

RF EXPOSURE EVALUATION

According to FCC 1.1310: 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 Exposure				
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
300-1,500			f/300	6
1,500-100,000			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
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

MPE Calculation Method

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

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

E = Electric field (V/m)

P = Average 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

$$Pd = \frac{30 * P * G}{377 * D^2}$$

From the EUT RF output power, the minimum mobile separation distance, d=0.2m, as well as the gain of the used antenna, the RF power density can be obtained.

Measurement Result

WIFI 2.4G:

Antenna Type: Whip antenna 1

Antenna gain: 1.4dBi,

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
2412	802.11b	12.08	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		12.63	13±1	14.00	25.119	1.40	1.38	0.0069	1
2462		13.96	13±1	14.00	25.119	1.40	1.38	0.0069	1
2412	802.11g	12.06	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		12.68	13±1	14.00	25.119	1.40	1.38	0.0069	1
2462		13.65	13±1	14.00	25.119	1.40	1.38	0.0069	1
2412	802.11n20	12.3	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		12.83	13±1	14.00	25.119	1.40	1.38	0.0069	1
2462		13.9	13±1	14.00	25.119	1.40	1.38	0.0069	1
2422	802.11n40	12.55	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		12.56	13±1	14.00	25.119	1.40	1.38	0.0069	1
2452		13.16	13±1	14.00	25.119	1.40	1.38	0.0069	1

Antenna Type: Whip antenna 2

Antenna gain: 1.4dBi,

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
2412	802.11b	12.22	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		13.11	13±1	14.00	25.119	1.40	1.38	0.0069	1
2462		13.74	13±1	14.00	25.119	1.40	1.38	0.0069	1
2412	802.11g	12.41	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		13.06	13±1	14.00	25.119	1.40	1.38	0.0069	1
2462		13.55	13±1	14.00	25.119	1.40	1.38	0.0069	1
2412	802.11n20	12.6	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		13.29	13±1	14.00	25.119	1.40	1.38	0.0069	1
2462		13.73	13±1	14.00	25.119	1.40	1.38	0.0069	1
2422	802.11n40	12.83	13±1	14.00	25.119	1.40	1.38	0.0069	1
2437		12.92	13±1	14.00	25.119	1.40	1.38	0.0069	1
2452		13.32	13±1	14.00	25.119	1.40	1.38	0.0069	1

MIMO

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)	(mW/cm2)
2412	802.11n20	15.46	16±1	17	50.119	1.40	1.38	0.0138	1
2437		16.08	16±1	17	50.119	1.40	1.38	0.0138	1
2462		16.83	16±1	17	50.119	1.40	1.38	0.0138	1
2422	802.11n40	15.7	16±1	17	50.119	1.40	1.38	0.0138	1
2437		15.75	16±1	17	50.119	1.40	1.38	0.0138	1
2452		16.25	16±1	17	50.119	1.40	1.38	0.0138	1

WIFI 5.8G:

Antenna Type: Whip antenna 1

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
5745	802.11a	8.72	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5785		9.4	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5825		10.32	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5745	802.11nHT2 0	8.95	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5785		9.56	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5825		10.47	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5755	802.11nHT4 0	9.97	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5795		10.08	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5745	802.11acVH T20	8.87	10±1	11	12.589	1.80	1.51	0.0038	1
5785		9.57	10±1	11	12.589	1.80	1.51	0.0038	1
5825		10.5	10±1	11	12.589	1.80	1.51	0.0038	1
5755	802.11acVH T40	10.05	10±1	11	12.589	1.80	1.51	0.0038	1
5795		10.09	10±1	11	12.589	1.80	1.51	0.0038	1
5775	802.11acVH T80	10.91	10±1	11	12.589	1.80	1.51	0.0038	1

WIFI 5.8G:

Antenna Type: Whip antenna 2

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
5745	802.11a	8.58	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5785		10.04	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5825		10.13	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5745	802.11nHT2 0	8.63	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5785		10.31	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5825		10.35	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5755	802.11nHT4 0	9.85	9±1	10	10.000	1.80	1.51	0.0030	1
5795		9.75	9±1	10	10.000	1.80	1.51	0.0030	1
5745	802.11acVH T20	8.68	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5785		9.2	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5825		10.32	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5755	802.11acVH T40	9.93	9±1	10	10.000	1.80	1.51	0.0030	1
5795		9.8	9±1	10	10.000	1.80	1.51	0.0030	1
5775	802.11acVH T80	8.62	8±1	9	7.943	1.80	1.51	0.0024	1

MIMO

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density
		(dBm)		tune-up power		Gain		(mW/cm2)	(mW/cm2)
				(dBm)	(mW)	(dBi)	Numeric		
5745	802.11nHT2 0	11.8	11±1	12	15.849	1.80	1.51	0.0048	1
5785		12.96	12±1	13	19.953	1.80	1.51	0.0060	1
5825		16.03	16±1	17	50.119	1.80	1.51	0.0151	1
5755	802.11nHT4 0	13.04	13±1	14	25.119	1.80	1.51	0.0076	1
5795		12.81	13±1	14	25.119	1.80	1.51	0.0076	1
5745	802.11acVH T20	8.68	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5785		9.2	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5825		10.32	9.5±1	10.5	11.220	1.80	1.51	0.0034	1
5755	802.11acVH T40	9.93	9±1	10	10.000	1.80	1.51	0.0030	1
5795		9.8	9±1	10	10.000	1.80	1.51	0.0030	1
5775	802.11acVH T80	8.62	8±1	9	7.943	1.80	1.51	0.0024	1

For CDMA2000/WCDMA/LTE

Antenna Type: Whip antenna

Operating Mode	Maximum measured EIRP(ERP)	Maximum measured EIRP(ERP)	Evaluation result	Power density Limits
	(dBm)	(mW)	(mW/cm ²)	(mW/cm ²)
WCDMA Band II	24.61	289.07	0.0575	1.0000
WCDMA Band IV	24.36	272.90	0.0543	1.0000
WCDMA Band V	22.06	160.69	0.0320	0.5509
CDMA 2000 BC0	25.04	319.15	0.0635	0.5498
CDMA 2000 BC1	25.13	325.84	0.0648	1.0000
LTE Band 2	24.9	309.03	0.0615	1.0000
LTE Band 4	24.67	293.09	0.0583	1.0000
LTE Band 5	24.47	279.90	0.0557	0.5498
LTE Band 12	24.99	315.50	0.0628	0.4465
LTE Band 13	25.17	328.85	0.0654	0.5197
LTE Band 17	23.96	248.89	0.0495	0.4710
LTE Band 25	24.19	262.42	0.0522	1.0000
LTE Band 26 (814-824MHz)	24.74	297.85	0.0593	0.5431
LTE Band 26 (824-849MHz)	24.94	311.89	0.0620	0.5498
LTE Band 41	24.96	313.33	0.0623	1.0000
LTE Band 66	24.01	251.77	0.0501	1.0000
LTE Band 71	24.85	305.49	0.0608	0.4437

Synchronous transmission:

According KDB 447498 D01, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0 .

The evaluation here considers a LTE/WCDMA transmitter & a WIFI transmitter. The MPE ratio is defined by the ratio of power density to MPE limit. The sum of the MPE ratios is calculated as follows:

$$\Sigma MPE \text{ Ratio} = \text{Max (GSM/LTE/WCDMA MPE ratio)} + \text{WIFI(Lora MPE ratio)}$$

Conclusion:

For the max result : $0.0151 + 0.1406 = 0.1557 \leq 0.4465$ for Max Power Density, compliance the RF Exposure.



Signature:

Date: 2021/4/15

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