RF Exposure Info / MPE Sample Calculation

Model: ION-E OAPL 17E/17E/23/23 C-PE-F1
FCC-ID: XS5-OAPL17E23

The ION-E is a unified wireless infrastructure platform defined around IT based architecture. It brings together licensed wireless and power, plus Gigabit Ethernet for WiFi into one wireless system that can scale to building size and is technology and spectrum agnostic and adaptive.

A basic ION-E system comprises the following main components.
•Central Area Node (CAN)—provides server-level control and primary signal distribution. 2U and 4U subrack options are available.
•Transport Expansion Node (TEN)—connects to a CAN using Multi-Mode or Single-Mode fiber as a secondary distribution point. 2U and 4U subrack options are available.
•Access Point—connects CAN/TEN to antennas or other wireless devices, and can be any of the following.

–Universal Access Point (UAP)—connects the CAN/TEN to an internal antenna; receives data and power through Category 6A twisted pair cabling. Supports Gigabit Ethernet for WiFi, IP cameras, or other devices in addition to wireless over a common cable.

–UAP-X—connects the CAN/TEN to an external antenna; otherwise functions the same as the standard UAP.

–Carrier Access Point, Low Power (CAP L)—interfaces with the CAN/TEN via a CAT 6A cable, or via an optical link. On the downlink, the CAP L converts some or all of the data arriving at the CAP L to analog signals and sends them to the an antenna. On the uplink, received signals are digitized and serialized into data streams which are sent back to the CAN/TEN. Each CAP L contains up to four transceiver paths for RF coverage.

The specific device generally will be <u>professionally</u> installed.
Hereby the gain of the finally installed antenna(s), cable attenuation and antenna height will be defined site specific at the time of licensing with the appropriate FCC Bureau(s).

The maximum permissible exposure limit is defined in **47 CFR 1.1310 (B).**

S = power density limit [W/m]
P = power [W]
R = distance [m]

$S_n = \frac{P_n G_n}{4\pi R_n^{\,2}}$ => $R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$ (to calculate the distance at one frequency)

If we have more bands, than we have to calculated as a percentage:
The additional of the terms have to be lower than 1.

$$\frac{S_{cal1}}{S_1} + \frac{S_{cal2}}{S_2} + \frac{S_{cal3}}{S_3} + ... + \frac{S_{caln}}{S_n} < 1$$

$$\frac{\frac{P_1 G_1}{4\pi R_1^{\,2}}}{S_1} + \frac{\frac{P_2 G_2}{4\pi R_2^{\,2}}}{S_2} + \frac{\frac{P_3 G_3}{4\pi R_3^{\,2}}}{S_3} + ... + \frac{\frac{P_n G_n}{4\pi R_n^{\,2}}}{S_n} < 1$$

We are looking for a distance of ensures that the formula is satisfied.

$R_1 = R_2 = R_3 = ... = R_n$

$$\frac{P_1 G_1}{4\pi R^2 S_1} + \frac{P_2 G_2}{4\pi R^2 S_2} + \frac{P_3 G_3}{4\pi R^2 S_3} + ... + \frac{P_n G_n}{4\pi R^2 S_n} < 1$$

$$\frac{P_1 G_1}{4\pi S_1} + \frac{P_2 G_2}{4\pi S_2} + \frac{P_3 G_3}{4\pi S_3} + ... + \frac{P_n G_n}{4\pi S_n} < R^2$$

$$\sqrt{\frac{P_1 G_1}{4\pi S_1} + \frac{P_2 G_2}{4\pi S_2} + \frac{P_3 G_3}{4\pi S_3} + ... + \frac{P_n G_n}{4\pi S_n}} < R$$

With $R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$ => $R_n^{\,2} = \frac{P_n G_n}{4\pi S_n}$

$$\sqrt{R_1^{\,2} + R_2^{\,2} + R_3^{\,2} + ... + R_n^{\,2}} < R$$

What you have to do for calculate the minimum distance were the power density limit is met:

1) If you have **one path**, you have to put you special values in the following formula.

$$R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$$ (Distance for one carrier)

Limits for General Population / Uncontrolled Exposures

Frequency Range (MHz)	Power Density (mW/cm^2)
300 – 1500	S = f/1500
1550 – 100,000	S = 1

2) If you have **more than one path**, you must add the individual terms quadratic.

$$R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$$ (Distance for individual carrier)

$$\sqrt{R_1^2 + R_2^2 + R_3^2 + \ldots + R_n^2} < R$$ (See previous page)

For example:

The EUT operates in the 2 frequency bands (see table):

Calculation for every path with maximum allowed antenna gain and without cable loss:

Frequency [MHz]	Max Power out [dBm]	Max. allowed antenna gain, **without** cable loss [dBi]	Max. Distance [m]
2110 - 2180	21	9	0,0282
2350 - 2360	20	9	0,0251

The worst case would be if all bands were active:

$$\sqrt{R_1^2 + R_2^2 + R_3^2 + \ldots + R_n^2} < R$$

$R_{all} > 0.038$ m (see previous page for derivation)

For more accurate calculation, the cable loss and actual antenna gain have to be included in the finally system.

The antenna(s) used with device must be fixed-mounted on permanent structures with a distance to any human body to comply with the RF Exposure limit.