

MPE Report

Applicant : Plume Design, Inc.
Product Name : SuperPod with WiFi 6
Trade Name : Plume Design, Inc.
Model Number : F4A
Applicable Standard : 47 CFR § 2.1091
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Revision History

Rev.	Issued Date	Revisions	Revised By
00	Jun. 17, 2022	Initial Issue	Vivien Li
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		Update chapter 6 (P.12)	

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1. General Information

1.1 Reference Applicable Standard

Standard	Description	Version
IEEE C95.1	American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 KHz to 100 GHz, New York.	1992
47 CFR Part §2.1091	Radiofrequency radiation exposure evaluation: mobile devices.	-
47 CFR Part §1.1310	Radiofrequency radiation exposure limits.	-
KDB 447498 D04	RF exposure procedures and equipment authorization policies for mobile and portable devices	v01

2. Description of Equipment under Test (EUT)

Applicant	Plume Design, Inc. 325 Lytton Ave., Palo Alto, CA 94301
Product Name	SuperPod with WiFi 6
Trade Name	Plume Design, Inc.
Model Number	F4A
FCC ID	2AG7G-F4A
Frequency Range	WLAN 2.4 GHz Band : 2412 - 2462 MHz WLAN 5.2 GHz Band : 5180 - 5240 MHz WLAN 5.3 GHz Band : 5260 - 5320 MHz WLAN 5.6 GHz Band : 5500 - 5720 MHz WLAN 5.8 GHz Band : 5720 - 5825 MHz Bluetooth : 2402 - 2480 MHz
Supported Modulations	WLAN 2.4 GHz : 802.11b/g/n/ac/ax HT20/HT40/VHT20/VHT40/ HE20/HE40
	WLAN 5 GHz : 802.11a/n/ac/ax HT20/HT40/VHT20/VHT40/VHT80/VHT160/HE20/HE40/HE80/HE160
	Bluetooth : LE

Note:

The above information of DUT was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

Antenna Information:

Antenna Gain(dBi)								
Band	ANT H1	ANT H2	ANT L1	ANT L2	ANT L3	ANT L4	Gant Gain	BF Gain
2.4 GHz	0.80	0.80	-	-	-	-	3.10	5.80
5.2 GHz	-	-	3.30	2.20	3.00	3.70	3.70	7.28
5.3 GHz	-	-	3.20	2.10	3.10	3.70	3.70	8.41
5.6 GHz	4.10	2.30	-	-	-	-	4.10	6.30
5.8 GHz	2.80	2.40	-	-	-	-	2.80	5.52
Bluetooth	-	-	-	-	0.10	-	-	-

3. RF Exposure Limit

For devices that operate at larger distances from persons, where there are minimal RF coupling interactions between a device and the user or nearby persons, RF exposure compliance using maximum permissible exposure (MPE) limits is applied. The limits for MPE is listed as below:

Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
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
300-1500	-	-	F / 1,500	30
1,500-100,000	-	-	1.0	30
Limits for Occupational / Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1,842 / 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

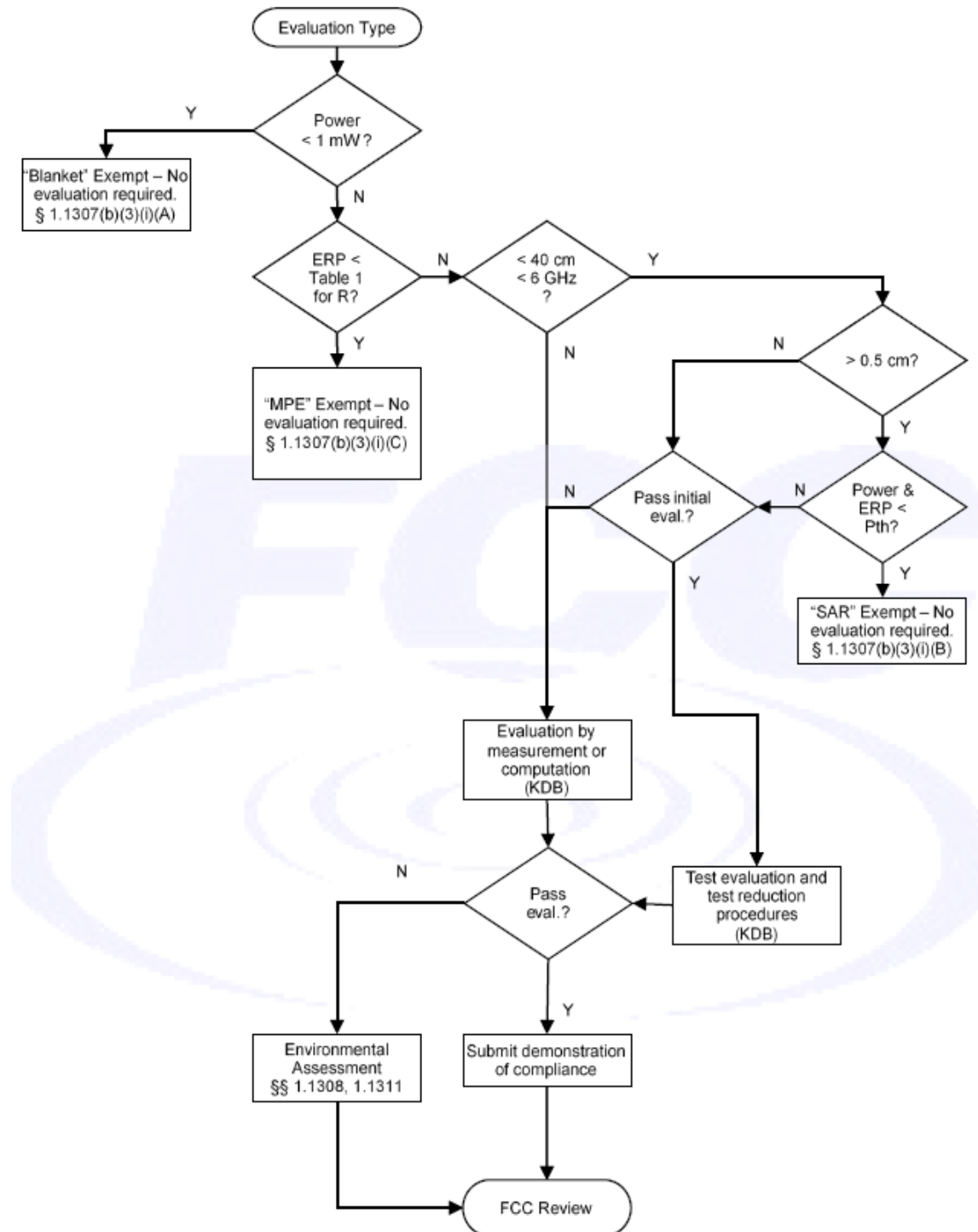
f = frequency in MHz. * = Plane-wave equivalent power density.

4. RF Exposure Assessment

4.1 Exemption Evaluation

Exemption evaluation was performed according to the appendix A and B in KDB447498 D04.

The General Sequence for Determination of Procedure demonstrated in Figure A.1 of KDB447498 D04 was applied.



4.2 Human Exposure Assessment

Due to the design and installation of this product, it is not possible to conduct SAR evaluation. This is because client either manufactures or supplies the antenna(s) that will be used in the installation of this product. Therefore, this product will be evaluated as a mobile device per 47 CFR § 1.1310 titled “Radiofrequency radiation exposure limits”, generally referred to as MPE limits.

In 47 CFR § 2.1091, paragraph (b) defines a mobile device as “a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter’s radiating structure(s) and the body of the user or nearby persons.” This product is intended to be installed into a vehicle such that the unit is physically secured at one location. In the installation guide supplied with the product, Client has made the following statement: “IMPORTANT: To meet the FCC’s RF Exposure Guidelines, the antenna should be installed so there is at least 20 cm of separation between the body of the user and nearby persons and the antenna”. Based on the installation of the transceiver and the antenna, the transmitters radiating structure is more than 20 cm from the user. Thus, this product is a “mobile device” as defined in section § 2.1091 paragraph (b).

Exposure evaluation

$$S_{eirp} = \frac{EIRP}{4\pi d^2} = \frac{PG}{4\pi d^2} (W / m^2)$$

Where

S= Power density in W/m²

EIRP = Equivalent Isotropic Radiated Power in W

P = power of transmitter;

G = the antenna gain;

d = the distance between antennas and evaluation point in m

Total Exposure Ratio (TER):

According to KDB447498, either SAR-based or MPE-based exemption may be considered for test exemption for fixed, mobile, or portable device exposure conditions; therefore, the contributions from each exemption in conjunction with the measured SAR (*Evaluated_k* term) shall be used to determine exemption for simultaneous transmission according to the following formula [repeated from § 1.1307(b)(3)(ii)(B)].

The sum of the ratios of the applicable terms for SAR-based, MPE-based and measured SAR or MPE shall be less than 1, to determine simultaneous transmission exposure compliance.

$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$	
a	number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for P _{th} , including existing exempt transmitters and those being added.
b	number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.
c	number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.
P_i	the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).
P_{th,i}	the exemption threshold power (P _{th}) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source i.
ERP_j	the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source j.
ERP_{th,j}	exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.
Evaluated_k	the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation.
Exposure Limit_k	either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources, as applicable

5. Maximum Tune-up Power

The transmission of device operates :

WLAN 2.4GHz mode transmits by 1TX located on Ant H1, and by 2TX located on Ant H1 and Ant H2 respectively.

5GHz U-NII-1 and U-NII-2A mode transmit by 4TX located on Ant L1, Ant L2, Ant L3 and Ant L4, respectively.

5GHz U-NII-2C and U-NII-3 mode transmit by 2TX located on Ant H1 and Ant H2, respectively.

Standalone :

Operate Band	Frequency (MHz)	ANT L3
Bluetooth	2402 - 2480	-1 dB

Operate Band	Frequency (MHz)	ANT H1
2.4 GHz	2412 - 2462	24.5 dB

Operate Band	Frequency (MHz)	ANT L1
5.2 GHz	5180 - 5240	24 dB
5.3 GHz	5260 - 5320	24 dB

Operate Band	Frequency (MHz)	ANT H1
5.6 GHz	5500 - 5720	24 dB
5.8 GHz	5720 - 5825	24.5 dB

Beam forming OFF :

Operate Band	Frequency (MHz)	ANT H1 +ANT H2
2.4 GHz	2412 - 2462	27.5 dB

Operate Band	Frequency (MHz)	ANT L1 + ANT L2 +ANT L3 + ANT L4
5.2 GHz	5180 - 5240	28.5 dB
5.3 GHz	5260 - 5320	24 dB

Operate Band	Frequency (MHz)	ANT H1 +ANT H2
5.6 GHz	5500 - 5720	24 dB
5.8 GHz	5720 - 5825	27 dB

Beam forming ON :

Operate Band	Frequency (MHz)	ANT H1 +ANT H2
2.4 GHz	2412 - 2462	24.5 dB

Operate Band	Frequency (MHz)	ANT L1 + ANT L2 +ANT L3 + ANT L4
5.2 GHz	5180 - 5240	25 dB
5.3 GHz	5260 - 5320	20 dB

Operate Band	Frequency (MHz)	ANT H1 +ANT H2
5.6 GHz	5500 - 5720	21.5 dB
5.8 GHz	5720 - 5825	24 dB

6. Result

Band	Frequency (MHz)	Distance (cm) [R]	Tune-up Power (dBm) [P]	ANT Gain (dBi)	Numeric Gain [G]	Duty Cycle	Power with Duty cycle (mW) [P]x[G]	Power Density (mW/cm ²) [S]	Standalone Limit (W/m ²)	Antenna
2.4 GHz	2412 - 2462	20.0	24.50	5.80	3.80	1	1070.99	0.21	1.00	Beam forming On
5.2 GHz	5180 - 5240	20.0	25.00	7.28	5.35	1	1691.82	0.34	1.00	Beam forming On
5.3 GHz	5260 - 5320	20.0	20.00	8.41	6.93	1	693.00	0.14	1.00	Beam forming On
5.6 GHz	5500 - 5720	20.0	21.50	6.30	4.27	1	603.15	0.12	1.00	Beam forming On
5.8 GHz	5720 - 5825	20.0	24.00	5.52	3.56	1	894.23	0.18	1.00	Beam forming On
2.4 GHz	2412 - 2462	20.0	27.50	3.10	2.04	1	1147.18	0.23	1.00	Beam forming OFF
5.2 GHz	5180 - 5240	20.0	28.50	3.70	2.34	1	1656.59	0.33	1.00	Beam forming OFF
5.3 GHz	5260 - 5320	20.0	24.00	3.70	2.34	1	587.78	0.12	1.00	Beam forming OFF
5.6 GHz	5500 - 5720	20.0	24.00	4.10	2.57	1	645.55	0.13	1.00	Beam forming OFF
5.8 GHz	5720 - 5825	20.0	27.00	2.80	1.91	1	957.27	0.19	1.00	Beam forming OFF
Bluetooth	2402 - 2480	20.0	-1.00	0.10	1.02	1	0.81	0.00	1.00	ANT L3

Note:

1. The maximum power and gain were applied to evaluate MPE.
2. The maximum power and directional gain were applied to evaluate MPE for multiple antennas transmitting. If all transmit signals are completely uncorrelated, directional gain = Gant.
3. The Numeric Gain calculated by $10^{\text{ant. Gain (dBi)} / 10}$.

Simultaneous Transmission:

WLAN 2.4G + WLAN5G + Bluetooth

Total MPE : 0.56 mW/cm ²	TER : 0.56
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7. Conclusion

The result shows that this device is compliance with the exposure limits in 47 CFR §1.1310.

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