



# **1 Human Exposure Assessment**

## **1.1 Maximum Permissible Exposure**

### **1.1.1 Limit of Maximum Permissible Exposure**

<b>Limits for Occupational / Controlled Exposure</b>				
<b>Frequency Range (MHz)</b>	<b>Electric Field Strength (E) (V/m)</b>	<b>Magnetic Field Strength (H) (A/m)</b>	<b>Power Density (S) (mW/ cm<sup>2</sup>)</b>	<b>Averaging Time  E <sup>2</sup>, H <sup>2</sup> or S (minutes)</b>
0.3-3.0	614	1.63	(100)*	6
3.0-30	1,842 / f	4.89 / f	(900 / f <sup>2</sup> )*	6
30-300	61.4	0.163	1.0	6
300-1,500	-	-	F/300	6
1,500-100,000	-	-	5	6
<b>Limits for General Population / Uncontrolled Exposure</b>				
<b>Frequency Range (MHz)</b>	<b>Electric Field Strength (E) (V/m)</b>	<b>Magnetic Field Strength (H) (A/m)</b>	<b>Power Density (S) (mW/ cm<sup>2</sup>)</b>	<b>Averaging Time  E <sup>2</sup>, H <sup>2</sup> or S (minutes)</b>
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f <sup>2</sup> )*	30
30-300	27.5	0.073	0.2	30
300-1,500	-	-	F/1500	30
1,500-100,000	-	-	1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density				
Note 2: For the applicable limit, see FCC 1.1310				



<b>RF Field Strength Limits for Controlled Use Devices (Controlled Environment)</b>				
<b>Frequency Range (MHz)</b>	<b>Electric Field (V/m rms)</b>	<b>Magnetic Field (A/m rms)</b>	<b>Power Density (W/m<sup>2</sup>)</b>	<b>Averaging Time (minutes)</b>
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
300-1,500	3.54 <i>f</i> <sup>0.5</sup>	0.0094 <i>f</i> <sup>0.5</sup>	<i>f</i> /30	6
1,500-15,000	137	0.364	50	6
15,000-150,000	137	0.364	50	616000/ <i>f</i> <sup>1.2</sup>
150,000-300,000	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>
<b>RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)</b>				
<b>Frequency Range (MHz)</b>	<b>Electric Field (V/m rms)</b>	<b>Magnetic Field (A/m rms)</b>	<b>Power Density (W/m<sup>2</sup>)</b>	<b>Averaging Time (minutes)</b>
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
300-1,500	1.585 <i>f</i> <sup>0.5</sup>	0.0042 <i>f</i> <sup>0.5</sup>	<i>f</i> /150	6
1,500-15,000	61.4	0.163	10	6
15,000-150,000	61.4	0.163	10	616000/ <i>f</i> <sup>1.2</sup>
150,000-300,000	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				

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	1,842 / f	4.89 / f	(900 / f <sup>2</sup> )*	6
30-300	61.4	0.163	1.0	6
300-1,500	-	-	F/300	6
1,500-100,000	-	-	5.0	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)
0.3-3.0	614	1.63	(100)*	30
3-30	1,842 / f	4.89 / f	(180/f <sup>2</sup> )*	30
30-300	27.5	0.073	1.0	30
300-1,500	-	-	F/1500	30
1,500-100,000	-	-	1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density				
Note 2: For the applicable limit, see NCC LP0002 Section 5.20.2				

### 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

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	22.13	Yes
5250-5350		5260-5320	52-64 [4]	2	21.52	Yes
5470-5725		5500-5700	100-140 [8]	2	21.19	Yes
5725-5850		5745-5825	149-165 [5]	2	24.23	Yes
5150-5250	n (HT20)	5180-5240	36-48 [4]	2	22.11	Yes
5250-5350		5260-5320	52-64 [4]	2	21.76	Yes
5470-5725		5500-5700	100-140 [8]	2	21.38	Yes
5725-5850		5745-5825	149-165 [5]	2	24.15	Yes
5150-5250	n (HT40)	5190-5230	38-46 [2]	2	23.75	Yes
5250-5350		5270-5310	54-62 [2]	2	22.57	Yes
5470-5725		5510-5670	102-134 [3]	2	22.49	Yes
5725-5850		5755-5795	151-159 [2]	2	23.75	Yes

Note 1: RF output power specifies that Maximum Conducted 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 RF Output Power Result								
Exposure Environment			General Population / Uncontrolled Exposure					
Separation Distance (cm)			20					
Power Level		1	RF Output Power (dBm)					
Frequency Range (MHz)	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> )
5150-5250	802.11n (HT40)	2	20.54	20.93	23.75	1.64	25.39	0.06882
5250-5350	802.11n (HT40)	2	19.54	19.57	22.57	1.64	24.21	0.05247
5470-5725	802.11n (HT40)	2	19.66	19.30	22.49	1.64	24.13	0.05152
5725-5850	802.11a	2	20.88	21.54	24.23	1.64	25.87	0.07692
Maximum Permissible Exposure Limit (mW/cm <sup>2</sup> )								1

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

RF General Information						
Frequency Range (MHz)	IEEE Std. 802.11 Protocol	Ch. Frequency (MHz)	Channel Number	Number of Transmit Chains (N <sub>TX</sub> )	RF Output Power (dBm)	Co-location
2400-2483.5	BR / EDR	2402-2480	0-78 [79]	1	7.14	Yes
2400-2483.5	v4.0 LE	2402-2480	0-39 [40]	1	6.72	Yes
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	Freq. (MHz)	RF Output Power	Antenna Gain (dBi)	EIRP Power	PD (S) (W/m <sup>2</sup> )
BR-1Mbps	2480	7.14	2.26	9.40	0.00182
LE-1Mbps	2480	6.72	2.26	8.98	0.01835
Maximum Permissible Exposure Limit (mW/cm <sup>2</sup> )					1