

RF Exposure Evaluation For FCC ID: 2AKWS-TXSERIES

Refer user manual this device is a Smart Projector, 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

BLUETOOTH 3.0			
Mode	GFSK	π/4-DQPSK	8-DPSK
Peak Power (dBm)	5.55	4.80	5.01
BLE			
Mode	Low Channel	Middle Channel	High Channel
Peak Power (dBm)	-0.68	0.64	0.30

Antenna 0

2.4G WIFI			
Mode	Antenna Gain	802.11b	802.11g
Peak Power (dBm)	0	21.61	21.99
5150 MHz ~ 5725 MHz			
Mode	Antenna Gain	802.11a	
Peak Power (dBm)	0	16.76	
5725 MHz ~ 5850 MHz			
Mode	Antenna Gain	802.11a	
Peak Power (dBm)	0	13.05	

Note: This report listed the worst case peak power value, please refer to RF test report for more details.

Antenna 1

2.4G WIFI			
Mode	Antenna Gain	802.11b	802.11g
Peak Power (dBm)	0	21.33	20.11
5150 MHz ~ 5725 MHz			
Mode	Antenna Gain	802.11a	
Peak Power (dBm)	0	15.46	
5725 MHz ~ 5850 MHz			
Mode	Antenna Gain	802.11a	
Peak Power (dBm)	0	12.45	
Note: This report listed the worst case peak power value, please refer to RF test report for more details.			

Antenna 0+ Antenna 1

2.4G WIFI					
Mode	Antenna Gain	802.11n20		802.11n40	
Peak Power (dBm)	0	24.97		24.75	
5G WIFI					
Mode	Antenna Gain	5150 MHz ~ 5725 MHz		5725 MHz ~ 5850 MHz	
		802.11n20	802.11n40	802.11n20	802.11n40
Conducted Power (dBm)	0	18.46	18.16	12.34	11.10
Note: This report listed the worst case peak power value, please refer to RF test report for more details.					

Test Configuration

Mode	Antenna		
	Antenna 0	Antenna 1	Antenna 0 + Antenna1
802.11a	√	√	-
802.11b	√	√	-
802.11g	√	√	-
802.11n20	√	√	√
802.11n40	√	√	√
Note 1: The 802.11a, 802.11b and 802.11g only support single antenna launch.			
Note 2: The 802.11n20 and 802.11n40 support double antennas launch.			

Turn-up power

Mode	Range (dBm)
Bluetooth 3.0	3.10-6.00
Bluetooth 4.0	(-1.00)-1.10
2.4G WIFI(802.11g Antenna 0)	21.30-22.50
2.4G WIFI(MIMO)	24.20-25.50
5150 MHz ~ 5725 MHz(802.11a Antenna 0)	15.00-17.30
5725 MHz ~ 5850 MHz (802.11a Antenna 0)	12.00-13.50
5150 MHz ~ 5725 MHz(802.11n20 MIMO)	18.00-19.00
5725 MHz ~ 5850 MHz (802.11n20 MIMO)	11.00-12.80

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
Bluetooth 3.0	6.00	0	3.98	20	1	7.918*10 ⁻⁴	Pass
2.4GWIFI(802.11g Antenna 0)	22.50	0	177.83	20	1	0.035	Pass
2.4G WIFI (MIMO)	25.50	0	354.81	20	1	0.071	Pass
5150 MHz ~ 5725 MHz(802.11a Antenna 0)	17.30	0	53.70	20	1	0.011	Pass
5725 MHz ~ 5850 MHz (802.11a Antenna 0)	13.50	0	22.39	20	1	0.004	Pass
5150 MHz ~ 5725 MHz(802.11n20 MIMO)	19.00	0	79.43	20	1	0.016	Pass
5725 MHz ~ 5850 MHz (802.11n20 MIMO)	12.80	0	19.05	20	1	0.004	Pass

Collocated Power Density Calculation

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth 3.0+WIFI 2.4GHz	Verdict
Bluetooth 3.0	2400MHz ~ 2483.5MHz	7.918*10 ⁻⁴	0.036	Pass
2.4GWIFI(802.11g Antenna 0)	2412MHz ~ 2462MHz	0.035		Pass

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth 3.0+WIFI 5.2GHz	Verdict
Bluetooth 3.0	2400MHz ~ 2483.5MHz	7.918×10^{-4}	0.012	Pass
5150 MHz ~ 5725 MHz(802.11a Antenna 0)	5150 MHz ~ 5725 MHz	0.011		Pass
Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth 3.0+WIFI 5.8GHz	Verdict
Bluetooth 3.0	2400MHz ~ 2483.5MHz	7.918×10^{-4}	0.005	Pass
5725 MHz ~ 5850 MHz(802.11a Antenna 0)	5725 MHz ~ 5850 MHz	0.004		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 WLAN 2.4GHz+WLAN 5GHz.
- Both of the 2.4GHz/5GHz can transmit simultaneously, the formula of calculated the MPE is $CPD1 / LPD1 + CPD2 / LPD2 + \dots$.etc. < 1
CPD = Calculation power density
LPD = Limit of power density
- Both of the 5GHz WIFI and 2.4GHz WIFI can't transmit simultaneously at same time.
The 5GHz WIFI (MIMO) or 2.4GHz WIFI (MIMO) and Bluetooth can't transmit simultaneously at same time.
The 5GHz WIFI or 2.4GHz WIFI and Bluetooth can transmit simultaneously at same time.
- The worst-case situation is 0.036, which is less than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.
- The Smart Projector work frequency range used are 2400 MHz ~ 2483.5 MHz, 5150 MHz ~ 5725 MHz and 5725 MHz ~ 5850 MHz the result close to the limit by the above formula.
- More power list please refer to RF test report.

Conclusion:

According to 47 CFR §2.1091, the RF exposure analysis concludes that the RF Exposure is FCC compliant.