

RF Exposure Evaluation For FCC ID: Z7RBVILLA

Refer user manual this device is a VILLA, and this device was designed used in Mobile devices that the minimum distance between human's body is **20cm**. 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/f ²)*
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

BLUETOOTH						
Mode	BT3.0					
	GFSK	π/4-DQPSK			8-DPSK	
Peak Power (dBm)	1.26	-4.73			-4.62	
Mode	BLE					
	Low Channel		Middle Channel		High Channel	
Peak Power (dBm)	-3.65		-3.62		-4.36	
WLAN						
Mode	2.4G					
	802.11b	802.11g	802.11n-20 MHz		802.11n-40 MHz	
Peak Power (dBm)	15.89	19.61	18.43		17.70	
Mode	5G					
	Band I (5150 - 5250 MHz)					
	11a	11n (HT20)	11n (HT40)	11ac (HT20)	11ac (HT40)	11ac (HT80)
Peak Power (dBm)	18.82	17.85	17.53	17.96	17.44	16.60
Mode	Band IV (5725 - 5850 MHz)					
	11a	11n (HT20)	11n (HT40)	11ac (HT20)	11ac (HT40)	11ac (HT80)
Peak Power (dBm)	19.65	18.90	18.93	18.89	19.04	18.09
Note						
1. This report listed the worst case peak power value, please refer to RF test report for more details.						
2. This product contain three antenna to support Bluetooth, 2.4G WiFi and 5G WiFi respectively.						
3. Bluetooth and WLAN (2.4G and 5G) antenna can't transmit simultaneously at same time.						
4. Only 2.4G WLAN and 5G WLAN can transmit simultaneously at same time.						

Turn-up power

Mode		Range (dBm)
GFSK		(-1.00) - (2.00)
π/4-DQPSK		(-6.00) - (-4.00)
8-DPSK		(-6.00) - (-4.00)
BLE		(-5.00) - (-3.00)
802.11b		13.50 - 16.50
802.11g		17.50 - 20.50
802.11n-20 MHz (2.4G)		15.50 - 19.00
802.11n-40 MHz (2.4G)		16.00 - 18.50
5G Band1	802.11a	17.00 -19.50
	802.11n (HT20)	16.00 - 18.50
	802.11n (HT40)	16.00 - 18.50
	802.11ac (HT20)	16.00 - 18.50
	802.11ac (HT40)	15.00 - 18.50

	802.11ac (HT80)	15.50 - 17.50
5G Band4	802.11a	17.00 - 19.50
	802.11n (HT20)	16.00 - 18.50
	802.11n (HT40)	16.00 - 18.50
	802.11ac (HT20)	16.50 - 18.50
	802.11ac (HT40)	15.00 - 18.00
	802.11ac (HT80)	15.50 - 17.50

Test result

Evolution mode	Maximum peak output power (dBm)	Antenna Gain (typical) (dBi):	Total Power (mw)	Distance (cm)	Limit of Power Density (mW/cm ²)	Power Density (mW/cm ²)	Verdict
BT3.0	2.00	0	1.58	20	1	0.003	Pass
BLE	-3.00	0	0.50	20	1	0.010	Pass
WLAN 2.4G	20.50	0	112.2	20	1	0.022	Pass
WLAN 5G Band 1	19.50	0	89.13	20	1	0.018	Pass
WLAN 5G Band 4	19.50	0	89.13	20	1	0.018	Pass

Collocated Power Density Calculation

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of WIFI 2.4GHz+WIFI 5GHz	Verdict
2.4G WIFI	2412MHz ~ 2462MHz	0.022	0.040	Pass
5G WIFI	5150MHz ~ 5850MHz	0.018		Pass

Note:

- Σ (Power Density / Limit): This is a summation of [(power density for each transmitter/ antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for WLAN 2.4GHz+WLAN 5GHz.
- Both of the 2.4GHz/5GHz can transmit simultaneously, the formula of calculated the MPE is $CPD1 / LPD1 + CPD2 / LPD2 + \dots \text{etc.} < 1$
CPD = Calculation power density
LPD = Limit of power density
- Both of the 5.2GHz WIFI and 5.8GHz WIFI can't transmit simultaneously at same time.
- The worst-case situation is 0.040, which is less than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.
- The VILLA work frequency range used is 2400 MHz ~ 2483.5 MHz, 5150 MHz~ 5250 MHz and 5725 MHz ~ 5850 MHz the result close to the limit by the above formula so, we select worst case

power to calculate the exclusion power threshold.

6. The VILLA Module work frequency range used is 2400 MHz ~ 2483.5 MHz, GHz the result close to the limit by the above formula, so we select 2402 MHz to calculate the exclusion power threshold.
7. More power list please refer to RF test report.

Conclusion:

RF exposure Evaluation Results: **Compliance**