

RF Exposure

1. Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissible Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm ²]	Averaging Time [minute]
Limits for General Population / Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824/f	2.19/f	*(180/f ²)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1 500	/	/	f/1 500	30
1 500 ~ 15 000	/	/	1.0	30

f=frequency in MHz, * = plane-wave equivalent power density

MPE (Maximum Permissible Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad (\Rightarrow R = \sqrt{PG/4\pi S})$$

S = power density [mW/cm²]

P = Power input to antenna [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 [cm]

2. RF Exposure Compliance Issue

The information should be included in the user's manual:

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

3. Calculation Result of RF Exposure

Mode	Target power [dBm]	Tune up tolerance [dB]	Max tune up power [dBm]	Max tune up power [mW]	Ant Gain [dBi]	Ant Gain [mW]	Power Density at 20 cm [mW/cm ²]	Limit [mW/cm ²]
802.11b_ant2_Middle	19.00	±1.00	20.00	100.00	2.83	1.92	0.038 17	1.000 00
5.0 GHz_802.11a_ant0_Middle	17.00	±1.00	18.00	63.10	1.99	1.58	0.019 85	1.000 00
5.8 GHz_802.11a_ant0_Middle	20.00	±1.00	21.00	125.89	3.89	2.45	0.061 34	1.000 00
Total	-						0.119 36	1.000 00

4. Target power and tolerance, Max tuneup power

- WiFi 2.4 GHz

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11b_ant0_Lowest	19.00	±1.00	20.00	19.22
802.11b_ant0_Middle	19.00	±1.00	20.00	19.43
802.11b_ant0_Highest	19.00	±1.00	20.00	19.28
802.11b_ant1_Lowest	19.00	±1.00	20.00	19.17
802.11b_ant1_Middle	19.00	±1.00	20.00	19.46
802.11b_ant1_Highest	19.00	±1.00	20.00	19.33
802.11b_ant2_Lowest	19.00	±1.00	20.00	19.21
802.11b_ant2_Middle	19.00	±1.00	20.00	19.55
802.11b_ant2_Highest	19.00	±1.00	20.00	19.12
802.11g_ant0_Lowest	15.50	±1.00	16.50	14.76
802.11g_ant0_Middle	19.00	±1.00	20.00	18.62
802.11g_ant0_Highest	15.50	±1.00	16.50	14.80

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11g_ant1_Lowest	15.50	±1.00	16.50	15.08
802.11g_ant1_Middle	19.00	±1.00	20.00	18.72
802.11g_ant1_Highest	15.50	±1.00	16.50	15.28
802.11g_ant2_Lowest	15.50	±1.00	16.50	15.15
802.11g_ant2_Middle	19.00	±1.00	20.00	18.72
802.11g_ant2_Highest	15.50	±1.00	16.50	14.64
802.11n HT20_ant0_Lowest	15.50	±1.00	16.50	14.64
802.11n HT20_ant0_Middle	19.00	±1.00	20.00	18.55
802.11n HT20_ant0_Highest	15.50	±1.00	16.50	14.63
802.11n HT20_ant1_Lowest	15.50	±1.00	16.50	14.89
802.11n HT20_ant1_Middle	19.00	±1.00	20.00	18.55
802.11n HT20_ant1_Highest	15.50	±1.00	16.50	15.31
802.11n HT20_ant2_Lowest	15.50	±1.00	16.50	15.10
802.11n HT20_ant2_Middle	19.00	±1.00	20.00	18.72
802.11n HT20_ant2_Highest	15.50	±1.00	16.50	14.61
802.11n HT40_ant0_Lowest	13.50	±1.00	14.50	12.90
802.11n HT40_ant0_Middle	16.50	±1.00	17.50	16.14
802.11n HT40_ant0_Highest	13.50	±1.00	14.50	13.02
802.11n HT40_ant1_Lowest	13.50	±1.00	14.50	12.68
802.11n HT40_ant1_Middle	16.50	±1.00	17.50	16.21
802.11n HT40_ant1_Highest	13.50	±1.00	14.50	12.72
802.11n HT40_ant2_Lowest	13.50	±1.00	14.50	13.01
802.11n HT40_ant2_Middle	16.50	±1.00	17.50	15.90
802.11n HT40_ant2_Highest	13.50	±1.00	14.50	12.99

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11n HT20 ant0+1_Lowest	15.50	±1.00	16.50	15.49
802.11n HT20 ant0+1_Middle	19.00	±1.00	20.00	18.47
802.11n HT20 ant0+1_Highest	15.50	±1.00	16.50	15.41
802.11n HT40 ant0+1_Lowest	13.50	±1.00	14.50	13.35
802.11n HT40 ant0+1_Middle	16.50	±1.00	17.50	15.92
802.11n HT40 ant0+1_Highest	13.50	±1.00	14.50	13.46
802.11n HT20 ant0+1+2_Lowest	15.50	±1.00	16.50	16.34
802.11n HT20 ant0+1+2_Middle	19.00	±1.00	20.00	18.84
802.11n HT20 ant0+1+2_Highest	15.50	±1.00	16.50	16.22
802.11n HT40 ant0+1+2_Lowest	13.50	±1.00	14.50	14.11
802.11n HT40 ant0+1+2_Middle	16.50	±1.00	17.50	16.23
802.11n HT40 ant0+1+2_Highest	13.50	±1.00	14.50	14.17

- WiFi 5.0 GHz

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11a_ant0_Lowest	17.00	±1.00	18.00	17.81
802.11a_ant0_Middle	17.00	±1.00	18.00	17.89
802.11a_ant0_Highest	17.00	±1.00	18.00	17.82
802.11a_ant1_Lowest	17.00	±1.00	18.00	17.71
802.11a_ant1_Middle	17.00	±1.00	18.00	17.68
802.11a_ant1_Highest	17.00	±1.00	18.00	17.67
802.11a_ant2_Lowest	17.00	±1.00	18.00	17.21
802.11a_ant2_Middle	17.00	±1.00	18.00	17.69
802.11a_ant2_Highest	17.00	±1.00	18.00	17.67

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11n HT20_ant0 Lowest	16.50	±1.00	17.50	17.42
802.11n HT20_ant0 Middle	16.50	±1.00	17.50	17.33
802.11n HT20_ant0 Highest	16.50	±1.00	17.50	17.34
802.11n HT20_ant1 Lowest	16.50	±1.00	17.50	17.22
802.11n HT20_ant1 Middle	16.50	±1.00	17.50	15.83
802.11n HT20_ant1 Highest	16.50	±1.00	17.50	16.73
802.11n HT20_ant2 Lowest	16.50	±1.00	17.50	16.59
802.11n HT20_ant2 Middle	16.50	±1.00	17.50	17.12
802.11n HT20_ant2 Highest	16.50	±1.00	17.50	17.23
802.11ac VHT20 ant0_Lowest	16.50	±1.00	17.50	17.32
802.11ac VHT20 ant0_Middle	16.50	±1.00	17.50	17.37
802.11ac VHT20 ant0_Highest	16.50	±1.00	17.50	17.34
802.11ac VHT20 ant1_Lowest	16.50	±1.00	17.50	17.27
802.11ac VHT20 ant1_Middle	16.50	±1.00	17.50	15.79
802.11ac VHT20 ant1_Highest	16.50	±1.00	17.50	16.28
802.11ac VHT20 ant2_Lowest	16.50	±1.00	17.50	16.51
802.11ac VHT20 ant2_Middle	16.50	±1.00	17.50	16.90
802.11ac VHT20 ant2_Highest	16.50	±1.00	17.50	17.00
802.11n HT40 ant0_Lowest	14.00	±1.00	15.00	13.77
802.11n HT40 ant0_Middle	14.00	±1.00	15.00	14.32
802.11n HT40 ant1_Lowest	14.00	±1.00	15.00	13.42
802.11n HT40 ant1_Middle	14.00	±1.00	15.00	13.74
802.11n HT40 ant2_Lowest	14.00	±1.00	15.00	13.59
802.11n HT40 ant2_Middle	14.00	±1.00	15.00	13.96
802.11ac VHT40 ant0_Lowest	14.00	±1.00	15.00	13.77
802.11ac VHT40 ant0_Middle	14.00	±1.00	15.00	14.27

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11ac VHT40 ant1_Lowest	14.00	±1.00	15.00	13.37
802.11ac VHT40 ant1_Middle	14.00	±1.00	15.00	13.69
802.11ac VHT40 ant2_Lowest	14.00	±1.00	15.00	13.58
802.11ac VHT40 ant2_Middle	14.00	±1.00	15.00	13.98
802.11ac VHT80 ant0_Lowest	12.00	±1.00	13.00	12.33
802.11ac VHT80 ant1_Lowest	12.00	±1.00	13.00	12.30
802.11ac VHT80 ant2_Lowest	12.00	±1.00	13.00	12.37
802.11n HT20 ant0+1_Lowest	16.50	±1.00	17.50	16.29
802.11n HT20 ant0+1_Middle	16.50	±1.00	17.50	16.79
802.11n HT20 ant0+1_Highest	16.50	±1.00	17.50	16.86
802.11ac VHT20 ant0+1_Lowest	16.50	±1.00	17.50	16.56
802.11ac VHT20 ant0+1_Middle	16.50	±1.00	17.50	17.05
802.11ac VHT20 ant0+1_Highest	16.50	±1.00	17.50	17.12
802.11n HT40 ant0+1_Lowest	14.00	±1.00	15.00	13.65
802.11n HT40 ant0+1_Highest	14.00	±1.00	15.00	13.59
802.11ac VHT40 ant0+1_Lowest	14.00	±1.00	15.00	13.75
802.11ac VHT40 ant0+1_Highest	14.00	±1.00	15.00	14.10
802.11ac VHT80 ant0+1_Lowest	12.00	±1.00	13.00	12.53
802.11n HT20 ant0+1+2_Lowest	16.50	±1.00	17.50	16.32
802.11n HT20 ant0+1+2_Middle	16.50	±1.00	17.50	16.96
802.11n HT20 ant0+1+2_Highest	16.50	±1.00	17.50	16.86
802.11ac VHT20 ant0+1+2_Lowest	16.50	±1.00	17.50	16.19
802.11ac VHT20 ant0+1+2_Middle	16.50	±1.00	17.50	16.61
802.11ac VHT20 ant0+1+2_Highest	16.50	±1.00	17.50	16.81

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11n HT40 ant0+1+2_Lowest	14.00	±1.00	15.00	13.79
802.11n HT40 ant0+1+2_Highest	14.00	±1.00	15.00	14.37
802.11ac VHT40 ant0+1+2_Lowest	14.00	±1.00	15.00	14.07
802.11ac VHT40 ant0+1+2_Highest	14.00	±1.00	15.00	14.25
802.11ac VHT80 ant0+1+2_Lowest	12.00	±1.00	13.00	12.66

- WiFi 5.8 GHz

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11a_ant0 Lowest	20.00	±1.00	21.00	19.17
802.11a_ant0 Middle	20.00	±1.00	21.00	19.29
802.11a_ant0 Highest	20.00	±1.00	21.00	19.20
802.11a_ant1 Lowest	20.00	±1.00	21.00	19.14
802.11a_ant1 Middle	20.00	±1.00	21.00	19.18
802.11a_ant1 Highest	20.00	±1.00	21.00	19.11
802.11a_ant2 Lowest	20.00	±1.00	21.00	19.25
802.11a_ant2 Middle	20.00	±1.00	21.00	19.12
802.11a_ant2 Highest	20.00	±1.00	21.00	19.23
802.11n HT20_ant0 Lowest	19.50	±1.00	20.50	18.85
802.11n HT20_ant0 Middle	19.50	±1.00	20.50	18.84
802.11n HT20_ant0 Highest	19.50	±1.00	20.50	18.69
802.11n HT20_ant1 Lowest	19.50	±1.00	20.50	18.78
802.11n HT20_ant1 Middle	19.50	±1.00	20.50	18.80
802.11n HT20_ant1 Highest	19.50	±1.00	20.50	18.67
802.11n HT20_ant2 Lowest	19.50	±1.00	20.50	18.65
802.11n HT20_ant2 Middle	19.50	±1.00	20.50	18.70
802.11n HT20_ant2 Highest	19.50	±1.00	20.50	18.52

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11ac VHT20 ant0_Lowest	19.50	±1.00	20.50	18.92
802.11ac VHT20 ant0_Middle	19.50	±1.00	20.50	18.75
802.11ac VHT20 ant0_Highest	19.50	±1.00	20.50	18.77
802.11ac VHT20 ant1_Lowest	19.50	±1.00	20.50	18.75
802.11ac VHT20 ant1_Middle	19.50	±1.00	20.50	19.00
802.11ac VHT20 ant1_Highest	19.50	±1.00	20.50	18.85
802.11ac VHT20 ant2_Lowest	19.50	±1.00	20.50	18.65
802.11ac VHT20 ant2_Middle	19.50	±1.00	20.50	18.75
802.11ac VHT20 ant2_Highest	19.50	±1.00	20.50	18.66
802.11n HT40 ant0_Lowest	19.50	±1.00	20.50	18.70
802.11n HT40 ant0_Middle	19.50	±1.00	20.50	19.02
802.11n HT40 ant1_Lowest	19.50	±1.00	20.50	18.90
802.11n HT40 ant1_Middle	19.50	±1.00	20.50	18.98
802.11n HT40 ant2_Lowest	19.50	±1.00	20.50	18.82
802.11n HT40 ant2_Middle	19.50	±1.00	20.50	18.98
802.11ac VHT40 ant0_Lowest	19.50	±1.00	20.50	18.78
802.11ac VHT40 ant0_Middle	19.50	±1.00	20.50	18.74
802.11ac VHT40 ant1_Lowest	19.50	±1.00	20.50	18.65
802.11ac VHT40 ant1_Middle	19.50	±1.00	20.50	18.90
802.11ac VHT40 ant2_Lowest	19.50	±1.00	20.50	18.80
802.11ac VHT40 ant2_Middle	19.50	±1.00	20.50	18.96
802.11ac VHT80 ant0_Lowest	19.50	±1.00	20.50	18.89
802.11ac VHT80 ant1_Lowest	19.50	±1.00	20.50	18.82
802.11ac VHT80 ant2_Lowest	19.50	±1.00	20.50	18.94

Mode	Target power [dBm]	Tolerance [dB]	Max tuneup power [dBm]	Average Power [dBm]
802.11n HT20 ant0+1_Lowest	19.50	±1.00	20.50	18.57
802.11n HT20 ant0+1_Middle	19.50	±1.00	20.50	18.59
802.11n HT20 ant0+1_Highest	19.50	±1.00	20.50	18.66
802.11ac VHT20 ant0+1_Lowest	19.50	±1.00	20.50	18.58
802.11ac VHT20 ant0+1_Middle	19.50	±1.00	20.50	18.60
802.11ac VHT20 ant0+1_Highest	19.50	±1.00	20.50	18.58
802.11n HT40 ant0+1_Lowest	19.50	±1.00	20.50	18.67
802.11n HT40 ant0+1_Highest	19.50	±1.00	20.50	18.68
802.11ac VHT40 ant0+1_Lowest	19.50	±1.00	20.50	18.83
802.11ac VHT40 ant0+1_Highest	19.50	±1.00	20.50	18.79
802.11ac VHT80 ant0+1_Lowest	19.50	±1.00	20.50	18.83
802.11n HT20 ant0+1+2_Lowest	19.50	±1.00	20.50	18.67
802.11n HT20 ant0+1+2_Middle	19.50	±1.00	20.50	18.77
802.11n HT20 ant0+1+2_Highest	19.50	±1.00	20.50	18.73
802.11ac VHT20 ant0+1+2_Lowest	19.50	±1.00	20.50	18.63
802.11ac VHT20 ant0+1+2_Middle	19.50	±1.00	20.50	18.67
802.11ac VHT20 ant0+1+2_Highest	19.50	±1.00	20.50	18.62
802.11n HT40 ant0+1+2_Lowest	19.50	±1.00	20.50	19.13
802.11n HT40 ant0+1+2_Highest	19.50	±1.00	20.50	18.95
802.11ac VHT40 ant0+1+2_Lowest	19.50	±1.00	20.50	18.99
802.11ac VHT40 ant0+1+2_Highest	19.50	±1.00	20.50	18.79
802.11ac VHT80 ant0+1+2_Lowest	19.50	±1.00	20.50	19.02