

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 ²)	Averaging Time E ² , H ² 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 ²)	Averaging Time E ² , H ² 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 ²)	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 × 10 ⁻⁴ <i>f</i> ^{0.5}	3.33 × 10 ⁻⁴ <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 ²)	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> ^{0.5}	0.0042 <i>f</i> ^{0.5}	<i>f</i> /150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 × 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 × 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}
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 WLAN)

Transmitter Chains & Receiver Chains Information					
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N _{TX})	Number of Receive Chains (N _{RX})	Correlation Signals with Multiple N _{TX}	RF Output Power (dBm)	Co-location
b	1	1	Uncorrelated	15.99	N/A
g	1	1	Uncorrelated	14.89	N/A
n (HT20)	1	1	Uncorrelated	14.38	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			
Modulation Mode	N _{TX}	RF Output Power (dBm)	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
b	1	15.99	2	17.99	0.01252
g	1	14.89	2	16.89	0.00972
n (HT20)	1	14.38	2	16.38	0.00864
Maximum Permissible Exposure Limit (mW/cm ²)					1
Note 1: N _{TX} = Number of Transmit Chains					

1.1.4 Result of Maximum Permissible Exposure-(2.4G BT)

RF General Information					
Frequency Range (MHz)	Bluetooth Version	Ch. Frequency (MHz)	Channel Number	RF Output Power (dBm)	Co-location
2400-2483.5	v2.1 Basic	2402-2480	0-78 [79]	-0.12	N/A
2400-2483.5	v2.1 + EDR	2402-2480	0-78 [79]	2.03	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 Peak Conducted Output Power.					

Maximum Permissible Exposure Result				
Exposure Environment	General Population / Uncontrolled Exposure			
Separation Distance (cm)	20			
Modulation Mode	RF Output Power (dBm)	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
BT-1M	-0.12	2	1.88	0.00031
BT-3M	2.03	2	4.03	0.00050
Maximum Permissible Exposure Limit (mW/cm ²)				1

1.1.5 Result of Maximum Permissible Exposure-(5.8G)

Transmitter Chains & Receiver Chains Information					
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N _{TX})	Number of Receive Chains (N _{RX})	Correlation Signals with Multiple N _{TX}	RF Output Power (dBm)	Co-location
a	1	1	Uncorrelated	15.96	N/A
n (HT20)	1	1	Uncorrelated	15.84	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			
Modulation Mode	N _{TX}	RF Output Power (dBm)	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
a	1	15.96	2	17.96	0.01244
n (HT20)	1	15.84	2	17.84	0.01210
Maximum Permissible Exposure Limit (mW/cm ²)					1
Note 1: N _{TX} = Number of Transmit Chains					

1.1.6 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 _{TX})	RF Output Power (dBm)	Co-location
5150-5250	a	5180-5240	36-48 [4]	1	10.83	N/A
5250-5350		5260-5320	52-64 [4]	1	14.32	
5470-5725		5500-5700	100-140 [8]	1	15.22	
5150-5250	n (HT20)	5180-5240	36-48 [4]	1	9.91	N/A
5250-5350		5260-5320	52-64 [4]	1	13.01	
5470-5725		5500-5700	100-140 [8]	1	13.41	

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			
Modulation Mode	N _{TX}	RF Output Power (dBm)	DG (dBi)	EIRP Power	PD (S) (W/m ²)
a	1	10.83	2	12.83	0.00382
a	1	14.32	2	16.32	0.00853
a	1	15.22	2	17.22	0.01049
n (HT20)	1	9.91	2	11.91	0.00309
n (HT20)	1	13.01	2	15.01	0.00631
n (HT20)	1	13.41	2	15.41	0.00691
Maximum Permissible Exposure Limit (mW/cm ²)					1