

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

Operation Frequency: BLE: 2402-2480MHz

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

Antenna gain:1.55dBi,

R=20cm

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain			
				(dBm)	(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)
2402	BLE	1.97	2±1	3	1.995	1.55	1.43	0.0006	1
2440		1.58	1±1	2	1.585	1.55	1.43	0.0005	1
2480		0.42	1±1	2	1.585	1.55	1.43	0.0005	1

Operation Frequency: WIFI: 2412-2462MHz for 802.11b/g/11n(HT20);

2422-2452MHz for 802.11n(HT40);

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

Antenna gain:1.55dBi,

R=20cm

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric	(mW/cm2)	(mW/cm2)
2412	802.11b	16.16	17±1	18	63.096	1.55	1.43	0.0179	1
2437		16.1	17±1	18	63.096	1.55	1.43	0.0179	1
2462		17.07	17±1	18	63.096	1.55	1.43	0.0179	1
2412	802.11g	8.95	8±1	9	7.943	1.55	1.43	0.0023	1
2437		13.65	13±1	14	25.119	1.55	1.43	0.0071	1
2462		13.86	13±1	14	25.119	1.55	1.43	0.0071	1
2412	802.11n HT20	8.9	8±1	9	7.943	1.55	1.43	0.0023	1
2437		14.51	14±1	15	31.623	1.55	1.43	0.0090	1
2462		14.73	14±1	15	31.623	1.55	1.43	0.0090	1
2422	802.11n HT40	9.19	9±1	10	10.000	1.55	1.43	0.0028	1
2437		14.67	15±1	16	39.811	1.55	1.43	0.0113	1
2452		14.97	15±1	16	39.811	1.55	1.43	0.0113	1

Operation Frequency: WIFI: U-NII-1: 5150 MHz ~5250MHz;

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

Antenna gain:3.14dBi,

R=20cm

Channel Freq. (MHz)	modulation	conducted power	Tune-up pow er (dBm)	Max		Antenna		Evaluation result (mW/cm2)	Power density Limits (mW/cm2)
		(dBm)		tune-up pow er		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
5180	802.11a	7.38	7±1	8	6.310	3.14	2.06	0.0026	1
5200		12.3	12±1	13	19.953	3.14	2.06	0.0082	1
5240		11.24	11±1	12	15.849	3.14	2.06	0.0065	1
5180	802.11HT20	7.17	7±1	8	6.310	3.14	2.06	0.0026	1
5200		13.13	13±1	14	25.119	3.14	2.06	0.0103	1
5240		12.07	12±1	13	19.953	3.14	2.06	0.0082	1
5190	802.11HT40	7.5	7±1	8	6.310	3.14	2.06	0.0026	1
5230		12.29	12±1	13	19.953	3.14	2.06	0.0082	1
5180		7.15	7±1	8	6.310	3.14	2.06	0.0026	1
5200	802.11AC20	13.06	13±1	14	25.119	3.14	2.06	0.0103	1
5240		11.99	11±1	12	15.849	3.14	2.06	0.0065	1
5190		7.45	7±1	8	6.310	3.14	2.06	0.0026	1
5230	802.11AC40	12.39	12±1	13	19.953	3.14	2.06	0.0082	1
5210		8.04	8±1	9	7.943	3.14	2.06	0.0033	1

Operation Frequency: WIFI: U-NII-2A: 5250 MHz ~5350MHz;

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

Antenna gain:3.14dBi,

R=20cm

Channel Freq. (MHz)	modulation	conducted power	Tune-up pow er (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up pow er		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
5260	802.11a	8.06	8±1	9	7.943	3.14	2.06	0.0033	1
5280		11.77	11±1	12	15.849	3.14	2.06	0.0065	1
5320		10.71	10±1	11	12.589	3.14	2.06	0.0052	1
5260	802.11HT20	7.92	7±1	8	6.310	3.14	2.06	0.0026	1
5280		12.67	12±1	13	19.953	3.14	2.06	0.0082	1
5320		11.56	11±1	12	15.849	3.14	2.06	0.0065	1
5270	802.11HT40	8.06	8±1	9	7.943	3.14	2.06	0.0033	1
5310		12.28	12±1	13	19.953	3.14	2.06	0.0082	1
5260		7.78	7±1	8	6.310	3.14	2.06	0.0026	1
5280	802.11AC20	12.48	12±1	13	19.953	3.14	2.06	0.0082	1
5320		11.4	11±1	12	15.849	3.14	2.06	0.0065	1
5270		8.53	8±1	9	7.943	3.14	2.06	0.0033	1
5310	802.11AC40	6.79	6±1	7	5.012	3.14	2.06	0.0021	1
5290		8.28	8±1	9	7.943	3.14	2.06	0.0033	1

Operation Frequency: WIFI: U-NII-2C: 5470MHz~5725MHz;

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

Antenna gain:3.14dBi,

R=20cm

Channel Freq. (MHz)	modulation	conducted pow er	Tune-up power (dBm)	Max		Antenna		Evaluation result (mW/cm ²)	Power density Limits (mW/cm ²)
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
5500	802.11a	12.45	12±1	13	19.953	3.14	2.06	0.0082	1
5600		13.92	13±1	14	25.119	3.14	2.06	0.0103	1
5700		10.34	10±1	11	12.589	3.14	2.06	0.0052	1
5500	802.11HT20	12.55	12±1	13	19.953	3.14	2.06	0.0082	1
5600		10.81	10±1	11	12.589	3.14	2.06	0.0052	1
5700		9.66	9±1	10	10.000	3.14	2.06	0.0041	1
5510	802.11HT40	10.85	10±1	11	12.589	3.14	2.06	0.0052	1
5590		9.82	9±1	10	10.000	3.14	2.06	0.0041	1
5670		8.41	8±1	9	7.943	3.14	2.06	0.0033	1
5500	802.11AC20	12.34	12±1	13	19.953	3.14	2.06	0.0082	1
5600		10.77	10±1	11	12.589	3.14	2.06	0.0052	1
5700		9.63	9±1	10	10.000	3.14	2.06	0.0041	1
5510	802.11AC40	10.73	10±1	11	12.589	3.14	2.06	0.0052	1
5590		9.8	9±1	10	10.000	3.14	2.06	0.0041	1
5670		8.51	8±1	9	7.943	3.14	2.06	0.0033	1
5530	802.11AC80	10.85	10±1	11	12.589	3.14	2.06	0.0052	1
5610		10.07	10±1	11	12.589	3.14	2.06	0.0052	1

Operation Frequency: WIFI: U-NII-3: 5725 MHz ~5825 MHz ;

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

Antenna gain:3.14dBi,

R=20cm

Channel Freq. (MHz)	modulation	conducted power	Tune-up power (dBm)	Max		Antenna		Evaluation result	Power density Limits
		(dBm)		tune-up power		Gain			
				(dBm)	(mW)	(dBi)	Numeric		
5745	802.11a	4.95	5±1	6	3.981	3.14	2.06	0.0016	1
5785		5.19	5±1	6	3.981	3.14	2.06	0.0016	1
5825		6.31	6±1	7	5.012	3.14	2.06	0.0021	1
5745	802.11HT20	7.44	7±1	8	6.310	3.14	2.06	0.0026	1
5785		6.18	6±1	7	5.012	3.14	2.06	0.0021	1
5825		8.12	8±1	9	7.943	3.14	2.06	0.0033	1
5755	802.11HT40	5.61	6±1	7	5.012	3.14	2.06	0.0021	1
5795		6.16	6±1	7	5.012	3.14	2.06	0.0021	1
5745	802.11AC20	5.72	5±1	6	3.981	3.14	2.06	0.0016	1
5785		4.98	4±1	5	3.162	3.14	2.06	0.0013	1
5825		6.07	6±1	7	5.012	3.14	2.06	0.0021	1
5755	802.11AC40	5.96	5±1	6	3.981	3.14	2.06	0.0016	1
5795		6.04	6±1	7	5.012	3.14	2.06	0.0021	1
5775	802.11AC80	8.42	9±1	10	10.000	3.14	2.06	0.0041	1

LTE Module Evaluation Result:

R=20cm

Channel Freq. (MHz)	modulation	Antenna Gain	Maximum power (dBm)	EIRP/ERP (dBm)	EIRP/ERP Limits (dBm)	EIRP/ERP (mW)	Evaluation result	Power density Limits
							(mW/cm ²)	(mW/cm ²)
824	GSM 850	1.4	35	27.21	38.45	526.0173	0.1046	0.5493
1850	GSM 1900	1.4	31	23.21	33.00	209.4112	0.0417	1.0000
1850	LTE Band 2	1.4	25	26.4	33.00	436.5158	0.0868	1.0000
1710	LTE Band 4	1.4	25	26.4	30.00	436.5158	0.0868	1.0000
824	LTE Band 5	1.4	25	26.4	38.45	436.5158	0.0868	0.5493
2500	LTE Band 7	1.4	25	26.4	33.00	436.5158	0.0868	1.0000
699	LTE Band 12	1.4	25	26.4	34.77	436.5158	0.0868	0.4660
777	LTE Band 13	1.4	25	26.4	44.77	436.5158	0.0868	0.5180
704	LTE Band 17	1.4	25	26.4	34.77	436.5158	0.0868	0.4693
1850	LTE Band 25	1.4	25	26.4	33.00	436.5158	0.0868	1.0000
814	LTE Band 26	1.4	25	26.4	50.00	436.5158	0.0868	0.5427
2496	LTE Band 38	1.4	25	26.4	33.00	436.5158	0.0868	1.0000
2496	LTE Band 41	1.4	25	26.4	33.00	436.5158	0.0868	1.0000
1710	LTE Band 66	1.4	25	26.4	30.00	436.5158	0.0868	1.0000

Remark:

- 1.GSM Operating Band: Frame-average power=Burst power+Division Factors(-9.19).
- 2."Maximum Power"comes from the largest "Tune-up"provided by the customer.

Note: The antenna gain specified in the table is based on the antenna configured for the finished product.

LTE power results are derived from the module report, FCC ID: XMR2023EG912UGL
grant data: 02/28/2023
simultaneous emission

Power density Limits (mW/cm ²) BLE	Power density Limits (mW/cm ²) WIFI	Power density Limits (mW/cm ²) U-NII	Power density Limits (mW/cm ²) LTE	Calculate Evaluation result (mW/cm ²)	Power density Limits (mW/cm ²)
0.0006	0.0179	0.0103	0.1046	0.1334	1

Conclusion:

For the max result : $0.1334 \leq 1$ for Max Power Density, compliance RF exposure.



Signature:

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