RF Exposure Info / MPE Sample Calculation

Model: TFAH-ES70/80
FCC-ID: XS5-TFAHES78

The Andrew Intelligent Optical Network (ION) Series is the industry-leading optical distribution system that covers the full range of power levels, sending signals loss-free at distances ranging from 100 m to 20 km.

ION-B Series provides optimized multi-band, multi-operator, cost effective solutions.

The ION-B Series system is a Radio-over-Fiber solution able to meet any signal distribution need, from the simplest to the most demanding applications.

The TFAH-ES70/80 is a dual band high power remote unit designed to distribute LMR700 and LMR800 band signals along the same fiber.
RF signals are transported to the remote units via single mode fiber at 1310 nm.

The remote unit can be placed up to 3 km (about 2 miles) from the master unit side.

The system includes an Automatic Gain Control (AGC) that avoids field adjustments and reduces design, installation and optimization time.

As part of the ION-B Series the unit can be easily commissioned and supervised via a web-based Graphical User Interface (GUI).

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.

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

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

We are looking for a distance of ensures that the formula is satisfied.
$$R_1 = R_2 = R_3 = \dots = R_n$$

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

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

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

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

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

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

1) If you have **<u>one path</u>**, 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 **<u>more than one path</u>**, 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 operates 4 frequency bands:

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

Frequency [MHz]	Max Power out [dBm]	f. e. Antenna gain, **without** cable loss [dBi]	Max. Distance [m]
758	31	9	0.3968
769	31	9	0.3940
851	31	9	0.3745
862	31	9	0.3721

The worst case would be if all bands were active:

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

<u>R$_{all}$</u> > 0.591 m   (see previous page for formula)

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.