

# 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	17.97	N/A
g	1	1	N/A	17.18	N/A
n (HT20)	1	1	Uncorrelated	17.63	N/A
n (HT40)	1	1	Uncorrelated	18.80	N/A
n (HT20)	2	2	Uncorrelated	22.90	N/A
n (HT40)	2	2	Uncorrelated	23.51	N/A
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	17.68	-	-	-	17.97	5.72	23.69	0.0465
11G-20M	1	15.51	-	-	-	17.18	5.72	22.90	0.0388
11N2.4G-20M	1	15.90	-	-	-	17.63	5.72	23.35	0.0430
11N2.4G-40M	1	15.79	-	-	-	18.80	5.72	24.52	0.0563
11N2.4G-20M	2	18.62	17.65	-	-	22.90	5.72	28.62	0.1448
11N2.4G-40M	2	18.88	18.42	-	-	23.51	5.72	29.23	0.1665
Maximum Permissible Exposure Limit (mW/cm <sup>2</sup> )									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	14.97	N/A
n (HT20)	1	1	Uncorrelated	15.66	N/A
n (HT40)	1	1	Uncorrelated	15.07	N/A
n (HT20)	2	2	Uncorrelated	18.44	N/A
n (HT40)	2	2	Uncorrelated	17.64	N/A
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	14.97	-	-	-	14.97	6.36	21.33	0.0270
11N5.8G-20M	1	15.57	-	-	-	15.66	6.36	22.02	0.0317
11N5.8G-40M	1	14.89	-	-	-	15.07	6.36	21.43	0.0277
11N5.8G-20M	2	15.69	15.15	-	-	18.44	6.36	24.80	0.0601
11N5.8G-40M	2	14.56	14.33	-	-	17.64	6.36	24.00	0.0500
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~5.6G)**

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]	1	13.49	N/A
5250-5350		5260-5320	52-64 [4]	1	15.04	
5470-5725		5500-5700	100-140 [8]	1	14.95	
5150-5250	n (HT20)	5180-5240	36-48 [4]	1	13.46	N/A
5250-5350		5260-5320	52-64 [4]	1	15.07	
5470-5725		5500-5700	100-140 [8]	1	14.76	
5150-5250	n (HT40)	5190-5230	38-46 [2]	1	15.03	N/A
5250-5350		5270-5310	54-62 [2]	1	15.38	
5470-5725		5510-5670	102-134 [3]	1	15.38	
5150-5250	n (HT20)	5180-5240	36-48 [4]	2	13.82	N/A
5250-5350		5260-5320	52-64 [4]	2	18.70	
5470-5725		5500-5700	100-140 [8]	2	15.19	
5150-5250	n (HT40)	5190-5230	38-46 [2]	2	16.52	N/A
5250-5350		5270-5310	54-62 [2]	2	17.54	
5470-5725		5510-5670	102-134 [3]	2	17.73	

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.)

<b>Worst Maximum Permissible Exposure Result</b>									
<b>Exposure Environment</b>		General Population / Uncontrolled Exposure							
<b>Separation Distance (cm)</b>		20							
<b>Condition</b>		<b>RF Output Power (dBm)</b>							
<b>Modulation Mode</b>	<b>N<sub>TX</sub></b>	<b>Chain-Port 1</b>	<b>Chain-Port 2</b>	-	-	<b>Sum Chain</b>	<b>DG (dBi)</b>	<b>EIRP Power</b>	<b>PD (S) (W/m<sup>2</sup>)</b>
11A5.2G-20M	1	13.49	-	-	-	13.49	6.36	19.85	0.0192
11A5.3G-20M	1	15.04	-	-	-	15.04	6.36	21.4	0.0275
11A5.6G-20M	1	14.95	-	-	-	14.95	6.36	21.31	0.0269
11N5.2G-20M	1	13.46	-	-	-	13.46	6.36	19.82	0.0191
11N5.3G-20M	1	15.07	-	-	-	15.07	6.36	21.43	0.0277
11N5.6G-20M	1	14.76	-	-	-	14.76	6.36	21.12	0.0258
11N5.2G-40M	1	15.03	-	-	-	15.03	6.36	21.39	0.0274
11N5.3G-40M	1	15.38	-	-	-	15.38	6.36	21.74	0.0297
11N5.6G-40M	1	15.38	-	-	-	15.38	6.36	21.74	0.0297
11N5.2G-20M	2	10.59	10.67	-	-	13.82	6.36	20.18	0.0207
11N5.3G-20M	2	15.57	15.45	-	-	18.70	6.36	25.06	0.0638
11N5.6G-20M	2	12.03	11.96	-	-	15.19	6.36	21.55	0.0284
11N5.2G-40M	2	12.93	12.93	-	-	16.52	6.36	22.88	0.0386
11N5.3G-40M	2	13.91	13.99	-	-	17.54	6.36	23.90	0.0488
11N5.6G-40M	2	14.15	14.12	-	-	17.73	6.36	24.09	0.0510
<b>Maximum Permissible Exposure Limit (mW/cm<sup>2</sup>)</b>									<b>1</b>