

# 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
11B-20M	1	1	N/A	17.41	N/A
11G-20M	1	1	N/A	17.90	N/A
n (HT-20)	1	1	Uncorrelated	17.57	N/A
n (HT-20)	2	2	Uncorrelated	20.49	N/A
n (HT-40)	1	1	Uncorrelated	14.24	N/A
n (HT-40)	2	2	Uncorrelated	16.54	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	DG (dBi)	EIRP Power	PD (S) (mW/cm <sup>2</sup> )
11B-20M	1	17.41	-	-	-	17.41	3.19	20.60	0.01095
11G-20M	1	17.90	-	-	-	17.90	3.19	21.09	0.01226
11N-HT-20	1	17.57	-	-	-	17.57	3.19	20.76	0.01136
11N-HT-20	2	17.47	17.49	-	-	20.49	2.49	22.98	0.02225
11N-HT-40	1	14.24	-	-	-	14.24	3.19	17.43	0.00528
11N-HT-40	2	13.36	13.69	-	-	16.54	2.49	19.03	0.00896
<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
11A5.8G-20M	1	1	Correlated	15.30	N/A
11N5.8G- HT20	1	1	Uncorrelated	15.39	N/A
11N5.8G- HT20	2	2	Uncorrelated	18.07	N/A
11N5.8G- HT40	1	1	Uncorrelated	14.32	N/A
11N5.8G- HT40	2	2	Uncorrelated	17.08	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	DG (dBi)	EIRP Power	PD (S) (mW/cm <sup>2</sup> )
11A5.8G-20M	1	15.30	-	-	-	15.30	3.37	18.67	0.00674
11N5.8G- HT20	1	15.39	-	-	-	15.39	3.37	18.76	0.00688
11N5.8G- HT20	2	15.35	14.76	-	-	18.07	3.19	21.27	0.01277
11N5.8G- HT40	1	14.32	-	-	-	14.32	3.37	17.69	0.00538
11N5.8G- HT40	2	14.15	13.99	-	-	17.08	3.19	20.27	0.01015
<b>Maximum Permissible Exposure Limit (mW/cm<sup>2</sup>)</b>									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					
Modulation Mode	Ch. Freq. (MHz)	Channel Number	Transmit Chains (N <sub>TX</sub> )	RF Output Power (dBm)	Co-location
11A5.2G-20M	5180-5240	36-48 [4]	1	13.76	N/A
11A5.3G-20M	5260-5320	52-64 [4]	1	14.67	
11A5.6G-20M	5500-5700	100-140 [8]	1	14.41	
11N5.2G-HT-20	5180-5240	36-48 [4]	1	13.76	N/A
11N5.3G-HT-20	5260-5320	52-64 [4]	1	14.64	
11N5.6G-HT-20	5500-5700	100-140 [8]	1	14.40	
11N5.2G-HT-20	5180-5240	36-48 [4]	2	14.02	
11N5.3G-HT-20	5260-5320	52-64 [4]	2	17.10	
11N5.6G-HT-20	5500-5700	100-140 [8]	2	16.63	
11N5.2G-HT-40	5190-5230	38-46 [2]	1	13.45	
11N5.3G-HT-40	5270-5310	54-62 [2]	1	13.74	N/A
11N5.6G-HT-40	5510-5670	102-134 [3]	1	13.32	
11N5.2G-HT-40	5190-5230	38-46 [2]	2	16.43	
11N5.3G-HT-40	5270-5310	54-62 [2]	2	16.76	
11N5.6G-HT-40	5510-5670	102-134 [3]	2	16.79	

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	-	-	Sum Chain	DG (dBi)	EIRP Power	PD (S) (W/m <sup>2</sup> )
11A5.2G-20M	1	13.76	-	-	-	13.76	3.37	17.13	0.00473
11A5.3G-20M	1	14.67	-	-	-	14.67	3.37	18.04	0.00583
11A5.6G-20M	1	14.41	-	-	-	14.41	3.37	17.78	0.00549
11N5.2G-20M	1	13.76	-	-	-	13.76	3.37	17.13	0.00473
11N5.3G-20M	1	14.64	-	-	-	14.64	3.37	18.01	0.00579
11N5.6G-20M	1	14.40	-	-	-	14.40	3.37	17.77	0.00548
11N5.2G-20M	2	11.30	10.70	-	-	14.02	3.19	17.21	0.00502
11N5.3G-20M	2	14.11	14.07	-	-	17.10	3.19	20.29	0.01020
11N5.6G-20M	2	13.95	13.26	-	-	16.63	3.19	19.82	0.00915
11N5.2G-40M	1	13.45	-	-	-	13.45	3.37	16.82	0.00440
11N5.3G-40M	1	13.74	-	-	-	13.74	3.37	17.11	0.00470
11N5.6G-40M	1	13.32	-	-	-	13.32	3.37	16.69	0.00427
11N5.2G-40M	2	13.45	13.40	-	-	16.43	3.19	19.63	0.00875
11N5.3G-40M	2	13.68	13.83	-	-	16.76	3.19	19.96	0.00944
11N5.6G-40M	2	13.70	13.86	-	-	16.79	3.19	19.98	0.00950
<b>Maximum Permissible Exposure Limit (mW/cm<sup>2</sup>)</b>									<b>1</b>