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/cm^2) 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 10log(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
(note power in each column represents the incremental power due to the additional radio operating in the band, the actual power per radio would be relatively equally distributed between all radios in the band)

Band and Mode	1					2				3				4			
	Pout (dBm)	Pout (mW)	Gain (dBi)	EIRP dBm	EIRP mW	Pout (mW)	Gain (dBi)	EIRP dBm	EIRP mW	Pout (mW)	Gain (dBi)	EIRP dBm	EIRP mW	Pout (mW)	Gain (dBi)	EIRP dBm	EIRP mW
2400-2483.5 MHz Total power output must be lower than 1 Watt and total eirp < 4 Watts																	
802.11b Single Chain	21.3	134.9	2.5	23.8	239.9	134.9	1.0	22.3	169.8	134.9	1.0	22.3	169.8	Only 3 non-overlapping 20 MHz channels in this band			
802.11g Single Chain	19.7	93.3	2.5	22.2	166.0	93.3	1.0	20.7	117.5	93.3	1.0	20.7	117.5				
802.11b 3x	25.1	323.6	5.8	30.9	1230.3	323.6	5.8	30.9	1230.3	323.6	5.8	30.9	1230.3				
802.11g 3x	24.2	263.0	5.8	30	1000.0	263.0	5.8	30.0	1000.0	263.0	5.8	30.0	1000.0				
802.11n 20	24.2	263.0	1.0	25.2	331.1	263.0	1.0	25.2	331.1	263.0	1.0	25.2	331.1				
802.11n 40	24.5	281.8	1.0	25.5	354.8	Only one non-overlapping 40 MHz channel in this band											
5150-5250 MHz Total power output must be lower than 17dBm (50mW) and total eirp < 23dBm (200 mW). Once more than radio is operating in the band the maximum power per radio is reduced to 17dBm - 10log(n), where n is the number of radios operating in the band.																	
802.11a Single Chain	16.2	41.7	3	19.2	83.2	8.3	3	11.3	13.5	0.0	3	-	0.0	0.0	3	-	0.0
802.11a 2x	16.1	40.71	6	22.1	162.2	9.3	6	15.3	33.6	0.0	6	-	0.0	0.0	6	-	0.0
802.11n 20	16.6	45.7	3	19.6	91.2	4.3	3	7.3	5.4	0.0	3	-	0.0	0.0	3	-	0.0
802.11n 40	16.3	42.7	3	19.3	85.1	Only one 40 MHz channel in this band											
5725-5850 MHz, total power output must be lower than 1 Watt and total eirp < 4 Watts																	
802.11a Single Chain	15.4	34.7	3	18.4	69.2	34.7	3	18.4	69.2	34.7	3	18.4	69.2	34.7	3	18.4	69.2
802.11a 2x	18.0	63.1	6	24	251.2	63.1	6	24.0	251.2	63.1	6	24.0	251.2	63.1	6	24.0	251.2
802.11n 20	18.6	73.1	3	21.64	145.9	73.1	3	21.6	145.9	73.1	3	21.6	145.9	73.1	3	21.6	145.9
802.11n 40	18.5	70.8	3	21.5	141.3	70.8	3	21.5	141.3	Only two 40 MHz channels available in this band							
5250-5350 MHz Total power output must be lower than 24 dBm (250mW) and total eirp < 30dBm (1000 mW). Once more than radio is operating in the band the maximum power per radio is reduced to 24dBm - 10log(n), where n is the number of radios operating in the band.																	
802.11a Single Chain	18.3	67.6	3	21.3	134.9	67.6	3	21.3	134.9	67.6	3	21.3	134.9	47.2	3	19.7	94.1
802.11a 2x	21.3	134.9	6	27.3	537.0	115.1	6	26.6	458.2	0.0	6	-	0.0	0.0	6	-	0.0
802.11n 20	20.9	123.0	3	23.9	245.5	123.0	3	23.9	245.5	3.9	3	9.0	7.9	0.0	3	-	0.0
802.11n 40	22.8	190.6	3	25.8	380.2	Only one 40 MHz channel in this band											
5470-5725 MHz Total power output must be lower than 24 dBm (250mW) and total eirp < 30dBm (1000 mW). Once more than radio is operating in the band the maximum power per radio is reduced to 24dBm - 10log(n), where n is the number of radios operating in the band.																	
802.11a Single Chain	20.2	104.7	3	23.2	208.9	104.7	3	23.2	208.9	40.6	3	19.1	81.0	0	3	-	0.0
802.11a 2x	22.4	173.8	6	28.4	691.8	76.2	6	24.8	303.4	0.0	6	-	0.0	0	6	-	0.0
802.11n 20	20.4	109.6	3	23.4	218.8	109.6	3	23.4	218.8	30.7	3	17.9	61.3	0	3	-	0.0
802.11n 40	22.3	169.8	3	25.3	338.8	80.2	3	22.0	160.0	0.0	3	-	0.0	0	3	-	0.0

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 5470-5725 MHz band, 802.11a 2x2 mode	691.8	mW
Total eirp:	**4382.7**	**mW**

From this worst case scenario, the total eirp across all 2.4 GHz and 5GHz bands is 4382.7mW. The power density 20cm from the device is:

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

$$P_d = 4382.7/(4\pi 20^2)$$

$$P_d = 0.872 \text{ mW/cm}^2$$

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 (which require a separation distance of at least 25cm).