RF Exposure Info / MPE Sample Calculation

Model: ION-U H 7P/80-85P/17EP/19P
FCC-ID: XS5-UH7817E19P

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 remotes units and SISO and MIMO operation.

The ION-U H 7P/80-85P/17EP/19P is a multi-band, multi-operator Remote Unit used in conjunction with a Master Unit in the ION optical distribution system. This system transports up to four frequency bands simultaneously (700 MHz, 800/850 MHz, 1700/2100 MHz, and 1900 MHz), providing a cost-effective solution for distributing capacity from one or more base stations.

It has been specifically tested and optimized for GMSK, EDGE, UMTS, HSPA+, LTE, and other OFDM modulations. Furthermore it is provisioned for future modulation scheme evolutions. These Remote 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 unit utilizes a single fiber to support multiple bands in both the uplink and downlink directions. WDM (Wave Division Multiplex) filters are integrated in the optical modules. For the UL, a wavelength within 1546 nm – 1550 nm is used. For the DL, a wavelength of 1310 ±10 nm is used. The maximum output power for the UL and DL is 6.7 mW.

The specific device generally will be professionally 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^2]
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.

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

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

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

$R_1 = R_2 = R_3 = \ldots = R_n$

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

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

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

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

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

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)

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

For example:

The EUT has 4 frequency bands: 728-757 MHz, 862-894 MHz, 1930 - 1995 MHz and 2110 - 2180 MHz.

The max measured conducted output power is 43.0 dBm (20 W).

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

Frequency [MHz]	Max Power out [dBm]	Max. allowed Antenna gain, **without** cable loss [dBi]	Max. Distance [m]
728	43	9	0.510
862	43	9	0.469
1930	43	9	0.355
2110	43	9	0.355

The worst case would be if all bands were active:

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

R_{all} > 0.855 m

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.