FCC Maximum Permissible Exposure (MPE) Estimation Report

Report Number	:	**68.710.24.0280.01-S1**	Date of Issue:	2024-09-18
Model / HVIN	:	**X1000**		
Product Type	:	Robotic Vacuum Cleaner		
Applicant	:	Zhiyi (Zhongshan) Technology Co., Ltd.		
Address	:	No. 39, Donghui Road, Cuiheng New District, 528400 Zhongshan, Guangdong, PEOPLE'S REPUBLIC OF CHINA		
Manufacturer	:	Zhiyi (Zhongshan) Technology Co., Ltd.		
Address	:	No. 39, Donghui Road, Cuiheng New District, 528400 Zhongshan, Guangdong, PEOPLE'S REPUBLIC OF CHINA		
Test Result	:	■ **Positive** ☐ **Negative**		
Total pages including Appendices	:	**9**		

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2 Details about the Test Laboratory

Details about the Test Laboratory
Test Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch Building 12 & 13, Zhiheng Wisdomland Business Park, Guankou Erlu, Nantou, Nanshan District, Shenzhen, Guangdong, China
Telephone:	86 755 8828 6998
Fax:	86 755 8828 5299
FCC Registration No.:	514049
FCC Designation Number:	CN5009

3 Description of the Equipment Under Test

Product:	Robotic Vacuum Cleaner
Model no.:	X1000
FCC ID:	2BD8J-X1000
Options and accessories:	ADAPTER: Manufacturer: Dongguan Guanjin Electronics Technology Co., Ltd. Model: K65A320200E2 Input: 100-240V~, 50/60Hz, 1.5A Output: 32.0V⎓, 2.0A, 64.0W Docking Station: Manufacturer: Zhiyi (Zhongshan) Technology Co., Ltd. Model: X1000 Input: 32V⎓, 2000mA
Ratings:	Charging Input: 32V⎓, 2000mA Battery: 25.2V⎓, 4700mAh
RF Transmission Frequency:	2412MHz - 2462MHz for 2.4GHz Wi-Fi; 5180MHz – 5320MHz, 5500MHz – 5700MHz, 5745MHz – 5825MHz for 5GHz Wi-Fi
No. of Operated Channel:	11 for 2.4GHz Wi-Fi; 43 for 5GHz Wi-Fi
Modulation:	802.11b: BPSK, QPSK, CCK 802.11g: BPSK, QPSK, 16-QAM, 64-QAM 802.11n: BPSK, QPSK, 16-QAM, 64-QAM 802.11a: BPSK, QPSK, 16-QAM, 64-QAM 802.11n: BPSK, QPSK, 16-QAM, 64-QAM 802.11ac: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM
Antenna Type:	Integrated FPC antenna
Antenna Gain:	1.48 dBi for 2.4GHz Wi-Fi; 2.76 dBi for 5GHz Wi-Fi
Description of the EUT:	The EUT is a Robotic Vacuum Cleaner supports 2.4GHz Wi-Fi and 5GHz U-NII bands Wi-Fi functions: 2412MHz - 2462MHz for 2.4GHz Wi-Fi; 5180MHz – 5320MHz, 5500MHz – 5700MHz, 5745MHz – 5825MHz for 5GHz Wi-Fi.

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4 Test Specifications

Test Standards	
ANSI Std C95.1-2019	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-2019)
KDB 447498 D01	General RF Exposure Guidance v06
CFR § 2.1091	Radiofrequency radiation exposure evaluation: mobile devices.

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5 General Information

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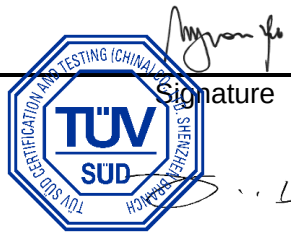
Prepared By Project Engineer	2024-09-18 Date	Myron Yu Name	 Signature
Approved by Project Manager	2024-09-18 Date	Jessie He Name	Signature

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6 RF Exposure Requirements

An estimation of MPE in this application for product is used to ensure if it complies with the rules of the standard in the regulation list above.

Maximum permissible exposure (MPE) refers to the RF energy that is acceptable for human exposure. It is broken down into two categories, Occupational/controlled and General population/uncontrolled.

Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

A rough estimation of the expected exposure in power flux density on a given point can be made with the following equation:

$$S = \frac{P \times G}{4 \times \pi \times R^2}$$

Where:

S = power density

P = power input to the antenna

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

R= distance to the centre of radiation of the antenna

EIRP = P*G

The antenna of the product, under normal use condition is at least 20 cm away from the body of the user. Warning statement to the user for keeping at least 20cm separation distance and the prohibition of operating to a person has been printed on the user's manual. Therefore, the S of the device is calculated with R=20cm, and if it is below the limit S, then we can conclude the device complies with the rules.

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7 FCC MPE Limits

We analysis if it comply with the limits for General population/uncontrolled exposure. The FCC MPE limits for field strength and power density are given in 47CFR 1.1310(Table below). These limits are generally based on recommended exposure guidelines published by the National Council on Radiation Protection and Measurements (NCRP), and also partly based on guidelines recommended by the American National Standards Institute (ANSI) in Section 4.1 of ANSI/IEEE C95.1.

(A) 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 (minute)$\|E\|^2$,$\|H\|^2$ or S
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
(B) 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 (minute)$\|E\|^2$,$\|H\|^2$ or S
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	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	

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8 RF Exposure Evaluation (FCC)

8.1 Calculation of Power Density for Single Chain Transmitters

Mode	EIRP (dBm)	EIRP (mW)	R (cm)	S (mW/cm^2)	Limit (mW/cm^2)
2.4GHz Wi-Fi	23.69	233.88	20	0.0465	1.0
5GHz Wi-Fi	16.15	41.21	20	0.0082	1.0

Remark: The product also has multiple transmitters, the simultaneous transmit function is not supported.

8.2 Conclusion

According to the table above, the calculated power density S is below the limit value of 1 mW/cm^2, therefore, the product complies with the requirements.

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