1 Maximum Permissible Exposure

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/ cm²)**	**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/ cm²)**	**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/f	4.9/f	-	6
10-30	60	4.9/f	-	6
30-300	60	0.163	10*	6
300-1500	3.54 f 0.5	0.0094 f 0.5	f/30	6
1500-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/f 1.2
150000-300000	0.354 f 0.5	9.4 x 10-4 f 0.5	3.33 x 10-4 f	616000/f 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/f	2.19/f	-	6
10-30	28	2.19/f	-	6
30-300	28	0.073	2*	6
300-1500	1.585 $f^{0.5}$	0.0042 $f^{0.5}$	f/150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/$f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/$f^{1.2}$
Note 1: f is frequency in MHz. Note 2: For the applicable limit, see IC RSS-102				

1.1.2 MPE Calculation Method

E (V/m) = $\frac{\sqrt{30 \times P \times G}}{d}$

Power Density: Pd (W/m^2) = $\frac{E^2}{377}$

E = Electric field (V/m)
P = RF output power (W)
G = EUT Antenna numeric gain (numeric)
d = Separation distance between radiator and human body (m)

The formula can be changed to

Pd = $\frac{30 \times P \times G}{377 \times d^2}$

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_{TX})**	**RF Output Power (dBm)**	**Co-location**
5250-5350	a	5260-5320	52-64 [4]	2	23.59	N/A
5250-5350	n(HT20)	5260-5320	52-64 [4]	2	23.65	N/A
5250-5350	n(HT40)	5270-5310	54-62 [2]	2	23.55	N/A
5250-5350	ac(VHT20)	5260-5320	52-64 [4]	2	23.65	N/A
5250-5350	ac(VHT40)	5270-5310	54-62 [2]	2	23.51	N/A
5250-5350	ac(VHT80)	5290	58 [1]	2	15.19	N/A

Note 1: RF output power specifies that Maximum Conducted Output Power.
Note 2: RF output power specifies that Maximum Peak Conducted Output Power for ac(VHT80) only.
Note 3: 802.11a/n uses a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM modulation.
Note 4: 802.11ac uses a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM, 256QAM modulation.
Note 5: 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							
Condition	**RF Output Power (dBm)**							
Modulation Mode	**Chain-Port 1**	**Chain-Port 2**	**Chain-Port 3**	**Chain-Port 4**	**Sum Chain**	**DG (dBi)**	**EIRP Power**	**PD (S) (mW/cm²)**
a	20.48	20.69	---	---	23.59	2.90	26.49	0.089
n(HT20)	20.52	20.75	---	---	23.65	2.90	26.55	0.090
n(HT40)	20.41	20.66	---	---	23.55	2.90	26.45	0.088
ac(VHT20)	20.57	20.72	---	---	23.65	2.90	26.55	0.090
ac(VHT40)	20.36	20.63	---	---	23.51	2.90	26.41	0.087
ac(VHT80)	12.09	12.28	---	---	15.19	2.90	18.09	0.013
Maximum Permissible Exposure Limit (mW/cm²)								1

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
5470-5725	a	5500-5700	100-140 [8]	2	23.54	N/A
5470-5725	n(HT20)	5500-5700	100-140 [8]	2	23.55	N/A
5470-5725	n(HT40)	5510-5670	102-134 [3]	2	23.52	N/A
5470-5725	ac(VHT20)	5500-5700	100-140 [8]	2	23.50	N/A
5470-5725	ac(VHT40)	5510-5670	102-134 [3]	2	23.54	N/A
5470-5725	ac(VHT80)	5530	106 [1]	2	14.38	N/A

Note 1: RF output power specifies that Maximum Conducted Output Power.
Note 2: RF output power specifies that Maximum Peak Conducted Output Power for ac(VHT80) only.
Note 3: 802.11a/n uses a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM modulation.
Note 4: 802.11ac uses a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM, 256QAM modulation.
Note 5: 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							
Condition	RF Output Power (dBm)							
Modulation Mode	Chain-Port 1	Chain-Port 2	Chain-Port 3	Chain-Port 4	Sum Chain	DG (dBi)	EIRP Power	PD (S) (mW/cm²)
a	20.43	20.63	---	---	23.54	2.90	26.44	0.088
n(HT20)	20.48	20.59	---	---	23.55	2.90	26.45	0.088
n(HT40)	20.35	20.67	---	---	23.52	2.90	26.42	0.087
ac(VHT20)	20.32	20.65	---	---	23.50	2.90	26.40	0.087
ac(VHT40)	20.36	20.68	---	---	23.54	2.90	26.44	0.088
ac(VHT80)	11.06	11.67	---	---	14.38	2.90	17.28	0.011
Maximum Permissible Exposure Limit (mW/cm²)								1

MPE of Co-location evaluation:

2.4 and 5GHz can transmit at the same time, MPE evaluation is as below formula

PD1 / Limit1 + PD2 / Limit 2 + ….. < 1

PD = Power density

1) 2.4 + 5.3GHz = 0.118 / 1 + 0.090 / 1 = 0.208 < 1
2) 2.4 + 5.6GHz = 0.118 / 1 + 0.088 / 1 = 0.206 < 1

Note: Result of Maximum Permissible Exposure for 2.4 GHz comes from original MPE report FA330625-01