RF Exposure Evaluation

Limits

The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b)

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz

Friis transmission formula: **$Pd = (Pout*G)/(4*pi*r^2)$**

Where

Pd = power density in mW/cm2, **Pout** = output power to antenna in mW;

G = gain of antenna in linear scale, **Pi = 3.1416;**

R = distance between observation point and center of the radiator in cm

Pd id the limit of MPE, $1mW/cm^2$. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

Test Procedure

Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

Measurement Result

BT:

Operation Frequency: 2402-2480MHz

Power density limited: 1mW/ cm^2

BT Antenna 1 Type: FPCB Antenna;

BT Antenna 2 Type: PCB Antenna;

BT Antenna 1 gain: 2dBi

BT Antenna 2 gain: 2dBi

2.4GWiFi:

Operation Frequency: 2412MHz~2462MHz for 802.11b/g/n20

2422MHz~2452MHz for 802.11n40

Power density limited: 1mW/ cm^2

2.4G WiFi Antenna 1 Type: PCB Antenna;

2.4G WiFi Antenna 2 Type: PCB Antenna;

2.4G WiFi Antenna 1 gain: 3dBi

2.4G WiFi Antenna 2 gain: 3dBi

5GWiFi:

Operation Frequency: 5150 MHz to 5250 MHz for 802.11a/n/ac

5745 MHz to 5825 MHz far 802.11a/n/ac

5G WiFi Antenna 1 Type: PCB Antenna;

5G WiFi Antenna 2 Type: PCB Antenna;

5G WiFi Antenna 1 gain: 3dBi

5G WiFi Antenna 2 gain: 3dBi

R=20cm

mW=10^(dBm/10)

antenna gain Numeric=10^(dBi/10)= 10^(3/10)=2

BT：ANT 1

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max		Antenna		Evaluation result (mW/cm²)	Power density Limits (mW/cm²)
				tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
2402	GFSK	-2.15	(-2)±1	-1	0.794	2	1.58	0.0003	1
2441		-0.34	0±1	1	1.259	2	1.58	0.0004	1
2480		0.22	0±1	1	1.259	2	1.58	0.0004	1
2402	π/4-DQPSK	-2.47	(-2)±1	-1	0.794	2	1.58	0.0003	1
2441		-0.43	0±1	1	1.259	2	1.58	0.0004	1
2480		0.15	0±1	1	1.259	2	1.58	0.0004	1
2402	8DPSK	-2.48	(-2)±1	-1	0.794	2	1.58	0.0003	1
2441		-0.41	0±1	1	1.259	2	1.58	0.0004	1
2480		0.18	0±1	1	1.259	2	1.58	0.0004	1

BT：ANT 2

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max		Antenna		Evaluation result (mW/cm²)	Power density Limits (mW/cm²)
				tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
2402	GFSK	-2.78	(-2)±1	-1	0.794	2	1.58	0.0003	1
2441		-2.05	(-2)±1	-1	0.794	2	1.58	0.0003	1
2480		-2.11	(-2)±1	-1	0.794	2	1.58	0.0003	1
2402	π/4-DQPSK	-2.78	(-2)±1	-1	0.794	2	1.58	0.0003	1
2441		-2.07	(-2)±1	-1	0.794	2	1.58	0.0003	1
2480		-2.13	(-2)±1	-1	0.794	2	1.58	0.0003	1
2402	8DPSK	-2.75	(-2)±1	-1	0.794	2	1.58	0.0003	1
2441		-2.05	(-2)±1	-1	0.794	2	1.58	0.0003	1
2480		-2.08	(-2)±1	-1	0.794	2	1.58	0.0003	1

2.4G WiFi: ANT 1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power	Max		Antenna		Evaluation result at 20cm	Power density Limits
		(dBm)	(dBm)	tune-up power		Gain		Power density(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
		Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	
2412	802.11b	18.3	18±1	19	79.433	3	2	0.03153	1
2437		17.35	18±1	19	79.433	3	2	0.03153	1
2462		19.86	19±1	20	100.000	3	2	0.03969	1
2412	802.11g	15.54	15±1	16	39.811	3	2	0.01580	1
2437		17.63	17±1	18	63.096	3	2	0.02505	1
2462		17.83	17±1	18	63.096	3	2	0.02505	1
2412	802.11n H20	18.21	18±1	19	79.433	3	2	0.03153	1
2437		17.73	17±1	18	63.096	3	2	0.02505	1
2462		19.32	19±1	20	100.000	3	2	0.03969	1
2422	802.11n H40	17.9	17±1	18	63.096	3	2	0.02505	1
2437		18.06	18±1	19	79.433	3	2	0.03153	1
2452		17.83	17±1	18	63.096	3	2	0.02505	1

2.4G WiFi: ANT 2

Channel Freq. (MHz)	modulation	conducted power	Tune-up power	Max		Antenna		Evaluation result at 20cm	Power density Limits
		(dBm)	(dBm)	tune-up power		Gain		Power density(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
		Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	
2412	802.11b	18.74	18±1	19	79.433	3	2.00	0.03153	1
2437		17.38	17±1	18	63.096	3	2.00	0.02505	1
2462		20.19	20±1	21	125.893	3	2.00	0.04997	1
2412	802.11g	15.27	15±1	16	39.811	3	2.00	0.01580	1
2437		17.8	17±1	18	63.096	3	2.00	0.02505	1
2462		17.81	17±1	18	63.096	3	2.00	0.02505	1
2412	802.11n H20	17.89	17±1	18	63.096	3	2.00	0.02505	1
2437		17.81	17±1	18	63.096	3	2.00	0.02505	1
2462		19.28	19±1	20	100.000	3	2.00	0.03969	1
2422	802.11n H40	18.43	18±1	19	79.433	3	2.00	0.03153	1
2437		17.93	17±1	18	63.096	3	2.00	0.02505	1
2452		18.04	18±1	19	79.433	3	2.00	0.03153	1

5.2G WiFi: ANT 1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power	Max		Antenna		Evaluation result at 20cm	Power density Limits
		(dBm)	(dBm)	tune-up power		Gain		Power density(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
		Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	
5180	802.11a	12.76	12±1	13	19.953	3	2.00	0.00792	1
5200		13.21	13±1	14	25.119	3	2.00	0.00997	1
5240		14.83	14±1	15	31.623	3	2.00	0.01255	1
5180	802.11n (HT20)	11.87	11±1	12	15.849	3	2.00	0.00629	1
5200		12.92	12±1	13	19.953	3	2.00	0.00792	1
5240		14.42	14±1	15	31.623	3	2.00	0.01255	1
5190	802.11n (HT40)	11.84	12±1	13	19.953	3	2.00	0.00792	1
5230		12.09	12±1	13	19.953	3	2.00	0.00792	1
5180	802.11ac (VHT20)	13.19	13±1	14	25.119	3	2.00	0.00997	1
5200		13.27	13±1	14	25.119	3	2.00	0.00997	1
5240		14.8	14±1	15	31.623	3	2.00	0.01255	1
5190	802.11ac (VHT40)	10.96	10±1	11	12.589	3	2.00	0.00500	1
5230		11.5	11±1	12	15.849	3	2.00	0.00629	1
5210	802.11ac (VHT80)	11.96	11±1	12	15.849	3	2.00	0.00629	1

5.2G WiFi: ANT 2

Channel Freq. (MHz)	modulation	conducted power	Tune-up power	Max		Antenna		Evaluation result at 20cm	Power density Limits
		(dBm)	(dBm)	tune-up power		Gain		Power density(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
		Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	
5180	802.11a	10.61	10±1	11	12.589	3	2.00	0.00500	1
5200		10.88	10±1	11	12.589	3	2.00	0.00500	1
5240		11.81	11±1	12	15.849	3	2.00	0.00629	1
5180	802.11n (HT20)	10.32	10±1	11	12.589	3	2.00	0.00500	1
5200		10.34	10±1	11	12.589	3	2.00	0.00500	1
5240		11.83	11±1	12	15.849	3	2.00	0.00629	1
5190	802.11n (HT40)	10.96	10±1	11	12.589	3	2.00	0.00500	1
5230		12.31	12±1	13	19.953	3	2.00	0.00792	1
5180	802.11ac (VHT20)	11.7	11±1	12	15.849	3	2.00	0.00629	1
5200		11.6	11±1	12	15.849	3	2.00	0.00629	1
5240		12.55	12±1	13	19.953	3	2.00	0.00792	1
5190	802.11ac (VHT40)	10.1	10±1	11	12.589	3	2.00	0.00500	1
5230		12.42	12±1	13	19.953	3	2.00	0.00792	1
5210	802.11ac (VHT80)	12.87	12±1	13	19.953	3	2.00	0.00792	1

5.8G WiFi: ANT 1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power	Max		Antenna		Evaluation result at 20cm	Power density Limits
		(dBm)	(dBm)	tune-up power		Gain		Power density(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
		Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	Ant 1	
5745	802.11a	15.27	15±1	16	39.811	3	2.00	0.01580	1
5785		16.24	16±1	17	50.119	3	2.00	0.01989	1
5825		16.48	16±1	17	50.119	3	2.00	0.01989	1
5745	802.11n (HT20)	15.7	15±1	16	39.811	3	2.00	0.01580	1
5785		16.08	16±1	17	50.119	3	2.00	0.01989	1
5825		16.67	16±1	17	50.119	3	2.00	0.01989	1
5755	802.11n (HT40)	15.29	15±1	16	39.811	3	2.00	0.01580	1
5795		16.06	16±1	17	50.119	3	2.00	0.01989	1
5745	802.11ac (VHT20)	15.65	15±1	16	39.811	3	2.00	0.01580	1
5785		15.96	15±1	16	39.811	3	2.00	0.01580	1
5825		16.3	16±1	17	50.119	3	2.00	0.01989	1
5755	802.11ac (VHT40)	15.37	15±1	16	39.811	3	2.00	0.01580	1
5795		16.09	16±1	17	50.119	3	2.00	0.01989	1
5775	802.11ac (VHT80)	16.85	16±1	17	50.119	3	2.00	0.01989	1

5.8G WiFi: ANT 2

Channel Freq. (MHz)	modulation	conducted power	Tune-up power	Max		Antenna		Evaluation result at 20cm	Power density Limits
		(dBm)	(dBm)	tune-up power		Gain		Power density(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
		Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	Ant 2	
5745	802.11a	15.92	15±1	16	39.811	3	2.00	0.01580	1
5785		16.42	16±1	17	50.119	3	2.00	0.01989	1
5825		16.75	16±1	17	50.119	3	2.00	0.01989	1
5745	802.11n (HT20)	15.89	15±1	16	39.811	3	2.00	0.01580	1
5785		16.41	16±1	17	50.119	3	2.00	0.01989	1
5825		16.76	16±1	17	50.119	3	2.00	0.01989	1
5755	802.11n (HT40)	15.07	15±1	16	39.811	3	2.00	0.01580	1
5795		16.11	16±1	17	50.119	3	2.00	0.01989	1
5745	802.11ac (VHT20)	15.82	15±1	16	39.811	3	2.00	0.01580	1
5785		16.44	16±1	17	50.119	3	2.00	0.01989	1
5825		16.74	16±1	17	50.119	3	2.00	0.01989	1
5755	802.11ac (VHT40)	15.46	15±1	16	39.811	3	2.00	0.01580	1
5795		16.22	16±1	17	50.119	3	2.00	0.01989	1
5775	802.11ac (VHT80)	16.06	16±1	17	5.119	3	2.00	0.01989	1

Conclusion:

Simultaneous transmit:

NO,	Configurations	Maximum MPE Value					Limits
		BT ANT 1	BT ANT 2	2.4G WiFi	5G WiFi	Transmit simultaneously	
1	BT ANT 1+BT ANT 2+2.4G WiFi+5G WiFi	0.0004	0.0003	0.04997	0.01989	0.07056	1

Note:

According to KDB 447498 D01 General RF Exposure Guidance v06, At the transmit simultaneously calculation method is as follows:

Transmit simultaneously MPE = Σ of MPE ratios

MPE ratios = Field strengths or power density / MPE limit at the test frequency

For the max result: 0.07056≤ 1.0 SAR, No SAR is required.