RF Exposure Info / MPE Sample Calculation

Model: ION-U EU H 23/23

The ION-U is an optical fiber based DAS system that efficiently takes the outputs of multiple Base Transceiver Stations (BTS) sectors and converts those RF signals to optical to send them over fiber optic cables to Remote Units to provide coverage in indoor and outdoor locations. The system supports both low power and high power Remote Units and SISO and MIMO operation.

The ION-U EU H 23/23 is a SISO or MIMO Extension Unit used in conjunction with a Remote Unit in the ION optical distribution system. This system transports up to two frequency bands simultaneously (WCS2300 MHz), providing a cost-effective solution for distributing capacity from one or more base stations.

It has been specifically tested and optimized for UMTS, HSPA+, LTE, and OFDM modulations. Furthermore it is provisioned for future modulation scheme evolutions.

These Remote and Extension Units feature independent downlink and uplink gain adjustments and an integrated channel power detector for in-band spectrum and PIM analysis and end-to-end auto leveling.

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/cm²)
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)

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

For example:

The EUT has one frequency band: 2350 – 2360 MHz

The max measured conducted output power is 42.0 dBm.

Frequency [MHz]	Max Power out [dBm]	Antenna gain f.e.[dBi]	Max. Distance [m]
2355	45	9	1.414

The worst case would be if all bands were active (MIMO) => 42 dBm + 3 dBm = 45 dBm.

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.

The product is to be marketed without antennas, RF exposure assessment, site evaluation will be conducted when applying for licensing.