

MPE Calculations XN4 802.11abgn Arrays

The device is classified as a mobile device. The user's manual specifies a minimum separation distance of at least 26cm, consistent with this classification. As shown in the calculations below, the power density 20cm from the device is below the maximum permitted level for uncontrolled exposure with one or more radios active.

FCC part 1.1310, Table 1 limits the power density for uncontrolled exposure. The power density, P_d (mW/cm²) calculated from the maximum EIRP, P_t (mW) and the distance, d (m), between the transmitting antenna and the closest person, can be calculated using:

$$P_d = P_t / (4 \pi d^2)$$

The maximum eirp in each band is shown in the following tables for all modes of operation. The total eirp is calculated for a single radio in the band and for multiple radios in the band. For the multiple radio scenarios the correction factor of $10\log(n)$, where n is the number of active transceivers, is add to the output power for the single-radio.

The maximum number of radios in each band is limited by the number of non-overlapping channels available in that band. The maximum eirp is limited by the FCC/Industry Canada rules. The output power per radio operating in each of the bands is shown on the table on the following page. From this tabe the worst case scenario for rf exposure can be determined by selecting the four radios with the highest eirp. In this case it would be three radios operating in the 2.4GHz band using 802.11b MIMO (3x3) and the fourth operating in the 5.7GHz band using 802.11a MIMO (2x2).

Output power and eirp per radio versus number of radios operating in the band

| Band and Mode | 1 | | | | 2 | | | | 3 | | | | 4 | | | |
|----------------------|------------|------------|---------------|--------|--|------------|---------------|--------|---|------------|---------------|--------|---|------------|---------------|-------|
| | Pout (dBm) | Gain (dBi) | EIRP (dBm mW) | | Pout (dBm) | Gain (dBi) | EIRP (dBm mW) | | Pout (dBm) | Gain (dBi) | EIRP (dBm mW) | | Pout (dBm) | Gain (dBi) | EIRP (dBm mW) | |
| 2.4GHz Band | | | | | | | | | | | | | | | | |
| 802.11b Single Chain | 21.3 | 2.5 | 23.8 | 239.9 | 21.3 | 1.0 | 22.3 | 169.8 | 21.3 | 1.0 | 22.3 | 169.8 | Only 3 non-overlapping 20 MHz channels in this band | | | |
| 802.11g Single Chain | 19.7 | 2.5 | 22.2 | 166.0 | 19.7 | 1.0 | 20.7 | 117.5 | 19.7 | 1.0 | 20.7 | 117.5 | | | | |
| 802.11b 3x | 25.1 | 5.8 | 30.9 | 1230.3 | 25.1 | 5.8 | 30.9 | 1230.3 | 25.1 | 5.8 | 30.9 | 1230.3 | | | | |
| 802.11g 3x | 24.2 | 5.8 | 30 | 1000.0 | 24.2 | 5.8 | 30 | 1000.0 | 24.2 | 5.8 | 30 | 1000.0 | | | | |
| 802.11n 20 | 24.2 | 1.0 | 25.2 | 331.1 | 24.2 | 1.0 | 25.2 | 331.1 | 24.2 | 1.0 | 25.2 | 331.1 | | | | |
| 802.11n 40 | 24.5 | 1.0 | 25.5 | 354.8 | Only one non-overlapping 40 MHz channel in this band | | | | | | | | | | | |
| 5150-5250 MHz | | | | | | | | | | | | | | | | |
| 802.11a Single Chain | 16.2 | 3 | 19.2 | 83.2 | 16.2 | 3 | 19.2 | 83.2 | 15.2 | 3 | 18.23 | 66.5 | 14.0 | 3 | 16.98 | 49.9 |
| 802.11a 2x | 16.1 | 6 | 22.1 | 162.2 | 14.0 | 6 | 19.99 | 99.8 | 12.2 | 6 | 18.23 | 66.5 | 11.0 | 6 | 16.98 | 49.9 |
| 802.11n 20 | 16.6 | 3 | 19.6 | 91.2 | 16.6 | 3 | 19.6 | 91.2 | 15.2 | 3 | 18.23 | 66.5 | 14.0 | 3 | 16.98 | 49.9 |
| 802.11n 40 | 16.3 | 3 | 19.3 | 85.1 | Only one 40 MHz channel in this band | | | | | | | | | | | |
| 5725-5850 MHz | | | | | | | | | | | | | | | | |
| 802.11a Single Chain | 15.4 | 3 | 18.4 | 69.2 | 15.4 | 3 | 18.4 | 69.2 | 15.4 | 3 | 18.4 | 69.2 | 15.4 | 3 | 18.4 | 69.2 |
| 802.11a 2x | 18.0 | 6 | 24 | 251.2 | 18.0 | 6 | 24 | 251.2 | 18.0 | 6 | 24 | 251.2 | 18.0 | 6 | 24 | 251.2 |
| 802.11n 20 | 18.6 | 3 | 21.64 | 145.9 | 18.6 | 3 | 21.64 | 145.9 | 18.6 | 3 | 21.64 | 145.9 | 18.6 | 3 | 21.64 | 145.9 |
| 802.11n 40 | 18.5 | 3 | 21.5 | 141.3 | 18.5 | 3 | 21.5 | 141.3 | Only two 40 MHz channels available in this band | | | | | | | |

Worst case scenario for rf exposure:

- Radio #1 operating in 2.4GHz band, 802.11b 3x3 mode 1230.3 mW
- Radio #2 operating in 2.4GHz band, 802.11b 3x3 mode 1230.3 mW
- Radio #3 operating in 2.4GHz band, 802.11b 3x3 mode 1230.3 mW
- Radio #4 operating in 5.7GHz band, 802.11a 2x2 mode 251.2 mW

Total eirp: 3942 mW

From this worst case scenario, the total eirp across the 2.4GHz and 5.7GHz bands is 3183 mW. The power density 20cm from the device is:

$$P_d = P_t / (4 \pi d^2)$$

$$P_d = 3183 / (4 \pi 20^2)$$

$$P_d = 3183 / (4 \pi 20^2)$$

$$P_d = 0.784 \text{ mW/cm}^2$$

The limits specified in RSS-102 and FCC part 1.1310 for devices operating in the frequency range 1500 MHz to 115000 MHz is 1mW/cm^2 (10W/m^2).

This estimate is conservative as it assumes all transmitting radios would be transmitting continuously and simultaneously. It also considers the total eirp to be sourced from a single point when the actual sources are distributed in a circle with a non-zero separation between each antenna set.

The estimation of rf power density at a distance of 20cm from the device shows that the device does not exceed the with the rf exposure limits when installed and used in accordance with the user manual instructions.