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) , Part 2.1091

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 (V/m) = $\frac{\sqrt{30*P*G}}{d}$ Power Density: *Pd* (W/m²) = $\frac{E^2}{377}$

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.

BT:
Measurement Result
Operation Frequency: 2402MHz~2480MHz
Power density limited: 1mW/ cm^2
Antenna Type: FPC Antenna
Antenna gain: 4.62dBi
R=20cm
mW=10^(dBm/10)
Max antenna gain Numeric=10^(dBi/10)=10^(4.62/10)=2.90

BR EDR

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max tune-up power (dBm)	Max tune-up power (mW)	Antenna Gain (dBi)	Antenna Gain Numeric	Evaluation result (mW/cm2)	Power density (mW/cm2)
2402	GFSK	5.89	6±1	7	5.012	4.62	2.90	0.00289	1
2441		6.73	6±1	7	5.012	4.62	2.90	0.00289	1
2480		7.14	6±1	7	5.012	4.62	2.90	0.00289	1
2402	π/4-DQPSK	5.08	6±1	7	5.012	4.62	2.90	0.00289	1
2441		5.38	6±1	7	5.012	4.62	2.90	0.00289	1
2480		5.81	6±1	7	5.012	4.62	2.90	0.00289	1
2402	8-DPSK	5.02	6±1	7	5.012	4.62	2.90	0.00289	1
2441		5.34	6±1	7	5.012	4.62	2.90	0.00289	1
2480		5.89	6±1	7	5.012	4.62	2.90	0.00289	1

BLE

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max tune-up power (dBm)	Max tune-up power (mW)	Antenna Gain (dBi)	Antenna Gain Numeric	Evaluation result (mW/cm2)	Power density (mW/cm2)
2402	GFSK(1M)	3.28	3±1	4	2.512	4.62	2.90	0.00145	1
2440		3.26	3±1	4	2.512	4.62	2.90	0.00145	1
2480		3.67	3±1	4	2.512	4.62	2.90	0.00145	1

Channel Freq. (MHz)	modulation	conducted power (dBm)	Tune-up power (dBm)	Max tune-up power (dBm)	Max tune-up power (mW)	Antenna Gain (dBi)	Antenna Gain Numeric	Evaluation result (mW/cm2)	Power density (mW/cm2)
2402	GFSK(1M)	3.26	3±1	4	2.512	4.62	2.90	0.00145	1
2440		3.22	3±1	4	2.512	4.62	2.90	0.00145	1
2480		3.75	3±1	4	2.512	4.62	2.90	0.00145	1

2.4G WIFI/5G WIFI:

Operation Frequency: WIFI 802.11b/g/n HT20: 2412-2462MHz,
WIFI 802.11n HT40:2422-2452MHz
Power density limited: 1mW/ cm^2
Antenna Type: Ant0: FPC Antenna, Ant1: FPC Antenna
Antenna gain: Ant0: 2.05dBi, Ant1: 4.62dBi

Operation Frequency: WIFI 802.11a/ac/n(HT20): 5180-5240MHz; 5745-5825MHz;
WIFI 802.11ac/n(HT40): 5190-5230MHz;5755-5795MHz;
WIFI 802.11ac80:5210-5210MHz;5775-5775MHz

Power density limited: 1mW/cm
Antenna Type: Ant0:FPC Antenna, Ant1: FPC Antenna
Antenna gain: Ant0: 5.06dBi, Ant1: 5.46dBi
R=20cm
mW=10^(dBm/10)

WLAN2.4G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm^2)	MPE Limit (mW/cm^2)	Conclusion
Ant0	18.11	2.05	20.16	103.75	20	0.02064	1	Pass
Ant1	17.98	4.62	22.60	181.97	20	0.03620	1	

WLAN5.2G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm^2)	MPE Limit (mW/cm^2)	Conclusion
Ant0	12.5	5.06	17.56	57.02	20	0.01134	1	Pass
Ant1	13.33	5.46	18.79	75.68	20	0.01506	1	

WLAN5.3G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	MPE Limit (mW/cm2)	Conclusion
Ant0	12.06	5.06	17.12	51.52	20	0.01025	1	Pass
Ant1	11.7	5.46	17.16	52.00	20	0.01034	1	

WLAN5.6G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	MPE Limit (mW/cm2)	Conclusion
Ant0	11.77	5.06	16.83	48.19	20	0.00959	1	Pass
Ant1	11.39	5.46	16.85	48.42	20	0.00963	1	

WLAN5.8G SISO MODE max result

Antenna	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	MPE Limit (mW/cm2)	Conclusion
Ant0	12.27	5.06	17.33	54.08	20	0.01076	1	Pass
Ant1	11.84	5.46	17.3	53.70	20	0.01068	1	

SIMULTANEOUS TRANSMISSIONS

When a number of sources at different frequencies, and/or broadband sources, contribute to the total exposure, it becomes necessary to weigh each contribution relative to the MPE. To comply with the MPE, the fraction of the MPE in terms of E^2, H^2 (or power density) incurred within each frequency interval should be determined and the sum of all such fractions should not exceed unity. In order to ensure compliance with the MPE for a controlled environment, the sum of the ratios of the power density to the corresponding MPE should not exceed unity. That is

$$\sum_{i=1}^{n} \frac{S_i}{MPE_i} \leq 1$$

WLAN2.4G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	4.62	11.62	14.52	20	0.00289	0.07152	1	Pass
WIFI 2.4G ANT0	16.86	6.44	23.30	213.80	20	0.04253			
WIFI 2.4G ANT1	14.74	6.44	21.18	131.22	20	0.02610			

WLAN5.2G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	4.62	11.62	14.52	20	0.00289	0.03210	1	Pass
WIFI 5.2G ANT0	10.53	8.27	18.80	75.86	20	0.01509			
WIFI 5.2G ANT1	10.24	8.27	18.51	70.96	20	0.01412			

WLAN5.3G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	4.62	11.62	14.52	20	0.00289	0.03108	1	Pass
WIFI 5.3G ANT0	10.42	8.27	18.69	73.96	20	0.01471			
WIFI 5.3G ANT1	10.04	8.27	18.31	67.76	20	0.01348			

WLAN5.6G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	4.62	11.62	14.52	20	0.00289	0.03556	1	Pass
WIFI 5.6G ANT0	11.72	8.27	19.99	99.77	20	0.01785			
WIFI 5.6G ANT1	10.76	8.27	19.03	79.98	20	0.01482			

WLAN5.8G MIMO MODE max result

Band	Tune-up limit (dBm)	Gain (dBi)	EIRP (dBm)	EIRP (mW)	R(cm)	S (mW/cm2)	Calculation result	Power density Limits (Ratio)	Conclusion
BT	7.00	4.62	11.62	14.52	20	0.00289	0.03865	1	Pass
WIFI 5.8G ANT0	11.72	8.27	19.99	99.77	20	0.01985			
WIFI 5.8G ANT1	10.76	8.27	19.03	79.98	20	0.01591			

Conclusion:

The conclusion for Max MIMO mode should be 0.073＜1 for Max Power Density, Compliance the RF exposure

Alex Li

Signature:
Date: 2024-12-27

NAME AND TITLE (Please print or type): alex li/Manager

COMPANY (Please print or type): Shenzhen NTEK Testing Technology Co., Ltd./ No. 24 Xinfa East Road, Xiangshan Community, Xinqiao Street, Baoan District, Shenzhen, Guangdong, People's Republic of China