

Per FCC §1.1310

MPE Evaluation Formula: $P_d = (P_r) / (4\pi r^2)$

Where,

P_d = Power Density (mW/cm²)

P_r = Output Power in EIRP (mW) = $1 * 10^{((P_{out} + G)/10)}$

P_{out} = Conducted output power (dBm)

G = gain of antenna (dBi)

π = 3.1416

r = distance between observation point and center of the radiator (cm)

FCC 47 CFR 1.1310 MPE Exclusion Calculation										
Antenna	Tx	Bandwidth (MHz)	Frequency Range (MHz)	Maximum Conducted Output Power (dBm)	Antenna Gain (dBi)	EIRP (mW)	Separation Distance (cm)	Worst Case (mW/cm ²)	Threshold (mW/cm ²)	Result
1	2.4GHz	5	2412 - 2462	25.99	3.00	792.36	20	0.16	1.0	Pass by Exclusion; Threshold Value is less than 1.0
2	2.4GHz		2412 - 2462							
1	U-NII 1	5	5190 – 5230	14.41	4.00	69.29	20	0.01	1.0	Pass by Exclusion; Threshold Value is less than 1.0
2	U-NII 1		5190 – 5230							
1	U-NII 3	5	5755 - 5795	13.67	4.00	58.51	20	0.01	1.0	Pass by Exclusion; Threshold Value is less than 1.0
2	U-NII 3		5755 - 5795							
1	2.4GHz	10	2412 - 2462	26.36	3.00	862.53	20	0.17	1.0	Pass by Exclusion; Threshold Value is less than 1.0
2	2.4GHz		2412 - 2462							
1	U-NII 1	10	5190 – 5230	14.56	4.00	71.73	20	0.01	1.0	Pass by Exclusion; Threshold Value is less than 1.0
2	U-NII 1		5190 – 5230							
1	U-NII 3	10	5755 - 5795	13.78	4.00	59.97	20	0.01	1.0	Pass by Exclusion; Threshold Value is less than 1.0
2	U-NII 3		5755 - 5795							

RSS-102 MPE exemption calculation

Summary:

Minimum typical separation distance between the antenna and the user = 20cm

Exemption limit from RSS-102 for routine evaluation based on frequency and separation distance for $\geq$

300MHz $\leq$ 6GHz = **2.722W** @ 2.461GHz, **4.549W** @ 5.23GHz, & **4.857W** @ 5.755GHz (see Appendix A)

EUT's Worst Case @ 2.4GHz W/ 5MHz BW= 792.36mW (see Worst Case calculation below)

EUT's Worst Case @ 2.4GHz W/ 10MHz BW = 862.53mW (see Worst Case calculation below)

EUT's Worst Case @ 5.23GHz W/ 5MHz BW = 69.29mW (see Worst Case calculation below)

EUT's Worst Case @ 5.23GHz W/ 10MHz BW = 71.73mW (see Worst Case calculation below)

EUT's Worst Case@ 5.755GHz W/ 5MHz BW = 58.51mW (see Worst Case calculation below)

EUT's Worst Case@ 5.755GHz W/ 10MHz BW = 59.97mW (see Worst Case calculation below)

792.36 < 2722, 862.53 < 2722, 69.29 < 4549, 71.73 < 4549, 58.51 < 4857, and 59.97 < 4857, therefore the

EUT is exempt from routine MPE evaluation.

Worst Case calculation:

@2.4GHz W/ 5MHz BW

25.99 dBm maximum conducted RF output power as measured using a method compliant with RSS-210

3 dBi peak antenna gain

EIRP = peak conducted RF power + peak antenna gain = 25.99 dBm + 3 dBi = 28.99 dBm = 792.36 mW

@2.4GHz W/ 10MHz BW

26.36 dBm maximum conducted RF output power as measured using a method compliant with RSS-210

3 dBi peak antenna gain

EIRP = peak conducted RF power + peak antenna gain = 26.36 dBm + 3 dBi = 29.36 dBm = 862.53 mW

@5.23GHz W/ 5MHz BW

14.41dBm Maximum conducted RF output power as measured using a method compliant with RSS-210

4 dBi peak antenna gain

EIRP = peak conducted RF power + peak antenna gain = 14.41 dBm + 4 dBi = 17.67 dBm = 69.29 mW

@5.23GHz W/ 10MHz BW

14.56dBm Maximum conducted RF output power as measured using a method compliant with RSS-210

4 dBi peak antenna gain

EIRP = peak conducted RF power + peak antenna gain = 14.56dBm + 4 dBi = 18.56 dBm = 71.73 mW

@5.755GHz W/ 5MHz BW

13.67dBm Maximum conducted RF output power as measured using a method compliant with RSS-210

4 dBi peak antenna gain

EIRP = peak conducted RF power + peak antenna gain = 13.67 dBm + 4 dBi = 17.67 dBm = 58.51 mW

@5.755GHz W/ 10MHz BW

13.78dBm Maximum conducted RF output power as measured using a method compliant with RSS-210

4 dBi peak antenna gain

EIRP = peak conducted RF power + peak antenna gain = 13.78 dBm + 4 dBi = 17.78dBm = 59.97 mW

Conclusion:

For our EUT transmitting at 2462 MHz with 5MHz bandwidth, if we evaluate the EUT against the exemption limits at a distance of 20cm (typical use case), the power at this distance must be below 2.722 W. $2.722\text{ W} - 0.792\text{ W} = 1.930\text{ W}$ of margin (pass).

For our EUT transmitting at 2462 MHz with 10MHz bandwidth, if we evaluate the EUT against the exemption limits at a distance of 20cm (typical use case), the power at this distance must be below 2.722 W. $2.722\text{ W} - 0.863\text{ W} = 1.859\text{ W}$ of margin (pass).

For our EUT transmitting at 5230 MHz with 5MHz bandwidth, if we evaluate the EUT against the exemption limits at a distance of 20cm (typical use case), the power at this distance must be below 4.549 W. $4.549\text{ W} - 0.069\text{ W} = 4.480\text{ W}$ of margin (pass).

For our EUT transmitting at 5230 MHz with 10MHz bandwidth, if we evaluate the EUT against the exemption limits at a distance of 20cm (typical use case), the power at this distance must be below 4.549 W. $4.549\text{ W} - 0.072\text{ W} = 4.477\text{ W}$ of margin (pass).

For our EUT transmitting at 5755 MHz with 5MHz Bandwidth, if we evaluate the EUT against the exemption limits at a distance of 20cm (typical use case), the power at this distance must be below 4.857 W. $4.857\text{ W} - 0.059\text{ W} = 4.798\text{ W}$ of margin (pass).

For our EUT transmitting at 5755 MHz with 10MHz Bandwidth, if we evaluate the EUT against the exemption limits at a distance of 20cm (typical use case), the power at this distance must be below 4.857 W. $4.857\text{ W} - 0.060\text{ W} = 4.797\text{ W}$ of margin (pass).

Appendix A:

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310, is listed in Table 1-1. According to FCC §1.1310 and RSS-102: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures (f = frequency)				
30-300	61.4	0.163	1.0	6
300-1500	...	...	f/300	6
1500-100,000	...	...	5.0	6
(B) Limits For General Population / Uncontrolled Exposure (f = frequency)				
30-300	27.5	0.073	0.2	30
300-1500	...	...	f/1500	30
1500-100,000	...	...	1.0	30

Table 1-1. Limits for Maximum Permissible Exposure (MPE)

From RSS-102

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 $22.48/f^{0.5}$ 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.