RF Exposure Evaluation For FCC ID: SMC-M61

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 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)

Antenna Configuration

Mode	Antenna			
	Antenna 1	Antenna 2	Antenna 3	Antenna 1 + Antenna 2
Bluetooth	√	√	√	-
802.11a	√	√	-	-
802.11b	√	√	-	-
802.11g	√	√	-	-
802.11n20	√	√	-	-
802.11n40	√	√	-	-
802.11ac	√	√	-	-

Note:

1. The product contains two RF modules(**F21AUUM13-W2 and BT8633**).

2. F21AUUM13-W2 module:

Supports IEEE 802.11 a/b/g/n/ac(1TX/1RX) and Bluetooth.

Supports two transmit chains which marked as ANT1 and ANT2 for testing in the report.

Both ANT 1 and ANT 2 support transmit and receive functions of IEEE 802.11 a/b/g/n/ac , but only one of them will be used at one time.

Both ANT 1 and ANT 2 support transmit and receive functions of Bluetooth , but only one of them will be used at one time.

3. BT8633 module:

Only supports Bluetooth.

Supports one transmit chain which marked as ANT 3 in the report.

4. Bluetooth (ANT1), Bluetooth (ANT2) and Bluetooth (ANT3) can't transmit simultaneously;

5. IEEE 802.11 a/b/g/n/ac (ANT1) and IEEE 802.11 a/b/g/n/ac (ANT2) can't transmit simultaneously;

6. Bluetooth (ANT1 or ANT2) and IEEE 802.11 a/b/g/n/ac can transmit simultaneously;

Test data

Bluetooth				
Mode	BR/EDR			BLE
	GFSK	Π/4-DQPSK	8-DPSK	GFSK
Peak Power (dBm) (ANT1)	7.91	9.17	9.66	8.94
Peak Power (dBm) (ANT2)	6.35	7.65	8.16	8.65
Peak Power (dBm) (ANT3)	3.31	2.53	2.88	3.47
Note: This report listed the worst case peak power value, please refer to RF test report for more details.				

2.4G WIFI				
Mode	802.11b	802.11g	802.11n20	802.11n40
Peak Power (dBm) (ANT1)	16.52	21.38	20.78	20.22
Peak Power (dBm) (ANT2)	16.26	21.03	20.49	19.91
Note: This report listed the worst case peak power value, please refer to RF test report for more details.				

5.2G WIFI (5150 - 5250 MHz)						
Mode	802.11a	802.11n20	802.11n40	802.11ac20	802.11ac40	802.11ac80
Peak Power (dBm) (ANT1)	9.78	9.71	9.73	9.38	9.74	7.55
Peak Power (dBm) (ANT2)	9.80	9.96	9.55	9.88	9.71	7.37
Note: This report listed the worst case peak power value, please refer to RF test report for more details.						

5.8G WIFI (5725 - 5850 MHz)						
Mode	802.11a	802.11n20	802.11n20	802.11ac20	802.11ac40	802.11ac80
Peak Power (dBm) (ANT1)	13.33	12.90	13.10	12.86	13.34	11.17
Peak Power (dBm) (ANT2)	13.20	13.32	13.31	13.18	12.93	10.65
Note: This report listed the worst case peak power value, please refer to RF test report for more details.						

Turn-up power

Mode		Range (dBm)
Bluetooth (ANT1)	GFSK	7.00-8.00
	Π/4-DQPSK	8.00-10.00
	8-DPSK	9.00-10.00
	BLE(GFSK)	8.00-9.00
Bluetooth (ANT2)	GFSK	5.00-7.00
	Π/4-DQPSK	6.00-8.00
	8-DPSK	7.00-9.00
	BLE(GFSK)	8.00-9.00
Bluetooth (ANT3)	GFSK	0.00-4.00
	Π/4-DQPSK	-1.00-3.00
	8-DPSK	-1.00-3.00

	BLE(GFSK)	0.00-4.00
	802.11b	15.00-17.00
2.4G WIFI (ANT1)	802.11g	19.00-22.00
	802.11n20	19.00-21.00
	802.11n40	19.00-21.00
	802.11b	15.00-17.00
2.4G WIFI (ANT2)	802.11g	19.00-22.00
	802.11n20	19.00-21.00
	802.11n40	18.00-20.00
	802.11a	7.00-10.00
	802.11n20	8.00-10.00
5.2G WIFI (ANT1)	802.11n40	7.00-10.00
	802.11ac20	7.00-10.00
	802.11ac40	7.00-10.00
	802.11ac80	7.00-8.00
	802.11a	7.00-10.00
	802.11n20	8.00-10.00
5.2G WIFI (ANT2)	802.11n40	8.00-10.00
	802.11ac20	7.00-10.00
	802.11ac40	8.00-10.00
	802.11ac80	7.00-8.00
	802.11a	11.00-14.00
	802.11n20	11.00-13.00
5.8G WIFI (ANT1)	802.11n40	10.00-14.00
	802.11ac20	11.00-13.00
	802.11ac40	10.00-14.00
	802.11ac80	11.00-12.00
	802.11a	11.00-14.00
	802.11n20	10.00-14.00
5.8G WIFI (ANT2)	802.11n40	10.00-14.00
	802.11ac20	10.00-14.00
	802.11ac40	10.00-13.00
	802.11ac80	10.00-11.00

Test result

Evolution mode	Maximum peak output power （dBm）	Antenna Gain (typical) (dBi):	Total Power (mw)	Distance (cm)	Limit of Power Density (mW/cm²)	Power Density (mW/cm²)	Verdict
Bluetooth (ANT1)	10.00	2.41	17.42	20	1.0	0.003	Pass
Bluetooth (ANT2)	9.00	2.53	14.22	20	1.0	0.003	Pass
Bluetooth (ANT3)	4.00	2.50	4.47	20	1.0	0.001	Pass
2.4G WIFI (ANT1)	22.00	2.41	276.06	20	1.0	0.055	Pass
2.4G WIFI (ANT2)	22.00	2.53	283.79	20	1.0	0.056	Pass

5.2G WIFI (ANT1)	10.00	4.00	25.12	20	1.0	0.005	Pass
5.2G WIFI (ANT2)	10.00	3.50	22.39	20	1.0	0.004	Pass
5.8G WIFI (ANT1)	14.00	4.00	63.10	20	1.0	0.013	Pass
5.8G WIFI (ANT2)	14.00	3.50	56.23	20	1.0	0.011	Pass

Collocated Power Density Calculation

Evolution mode	Frequency(MHz)	Power Density/Limit	Σ (Power Density / Limit) of Bluetooth +WIFI (2.4G/ 5.2G/ 5.8G)	Verdict
Bluetooth (ANT1)	2400MHz ~ 2483.5MHz	0.003	**0.059**	Pass
2.4G WIFI (ANT2)	2412MHz ~ 2462MHz	0.056		Pass
Bluetooth (ANT1)	2400MHz ~ 2483.5MHz	0.003	0.007	Pass
5.2G WIFI (ANT2)	5150MHz ~ 5250MHz	0.004		Pass
Bluetooth (ANT1)	2400MHz ~ 2483.5MHz	0.003	0.014	Pass
5.8G WIFI (ANT2)	5725MHz ~ 5850MHz	0.011		Pass
Bluetooth (ANT2)	2400MHz ~ 2483.5MHz	0.003	0.058	Pass
2.4G WIFI (ANT1)	2412MHz ~ 2462MHz	0.055		Pass
Bluetooth (ANT2)	2400MHz ~ 2483.5MHz	0.003	0.008	Pass
5.2G WIFI (ANT1)	5150MHz ~ 5250MHz	0.005		Pass
Bluetooth (ANT2)	2400MHz ~ 2483.5MHz	0.003	0.014	Pass
5.8G WIFI (ANT1)	5725MHz ~ 5850MHz	0.011		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 (ANT1) +2.4G WIFI(ANT2), Bluetooth(ANT1)+ 5.2G(ANT2) or 5.8G WIFI(ANT2), and Bluetooth (ANT2) +2.4G WIFI(ANT1), Bluetooth(ANT2) + 5.2G (ANT1)or 5.8G WIFI(ANT1).

2. Bluetooth (ANT1) and WLAN (ANT2) or Bluetooth (ANT2) and WLAN (ANT1) can transmit simultaneously, the formula of calculated the MPE is
    CPD1 / LPD1 + CPD2 / LPD2 + ……etc. < 1
    CPD = Calculation power density
    LPD = Limit of power density

3. Both of the WIF I(ANT1) and WIFI (ANT 2) can't transmit simultaneously at same time.

4. The worst-case situation is 0.059, which is less than "1". This confirmed that the device comply with FCC 1.1310 MPE limit.

5. The Smart Projector work frequency range used is 2400MHz ~ 2483.5MHz, 2412MHz ~ 2462MHz, 5150MHz ~ 5250MHz and 5725MHz ~ 5850MHz the result close to the limit by the above formula so, we select worst case power to calculate the exclusion power threshold.

6. More power list please refer to RF test report.

Conclusion:

RF exposure Evaluation Results: **Compliance**