

- *Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004* on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (18th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC).
- US FCC limits for the general population. See the FCC web site at <http://www.fcc.gov>, and the policies, guidelines, and requirements in Part 1 of Title 47 of the Code of Federal Regulations, as well as the guidelines and suggestions for evaluating compliance in FCC OET Bulletin 65.
- Health Canada limits for the general population. See the Health Canada web site at [http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/limits-limités\\_e.html](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/99ehd-dhm237/limits-limités_e.html) and Safety Code 6.
- EN 50383:2002 to 2010 Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz - 40 GHz).
- BS EN 50385:2002 Product standard to demonstrate the compliances of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz – 40 GHz) – general public.
- ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines for the general public. See the ICNIRP web site at <http://www.icnirp.de/> and Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields.

## Power density exposure limit

Install the radios for the 450 Platform Family of wireless solutions so as to provide and maintain the minimum separation distances from all persons.

The applicable FCC power density exposure limit for RF energy in the 3.65, 4.9, 5.4 and 5.8 GHz frequency bands is **10 W/m<sup>2</sup>** and in 900 MHz frequency band is **6 W/m<sup>2</sup>**. For more information, see [Human exposure to radio frequency energy](#) on page 4-22.

The applicable ISED power density exposure limit for RF energy in unlicensed bands is  $0.02619 * (f^{0.6834})$ , where  $f$  is the lowest frequency of the supported band. For licensed bands, the power density exposure limit is  $0.6455 * (f^{0.5})$ , where  $f$  is the lowest frequency of the supported band.

## Calculation of power density

The following calculation is based on the ANSI IEEE C95.1-1991 method, as that provides a worst case analysis. Details of the assessment to EN50383:2002 can be provided, if required.

Peak power density in the far field of a radio frequency point source is calculated as follows:

$$S = \frac{P \cdot G}{4\pi d^2}$$

Where:

Is:

S	power density in W/m <sup>2</sup>
P	maximum average transmit power capability of the radio, in W
G	total Tx gain as a factor, converted from dB
d	distance from point source, in m

Rearranging terms to solve for distance yields:

$$d = \sqrt{\frac{P \cdot G}{4\pi \cdot S}}$$

## Calculated distances and power compliance margins

[Table 69](#) and [Table 70](#) shows calculated minimum separation distances, recommended distances and resulting margins for each frequency band and antenna combination for the USA and Canada. These are conservative distances that include compliance margins. At these and greater separation distances, the power density from the RF field is below generally accepted limits for the general population.

450 Platform Family ODU adheres to all applicable EIRP limits for transmit power when operating in MIMO mode. Separation distances and compliance margins include compensation for both transmitters.

Explanation of terms used in [Table 69](#) and [Table 70](#):

- P burst – maximum average transmit power during transmit burst (Watt)
- P – maximum average transmit power of the radio (Watt)
- G – total transmit gain as a factor, converted from dB
- S – power density (Watt/m<sup>2</sup>)
- d – minimum safe separation distance from point source (meters)

**Table 68** FCC minimum safe distances – PMP 450m 5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz

Band (GHz)	Antenna	PG (W)	S (W/ m <sup>2</sup> )	d (m)
5.1	90° sector	3.38	10	0.16
5.2	90° sector	0.85	10	0.08
5.4	90° sector	0.85	10	0.08
5.8	90° sector	3.38	10	0.16

**Table 69** FCC minimum safe distances – PMP/PTP 450i 900 MHz, 3.65 MHz, 4.9 GHz, 5.1 GHz, 5.2 GHz, 5.4 GHz and 5.8 GHz

Band	Antenna	P burst (W)	P (W)	G (dBi)	S (W/ m <sup>2</sup> )	d (m)
900 MHz	Sector antenna	-	0.19	22.75 (13 dBi)	6.0	0.27
3.65 GHz	90° sector antenna, integrated	-	0.316	50.0 (17 dBi)	10.0	0.36
	90° sector antenna, connectorized	-	0.316	40.0 (16 dBi)	10.0	0.32
	Panel, integrated	-	0.251	79.0 (19 dBi)	10.0	0.40
4.9 GHz	Omni-directional	0.2138	0.2512	20.0 (13 dBi)	10.0	0.17
	90° sector antenna	0.2138	0.2512	50.0 (17 dBi)	10.0	0.26
	2ft directional flat plate	0.2138	0.2512	631.0 (28 dBi)	10.0	0.93
	4ft directional parabolic	0.851	0.1000	2344.0 (34.9 dBi)	10.0	1.14
	6ft directional parabolic	0.1413	0.1659	5248.0 (37.2 dBi)	10.0	2.19
5.1 GHz	Omni-directional	0.170	0.200	20.0 (13.0 dBi)	10.0	0.15
	90° sector	0.034	0.040	50.1 (17.0 dBi)	10.0	0.10
	2ft directional flat plate	0.002	0.002	707.9 (28.5 dBi)	10.0	0.09
	4ft directional parabolic	0.011	0.013	2818.4 (34.5 dBi)	10.0	0.44
5.2 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	10.0	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	10.0	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	10.0	0.07
	4ft directional parabolic	0.000	0.000	2818.4 (34.5 dBi)	10.0	0.06
5.4 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	10.0	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	10.0	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	10.0	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	10.0	0.08
5.8 GHz	Omni-directional	0.24	0.28	20.0 (13 dBi)	10.0	0.18
	90° sector	0.10	0.12	50.0 (17 dBi)	10.0	0.18
	2ft directional flat plate	0.54	0.63	708.0 (28.5 dBi)	10.0	1.57
	4ft directional parabolic	0.54	0.63	3388.0 (35.3 dBi)	10.0	3.43
	6ft directional parabolic	0.54	0.63	6457.0 (38.1 dBi)	10.0	4.74

**Table 70** ISEDC minimum safe distances – PMP/PTP 450i 4.9 GHz and 5.8 GHz

Band	Antenna	P burst (W)	P (W)	G (dBi)	S (W/ m <sup>2</sup> )	d (m)
900 MHz	Sector	-	.02	20.0 (13 dBi)	2.74	0.11
3.5 GHz	90° sector antenna, integrated	-	0.794	50.0 (17 dBi)	37.10	0.29
	90° sector antenna, connectorized	-	0.794	40.0 (16 dBi)	37.10	0.23
	Panel, integrated	-	0.794	79.0 (19 dBi)	37.10	0.37
4.9 GHz	Omni-directional	0.214	0.251	20.0 (13 dBi)	8.71	0.20
	90° sector	0.214	0.251	50.1 (17 dBi)	8.71	0.31
	2ft directional flat plate	0.214	0.251	631.0 (28 dBi)	8.71	1.11
	6ft directional parabolic	0.141	0.166	5248.0 (37.2 dBi)	8.71	2.60
5.2 GHz	Omni-directional	0.009	0.011	20.0 (13.0 dBi)	9.13	0.04
	90° sector	0.012	0.014	50.1 (17.0 dBi)	9.13	0.06
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	9.13	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	9.13	0.06
5.4 GHz	Omni-directional	0.036	0.042	20.0 (13.0 dBi)	9.39	0.07
	90° sector	0.014	0.017	50.1 (17.0 dBi)	9.39	0.07
	2ft directional flat plate	0.001	0.001	707.9 (28.5 dBi)	9.39	0.07
	2ft directional parabolic	0.001	0.001	707.9 (28.5 dBi)	9.39	0.06
5.8 GHz	Omni-directional	0.24	0.28	20.0 (13 dBi)	9.69	0.20
	90° sector	0.10	0.12	50.1 (17 dBi)	9.69	0.20
	2ft directional flat plate	0.54	0.63	707.9 (28.5 dBi)	9.69	1.67
	4ft directional parabolic	0.54	0.63	3388.4 (35.3 dBi)	9.69	4.82

**Table 71** FCC minimum safe distances – PMP/PTP 450 900 MHz, 2.4 GHz, 3.65 GHz and 5 GHz

Band	Antenna	P burst (W)	G (dBi)	S (W/ m <sup>2</sup> )	d (m)
900 MHz	Yagi	0.032	13 (11 dBi)	6	0.07
	Sector Antenna	0.079	50 (17 dBi)	10	0.18
2.4 GHz	Integrated	0.158	6 (8 dBi)	10	0.09
	Reflector	0.040	100 (20 dBi)	10	0.18
	Sector Antenna	0.316	32 (15 dBi)	10	0.28
3.65 GHz	Integrated	0.316	6 (8 dBi)	10	0.12
	Reflector	0.25	100 (20 dBi)	10	0.45
	High-gain Ruggedized	0.25	79 (19 dBi)	10	0.40
	Sector	0.025	40 (16 dBi)	10	0.09
	Integrated	0.126	8 (9 dBi)	10	0.09
5.4 GHz	Reflector	0.003	316 (25 dBi)	10	0.09
	CLIP	0.020	50 (17 dBi)	10	0.09
	LENS	0.032	28 (14.5 dBi)	10	0.08
	Integrated Dish (450d)	0.0032	316 (25 dBi)	10	0.09
	Sector	0.079	40 (16 dBi)	10	0.16
	Integrated	0.158	8 (9 dBi)	10	0.10
5.8 GHz	Reflector	0.158	316 (25 dBi)	10	0.63
	CLIP	0.158	50 (17 dBi)	10	0.25
	LENS	0.158	28 (14.5 dBi)	10	0.19
	Integrated Dish (450d)	0.158	316 (25 dBi)	10	0.63

**Table 72** ISEDC minimum safe distances – PMP/PTP 450 900 MHz, 2.4 GHz, 3.5/3.65 GHz and 5 GHz

Band	Antenna	P burst (W)	G (dBi)	S (W/ m <sub>2</sub> )	d (m)
900 MHz	Yagi	0.316	13 (11 dBi)	2.74	0.35
2.4 GHz	Sector Antenna	0.079	50 (17 dBi)	5.35	0.24
	Integrated	0.158	6 (8 dBi)	5.35	0.12
	Reflector	0.040	100 (20 dBi)	5.35	0.24
3.5 GHz	Sector	0.316	32 (15 dBi)	37.10	0.15
	Integrated	0.316	6 (8 dBi)	37.10	0.06
	Reflector	0.316	100 (20 dBi)	37.10	0.26
	High-gain Ruggedized	0.316	79 (19 dBi)	37.10	0.23
3.65 GHz (lower Canada)	Sector	0.316	32 (15 dBi)	38.20	0.15
	Integrated	0.316	6 (8 dBi)	38.20	0.06
	Reflector	0.316	100 (20 dBi)	38.20	0.26
	High-gain Ruggedized	0.316	79 (19 dBi)	38.20	0.23
3.65 GHz (upper Canada)	Sector	0.316	32 (15 dBi)	38.20	0.14
	Integrated	0.316	6 (8 dBi)	38.20	0.06
	Reflector	0.20	100 (20 dBi)	38.20	0.20
	High-gain Ruggedized	0.003	79 (19 dBi)	38.20	0.23
5.4 GHz	Sector	0.025	40 (16 dBi)	9.39	0.09
	Integrated	0.126	8 (9 dBi)	9.39	0.09
	Reflector	0.003	316 (25 dBi)	9.39	0.09
	CLIP	0.020	50 (17 dBi)	9.39	0.09
	LENS	0.032	28 (14.5 dBi)	9.39	0.09
	Integrated Dish (450d)	0.0032	316 (25 dBi)	9.39	0.09
5.8 GHz	Sector	.079	40 (16 dBi)	9.69	0.16
	Integrated	0.158	8 (9 dBi)	9.69	0.10
	Reflector	0.158	316 (25 dBi)	9.69	0.064
	CLIP	0.158	50 (17 dBi)	9.69	0.25
	LENS	0.158	28 (14.5 dBi)	9.69	0.19
	Integrated Dish (450d)	0.158	316 (25 dBi)	9.69	0.64

- (\*1) P: maximum average transmit power capability of the radio including cable loss (Watt)  
*Capacité de puissance d'émission moyenne maximale de la radio comprenant la perte dans les câbles de connexion (W)*
- (\*2) G: total transmit gain as a factor, converted from dB  
*Gain total d'émission, converti à partir de la valeur en dB*
- (\*3) S: power density (W/m<sup>2</sup>)  
*Densité de puissance (W/m<sup>2</sup>)*
- (\*4) d: minimum distance from point source (meters)  
*Distance minimale de source ponctuelle (en mètres)*

**Note**

Gain of antenna in dBi =  $10 * \log(G)$ .

The regulations require that the power used for the calculations is the maximum power in the transmit burst subject to allowance for source-based time-averaging.

At 5.4 GHz and EU 5.8 GHz, the products are generally limited to a fixed EIRP which can be achieved with the Integrated Antenna. The calculations above assume that the maximum EIRP allowed by the regulations is being transmitted.

**Remarque**

Gain de l'antenne en dBi =  $10 * \log(G)$ .

Les règlements exigent que la puissance utilisée pour les calculs soit la puissance maximale de la rafale de transmission soumis à une réduction pour prendre en compte le rapport cyclique pour les signaux modulés dans le temps.

Pour une opération dans la CEE dans les bandes 5,4 GHz et 5,8 GHz, les produits sont généralement limités à une PIRE qui peut être atteinte avec l'antenne intégrée. Les calculs ci-dessus supposent que la PIRE maximale autorisée par la réglementation est atteinte.

**Note**

If there are no EIRP limits in the country of deployment, use the distance calculations for FCC 5.8 GHz for all frequency bands.

At FCC 5.8 GHz, for antennas between 0.6m (2ft) and 1.8m (6ft), alter the distance proportionally to the antenna gain.

**Remarque**

Si aucune limite de PIRE existe pour le pays de déploiement, utilisez les calculs de distance pour FCC 5,8 GHz pour toutes les bandes de fréquence.

Pour la band FCC 5,8 GHz et les antennes entre 0,6 m (2 pieds) et 1,8 m (6 pieds), modifier la distance proportionnellement au gain de l'antenne.