**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.

For MPE calculations, 960.000 MHz has been selected.

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm²) | Averaging time (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Controlled Exposure** | | | | |
| 0.3–3.0 | 614 | 1.63 | *100 | 6 |
| 3.0–30 | 1842/f | 4.89/f | *900/f² | 6 |
| 30–300 | 61.4 | 0.163 | 1.0 | 6 |
| 300–1,500 | ........................ | ........................ | f/300 | 6 |
| 1,500–100,000 | ........................ | ........................ | 5 | 6 |
| **(B) Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3–1.34 | 614 | 1.63 | *100 | 30 |
| 1.34–30 | 824/f | 2.19/f | *180/f² | 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

**Limits for maximum permissible exposure (MPE)**

- General Population / Uncontrolled exposure is f/1500. At 928.000 MHz, the calculated limit is 0.62 $mW/cm^2$

- Occupational /Controlled exposure is f/300. At 928.000 MHz, the calculated limit is 3.10 $mW/cm^2$

Minimum safe distances have been calculated below.

**For Uncontrolled Environment**

At 928.000 MHz, Power Density = 0.62 $mW/cm^2 = E^2/3770$

$E = \sqrt{0.62*3770}$

E = 49.3 V/m

**For Controlled Environment**

At 960.000 MHz, Power Density = 3.10 $mW/cm^2 = E^2/3770$

$E = \sqrt{3.10*3770}$

E = 108.1 V/m

The rated maximum transmitter power = 0.25 W (+24 dBm).

A worst case scenario duty cycle of 100% has been used for the calculations.

Shown below is the typical list of antennas (Information supplied by the client) that would be used with the product:

| | |
|---|---|
| Dual Polarized Omni-Directional Antenna | 8dBi, 2xN Female |
| Dual Polarized Compact Panel Antenna | 8dBi, 2xN Female |
| Dual Polarized, MIMO Directional Panel Antenna | 9dBi, 2xN Female |
| Compact Panel Antenna | 9dBi, 2xN Female / 2x4.3-10 Female |
| Compact Panel Antenna | 11dBi, 2xN Female / 2x4.3-10 Female |
| MIMO Low Profile Panel Antenna | 12dBi, 2xN Female |
| MIMO Panel Antenna | 16dBi, 2xN Female / 2x4.3-10 Female |
| MIMO Yagi Antenna (with optional Radome available) | 12dBi, 2xN Female |
| MIMO Yagi Antenna (with optional Radome available) | 15dBi, 2xN Female |

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

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

The calculation is as follows:

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

The calculations have been shown with following scenarios:

- MPE calculations for the product with both ports terminated in a 50 Ohm load
- Using 8 dBi gain antenna
- Using 9 dBi gain antenna
- Using 11 dBi gain antenna
- Using 12 dBi gain antenna
- Using 15 dBi gain antenna
- Using 16 dBi gain antenna

a) For Uncontrolled environments, the minimum distance is:

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

$P = 0.25$ W

$FS = E = 49.3$ V/m

| Frequency (MHz) | Antenna Gain (dBi) | Antenna Gain Numeric | Duty cycle | Safe distance (metres) |
|---|---|---|---|---|
| 928.000 | No gain (0) | 1.0 | 100% | 0.06 |
| | 8.0 | 6.3 | 100% | 0.14 |
| | 9.0 | 7.9 | 100% | 0.16 |
| | 11.0 | 12.6 | 100% | 0.20 |
| | 12.0 | 15.8 | 100% | 0.22 |
| | 15.0 | 31.6 | 100% | 0.31 |
| | 16.0 | 39.8 | 100% | 0.35 |

a) For Controlled environments, the minimum distance is:

D = (√ (30 * P * G * DC)) / FS

P = 0.25 W

FS = E = 108.1 V/m

| Frequency (MHz) | Antenna Gain (dBi) | Antenna Gain Numeric | Duty cycle | Safe distance (metres) |
|---|---|---|---|---|
| 928.000 | No gain (0) | 1.0 | 100% | 0.02 |
| | 8.0 | 6.3 | 100% | 0.06 |
| | 9.0 | 7.9 | 100% | 0.07 |
| | 11.0 | 12.6 | 100% | 0.09 |
| | 12.0 | 15.8 | 100% | 0.10 |
| | 15.0 | 31.6 | 100% | 0.14 |
| | 16.0 | 39.8 | 100% | 0.16 |

**Result:** Complies if a safe distance shown in the calculations above is followed.