



MPE Calculation

Applicant:	SHINING 3D Tech. Co., Ltd.
Address:	No.1398, Xiangbin Road, Wenyan, Xiaoshan, Hangzhou, Zhejiang, China
Product:	3D Printer
FCC ID:	2AMG4-CEL
Model No.:	AccuFab-CEL
Reference RF report #	709502306120-00A; 709502306120-00B, 709502306120-00D

According to subpart 15.247(i) and subpart §1.1307(b)(1), 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 Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1,500	/	/	f/1500	30
1,500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4 \pi R^2$ = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data: FPC Antenna



For 2.4GHz Wi-Fi (Report number: 709502306120-00A) Antenna1:

Maximum peak output power at antenna input terminal (dBm):	21.79
Maximum peak output power at antenna input terminal (mW):	151.01
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	5.39
Maximum Antenna Gain (numeric):	3.46
The worst case is power density at predication frequency at 20 cm (mW/cm ²):	0.1039
MPE limit for general population exposure at prediction frequency (mW/cm ²):	1.00

For 2.4GHz Wi-Fi (Report number: 709502306120-00A) Antenna2:

Maximum peak output power at antenna input terminal (dBm):	21.76
Maximum peak output power at antenna input terminal (mW):	149.97
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	3.23
Maximum Antenna Gain (numeric):	2.1
The worst case is power density at predication frequency at 20 cm (mW/cm ²):	0.0628
MPE limit for general population exposure at prediction frequency (mW/cm ²):	1.00

The max power density 0.1667 (mW/cm²) < 1 (mW/cm²)

Result: Compliant

For 5GHz Wi-Fi (Report number: 709502306120-00B) Antenna 1

Maximum peak output power at antenna input terminal (dBm):	13.79
Maximum peak output power at antenna input terminal (mW):	23.93
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	4.3
Maximum Antenna Gain (numeric):	2.69
The worst case is power density at predication frequency at 20 cm (mW/cm ²):	0.0128
MPE limit for general population exposure at prediction frequency (mW/cm ²):	1.00



For 5GHz Wi-Fi (Report number: 709502306120-00B) Antenna 2

Maximum peak output power at antenna input terminal (dBm):	13.74
Maximum peak output power at antenna input terminal (mW):	23.66
Prediction distance (cm):	20
Antenna Gain, typical (dBi):	5.72
Maximum Antenna Gain (numeric):	3.73
The worst case is power density at predication frequency at 20 cm (mW/cm ²):	0.0176
MPE limit for general population exposure at prediction frequency (mW/cm ²):	1.00

The max power density 0.0304 (mW/cm²) < 1 (mW/cm²)

Result: Compliant

For 13.56MHz NFC (Report number: 709502306120-00D)

Calculation method for 13.56MHz

Per the test report included herein, for 13.56MHz

According to C63.10 Annex G

$$\text{EIRP} = \text{pt} \times \text{gt} = (\text{E} \times \text{d})^2 / 30$$

where

pt is the transmitter output power in watts

gt is the numeric gain of the transmitting antenna (dimensionless)

E is the electric field strength in V/m

d is the measurement distance in meters (m)

transmitter output power for 433.92MHz Function

Field strength (E):	33.4 (dBuV/m) = 0.00005 (V/m)
Measurement Distance(dMeas):	3 (m)
Equivalent Isotropically Radiated Power(EIRP):	0.0000007mW

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = \text{PG} / 4 \pi R^2 =$ power density (in appropriate units, e.g. mW/cm²);

PG = 0.115248mW (in appropriate units, e.g., mW);

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

The max power density $0.0000007 / 4 \pi R^2 = 1.3926 \times 10^{-9} (\text{mW/cm}^2) < 0.97893 (\text{mW/cm}^2)$

Result: Compliant



Simultaneous transmission of MPE test exclusion for worst case configuration

2.4GHz Wi-Fi: the ratio is 0.1667/1

5GHz Wi-Fi: the ratio is 0.0304/1

13.56MHz: the ratio is $1.3926 \times 10^{-9} / 0.97893 = 1.423 \times 10^{-9}$

The sum of the MPE ratios for all simultaneous transmitting antennas:

$0.1667 + 0.0304 + 1.423 \times 10^{-9} = 0.1971$

As the sum of MPE ratios for all simultaneous transmitting antennas is ≤ 1.0 , simultaneous transmission MPE test exclusion will be applied.

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

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