

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)

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	Correlated	18.73	N/A
g	1	1	Correlated	13.53	N/A
n (HT20)	2	2	Uncorrelated	18.41	N/A
n (HT40)	2	2	Uncorrelated	17.12	N/A
n (HT20)	3	3	Uncorrelated	18.96	N/A
n (HT40)	3	3	Uncorrelated	18.55	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						
Power Level	1	RF Output Power (dBm)						
Modulation Mode	N_{TX}	Chain-Port 1	Chain-Port 2	Chain-Port 3	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
11b	1	-	18.73	-	18.73	4.2	22.93	0.03906
11g	1	-	13.53	-	13.53	4.2	17.73	0.01180
HT20,M8-15	2	15.31	15.49	-	18.41	4.2	22.61	0.03630
HT40,M8-15	2	14.13	14.09	-	17.12	4.2	21.32	0.02696
HT20,M16-23	3	14.26	14.02	14.27	18.96	4.2	23.16	0.04115
HT40,M16-23	3	13.87	13.61	13.84	18.55	4.2	22.75	0.03744
Maximum Permissible Exposure Limit (mW/cm ²)								1
Note 1: N_{TX} = 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_{TX})	Number of Receive Chains (N_{RX})	Correlation Signals with Multiple N_{TX}	RF Output Power (dBm)	Co-location
a	1	1	Correlated	10.16	N/A
n(HT20	2	2	Uncorrelated	12.41	N/A
n(HT40)	2	2	Uncorrelated	11.58	N/A
n(HT20	3	3	Uncorrelated	14.74	N/A
n(HT40)	3	3	Uncorrelated	14.12	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						
Power Level	1	RF Output Power (dBm)						
Modulation Mode	N_{TX}	Chain-Port 1	Chain-Port 2	Chain-Port 3	Sum Chain	DG (dBi)	EIRP Power	PD (S) (mW/cm ²)
11a	1	-	-	10.16	10.16	4.20	14.36	0.00543
HT20,M8-15	2	9.63	9.15	-	12.41	4.56	16.97	0.00990
HT40,M8-15	2	8.34	8.79	-	11.58	4.56	16.14	0.00819
HT20,M16-23	3	9.88	9.71	10.29	14.74	4.27	19.01	0.01582
HT40,M16-23	3	8.44	9.69	9.80	14.12	4.27	18.39	0.01373
Maximum Permissible Exposure Limit (mW/cm ²)								1
Note 1: N_{TX} = 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 _{TX})	RF Output Power (dBm)	Co-location
5150-5250	a	5180-5240	36-48 [4]	1	11.17	N/A
5250-5350		5260-5320	52-64 [4]	1	10.99	
5470-5725		5500-5700	100-140 [8]	1	10.70	
5150-5250	n (HT20)	5180-5240	36-48 [4]	2	14.81	N/A
5250-5350		5260-5320	52-64 [4]	2	14.80	
5470-5725		5500-5700	100-140 [8]	2	14.50	
5150-5250	n (HT40)	5190-5230	38-46 [2]	2	14.87	N/A
5250-5350		5270-5310	54-62 [2]	2	15.85	
5470-5725		5510-5670	102-134 [3]	2	15.18	
5150-5250	n (HT20)	5180-5240	36-48 [4]	3	13.39	N/A
5250-5350		5260-5320	52-64 [4]	3	14.82	
5470-5725		5500-5700	100-140 [8]	3	14.57	
5150-5250	n (HT40)	5190-5230	38-46 [2]	3	14.95	N/A
5250-5350		5270-5310	54-62 [2]	3	16.28	
5470-5725		5510-5670	102-134 [3]	3	15.24	
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	Max. Cond. Power	DG (dBi)	EIRP Power	PD (S) (W/m²)
11a	11.17	4.20	15.37	0.00685
HT20,M8-15	14.81	4.56	19.38	0.01723
HT40,M8-15	15.85	4.56	20.41	0.02186
HT20,M16-23	14.82	4.27	19.09	0.01612
HT40,M16-23	16.28	4.27	20.55	0.02257
Maximum Permissible Exposure Limit (mW/cm²)				1