

# 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> <sup>0.5</sup>	0.0094 <i>f</i> <sup>0.5</sup>	<i>f</i> /30	6
1500-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ <i>f</i> <sup>1.2</sup>
150000-300000	0.354 <i>f</i> <sup>0.5</sup>	9.4 x 10 <sup>-4</sup> <i>f</i> <sup>0.5</sup>	3.33 x 10 <sup>-4</sup> <i>f</i>	616000/ <i>f</i> <sup>1.2</sup>
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	1	1	N/A	18.67	Yes
g	1	1	N/A	17.06	Yes
n (HT20)	2	2	Uncorrelated	22.09	Yes
n (HT40)	2	2	Uncorrelated	22.17	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 Conducted (Average) 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	-	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm <sup>2</sup> )
11B-20M	1	-	18.67	-	-	18.67	4.50	23.17	0.04128
11G-20M	1	-	17.06	-	-	17.06	4.50	21.56	0.02849
11N2.4G-20M	2	19.59	18.51	-	-	22.09	4.50	26.59	0.09080
11N2.4G-40M	2	19.68	18.56	-	-	22.17	4.50	26.67	0.09233
<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	1	1	Correlated	18.13	Yes
n (HT20)	2	2	Uncorrelated	19.86	Yes
n (HT40)	2	2	Uncorrelated	19.52	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 Conducted (Average) 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	-	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm <sup>2</sup> )
11A5.8G-20M	1	-	18.13	-	-	18.13	7.00	25.13	0.06482
11N5.8G-20M	2	16.82	16.88	-	-	19.86	7.00	26.86	0.09655
11N5.8G-40M	2	16.60	16.42	-	-	19.52	7.00	26.52	0.08930
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)

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	1	1	Correlated	13.99	Yes
n (HT20)	2	2	Uncorrelated	11.31	Yes
n (HT40)	2	2	Uncorrelated	14.00	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 Conducted (Average) Output Power.

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	-	-	Sum Chain	DG (dBi)	EIRP Power	PD (S) (W/m <sup>2</sup> )
11A5.2G-20M	1	-	13.99	-	-	13.99	7.00	20.99	0.02499
11N5.2G-20M	2	8.91	8.04	-	-	11.31	7.00	18.31	0.01348
11N5.2G-40M	2	11.54	10.37	-	-	14.00	7.00	21.00	0.02507
<b>Maximum Permissible Exposure Limit (mW/cm<sup>2</sup>)</b>									<b>1</b>