

Maximum Permissible Exposure Report

1. Product Information

FCC ID	: 2ARMF-RAPNASMF
EUT	: Network audio system(built-in amplifier)
Test Model	: RAPNAS MF-1
Power Supply	: Input: AC 100~120V, 50/60Hz
Hardware Version	: Version1.0
Software Version	: Version1.0
Bluetooth	:
Frequency Range	: 2402MHz-2480MHz
Channel Number	: 79 channels for Bluetooth V4.2 (BDR/EDR) 40 channels for Bluetooth V4.2 (BT LE)
Channel Spacing	: 1MHz for Bluetooth V4.2 (BDR/EDR) 2MHz for Bluetooth V4.2 (BT LE)
Modulation Type	: GFSK, $\pi/4$ -DQPSK, 8-DPSK for Bluetooth V4.2 (BDR/EDR) GFSK for Bluetooth V4.2 (BT LE)
Bluetooth Version	: V4.2
WIFI(2.4G Band)	:
Frequency Range	: 2412MHz-2462MHz
Channel Spacing	: 5MHz
Channel Number	: 11 channels for 20MHz bandwidth(2412~2462MHz) 7 channels for 40MHz bandwidth(2422~2452MHz)
Modulation Type	: IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK); IEEE 802.11g/n: OFDM(64QAM, 16QAM, QPSK, BPSK)
WIFI(5G Band 1)	:
Frequency Range	: 5180MHz-5240MHz
Channel Number	: 4 channels for 20MHz bandwidth(5180-5240MHz) 2 channels for 40MHz bandwidth(5190~5230MHz) 1 channels for 80MHz bandwidth(5210MHz)
Modulation Type	: IEEE 802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
WIFI(5G Band 3)	:
Frequency Range	: 5745MHz-5825MHz
Channel Number	: 5 channels for 20MHz bandwidth(5745-5825MHz) 2 channels for 40MHz bandwidth(5755~5795MHz) 1 channels for 80MHz bandwidth(5775MHz)
Modulation Type	: IEEE 802.11a/n/ac: OFDM(64QAM, 16QAM, QPSK, BPSK)
Antenna Description	: The WIFI and BT shares the same PCB Trace Antenna. 3.5dBi(Max.) for 2.4G Band; 2.3dBi(Max.) for 5G Band
Exposure category	: General population/uncontrolled environment
EUT Type	: Production Unit
Device Type	: Mobile Device

2. Evaluation Method

Systems operating under the provisions of FCC 47 CFR section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

In accordance with 47 CFR FCC Part 2 Subpart J, section 2.1091 this device has been defined as mobile device whereby a distance of 0.2m normally can be maintained between the user and the device, and below RF Permissible Exposure limit shall comply with.

In accordance with KDB447498D01 for Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modelled or measured field strengths or power density, is ≤ 1.0 . The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to MPE limit, at the test frequency. Either the maximum peak or spatially averaged results from measurements or numerical simulations may be used to determine the MPE ratios. Spatial averaging does not apply when MPE is estimated using simple calculations based on far-field plane-wave equivalent conditions. The antenna installation and operating requirements for the host device must meet the minimum test separation distances required by all antennas, in both standalone and simultaneous transmission operations, to satisfy compliance.

3. Limit

3.1 Refer Evaluation Method

[ANSI C95.1-1999](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[FCC KDB publication 447498 D01 General 1 RF Exposure Guidance v06](#): Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

[FCC CFR 47 part1 1.1310](#): Radiofrequency radiation exposure limits.

[FCC CFR 47 part2 2.1091](#): Radiofrequency radiation exposure evaluation: mobile devices.

3.2 Limit

Limits for Maximum Permissible Exposure (MPE)/Controlled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
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 – 1500	/	/	f/300	6
1500 – 100,000	/	/	5	6

Limits for Maximum Permissible Exposure (MPE)/Uncontrolled Exposure

Frequency Range(MHz)	Electric Field Strength(V/m)	Magnetic Field Strength(A/m)	Power Density (mW/cm ²)	Averaging Time (minute)
Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	(100) *	30
3.0 – 30	824/f	2.19/f	(180/f ²)*	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	/	/	f/1500	30
1500 – 100,000	/	/	1.0	30

F=frequency in MHz

*=Plane-wave equivalent power density

4. MPE Calculation Method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S=PG/4\pi R^2$$

Where: S=power density

P=power input to antenna

G=power gain of the antenna in the direction of interest relative to an isotropic radiator

R=distance to the center of radiation of the antenna

5. Antenna Information

RAPNAS MF-1 can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain
PCB Trace Antenna	2.4GHz – 2.4835 GHz	3.5dBi
PCB Trace Antenna	5GHz – 6 GHz	2.3dBi

6. Conducted Power

[Bluetooth]

Mode	Channel	Frequency(MHz)	Peak Conducted Output Power (dBm)
GFSK	0	2402	1.515
	39	2441	-0.185
	78	2480	0.275
$\pi/4$ DQPSK	0	2402	0.732
	39	2441	-0.811
	78	2480	-0.588
8-DPSK	0	2402	0.881
	39	2441	-0.642
	78	2480	-0.387
GFSK BT – LE	0	2402	1.399
	19	2440	-0.028
	39	2480	0.231

[2.4GHz WLAN]

Mode	Channel	Frequency(MHz)	Peak Conducted Output Power (dBm)
IEEE 802.11b	1	2412	12.80
	6	2437	13.79
	11	2462	14.11
IEEE 802.11g	1	2412	12.73
	6	2437	14.63
	11	2462	10.70
IEEE 802.11n HT20	1	2412	14.24
	6	2437	14.92
	11	2462	10.60
IEEE 802.11n HT40	3	2422	11.39
	6	2437	13.65
	9	2452	12.43

[5GHz WLAN Band 1]

Mode	Channel	Frequency(MHz)	Average Conducted Output Power (dBm)
IEEE 802.11a	36	5180	12.48
	40	5200	12.42
	48	5240	12.78
IEEE 802.11n HT20	36	5180	12.27
	40	5200	12.49
	48	5240	12.89
IEEE 802.11n HT40	38	5190	12.72
	46	5230	13.28
IEEE 802.11ac VHT20	36	5180	12.19
	40	5200	12.54
	48	5240	12.86
IEEE 802.11ac VHT40	38	5190	14.48
	46	5230	13.34
IEEE 802.11ac VHT80	42	5210	11.64

[5GHz WLAN Band 3]

Mode	Channel	Frequency(MHz)	Average Conducted Output Power (dBm)
IEEE 802.11a	149	5745	11.77
	157	5785	11.57
	165	5825	11.27
IEEE 802.11n HT20	149	5745	11.81
	157	5785	11.73
	165	5825	11.59
IEEE 802.11n HT40	151	5755	12.44
	159	5795	12.94
IEEE 802.11ac VHT20	149	5745	12.19
	157	5785	12.54
	165	5825	12.86
IEEE 802.11ac VHT40	151	5755	14.48
	159	5795	13.34
IEEE 802.11ac VHT80	155	5775	9.10

7. Manufacturing Tolerance

[Bluetooth]

GFSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	2.0	0	1.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
$\pi/4$ DQPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1.0	0	0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
8-DPSK (Peak)			
Channel	Channel 0	Channel 39	Channel 78
Target (dBm)	1.0	0	0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
GFSK (BT - LE) (Peak)			
Channel	Channel 0	Channel 19	Channel 39
Target (dBm)	2.0	0	1.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[2.4GHz WLAN]

IEEE 802.11b (Peak)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	13.0	14.0	15.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11g (Peak)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	13.0	15.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Peak)			
Frequency (MHz)	2412	2437	2462
Target (dBm)	15.0	15.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Peak)			
Frequency (MHz)	2422	2437	2452
Target (dBm)	12.0	14.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

[5GHz WLAN Band 1]

IEEE 802.11a (Average)			
Frequency (MHz)	5180	5200	5240
Target (dBm)	13.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Frequency (MHz)	5180	5200	5240
Target (dBm)	13.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)			
Frequency (MHz)	5180	5240	5200
Target (dBm)	13.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Frequency (MHz)	5190	5230	
Target (dBm)	13.0	14.0	
Tolerance $\pm$ (dB)	1.0	1.0	
IEEE 802.11ac VHT40 (Average)			
Frequency (MHz)	5190	5230	
Target (dBm)	15.0	14.0	
Tolerance $\pm$ (dB)	1.0	1.0	
IEEE 802.11ac VHT80 (Average)			
Frequency (MHz)	5210		
Target (dBm)	12.0		
Tolerance $\pm$ (dB)	1.0		

[5GHz WLAN Band 3]

IEEE 802.11a (Average)			
Frequency (MHz)	5745	5785	5825
Target (dBm)	12.0	12.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT20 (Average)			
Frequency (MHz)	5745	5785	5825
Target (dBm)	12.0	12.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11ac VHT20 (Average)			
Frequency (MHz)	5745	5785	5825
Target (dBm)	13.0	13.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
IEEE 802.11n HT40 (Average)			
Frequency (MHz)	5755	5795	
Target (dBm)	13.0	13.0	
Tolerance $\pm$ (dB)	1.0	1.0	
IEEE 802.11ac VHT40 (Average)			
Frequency (MHz)	5755	5795	
Target (dBm)	15.0	14.0	
Tolerance $\pm$ (dB)	1.0	1.0	
IEEE 802.11ac VHT80 (Average)			
Frequency (MHz)	5775		
Target (dBm)	10.0		
Tolerance $\pm$ (dB)	1.0		

8. Measurement Results

8.1 Standalone MPE

As declared by the Applicant, the EUT is a wireless device used in a fix application, at least 20 cm from any body part of the user or nearby persons; from the maximum EUT RF output power, the minimum separation distance, $r=20\text{cm}$, as well as the gain of the used antenna refer to antenna information, the RF power density can be obtained.

[Bluetooth]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
GFSK	3.00	1.9953	3.50	2.2387	100%	0.0009	1.0000
$\pi/4$ DQPSK	2.00	1.5849	3.50	2.2387	100%	0.0007	1.0000
8-DPSK	2.00	1.5849	3.50	2.2387	100%	0.0007	1.0000
GFSK (BT LE)	3.00	1.9953	3.50	2.2387	100%	0.0009	1.0000

[2.4GHz WLAN]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11b	16.00	39.8107	3.50	2.2387	100%	0.0177	1.0000
IEEE 802.11g	16.00	39.8107	3.50	2.2387	100%	0.0177	1.0000
IEEE 802.11n HT20	16.00	39.8107	3.50	2.2387	100%	0.0177	1.0000
IEEE 802.11n HT40	15.00	31.6228	3.50	2.2387	100%	0.0141	1.0000

[5GHz WLAN Band 1]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	14.00	25.1189	2.30	1.6982	100%	0.0085	1.0000
IEEE 802.11n HT20	14.00	25.1189	2.30	1.6982	100%	0.0085	1.0000
IEEE 802.11ac VHT20	14.00	25.1189	2.30	1.6982	100%	0.0085	1.0000
IEEE 802.11n HT40	15.00	31.6228	2.30	1.6982	100%	0.0107	1.0000
IEEE 802.11ac VHT40	16.00	39.8107	2.30	1.6982	100%	0.0135	1.0000
IEEE 802.11ac VHT80	13.00	19.9526	2.30	1.6982	100%	0.0067	1.0000

[5GHz WLAN Band 3]

Modulation Type	Output power		Antenna Gain (dBi)	Antenna Gain (linear)	Duty Cycle	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
	dBm	mW					
IEEE 802.11a	13.00	19.9526	2.30	1.6982	100%	0.0067	1.0000
IEEE 802.11n HT20	13.00	19.9526	2.30	1.6982	100%	0.0067	1.0000
IEEE 802.11ac VHT20	14.00	25.1189	2.30	1.6982	100%	0.0085	1.0000
IEEE 802.11n HT40	14.00	25.1189	2.30	1.6982	100%	0.0085	1.0000
IEEE 802.11ac VHT40	16.00	39.8107	2.30	1.6982	100%	0.0135	1.0000
IEEE 802.11ac VHT80	11.00	12.5983	2.30	1.6982	100%	0.0043	1.0000

Remark:

1. Output power including turn-up tolerance;
2. Output power was adjust to duty cycle at 100% if measured duty cycle less than 98%;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer.

8.2 Simultaneous Transmission MPE

BT and WLAN can be active at the same time, but only with interleaving of packages switched on board level. That means that they cannot transmit at the same time, no need consider simultaneous transmission.

9. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

-----THE END OF REPORT-----