

## Annex F MPE calculation

### Prediction of MPE

This device is designed to be used only for fixed and mobile applications.

It has integrated internal antennas. External connectors are provided which allows connection of external antennas. The output can be switched either to the external antennas or the internal antennas. Simultaneous transmission with both antennas is restricted.

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all the persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

The table below is excerpted from Table 1B of 47 CFR 1.1310 titled Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure:

Frequency Range (MHz)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
300 – 1500	f (MHz) /1500	30
1500 – 100.000	1.0	30

Based on the above table the limits are: For 5900 MHz frequency band device: 1 mW/cm<sup>2</sup>

§ 2.1091: The limit for 5900 MHz mobile operations, where no routine evaluation is required, is: 3W EIRP

Max permissive power according to §90.377:

Channel No.	Frequency range (MHz)	Max. EIRP <sup>1</sup> (dBm)	Channel use
170 .....	5850–5855	.....	Reserved.
172 .....	5855–5865	33	Service Channel. <sup>2</sup>
174 .....	5865–5875	33	Service Channel.
175 .....	5865–5885	23	Service Channel. <sup>3</sup>
176 .....	5875–5885	33	Service Channel.
178 .....	5885–5895	33/44.8	Control Channel.
180 .....	5895–5905	23	Service Channel.
181 .....	5895–5915	23	Service Channel. <sup>3</sup>
182 .....	5905–5915	23	Service Channel.
184 .....	5915–5925	33/40	Service Channel. <sup>4</sup>

Using the equation from page 19 of OET Bulletin 65, Edition 97-01:

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. mW/cm<sup>2</sup>)

P = power input to the antenna (in appropriate units, e.g., mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Compliance with MPE limits can be guaranteed as the calculations below show:

**Internal Antennas**

Band	Maximum radiated output power (dBm)	Maximum radiated output power (mW)	Duty cycle	Equivalent radiated output power (Maximum radiated output power x duty cycle) (mW)
5860 MHz	32.1	1621.8	100%	1621.8
5875 MHz	22.5	177.8	100%	177.8
5890 MHz	33.2	2089.3	100%	2089.3
5905 MHz	22.5	177.8	100%	177.8
5920 MHz	32.2	1659.6	100%	1659.6

Maximum output power considerations:

P x G <sub>1</sub>	Maximum power input to the antenna x Antenna gain (dBi) to comply with MPE limits:	2089.3	mW
R	Distance:	20	cm
S	MPE limit for uncontrolled exposure:	0.42	mW/cm <sup>2</sup>

**Result:** Internal antenna configuration complies with MPE limits.

**External Antennas**

Band	Maximum conducted output power (dBm)	Maximum conducted output power (mW)	Duty cycle	Equivalent conducted output power (Maximum conducted output power x duty cycle) (mW)
5860 MHz	18.9	77.6	100%	77.6
5875 MHz	8.6	7.2	100%	7.2
5890 MHz	18.6	72.4	100%	72.4
5905 MHz	8.5	7.1	100%	7.1
5920 MHz	19.1	81.3	100%	81.3

Maximum output power considerations:

P Maximum power input to the antenna: 81.3 mW  
 R Distance: 20 cm  
 S MPE limit for uncontrolled exposure: 1 mW/cm<sup>2</sup>

**G<sub>1</sub>** Antenna gain (dBi) to comply with MPE limits: **17.9 dBi**

EIRP power limit according to §2.1091: 3 W EIRP

**G<sub>2</sub>** Antenna gain (dBi) to comply with ERP limits: **15.7 dBi**  
 (EIRP = Maximum conducted output power x Antenna gain)

ERP power limit according to §90.377: (low power channels) 0.2 W EIRP

**G<sub>3</sub>** Antenna gain (dBi) to comply with ERP limits: **14.4 dBi**  
 (ERP = Maximum conducted output power x Antenna gain)

ERP power limit according to §90.377: (high power channels) 2 W EIRP

**G<sub>4</sub>** Antenna gain (dBi) to comply with ERP limits: **13.9 dBi**  
 (ERP = Maximum conducted output power x Antenna gain)

**G<sub>5900 MHz band</sub>** **Min (G<sub>1</sub>, G<sub>2</sub>, G<sub>3</sub>, G<sub>4</sub>)** **13.9 dBi**

**Result:** The maximum antenna gain for mobile operation to comply with MPE and EIRP limits shall not exceed 13.9 dBi.