

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/m²)	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/m²)	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	2	2	Correlated	20.63	N/A
g	2	2	Correlated	19.79	N/A
n (HT20)	2	2	Uncorrelated	18.10	N/A
n (HT40)	2	2	Uncorrelated	18.18	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	-	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
11B-20M	2	18.58	16.39	-	-	20.63	4.90	25.53	0.0711
11G-20M	2	17.71	15.60	-	-	19.79	4.90	24.69	0.0586
11N2.4G-20M	2	16.05	13.86	-	-	18.10	1.89	19.99	0.0199
11N2.4G-40M	2	16.13	13.94	-	-	18.18	1.89	20.07	0.0202
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	2	2	Correlated	14.55	N/A
n (HT20)	2	2	Uncorrelated	14.44	N/A
n (HT40)	2	2	Uncorrelated	14.56	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	-	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
11A5.8G-20M	2	11.50	11.57	-	-	14.55	5.9	20.45	0.0220
11N5.8G-20M	2	11.44	11.42	-	-	14.44	2.89	17.33	0.0108
11N5.8G-40M	2	11.56	11.54	-	-	14.56	2.89	17.45	0.0111
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)

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	2	2	Correlated	12.53	N/A
n (HT20)	2	2	Uncorrelated	12.44	N/A
n (HT40)	2	2	Uncorrelated	12.51	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 Permissible Exposure 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	-	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (W/m ²)
11A5.2G-20M	2	9.52	9.51	-	-	12.53	5.90	18.43	0.0138
11N5.2G-20M	2	9.43	9.42	-	-	12.44	2.89	15.33	0.0068
11N5.2G-40M	2	9.55	9.44	-	-	12.51	2.89	15.40	0.0069
Maximum Permissible Exposure Limit (mW/cm ²)									1
Note 1: N _{TX} = Number of Transmit Chains									