

RF Exposure Evaluation for FCC ID: 2AFIW-B2200

Refer user manual this device is a Tri-band Wireless Gigabit Router, 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 that 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

ZigBee			
Mode	Low Channel	Middle Channel	High Channel
Peak Power (dBm)	12.97	9.96	7.40
Note: This report listed the worst case peak power value, please refer to RF test report for more details.			

Bluetooth			
Mode	BLE		
	Low Channel	Middle Channel	High Channel
Peak Power (dBm)	11.06	10.85	15.30
Note: This report listed the worst case peak power value, please refer to RF test report for more details.			

2.4G WIFI				
Mode	Main Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	20.95	19.71	19.74	19.85
Mode	Aux. Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	20.99	19.72	19.76	20.11
Mode	MIMO-Main Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	--	--	16.86	16.82
Mode	MIMO-Aux. Antenna			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	--	--	16.93	16.81
Mode	MIMO			
	802.11b	802.11g	802.11n20	802.11n40
Average Power (dBm)	--	--	19.91	19.83
Note: This report listed the worst case average power value, please refer to RF test report for more details.				

5G WIFI						
Band 1						
Mode	Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	20.12	19.96	19.93	20.07	19.72	12.07
Mode	Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	20.12	19.66	19.88	19.68	19.93	16.58
Mode	MIMO-Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	16.98	16.90	16.94	16.84	10.28
Mode	MIMO-Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	16.96	17.08	16.66	17.08	10.18
Mode	MIMO					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	19.82	20.00	19.80	19.97	13.24
Band 3						
Mode	Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	20.00	20.08	19.91	20.07	20.04	17.35
Mode	Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	17.54	20.03	19.93	20.05	19.96	11.89
Mode	MIMO-Main Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	17.07	16.90	17.03	16.92	12.00
Mode	MIMO-Aux. Antenna					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	17.00	17.03	17.07	16.92	10.55
Mode	MIMO					
	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Conducted Power (dBm)	--	20.05	19.98	19.98	19.93	14.35
Note: This report listed the worst case conducted power value, please refer to RF test report for more details.						

Turn-up power

Mode		Range (dBm)	
ZigBee		7.00-13.00	
Bluetooth		10.00-16.00	
2.4G WIFI	Main Antenna	8.00-21.00	
	Aux. Antenna	12.00-21.00	
	MIMO-Main Antenna	8.00-17.00	
	MIMO-Aux. Antenna	8.00-17.00	
	MIMO	11.00-20.00	
5G WIFI	Band 1	Main Antenna	12.00-21.00
		Aux. Antenna	15.00-21.00
		MIMO-Main Antenna	10.00-17.00
		MIMO-Aux. Antenna	10.00-18.00
		MIMO	13.00-20.00
	Band 3	Main Antenna	17.00-21.00
		Aux. Antenna	9.00-21.00
		MIMO-Main Antenna	9.00-18.00
		MIMO-Aux. Antenna	8.00-18.00
		MIMO	12.00-21.00

Test result

Evolution mode	Maximum output power (dBm)	Antenna Gain (typical) (dBi):	Total Power (mw)	Distance (cm)	Limit of Power Density (mW/cm ²)	Power Density (mW/cm ²)	Power Density/Limit	Verdict
ZigBee	13.00	5.0	63.10	20	1	0.013	0.013	Pass
Bluetooth	16.00	2.0	63.10	20	1	0.013	0.013	Pass
2.4G WIFI	21.00	3.0	251.19	20	1	0.050	0.050	Pass
5G WIFI	Band 1	21.00	501.19	20	1	0.100	0.100	Pass
	Band 3	21.00	501.19	20	1	0.100	0.100	Pass

Collocated Power Density Calculation

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth + ZigBee + 2.4G WIFI + 5G WIFI	Verdict
ZigBee	2400 MHz ~ 2483.5 MHz	0.013	0.176	Pass
Bluetooth	2400 MHz ~ 2483.5 MHz	0.013		Pass
2.4G WIFI	2400 MHz ~ 2483.5 MHz	0.050		Pass
5.2G WIFI	5150 MHz ~ 5250 MHz	0.100		Pass

Note:

1. Σ (Power Density / Limit): This is a summation of [(power density for each transmitter/ antenna included in the simultaneous transmission)/ (corresponding MPE limit)], for Bluetooth + ZigBee + 2.4G WIFI + 5G WIFI.
2. Both of the 2.4GHz/5GHz can transmit simultaneously, the formula of calculated the MPE is $CPD1 / LPD1 + CPD2 / LPD2 + \dots$.etc. < 1
CPD = Calculation power density
LPD = Limit of power density
3. The worst-case situation is 0.176, which is less than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.
4. The Tri-band Wireless Gigabit Router work frequency range used is 2400 MHz ~ 2483.5 MHz and 5150 MHz ~ 5250 MHz the result close to the limit by the above formula so, we select worst case power to calculate the exclusion power threshold.
5. More power list please refer to RF test report.

Conclusion:

RF exposure Evaluation Results: **Compliance**