

# 1 Human Exposure Assessment

## 1.1 Maximum Permissible Exposure

### 1.1.1 Limit of Maximum Permissible Exposure

Limits for Occupational / Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm <sup>2</sup> )	Averaging Time  E  <sup>2</sup> , H  <sup>2</sup> or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500	-	-	F/300	6
1500-100,000	-	-	5	6
Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm <sup>2</sup> )	Averaging Time  E  <sup>2</sup> , H  <sup>2</sup> or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	F/1500	30
1500-100,000	-	-	1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density Note 2: For the applicable limit, see FCC 1.1310				

RF Field Strength Limits for Controlled Use Devices (Controlled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m <sup>2</sup> )	Averaging Time (minutes)
0.003-1	600	4.9	-	6
1-10	600/ <i>f</i>	4.9/ <i>f</i>	-	6
10-30	60	4.9/ <i>f</i>	-	6
30-300	60	0.163	10*	6
300-1500	3.54 <i>f</i> 0.5	0.0094 <i>f</i> 0.5	<i>f</i> /30	6
1500-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ <i>f</i> 1.2
150000-300000	0.354 <i>f</i> 0.5	9.4 x 10 <sup>-4</sup> <i>f</i> 0.5	3.33 x 10 <sup>-4</sup> <i>f</i>	616000/ <i>f</i> 1.2
RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m <sup>2</sup> )	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	280/ <i>f</i>	2.19/ <i>f</i>	-	6
10-30	28	2.19/ <i>f</i>	-	6
30-300	28	0.073	2*	6
300-1500	1.585 <i>f</i> <sup>0.5</sup>	0.0042 <i>f</i> <sup>0.5</sup>	<i>f</i> /150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> <sup>1.2</sup>
150000-300000	0.158 <i>f</i> <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> <i>f</i>	616000/ <i>f</i> <sup>1.2</sup>
Note 1: <i>f</i> is frequency in MHz.				
Note 2: For the applicable limit, see IC RSS-102				

### 1.1.2 MPE Calculation Method

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d}$$

**E** = Electric field (V/m)

**G** = EUT Antenna numeric gain (numeric)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

$$\text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

**P** = RF output power (W)

**d** = Separation distance between radiator and human body (m)

1.1.3 Result of Maximum Permissible Exposure-(2.4G)

Transmitter Chains & Receiver Chains Information					
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N <sub>TX</sub> )	Number of Receive Chains (N <sub>RX</sub> )	Correlation Signals with Multiple N <sub>TX</sub>	RF Output Power (dBm)	Co-location
b	2	2	Correlated	24.57	Yes
g	2	2	Correlated	27.27	Yes
n (HT20)	2	2	Correlated	27.21	Yes
n (HT40)	2	2	Correlated	24.55	Yes

Note 1: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.)

Note 2: RF output power specifies that Maximum Peak Conducted Output Power.

Worst Maximum RF Output Power Result									
Exposure Environment		General Population / Uncontrolled Exposure							
Separation Distance (cm)		20							
Condition		RF Output Power (dBm)							
Modulation Mode	N <sub>TX</sub>	Chain-Port 1	Chain-Port 2	Chain-Port 3	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm <sup>2</sup> )
11B-20M	2	21.49	21.63	-	-	24.57	3.88	28.45	0.139
11G-20M	2	23.99	24.52	-	-	27.27	3.88	31.15	0.259
11N2.4G-20M	2	23.86	24.51	-	-	27.21	3.88	31.09	0.256
11N2.4G-40M	2	21.55	21.53	-	-	24.55	3.88	28.43	0.139
<b>Maximum Permissible Exposure Limit (mW/cm<sup>2</sup>)</b>									1

Note 1: N<sub>TX</sub> = Number of Transmit Chains

1.1.4 Result of Maximum Permissible Exposure-(5.8G)

Transmitter Chains & Receiver Chains Information					
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N <sub>TX</sub> )	Number of Receive Chains (N <sub>RX</sub> )	Correlation Signals with Multiple N <sub>TX</sub>	RF Output Power (dBm)	Co-location
a	2	2	Correlated	26.38	Yes
n (HT20)	2	2	Correlated	26.02	Yes
n (HT40)	2	2	Correlated	25.70	Yes

Note 1: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.)

Note 2: RF output power specifies that Maximum Peak Conducted Output Power.

Worst Maximum RF Output Power Result									
Exposure Environment		General Population / Uncontrolled Exposure							
Separation Distance (cm)		20							
Condition		RF Output Power (dBm)							
Modulation Mode	N <sub>TX</sub>	Chain-Port 1	Chain-Port 2	Chain-Port 3	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm <sup>2</sup> )
11A5.8G-20M	2	23.66	23.05	-	-	26.38	4.86	31.24	0.2647
11N5.8G-20M	2	23.22	22.79	-	-	26.02	4.86	30.88	0.2436
11N5.8G-40M	2	22.95	22.41	-	-	25.70	4.86	30.56	0.2263
Maximum Permissible Exposure Limit (mW/cm <sup>2</sup> )									1

Note 1: N<sub>TX</sub> = Number of Transmit Chains

1.1.5 Result of Maximum Permissible Exposure-(5.2G)

RF General Information						
Frequency Range (MHz)	IEEE Std. 802.11	Ch. Freq. (MHz)	Channel Number	Transmit Chains (N <sub>TX</sub> )	RF Output Power (dBm)	Co-location
5150-5250	a	5180-5240	36-48 [4]	2	15.40	Yes
5150-5250	n (HT20)	5180-5240	36-48 [4]	2	15.44	Yes
5150-5250	n (HT40)	5190-5230	38-46 [2]	2	16.51	N/A

Note 1: RF output power specifies that Maximum Conducted (Average) Output Power.  
 Note 2: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.)

Worst Maximum Permissible Exposure Result									
Exposure Environment		General Population / Uncontrolled Exposure							
Separation Distance (cm)		20							
Condition		RF Output Power (dBm)							
Modulation Mode	N <sub>TX</sub>	Chain-Port 1	Chain-Port 2	Chain-Port 3	-	Sum Chain	DG (dBi)	EIRP Power	PD (S) (W/m <sup>2</sup> )
11A5.2G-20M	2	12.05	12.71	-	-	15.40	3.42	18.82	0.0152
11N5.2G-20M	2	12.31	12.55	-	-	15.44	3.42	18.86	0.0153
11N5.2G-40M	2	13.56	13.44	-	-	16.51	3.42	19.93	0.0196
<b>Maximum Permissible Exposure Limit (mW/cm<sup>2</sup>)</b>									<b>1</b>