

FCC ID: 2AXDW-PD9

Maximum Permissible Exposure (MPE)

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

$$E \text{ (V/m)} = \frac{\sqrt{30 * P * G}}{d} \qquad \text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

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

Module 1 BT:

Operation Frequency: 2402MHz~2480MHz

Power density limited: $1\text{mW}/\text{cm}^2$

Antenna Type: FPCB antenna

WIFI antenna gain: 5.56dBi;

R=20cm

$\text{mW}=10^{(\text{dBm}/10)}$

antenna gain Numeric= $10^{(\text{dBi}/10)}=10^{(5.56/10)}=3.6$

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)	Numeric		
2402	GFSK	5.863	6.5±1	7.5	5.623413	3.6	0.00403	1
2441		7.029	6.5±1	7.5	5.623413	3.6	0.00403	1
2480		5.879	6.5±1	7.5	5.623413	3.6	0.00403	1
2402	π/4-DQPSK,	8.037	8.5±1	9.5	8.912509	3.6	0.00638	1
2441		9.4	8.5±1	9.5	8.912509	3.6	0.00638	1
2480		8.022	8.5±1	9.5	8.912509	3.6	0.00638	1
2402	8DPSK	8.487	9±1	10	10	3.6	0.00716	1
2441		9.547	9±1	10	10	3.6	0.00716	1
2480		8.503	9±1	10	10	3.6	0.00716	1
2402	BLE(GFSK)	7.968	8±1	9	7.943282	3.6	0.00569	1
2440		7.15	8±1	9	7.943282	3.6	0.00569	1
2480		8.54	8±1	9	7.943282	3.6	0.00569	1

2.4G WIFI:

Operation Frequency: WIFI 802.11b/g/n HT20: 2412-2462MHz,

WIFI 802.11n HT40:2422-2452MHz

Power density limited: $1\text{mW}/\text{cm}^2$

Antenna Type: FPCB antenna

WIFI antenna gain: 5.56dBi;

R=20cm

$\text{mW}=10^{(\text{dBm}/10)}$

antenna gain Numeric= $10^{(\text{dBi}/10)}=10^{(5.56/10)}=3.6$

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)	Numeric		
2412	802.11b	10.95	11±1	12	15.84893	3.6	0.01135	1
2437		11.21	11±1	12	15.84893	3.6	0.01135	1
2462		11.39	11±1	12	15.84893	3.6	0.01135	1
2412	802.11g	9.93	10±1	11	12.58925	3.6	0.00902	1
2437		9.89	10±1	11	12.58925	3.6	0.00902	1
2462		10.09	10±1	11	12.58925	3.6	0.00902	1
2412	802.11n H20	9.9	10±1	11	12.58925	3.6	0.00902	1
2437		9.91	10±1	11	12.58925	3.6	0.00902	1
2462		10.21	10±1	11	12.58925	3.6	0.00902	1
2422	802.11n H40	10.3	10±1	11	12.58925	3.6	0.00902	1
2437		10.44	10±1	11	12.58925	3.6	0.00902	1
2452		10.12	10±1	11	12.58925	3.6	0.00902	1

Measurement Result

Module 2 BT:

Operation Frequency: 2402MHz~2480MHz

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

WIFI antenna gain: 5.41dBi;

R=20cm

$mW=10^{(dBm/10)}$

antenna gain Numeric= $10^{(dBi/10)}=10^{(5.41/10)}=3.48$

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)	Numeric		
2402	GFSK	6.285	7±1	8	6.309573	3.48	0.00437	1
2441		6.948	7±1	8	6.309573	3.48	0.00437	1
2480		7.01	7±1	8	6.309573	3.48	0.00437	1
2402	π/4-DQPSK,	8.319	9±1	10	10	3.48	0.00692	1
2441		8.853	9±1	10	10	3.48	0.00692	1
2480		9.518	9±1	10	10	3.48	0.00692	1
2402	8DPSK	8.667	9±1	10	10	3.48	0.00692	1
2441		9.106	9±1	10	10	3.48	0.00692	1
2480		9.79	9±1	10	10	3.48	0.00692	1
2402	BLE(GFSK)	6.595	6±1	7	5.011872	3.48	0.00347	1
2440		6.436	6±1	7	5.011872	3.48	0.00347	1
2480		6.834	6±1	7	5.011872	3.48	0.00347	1

2.4G WIFI:

Operation Frequency: WIFI 802.11b/g/n HT20: 2412-2462MHz,HT40:2422-2452MHz

Power density limited: 1mW/ cm²

Antenna Type: FPCB antenna

WIFI antenna gain1/2: 5.41dBi/3.98dBi

R=20cm

$mW=10^{(dBm/10)}$

antenna gain Numeric= $10^{(dBi/10)}=10^{(5.41/10)}=3.48$

antenna gain Numeric= $10^{(dBi/10)}=10^{(3.98/10)}=2.50$

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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)	Numeric		
2412	802.11b	14.81	15±1	16	39.81072	2.5	0.01980	1
2437		14.77	15±1	16	39.81072	2.5	0.01980	1
2462		15.24	15±1	16	39.81072	2.5	0.01980	1
2412	802.11g	13.07	13±1	14	25.11886	2.5	0.01249	1
2437		13.04	13±1	14	25.11886	2.5	0.01249	1
2462		13.36	13±1	14	25.11886	2.5	0.01249	1
2412	802.11n H20	13.1	13±1	14	25.11886	2.5	0.01249	1
2437		12.93	13±1	14	25.11886	2.5	0.01249	1
2462		13.18	13±1	14	25.11886	2.5	0.01249	1
2422	802.11n H40	12.51	12±1	13	19.95262	2.5	0.00992	1
2437		11.93	12±1	13	19.95262	2.5	0.00992	1
2452		11.97	12±1	13	19.95262	2.5	0.00992	1

Module 2 5G WIFI:

Operation Frequency: WIFI 802.11a/ac/n(HT20): 5180-5240MHz;5260-5320MHz,5500-5700MHz,5745-5825MHz;WIFI 802.11ac/n(HT40): 5190-5230MHz;5270-5310MHz,5510-5670MHz5755-5795MHz; WIFI 802.11ac80:5210-5210MHz;5290-5290MHz;5530-5610MHz; 5775-5775MHz

Power density limited: 1mW/cm

Antenna Type: FPCB antenna

WIFI antenna1/2 gain: 5.48/3.47dBi;

R=20cm

$mW=10^{(dBm/10)}$

antenna gain Numeric= $10^{(dBi/10)}=10^{(5.48/10)}=3.53$

antenna gain Numeric= $10^{(dBi/10)}=10^{(3.47/10)}=2.22$

5.2G

SISO

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)	Numeric		
5180	802.11a	8.407	8±1	9	7.943282	3.53	0.00558	1
5200		8.072	8±1	9	7.943282	3.53	0.00558	1
5240		7.749	8±1	9	7.943282	3.53	0.00558	1
5180	802.11n ac20	8.432	8±1	9	7.943282	3.53	0.00558	1
5200		8.054	8±1	9	7.943282	3.53	0.00558	1
5240		7.738	8±1	9	7.943282	3.53	0.00558	1
5190	802.11n ac40	9.968	9±1	10	10	3.53	0.00702	1
5230		9.506	9±1	10	10	3.53	0.00702	1
5180	802.11n 20	8.235	8±1	9	7.943282	3.53	0.00558	1
5200		7.969	8±1	9	7.943282	3.53	0.00558	1
5240		7.776	8±1	9	7.943282	3.53	0.00558	1
5190	802.11n 40	9.928	9±1	10	10.00	3.53	0.00702	1
5230		9.495	9±1	10	10.00	3.53	0.00702	1
5210	802.11ac 80	9.329	9±1	10	10	3.53	0.00702	1

5.3G

SISO

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)	Numeric		
5260	802.11a	8.323	8±1	9	7.943282	3.53	0.00558	1
5280		8.446	8±1	9	7.943282	3.53	0.00558	1
5320		7.643	8±1	9	7.943282	3.53	0.00558	1
5260	802.11n ac20	8.352	8±1	9	7.943282	3.53	0.00558	1
5280		8.529	8±1	9	7.943282	3.53	0.00558	1
5320		7.738	8±1	9	7.943282	3.53	0.00558	1
5270	802.11n ac40	9.164	9±1	10	10	3.53	0.00702	1
5310		9.279	9±1	10	10	3.53	0.00702	1
5260	802.11n 20	8.229	8±1	10	10	3.53	0.00702	1
5280		8.381	8±1	9	7.943282	3.53	0.00558	1
5320		7.525	8±1	9	7.943282	3.53	0.00558	1
5270	802.11n 40	8.892	9±1	10	10	3.53	0.00702	1
5310		9.243	9±1	10	10	3.53	0.00702	1
5290	802.11ac 80	8.432	8±1	9	7.943282	3.53	0.00558	1

5.6G
SISO

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max		Antenna Gain	Evaluation result at 20cm Power density(mW/cm2)	Power density Limits (mW/cm2)
				tune-up power				
				(dBm)	(mW)	Numeric		
5500	802.11a	7.969	8±1	9	7.943282	3.53	0.00558	1
5600		8.311	8±1	9	7.943282	3.53	0.00558	1
5700		8.226	8±1	9	7.943282	3.53	0.00558	1
5500	802.11ac20	7.979	8±1	9	7.943282	3.53	0.00558	1
5600		8.245	8±1	9	7.943282	3.53	0.00558	1
5700		8.089	8±1	9	7.943282	3.53	0.00558	1
5510	802.11ac40	9.618	9±1	10	10	3.53	0.00702	1
5590		9.762	9±1	10	10	3.53	0.00702	1
5670		9.875	9±1	10	10	3.53	0.00702	1
5500	802.11n 20	8.008	8±1	9	19.95	3.53	0.00627	1
5600		8.218	8±1	9	19.95	3.53	0.00627	1
5700		8.08	8±1	9	19.95	3.53	0.00627	1
5510	802.11n 40	9.398	9±1	10	19.95	3.53	0.00627	1
5590		9.737	9±1	10	19.95	3.53	0.00627	1
5670		9.681	9±1	10	19.95	3.53	0.00627	1
5530	802.11ac 80	9.482	9±1	10	19.95	3.53	0.00627	1
5610		9.777	9±1	10	19.95	3.53	0.00627	1

5.8G
SISO

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max		Antenna Gain	Evaluation result at 20cm Power density(mW/cm2)	Power density Limits (mW/cm2)
				tune-up power				
				(dBm)	(mW)	Numeric		
5745	802.11a	8.877	9±1	10	10	3.53	0.00702	1
5785		8.361	9±1	10	10	3.53	0.00702	1
5825		9.298	9±1	10	10	3.53	0.00702	1
5745	802.11ac20	8.709	9±1	10	10	3.53	0.00702	1
5785		8.254	9±1	10	10	3.53	0.00702	1
5825		9.245	9±1	10	10	3.53	0.00702	1
5755	802.11ac40	9.071	9±1	10	10	3.53	0.00702	1
5795		8.843	9±1	10	10	3.53	0.00702	1
5745	802.11n 20	8.766	9±1	10	10	3.53	0.00702	1
5785		8.206	9±1	10	10	3.53	0.00702	1
5825		9.295	9±1	10	10	3.53	0.00702	1
5755	802.11n 40	8.862	8±1	9	7.943282	3.53	0.00558	1
5795		8.717	8±1	9	7.943282	3.53	0.00558	1
5775	802.11ac 80	9.722	9±1	10	10.00	3.53	0.00702	1

Module 3 WCDMA/LTE
 Antenna Type: FPCB antenna
 WCDMA Antenna gain: 5.64dBi;

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 2	23.46	221.81964	0.0441	1.0000
WCDMA Band 4	23.75	237.13737	0.0472	1.0000
WCDMA Band 5	22.81	190.98533	0.0380	0.5644
LTE Band 2	23.82	240.99054	0.0479	1.0000
LTE Band 4	22.82	191.42559	0.0381	1.0000
LTE Band 5	23.23	210.37784	0.0419	1.0000
LTE Band 12	23.60	229.08677	0.0456	0.4717
LTE Band 13	22.52	178.64876	0.0355	0.5213
LTE Band 25	22.18	165.19618	0.0329	1.0000
LTE Band 26A	22.38	172.98164	0.0344	0.5460
LTE Band 26B	23.70	234.42288	0.0466	0.5577
LTE Band 41	22.64	183.65383	0.0365	1.0000
LTE Band 66	22.58	181.13401	0.0360	1.0000

Module 2 WLAN2.4G MIMO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
Ant 1	12.82	5.41	18.23	66.53	20	0.013235	1	0.023391	Pass
Ant 2	13.10	3.98	17.08	51.05	20	0.010156	1		

Module 2 WLAN5G MIMO

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm ²)	MPE Limit (mW/cm ²)	Calculation result	Conclusion
Ant 1	9.968	5.48	15.448	35.06	20	0.006975	1	0.010335	Pass
Ant 2	8.806	3.47	12.276	16.89	20	0.003360	1		

Conclusion:

The conclusion should be $0.0479 < 0.4717$ for Max Power Density, Compliance the RF Exposure requirement.

The 2.4Gwifi module 2 has the maximum Power Density value 0.023391 mW/cm² in 2.4G MIMO transmitting mode;

The 5Gwifi module 2 has the maximum Power Density value 0.010335 mW/cm² in 5G MIMO transmitting mode;

Module 1&Module 2 and Module 3 cannot be transmitted at the same time.

In a separate module, WIFI and BT cannot be sent at the same time.

Signature:

Date: 2022-01-10



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