

Exposure of humans to RF fields

As per FCC KDB 447498 D01 and Section 2.1091 radio frequency transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels.

Calculations have been made using the General Public/Uncontrolled Exposure limits that are defined in Section 1.1310.

Minimum safe distances have been calculated below.

$$\text{Power density, mW/cm}^2 = E^2/3770$$

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)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500			F/1500	30
1500-100,000			1.0	30

Note 1: f = frequency in MHz ; *Plane-wave equivalent power density
Note 2: For the applicable limit, see FCC 1.1310

- General Population / Uncontrolled exposure is (f/1500) mW/cm²

As this radio can operate over the range of 406.9 to 480.0 MHz the lowest frequency of operation which will give the worst case result, would be 406.9 MHz.

The power density at 406.900 MHz comes out to be 0.271 mW/cm².

For Uncontrolled Environment

$$\text{Power Density} = 0.271 \text{ mW/cm}^2 = E^2/3770$$

$$E = \sqrt{0.271 \times 3770}$$

$$E = 31.9 \text{ V/m}$$

The rated maximum transmitter power = 5 watts (+37 dBm).

A duty cycle (DC) of 50% (0.5) has been applied as the device uses source based 50% TDMA which relates to the carrier duty cycle.

The client has declared that this transmitter can be operated using a non-directional antenna with a gain of 0 dBd or a directional antenna with a gain of up to 6 dBd.

Calculations of the safe distance for these types of antenna are detailed as below.

The minimum distance from the antenna at which the MPE is met is calculated from the following

Field strength in V/m (E),
Transmit power in watts (P)
Transmit antenna gain (G)
Transmitter duty cycle (DC)
Separation distance in metres (D)

The calculation is as follows:

$$D = \sqrt{(30 * P * G * DC) / E}$$

A sample calculation for the safe distance would be:

$$D = \sqrt{(30 * P * G * DC) / E}$$

$$D = \sqrt{(30 * 32.73 * 0.5) / 31.9}$$

$$D = 0.69 \text{ metres or } 69 \text{ cm}$$

Antenna Gain (dBd)	Max Gain (dBi)	Tx Power (dBm)	EIRP (dBm)	EIRP (Watts)	E Limit (V/m)	Safe Distance (metres)
0.0	2.15	37.0	39.15	8.22	31.9	0.34
6.0	8.15	37.0	45.15	32.73	31.9	0.69

Result: Complies if the safe distances defined for this environment is applied.