RF Exposure Evaluation For FCC ID: 2AV7T-PDI

Refer user manual this device is a Puductor2 Robot, and this device was designed used in Mobile devices that the minimum distance between human's body is **20 cm.** Based on the 47CFR 2.1091, this device belongs to Mobile device. The definition of the category as following:

Mobile Derives:
CFR Title 47 §2.1091(b)
(b) For purposes of this section, a mobile device is defined 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 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.
FCC KDB 447498 D01 General RF Exposure Guidance v06 Limit

Devices operating in standalone mobile exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When the categorical exclusion provision of § 2.1091(c) applies, the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to FCC Part 1.1307, systems operating under the provisions of this section shall be operated in a manner the ensures that the public is not exposed to radio frequency energy level in excess of the commission's guidelines.

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)
0.3-1.34	614	1.63	(100)*
1.34-30	824/f	2.19/f	(180/f2)*
30-300	27.5	0.073	0.2
300-1500			f/1500
1500-100,000			1.0

MPE calculation formula

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = power density

P = output power (mW)

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

R = Separation distance between radiator and human body (cm)

Test Data

AP Module

Bluetooth				
Mode	BR+EDR			BLE
	GFSK	π/4-DQPSK	8-DPSK	GFSK
Peak Power (dBm)	**5.47**	3.74	4.35	4.45
Note: This report listed the worst case Peak Power value, please refer to Report No. BL-SZ2140589-601 & BL-SZ2140589-602 for more details.				

2.4G WIFI				
Mode	Main Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	**14.42**	14.30	14.17	14.39
Mode	Aux. Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	**13.51**	13.18	13.29	13.28
Mode	MIMO-Main Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	--	--	**11.36**	11.29
Mode	MIMO-Aux. Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	--	--	**10.88**	10.54
Mode	MIMO			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	--	--	**13.95**	13.94
Note: This report listed the worst case average power value, please refer to Report No. BL-SZ2140589-603 for more details.				

5.2G WIFI						
Mode	Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	15.33	**15.96**	15.47	**15.96**	15.55	14.65
Mode	Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	16.72	16.91	**17.70**	16.96	16.92	16.08
Mode	MIMO-Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	12.59	13.15	12.63	**13.32**	8.56
Mode	MIMO-Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	14.02	**14.33**	14.07	14.26	9.60
Mode	MIMO					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	16.31	16.79	16.28	**16.83**	12.12
Note: This report listed the worst case conducted power value, please refer to Report No. BL-SZ2140589-604 for more details.						

5.3G WIFI						
Mode	Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	15.11	15.03	15.65	15.04	**15.69**	14.90
Mode	Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	15.93	16.02	**16.80**	16.03	16.67	16.14
Mode	MIMO-Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	12.33	**13.27**	12.54	13.23	10.89
Mode	MIMO-Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	13.29	**13.71**	13.03	13.64	11.39
Mode	MIMO					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	15.85	**16.51**	15.80	16.45	14.16
Note: This report listed the worst case conducted power value, please refer to Report No. BL-SZ2140589-604 for more details.						

5.6G WIFI						
Mode	Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	15.00	15.58	16.49	15.69	**17.03**	15.65
Mode	Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	16.10	16.01	**17.93**	16.10	17.88	16.60
Mode	MIMO-Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	12.99	13.24	12.80	**13.48**	11.95
Mode	MIMO-Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	14.12	14.38	14.02	**14.62**	13.09
Mode	MIMO					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	16.60	16.86	16.46	**17.10**	15.57
Note: This report listed the worst case conducted power value, please refer to Report No. BL-SZ2140589-604 for more details.						

5.8G WIFI						
Mode	Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	16.80	16.85	17.40	16.67	**17.53**	16.65
Mode	Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	17.63	17.67	18.59	17.58	**18.62**	17.98
Mode	MIMO-Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	13.58	**14.61**	14.24	14.46	13.65
Mode	MIMO-Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	14.69	**15.57**	14.79	15.47	14.88
Mode	MIMO					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	17.18	**18.07**	17.53	18.00	17.32
Note: This report listed the worst case conducted power value, please refer to Report No. BL-SZ2140589-604 for more details.						

ESP Module

Bluetooth				
Mode	BR+EDR			BLE
	GFSK	π/4-DQPSK	8-DPSK	GFSK
Peak Power (dBm)	6.69	8.65	**9.04**	3.52
Note: This report listed the worst case Peak Power value, please refer to Report No. BL-SZ2140589-601 & BL-SZ2140589-602 for more details.				

2.4G WIFI				
Mode	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	**16.19**	15.46	15.35	16.14
Note: This report listed the worst case average power value, please refer to Report No. BL-SZ2140589-603 for more details.				

Turn-up power

AP Module

Mode		Range (dBm)
Bluetooth		2.00-5.50
2.4G WIFI	Main Antenna	10.00-14.50
	Aux. Antenna	10.00-14.00
	MIMO-Main Antenna	8.50-11.50
	MIMO-Aux. Antenna	8.50-11.00
	MIMO	11.50-14.50
5.2G WIFI	Main Antenna	13.00-16.00
	Aux. Antenna	15.50-18.00
	MIMO-Main Antenna	8.50-13.50
	MIMO-Aux. Antenna	9.50-14.50
	MIMO	12.00-17.00
5.3G WIFI	Main Antenna	12.00-16.00
	Aux. Antenna	13.50-17.00
	MIMO-Main Antenna	8.50-13.50
	MIMO-Aux. Antenna	9.00-14.00
	MIMO	12.00-17.00
5.6G WIFI	Main Antenna	10.50-17.50
	Aux. Antenna	10.50-18.00
	MIMO-Main Antenna	8.50-13.50
	MIMO-Aux. Antenna	10.00-15.00
	MIMO	12.50-17.50
5.8G WIFI	Main Antenna	16.00-18.00
	Aux. Antenna	17.00-19.00
	MIMO-Main Antenna	13.00-15.00
	MIMO-Aux. Antenna	14.00-16.00
	MIMO	16.50-18.50

ESP Module

Mode	Range (dBm)
Bluetooth	2.50-9.50
2.4G WIFI	14.50-16.50

Test result

AP Module

Evolution mode	Max. output power (dBm)	Antenna Gain (dBi)	Total Power (mw)	Distance (cm)	Limit of Power Density (mW/cm²)	Power Density (mW/cm²)	Power Density/Limit	Verdict
Bluetooth	5.50	1.88	5.470	20	1.00	0.001	0.001	Pass
2.4G WIFI	14.50	1.88	43.451	20	1.00	0.009	0.009	Pass
5.2G WIFI	18.00	3.11	129.122	20	1.00	0.026	0.026	Pass
5.3G WIFI	17.00	3.11	102.565	20	1.00	0.020	0.020	Pass
5.6G WIFI	18.00	3.11	129.122	20	1.00	0.026	0.026	Pass
5.8G WIFI	19.00	3.55	179.887	20	1.00	0.036	0.036	Pass

ESP Module

Evolution mode	Max. output power (dBm)	Antenna Gain (dBi)	Total Power (mw)	Distance (cm)	Limit of Power Density (mW/cm²)	Power Density (mW/cm²)	Power Density/Limit	Verdict
Bluetooth	9.50	1.88	13.740	20	1.00	0.003	0.003	Pass
2.4G WIFI	16.50	1.88	68.865	20	1.00	0.014	0.014	Pass

Collocated Power Density Calculation

AP Module

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth + 2.4G WIFI + 5G WIFI	Verdict
Bluetooth	2400 MHz ~ 2483.5 MHz	0.001	**0.046**	Pass
2.4G WIFI	2400 MHz ~ 2483.5 MHz	0.009		
5G WIFI	5725 MHz ~ 5850 MHz	0.036		

ESP Module

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth + 2.4G WIFI	Verdict
Bluetooth	2400 MHz ~ 2483.5 MHz	0.003	0.017	Pass
2.4G WIFI	2400 MHz ~ 2483.5 MHz	0.014		

Note:

1. Σ(Power Density / Limit): This is a summation of [(power density for each transmitter/ antenna included in the simultaneous transmission)/ (corresponding Power Density limit)], for Bluetooth + 2.4G WIFI + 5G WIFI.
2. Both of the Bluetooth/2.4GHz/5GHz can transmit simultaneously, the formula of calculated the Power Density is
   CPD1 / LPD1 + CPD2 / LPD2 + ……etc. < 1
   CPD = Calculation power density
   LPD = Limit of power density
3. The worst-case situation is 0.046, which is less than “1”. This confirmed that the device comply with Council Recommendation 199-519-EC Power Density limit.
4. More power list please refer to RF test report.

Conclusion:

RF exposure Evaluation Results: **Compliance**