

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 x 10 ⁻⁴ <i>f</i> 0.5	3.33 x 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 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 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	Uncorrelated	18.59	N/A
b	3	3	Uncorrelated	21.91	N/A
g	1	1	Uncorrelated	18.59	N/A
g	3	3	Uncorrelated	21.24	N/A
n (HT20)	1	1	Uncorrelated	17.64	N/A
n (HT20)	3	3	Uncorrelated	21.34	N/A
n (HT40)	1	1	Uncorrelated	17.56	N/A
n (HT40)	3	3	Uncorrelated	21.28	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 _{TX}	Chain-Port 1	Chain-Port 2	Chain-Port 3	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
11B-20M	1	18.59	-	-	-	18.59	2.00	20.59	0.02279
11B-20M	3	17.24	17.04	17.12	-	21.91	2.00	23.91	0.04889
11G-20M	1	18.59	-	-	-	18.59	2.00	20.59	0.02279
11G-20M	3	16.61	16.34	16.44	-	21.24	2.00	23.24	0.04191
11N2.4G-20M	1	17.64	-	-	-	17.64	2.00	19.64	0.01831
11N2.4G-20M	3	17.07	16.11	16.46	-	21.34	2.00	23.34	0.04289
11N2.4G-40M	1	17.56	-	-	-	17.56	2.00	19.56	0.01798
11N2.4G-40M	3	17.07	16.03	16.35	-	21.28	2.00	23.28	0.04230
Maximum Permissible Exposure Limit (mW/cm²)									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	15.71	N/A
a	3	3	Correlated	19.92	N/A
n (HT20)	1	1	Uncorrelated	14.52	N/A
n (HT20)	3	3	Uncorrelated	18.58	N/A
n (HT40)	1	1	Uncorrelated	14.28	N/A
n (HT40)	3	3	Uncorrelated	17.59	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 _{TX}	Chain-Port 1	Chain-Port 2	Chain-Port 3	-	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
11A5.8G-20M	1	15.71	-	-	-	15.71	2.00	17.71	0.01174
11A5.8G-20M	3	15.33	14.49	15.56	-	19.92	2.00	21.92	0.03097
11N5.8G-20M	1	14.52	-	-	-	14.52	2.00	16.52	0.00893
11N5.8G-20M	3	13.75	13.61	14.05	-	18.58	2.00	20.58	0.02273
11N5.8G-40M	1	14.28	-	-	-	14.28	2.00	16.28	0.00845
11N5.8G-40M	3	13.08	12.68	12.67	-	17.59	2.00	19.59	0.01808
Maximum Permissible Exposure Limit (mW/cm²)									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	15.43	N/A
5250-5350		5260-5320	52-64 [4]	1	17.74	
5470-5725		5500-5700	100-140 [8]	1	15.10	
5150-5250	a	5180-5240	36-48 [4]	3	14.69	N/A
5250-5350		5260-5320	52-64 [4]	3	15.75	
5470-5725		5500-5700	100-140 [8]	3	16.85	
5150-5250	n (HT20)	5180-5240	36-48 [4]	1	15.40	N/A
5250-5350		5260-5320	52-64 [4]	1	17.18	
5470-5725		5500-5700	100-140 [8]	1	16.80	
5150-5250	n (HT20)	5180-5240	36-48 [4]	3	20.27	N/A
5250-5350		5260-5320	52-64 [4]	3	20.10	
5470-5725		5500-5700	100-140 [8]	3	20.02	
5150-5250	n (HT40)	5190-5230	38-46 [2]	1	16.41	N/A
5250-5350		5270-5310	54-62 [2]	1	16.73	
5470-5725		5510-5670	102-134 [3]	1	15.92	
5150-5250	n (HT40)	5190-5230	38-46 [2]	3	20.12	N/A
5250-5350		5270-5310	54-62 [2]	3	20.52	
5470-5725		5510-5670	102-134 [3]	3	20.33	

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 _{TX}	Chain-Port 1	Chain-Port 2	Chain-Port 3	-	Sum Chain	DG (dBi)	EIRP Power	PD (S) (W/m ²)
11A5.2G-20M	1	15.43	-	-	-	15.43	2.00	17.43	0.01746
11A5.3G-20M	1	17.74	-	-	-	17.74	2.00	19.74	0.01875
11A5.6G-20M	1	15.10	-	-	-	15.10	2.00	17.10	0.01021
11A5.2G-20M	3	10.29	9.66	9.79	-	14.69	2.00	16.69	0.00929
11A5.3G-20M	3	11.10	10.85	10.98	-	15.75	2.00	17.75	0.01186
11A5.6G-20M	3	12.03	12.06	12.15	-	16.85	2.00	18.85	0.01527
11N5.2G-20M	1	15.40	-	-	-	15.40	2.00	17.40	0.01094
11N5.3G-20M	1	17.18	-	-	-	17.18	2.00	19.18	0.01648
11N5.6G-20M	1	16.80	-	-	-	16.80	2.00	18.80	0.01510
11N5.2G-20M	3	15.47	15.30	15.73	-	20.27	2.00	22.27	0.03357
11N5.3G-20M	3	15.38	15.50	15.10	-	20.10	2.00	22.10	0.03228
11N5.6G-20M	3	15.20	15.18	15.36	-	20.02	2.00	22.02	0.03169
11N5.2G-40M	1	16.41	-	-	-	16.41	2.00	18.41	0.01380
11N5.3G-40M	1	16.73	-	-	-	16.73	2.00	16.73	0.01486
11N5.6G-40M	1	15.92	-	-	-	15.92	2.00	17.92	0.01233
11N5.2G-40M	3	15.45	15.44	15.15	-	20.12	2.00	22.12	0.03243
11N5.3G-40M	3	15.93	15.81	15.50	-	20.52	2.00	22.52	0.03556
11N5.6G-40M	3	15.39	15.61	15.68	-	20.33	2.00	22.33	0.03404
Maximum Permissible Exposure Limit (mW/cm²)									1