

5 FCC §2.1091, FCC §15.407(f) & ISEDC RSS-102 – RF Exposure

5.1 Applicable Standards

Option (A): 1.1307(b)(3)(i)(A): Available maximum time-averaged power is < 1 mW.

Option (B): 1.1307(b)(3)(i)(B): Device operates between 300 MHz and 6 GHz and the maximum time-averaged power or effective radiated power (ERP), whichever is greater, $\leq P_{th}$.

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

Option (C): 1.1307(b)(3)(i)(C): ERP is below a threshold calculated based on the distance

R between the person and the antenna / radiating structure, where $R > \lambda / 2$.

Single RF Sources Subject to Routine Environmental Evaluation	
RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1,920 R^2$.
1.34-30	$3,450 R^2/f^2$.
30-300	$3.83 R^2$.
300-1,500	$0.0128 R^2 f$.
1,500-100,000	$19.2 R^2$.
Note: R is in meters, f is in MHz.	

According to ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz⁶ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density

P = power input to antenna

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

5.3 RF exposure evaluation exemption for FCC

Radio 1: 15dBi antenna gain

Prediction frequency (MHz)	5745
Maximum Output Power (dBm) – Antenna 1	15.1dBm
Maximum Output Power (dBm) – Antenna 2	14.1dBm
Duty Cycle	0.22dB
Tolerances	0.50dB
Max antenna gain	15dBi
EIRP (dBm)	33.3dBm
ERP (W)	1.306
Prediction distance (cm)	40
1500 MHz $\leq f < 100000$ MHz	MPE-based Exemption Threshold
	P_{th} (W)
	$19.2R^2 = 3.072W$

Radio 2: 15dBi antenna gain

Prediction frequency (MHz)	5745
Maximum Output Power (dBm) – Antenna 1	17.8dBm
Maximum Output Power (dBm) – Antenna 2	17.4dBm
Duty Cycle	0.36dB
Tolerances	0.50dB
Max antenna gain	15dBi
EIRP (dBm)	35.97dBm
ERP (W)	2.415
Prediction distance (cm)	40
1500 MHz $\leq f < 100000$ MHz	MPE-based Exemption Threshold
	P_{th} (W)
	$19.2R^2 = 3.072W$

5.4 RF exposure evaluation exemption for IC

Radio 1: 15dBi antenna gain

Prediction frequency (MHz)	5745
Maximum Output Power (dBm) – Antenna 1	15.1dBm
Maximum Output Power (dBm) – Antenna 2	14.1dBm
Duty Cycle	0.22dB
Tolerances	0.50dB
Max antenna gain	15dBi
EIRP (dBm)	33.3dBm
EIRP (W)	2.13
Prediction distance (cm)	40
$300\text{MHz} \leq f < 6\text{GHz}$	MPE-based Exemption Threshold
	$P_{th} \text{ (W)}$
	$1.31 \times 10^{-2} f^{0.6834} \text{ W} = 4.857 \text{ watt.}$

The routine evaluation is exempted because $2.13 < 4.857 \text{ watt.}$

Radio 2: 15dBi antenna gain

Prediction frequency (MHz)	5745
Maximum Output Power (dBm) – Antenna 1	17.8dBm
Maximum Output Power (dBm) – Antenna 2	17.4dBm
Duty Cycle	0.36dB
Tolerances	0.50dB
Max antenna gain	15dBi
EIRP (dBm)	35.97dBm
ERP (W)	3.95
Prediction distance (cm)	40
$300\text{MHz} \leq f < 6\text{GHz}$	Exemption Limits for Routine Evaluation
	(W)
	$1.31 \times 10^{-2} f^{0.6834} \text{ W} = 4.857 \text{ watt.}$

The routine evaluation is exempted because $3.95\text{W} < 4.857 \text{ watt.}$

5.5 Calculations with additional Transmitters

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100% in terms of percentage.

Worst Case Scenario:

BLE (Highest power) – 13dBm

5GHz Radio 1 – 34.50dBm

5GHz Radio 2 – 35.50dBm

Total Power Densities (Percentages) = 5GHz Radio 1 Power Density % + 5GHz Radio 2 Power Density % +

BLE Power Density % + 4.9GHz Radio 1

Total Relative Power Densities (Percentages) = $(0.106/1.0) * 100 + (0.197/1.0) * 100 + (0.001/1) * 100 + (0.056/1.0) * 100 =$
 $= 10.6 \% + 19.7 \% + 1\% + 5.6 \%$
 $= 36.9\%$