0.2	24.53	1.40	25.93	23.78	238.781	1590	Complies

6 Simultaneous Transmission Analysis

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),

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

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations			
	1	WWAN	+	WiFi 2.4GHz	Bluetooth

6.1 Sum of the WIFI 2.4GHz + Bluetooth

1. Model: 010-00008 (Contains FCC ID: NKRM18QAG)
WWAN+WiFi 2.4GHz + Bluetooth:

Mode	Max Tune-up ERP(mW)	ERP Threshold(mW)	simultaneous Transmission	simultaneous Transmission Limit
WWAN	245.471	1686	0.209	≦1
WiFi 2.4GHz	118.850	3060		
Bluetooth	74.989	3060		

2. Model: 010-00006 (Contains FCC ID: NKRM18QF)
WWAN+WiFi 2.4GHz + Bluetooth:

Mode	Max Tune-up ERP(mW)	ERP Threshold(mW)	simultaneous Transmission	simultaneous Transmission Limit
WWAN	269.774	1686	0.223	≦1
WiFi 2.4GHz	118.850	3060		
Bluetooth	74.989	3060		

7 Facilities

All measurement facilities used to collect the measurement data are located at

☒ No.11, Wugong 6th Rd., Wugu Dist., New Taipei City, Taiwan.

☐ No. 12, Ln. 116, Wugong 3rd Rd., Wugu Dist., New Taipei City, Taiwan.

--End of Test Report--