RF Exposure Exemption Report

Apple Inc
Model: A3238 and A3239

In accordance with FCC CFR 47 Pt 1.1307

Prepared for: Apple Inc
One Apple Park Way
Cupertino, California
95014, USA

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Matthew Russell	Chief Engineer	Authorised Signatory	14-October-2024

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EXECUTIVE SUMMARY

The wireless devices described within this report are compliant with the exemption criteria related to human exposure to electromagnetic fields laid out in FCC CFR 47 Part 1.1307.

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	15-Aug-2024
2	6 GHz WLAN evaluated using FCC 1.1307(b)(3)(i)(C) 'Option C' (MPE Based Exemption)	08-October-2024
3	Re-evaluated based on "Mobile" device	14-October-2024

Table 1

1.2 Introduction

Applicant	Apple Inc
Manufacturer	Apple Inc
Model Number(s)	A3238 and A3239
Hardware Version(s)	REV1.0
Software Version(s)	N/A
Specification/Issue/Date	FCC 47 CFR Part 1.1307: 2022
Related Document(s)	• KDB 447498 D04 v01

1.3 Brief Summary of Results

The wireless device described within this report was compliant with the restrictions related to human exposure to electromagnetic fields for both general public and worker/occupational exposures for a separation distance of 20 cm.

The calculations shown in this report were made in accordance with the procedures specified in the applied test specification(s).

1.4 Product Information

1.4.1 Technical Description

The equipment under test (EUT) was a desktop computer.

1.4.2 Transmitter Description

The following radio access technologies and frequency bands are supported by the equipment under test.

Radio Access Technology	Frequency Band (MHz)	Minimum Frequency (MHz)	Output Power (dBm)	Duty Cycle (%)
Bluetooth (SISO) Core 0	2400-2483.5	2402	16.5	100
Bluetooth (SISO) Core 1	2400-2483.5	2402	16.5	100
Bluetooth (SISO) Core 2	2400-2483.5	2402	13.0	100
Bluetooth (2x2 MIMO) Core 0 and Core 1	2400-2483.5	2402	18.0	100
Thread (SISO) Core 0	2400-2483.5	2405	20.5	100
Thread (SISO) Core 1	2400-2483.5	2405	20.5	100
Thread (SISO) Core 2	2400-2483.5	2405	13.5	100
2.4 GHz WLAN (SISO) Core 0	2400-2483.5	2412	23.0	100
2.4 GHz WLAN (SISO) Core 1	2400-2483.5	2412	23.0	100
2.4 GHz WLAN (2x2 MIMO) Core 0 and Core 1	2400-2483.5	2412	26.0	100
5 GHz WLAN (SISO) Core 0	5150-5850	5180	21.5	100
5 GHz WLAN (SISO) Core 1	5150-5850	5180	21.5	100
5 GHz WLAN (2x2 MIMO) Core 0 and Core 1	5150-5850	5180	24.5	100
6 GHz WLAN (SISO) Core 0	5925-7125	5955	21.5	100
6 GHz WLAN (SISO) Core 1	5925-7125	5955	21.5	100
6 GHz WLAN (2x2 MIMO) Core 0 and Core 1	5925-7125	5955	24.5	100
NB Core 0	UNII-1	5162	13.5	100
NB Core 1	UNII-1	5162	13.5	100
NB Core 0 and Core 1	UNII-1	5162	13.0	100
NB Core 0	UNII-3	5733	14.5	100
NB Core 1	UNII-3	5733	14.5	100
NB Core 0 and Core 1	UNII-3	5733	17.5	100

Table 2 – Transmitter Description - FCC

Note: Transmitter power includes upper bounds of uncertainty therefore maximum values are used.

1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

Radio Access Technology	Antenna Model	Frequency Band (MHz)	Gain (dBi)	Antenna length (cm)	Minimum Separation Distance (cm)
Bluetooth / Thread / 2.4 GHz WLAN – Core 0	Not Specified	2400-2483.5	1.8	4.59	20.1
Bluetooth / Thread / 2.4 GHz WLAN – Core 1	Not Specified	2400-2483.5	1.1	4.59	20.1
Bluetooth / Thread / 2.4 GHz WLAN – Core 2	Not Specified	2400-2483.5	0.2	4.72	20.1
5 GHz WLAN – Core 0	Not Specified	5150-5850	4.7	4.59	20.1
5 GHz WLAN – Core 1	Not Specified	5150-5850	4.6	4.59	20.1
6 GHz WLAN – Core 0	Not Specified	5925-7125	3.5	4.59	20.1
6 GHz WLAN – Core 1	Not Specified	5925-7125	3.6	4.59	20.1
NB UNII-1 Core 0	Not Specified	5150-5250	3.1	4.59	20.1
NB UNII-1 Core 1	Not Specified	5150-5250	3.3	4.59	20.1
NB UNII-3 Core 0	Not Specified	5725-5850	1.8	4.59	20.1
NB UNII-3 Core 1	Not Specified	5725-5850	1.1	4.59	20.1

Table 3 – Antenna Description

In the case of more than one type of antenna being supported by the equipment, the calculation is based on the maximum of the antenna gains. If other antennas can be used that have greater gains, the minimum separation distances will need to be recalculated.

Note: Antenna gain includes upper bounds of uncertainty therefore maximum values are used.

1.4.4 Equipment Configuration

The device supports the following modes:-
- Bluetooth can operate in SISO modes on Core 0, 1, 2 & MIMO Mode on Core 0 – 1
- Thread can operate in SISO modes on Core 0, 1, 2
- WLAN can operate in SISO modes on Core 0, 1 & MIMO Mode on Core 0 – 1
- NB can operate in SISO modes on Core 0, 1 & MIMO Mode on Core 0 – 1

The device supports simultaneous operation in the following modes:
- Bluetooth and 5 GHz WLAN
- Bluetooth or Thread and 5 GHz / 6 GHz WLAN
- NB (Core 0) and 2.4 GHz WLAN (Core 1)
- NB (Core 1) and 2.4 GHz WLAN (Core 0)

Worst case configurations for simultaneous transmission were identified as;

Combination 1 - Thread Core 0 + 6 GHz WLAN (2x2 MIMO on Core 0 & 1)

Combination 2 - 2.4 GHz WLAN (SISO) Core 0 + NB Core 1

2 Assessment Details

2.1 Single RF Source options for determination of exemption.

Option	Reference	RF Exposure Test Exemptions for Single Source
A (1-mW Test Exemption)	FCC 1.1307(b)(3)(i)(A)	The available maximum time averaged power is no more than 1 mW, regardless of separation distance.
B (SAR-Based Exemption)	FCC 1.1307(b)(3)(i)(B)	The available maximum timeaveraged 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 $x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right)$ and f 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 (MPE-Based Exemption)	FCC 1.1307(b)(3)(i)(C)	Or 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). TABLE 1 TO § 1.1307(b)(3)(i)(C)—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.

2.2 Multiple RF Sources options for determination of exemption.

Option	Reference	
A 1-mW Test Exemption for Multiple Sources	FCC 1.1307(b)(3)(ii)(A)	The available maximum time averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).
B Simultaneous Transmission with both SAR-based and MPE-Based Test Exemptions	FCC 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. $\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$

2.3 Individual Antenna Port Exposure Results

2.3.1 Calculation of Exposure at Specified Separation Distance

The frequencies shown in the tables below have been chosen based on the lowest possible frequency that the EUT can transmit. A full list of the regional requirements is shown in Annex A.

RAT	Frequency (MHz)	Conducted Power Output mW	Duty Cycle %	Time Average Conducted Power Output mW	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Minimum Antenna to User Separation Distance (mm)	Pth (mW) 1.1307 (b)(3)(i)(B)	Greater of Max time averaged conducted power or ERP? mW	1.1307(b)(3)(i)(B) Exemption (Yes/No) (300 MHz to 6 GHz, 0.5 cm to 40 cm)
Bluetooth (SISO) Core 0	2402	44.668	100	44.668	1.514	67.608	41.225	201	3060	44.668	Yes
Bluetooth (SISO) Core 1	2402	44.668	100	44.668	1.288	57.544	35.088	201	3060	44.668	Yes
Bluetooth (SISO) Core 2	2402	19.953	100	19.953	1.047	57.544	35.088	201	3060	35.088	Yes
Bluetooth (2x2 (MIMO) Core 0 and Core 1	2402	63.096	100	63.096	1.514	95.499	58.231	201	3060	63.096	Yes
Thread (SISO) Core 0	2405	112.202	100	112.202	1.514	169.824	103.551	201	3060	112.202	Yes
Thread (SISO) Core 1	2405	112.202	100	112.202	1.288	144.544	88.137	201	3060	112.202	Yes
Thread (SISO) Core 2	2405	22.387	100	22.387	1.047	23.442	14.294	201	3060	22.387	Yes
2.4 GHz WLAN (SISO) Core 0	2412	199.526	100	199.526	1.514	301.995	184.143	201	3060	199.526	Yes
2.4 GHz WLAN (SISO) Core 1	2412	199.526	100	199.526	1.288	257.040	156.731	201	3060	199.526	Yes
2.4 GHz WLAN (2x2 MIMO) Core 0 and Core 1	2412	398.107	100	398.107	1.514	602.560	367.414	201	3060	398.107	Yes
5 GHz WLAN (SISO) Core 0	5180	141.254	100	141.254	2.951	416.869	254.189	201	3060	254.189	Yes
5 GHz WLAN (SISO) Core 1	5180	141.254	100	141.254	2.884	407.380	248.403	201	3060	248.403	Yes
5 GHz WLAN (2x2 MIMO) Core 0 and Core 1	5180	281.838	100	281.838	2.951	831.764	507.173	201	3060	507.173	Yes
NB Core 0	5162	22.387	100	22.387	2.512	56.234	34.289	201	3060	34.289	Yes
NB Core 1	5162	22.387	100	22.387	2.512	56.234	34.289	201	3060	34.289	Yes

RAT	Frequency (MHz)	Conducted Power Output mW	Duty Cycle %	Time Average Conducted Power Output mW	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Minimum Antenna to User Separation Distance (mm)	Pth (mW) 1.1307 (b)(3)(i)(B)	Greater of Max time averaged conducted power or ERP? mW	1.1307(b)(3)(i)(B) Exemption (Yes/No) (300 MHz to 6 GHz, 0.5 cm to 40 cm)
NB Core 0 and Core 1	5162	19.953	100	19.953	2.512	50.119	30.560	201	3060	30.560	Yes
NB Core 0	5733	28.184	100	28.184	2.042	57.544	35.088	201	3060	35.088	Yes
NB Core 1	5733	28.184	100	28.184	2.138	60.256	36.741	201	3060	36.741	Yes
NB Core 0 and Core 1	5733	56.234	100	56.234	2.138	120.226	73.309	201	3060	73.309	Yes

Table 4 – Transmitter Result

The calculations show that the individual transmitters comply with FCC 1.1307(b)(3)(i)(B) SAR-based exemption at a minimum distance of 0.2 m.

2.3.2 Single Source Calculation of Exposure at Specified Separation Distance FCC 1.1307(b)(3)(i)(C) 'Option C' (MPE Based Exemption)

RAT	Frequency (MHz)	Conducted Power Output (mW)	Duty Cycle %	Time Average Conducted Power Output (mW)	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Minimum separation distance for MPE evaluation λ/2 π mm	Actual Distance (mm)	Threshold ERP (mW)	1.1307(b)(3)(i)(C) Exemption (Yes/No) (300 kHz to 100 GHz)
6 GHz WLAN (SISO) Core 0	5955	141.254	100	141.254	2.239	316.228	192.822	8.0	201	776	Yes
6 GHz WLAN (SISO) Core 1	5955	141.254	100	141.254	2.291	323.594	197.313	8.0	201	776	Yes
6 GHz WLAN (2x2 MIMO) Core 0 and Core 1	5955	281.838	100	281.838	2.951	831.764	507.173	8.0	201	776	Yes

Table 5 – Transmitter Result

The calculations show that the individual transmitters comply with FCC 1.1307(b)(3)(i)(C) MPE-based exception at a minimum distance of 0.201 m.

2.4 Combined Antenna Port RF Exposure Results using "1.1307(b)(3)(i)(B) SAR / MPE Exemption"

2.4.1 Combination 1 - 6 GHz WLAN (2x2 MIMO on Core 0 & 1) + Thread Core 0

RAT Core	Frequency (MHz)	Conducted Power Output mW	Duty Cycle %	Time Average Conducted Power Output mW	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Test Separation Distance (mm)	ERPj / Max of time averaged conducted power or ERPth
Thread Core 0	2405	112.202	100	112.202	1.514	169.824	103.551	201	0.0367
6 GHz WLAN (2x2 MIMO) Core 0 and Core 1	5955	281.838	100	281.838	2.951	831.764	507.173	201	0.6538
Calculated RF exposure level at minimum compliance boundary of 0.201 m as a fraction of the limit									0.6905

Table 6 – Transmitter Result

2.4.2 Combination 2 – 2.4 GHz WLAN (Core 0) + NB (Core 1)

RAT	Frequency (MHz)	Conducted Power Output mW	Duty Cycle %	Time Average Conducted Power Output mW	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Test Separation Distance (mm)	ERPj / Max of time averaged conducted power or ERPth
2.4 GHz WLAN (SISO) Core 0	2412	199.526	100	199.526	1.514	301.995	184.143	201	0.0652
NB Core 1	5733	28.184	100	28.184	2.138	60.256	36.741	201	0.0120
Calculated RF exposure level at minimum compliance boundary of 0.201 m as a fraction of the limit									0.0774

Table 7 – Transmitter Result