

Maximum Permissible Exposure Report

1. Product Information

FCC ID:	2AZEVLWF01
Product name	Vilo Mesh Wi-Fi System
Test Model	VLWF01
Power supply	DC 12V by AC Adapter
Operation frequency	2412MHz-2462MHz 5180MHz-5240MHz 5745MHz-5825MHz
Antenna Type	ANT0: FPC Antenna ANT1: FPC Antenna
Antenna Gain	5.0dBi(Max)
Hardware version	0.1.14
Software version	RTL8197FS_VGx+RTL8812F+RTL8367_4L
Channel Number	11 Channels for 20MHz bandwidth (2412~2462MHz) 7 Channels for 40MHz bandwidth (2422~2452MHz) 4 channels for 20MHz bandwidth (5180-5240MHz) 2 channels for 40MHz bandwidth (5190~5230MHz) 1 channels for 80MHz bandwidth (5210MHz) 5 channels for 20MHz bandwidth(5745-5825MHz) 2 channels for 40MHz bandwidth(5755~5795MHz) 1 channels for 80MHz bandwidth(5775MHz)
Exposure category	General population/uncontrolled environment
EUT Type	Production Unit
Device Type	Mobile Devices

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

ES-D4 can only use antennas certificated as follows provided by manufacturer;

Antenna type and antenna number	Operate frequency band	Maximum antenna gain	Notes
Internal Antenna 0	2412MHz-2462MHz 5180MHz-5240MHz 5745MHz-5825MHz	5 dBi	WiFi Antenna
Internal Antenna 1	2402MHz-2480MHz 2412MHz-2462MHz 5180MHz-5240MHz 5745MHz-5825MHz	5 dBi	WiFi Antenna

6. Conducted Power

[2.4GWIFI Max Conducted Power]

Mode	Channel	Frequency (MHz)	ANT 0 Max Conducted Power(dBm)	ANT 1 Max Conducted Power(dBm)
11B	1	2412	10.7	10.01
	6	2437	12.2	11.62
	11	2462	12.76	12.91
11G	1	2412	10.51	10.7
	6	2437	11.76	12.38
	11	2462	12.48	13.77
11N20SISO	1	2412	10.05	10.32
	6	2437	11.52	11.96
	11	2462	12.03	13.37
11N40SISO	3	2422	9.99	10.45
	6	2437	10.74	11.21
	9	2452	11.15	12.25

[5.2GWIFI AVG Power]

Mode	Channel	Frequency (MHz)	ANT 0 AVG Power(dBm)	ANT 1 AVG Power(dBm)
11A	36	5180	8.5	9.94
	40	5200	9.49	10.81
	48	5240	10.63	11.93
11N20 SISO	36	5180	8.52	10.2
	40	5200	9.48	11.01
	48	5240	10.16	11.24
11N40 SISO	38	5190	8.97	9.47
	46	5230	10.46	10.77
11AC20 SISO	36	5180	8.88	9.77
	40	5200	9.78	10.64
	48	5240	10.32	10.78
11AC40 SISO	38	5190	8.15	10.27
	46	5230	9.63	11.61
11AC80 SISO	42	5210	11.93	10.8

[5.8WIFI AVG Power]

Mode	Channel	Frequency (MHz)	ANT 0 AVG Power(dBm)	ANT 1 AVG Power(dBm)
11A	149	5745	10.1	8.52
	157	5785	10.59	9.74
	165	5825	10.94	10.55
11N20 SISO	149	5745	10.32	7.88
	157	5785	10.83	9.27
	165	5825	10.96	10.12
11N40 SISO	151	5755	10.15	10.94
	159	5795	10.63	11.25
11AC20 SISO	149	5745	10.2	9.77
	157	5785	10.6	10.64
	165	5825	10.99	10.78
11AC40 SISO	151	5755	10.32	10.27
	159	5795	11.08	11.61
11AC80 SISO	155	5775	10.11	10.37

7. Measurement Results

2.4GWIFI(Ant 0)

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	12.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	11.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20SISO (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	11.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40SISO (Peak)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	9.0	10.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

2.4GWIFI(Ant 1)

11B (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	11.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11G (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	12.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20SISO (Peak)			
Channel	Channel 1	Channel 6	Channel 11
Target (dBm)	10.0	11.0	13.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40SISO (Peak)			
Channel	Channel 3	Channel 6	Channel 9
Target (dBm)	10.0	11.0	12.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

5.2GWIFI(Ant 0)

11A (AVG)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	8.0	9.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 SISO (AVG)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	8.0	9.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 SISO (AVG)			
Channel	Channel 38	Channel 46	
Target (dBm)	8.0	10.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC20 SISO (AVG)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	8.0	9.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 SISO (AVG)			
Channel	Channel 38	Channel 46	
Target (dBm)	8.0	9.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC80 SISO (AVG)			
Channel	Channel 42		
Target (dBm)	11.0		
Tolerance $\pm$ (dB)	1.0		

5.2GWIFI(Ant 1)			
11A (AVG)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	9.0	10.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 SISO(AVG)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	10.0	10.0	11.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 SISO(AVG)			
Channel	Channel 38	Channel 46	
Target (dBm)	9.0	10.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC20 SISO (AVG)			
Channel	Channel 36	Channel 40	Channel 48
Target (dBm)	9.0	10.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 SISO (AVG)			
Channel	Channel 38	Channel 46	
Target (dBm)	10.0	11.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC80 SISO(AVG)			
Channel	Channel 42		
Target (dBm)	10.0		
Tolerance $\pm$ (dB)	1.0		

5.8GWIFI(Ant 0)			
11A (AVG)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	10.0	10.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 SISO (AVG)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	10.0	10.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 SISO (AVG)			
Channel	Channel 151	Channel 159	
Target (dBm)	10.0	10.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC20 SISO (AVG)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	10.0	10.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 SISO (AVG)			
Channel	Channel 151	Channel 159	
Target (dBm)	10.0	11.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC80 SISO (AVG)			
Channel	Channel 155		
Target (dBm)	10.0		
Tolerance $\pm$ (dB)	1.0		

5.8GWIFI(Ant 1)			
11A (AVG)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	8.0	9.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N20 SISO (AVG)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	7.0	9.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11N40 SISO (AVG)			
Channel	Channel 151	Channel 159	
Target (dBm)	10.0	11.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC20 SISO (AVG)			
Channel	Channel 149	Channel 157	Channel 165
Target (dBm)	9.0	10.0	10.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
11AC40 SISO (AVG)			
Channel	Channel 151	Channel 159	
Target (dBm)	10.0	11.0	
Tolerance $\pm$ (dB)	1.0	1.0	
11AC80 SISO (AVG)			
Channel	Channel 155		
Target (dBm)	10.0		
Tolerance $\pm$ (dB)	1.0		

8. Evaluation Results

8.1 Standalone MPE Evaluation

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.

2.4GWIFI(Ant 0)

Band/Mode	f (GHz)	RF output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
		dBm	mW				
IEEE 802.11b	2.462	13.0	19.9526	5.0	3.1623	0.0126	1.0000
IEEE 802.11g	2.462	13.0	19.9526	5.0	3.1623	0.0126	1.0000
IEEE 802.11n HT20	2.462	13.0	19.9526	5.0	3.1623	0.0126	1.0000
IEEE 802.11n HT40	2.452	12.0	15.8489	5.0	3.1623	0.0100	1.0000

2.4GWIFI(Ant 1)

Band/Mode	f (GHz)	RF output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
		dBm	mW				
IEEE 802.11b	2.462	13.0	19.9526	5.0	3.1623	0.0126	1.0000
IEEE 802.11g	2.462	14.0	25.1189	5.0	3.1623	0.0158	1.0000
IEEE 802.11n HT20	2.462	14.0	25.1189	5.0	3.1623	0.0158	1.0000
IEEE 802.11n HT40	2.452	13.0	19.9526	5.0	3.1623	0.0126	1.0000

5.2GWIFI(Ant 0)

Band/Mode	f (GHz)	RF output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
		dBm	mW				
11A	5.240	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11N20 SISO	5.240	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11N40 SISO	5.230	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC20 SISO	5.240	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC40 SISO	5.230	10.0	10.0000	5.0	3.1623	0.0063	1.0000
11AC80 SISO	5.210	12.0	15.8489	5.0	3.1623	0.0100	1.0000

5.2GWIFI(Ant 1)

Band/Mode	f (GHz)	RF output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
		dBm	mW				
11A	5.240	12.0	15.8489	5.0	3.1623	0.0100	1.0000
11N20 SISO	5.240	12.0	15.8489	5.0	3.1623	0.0100	1.0000
11N40 SISO	5.230	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC20 SISO	5.240	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC40 SISO	5.230	12.0	15.8489	5.0	3.1623	0.0100	1.0000
11AC80 SISO	5.210	11.0	12.5893	5.0	3.1623	0.0079	1.0000

5.8GWIFI(Ant 0)

Band/Mode	f (GHz)	RF output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
		dBm	mW				
11A	5.825	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11N20 SISO	5.825	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11N40 SISO	5.795	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC20 SISO	5.825	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC40 SISO	5.795	12.0	15.8489	5.0	3.1623	0.0100	1.0000
11AC80 SISO	5.775	11.0	12.5893	5.0	3.1623	0.0079	1.0000

5.8GWIFI(Ant 2)

Band/Mode	f (GHz)	RF output power		Antenna Gain (dBi)	Antenna Gain (linear)	MPE (mW/cm ²)	MPE Limits (mW/cm ²)
		dBm	mW				
11A	5.825	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11N20 SISO	5.825	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11N40 SISO	5.795	12.0	15.8489	5.0	3.1623	0.0100	1.0000
11AC20 SISO	5.825	11.0	12.5893	5.0	3.1623	0.0079	1.0000
11AC40 SISO	5.795	12.0	15.8489	5.0	3.1623	0.0100	1.0000
11AC80 SISO	5.775	11.0	12.5893	5.0	3.1623	0.0079	1.0000

8.2 Simultaneous Transmission MPE

Simultaneous transmission MPE

According to KDB447498 for Transmitters used in mobile exposure conditions for simultaneous transmission operations;

$\sum \sum$ of MPE ratios ≤ 1.0

Ant_0 and Ant_1 for Simultaneous Transmission Results

Modulation Type	MPE _{Ant_1} (mW/cm ²)	MPE _{Ant_2} (mW/cm ²)	$\sum$ MPE ratios	Limit	Results
2.4GWIFI (IEEE 802.11n HT20)	0.0126	0.0158	0.0284	1.0	PASS
2.4GWIFI (IEEE 802.11n HT40)	0.0100	0.0126	0.0226	1.0	PASS
5.2GWIFI (IEEE 802.11n HT20)	0.0079	0.01	0.0179	1.0	PASS
5.2GWIFI (IEEE 802.11ac VHT20)	0.0079	0.0079	0.0158	1.0	PASS
5.2GWIFI (IEEE 802.11n HT40)	0.0079	0.0079	0.0158	1.0	PASS
5.2GWIFI (IEEE 802.11ac VHT40)	0.0063	0.01	0.0163	1.0	PASS
5.2GWIFI (IEEE 802.11ac VHT80)	0.01	0.0079	0.0179	1.0	PASS
5.8GWIFI (IEEE 802.11n HT20)	0.0079	0.0079	0.0158	1.0	PASS
5.8GWIFI (IEEE 802.11ac VHT20)	0.0079	0.0100	0.0179	1.0	PASS
5.8GWIFI (IEEE 802.11n HT40)	0.0079	0.0079	0.0158	1.0	PASS
5.8GWIFI (IEEE 802.11ac VHT40)	0.0100	0.0100	0.0200	1.0	PASS
5.8GWIFI (IEEE 802.11ac VHT80)	0.0079	0.0079	0.0158	1.0	PASS

Remark:

1. Output power including turn-up tolerance;
2. Output power is burst average power;
3. MPE evaluate distance is 20cm from user manual provide by manufacturer;
4. MPE values = $PG/4\pi R^2$

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-----