

RF Exposure Evaluation

Limits

KDB 447498 D01 General RF Exposure Guidance v06

FCC CFR 47 part2 2.1091: Radiofrequency radiation exposure evaluation: mobile devices

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: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

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 is the limit of MPE, 1 mW/cm². 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.

$$EIRP = E_{Meas} + 20 \log(d_{Meas}) - 104.7$$

EIRP is the equivalent isotropically radiated power, in dBm

E_{Meas} is the field strength of the emission at the measurement distance, in dB μ V/m

d_{Meas} is the measurement distance, in m

Test Result of RF Exposure Evaluation

wifi 2.4G mode: ANT1&ANT2 MIMO

Channel	Output power to antenna (dBm)		Output power to antenna (mW)		Power Density at R=20cm (mW/cm ²)		Limit (mW/cm ²)	Result
	Antenna1	Antenna2	Antenna1	Antenna2	Antenna1	Antenna2		
802.11b	8.52	9.17	7.1121	8.2604	0.00177	0.00206	1.0	PASS
802.11g	8.97	9.03	7.8886	7.9983	0.00197	0.00199	1.0	PASS
802.11n20	9.81	9.76	9.5719	9.4624	0.00477	0.00472	1.0	PASS
802.11n40	9.21	9.17	8.3368	8.2604	0.00416	0.00412	1.0	PASS

Remark: antenna gain=-0.98dBi

Directional Gain=0.98dBi+10log(2)=3.99dBi.

wifi 5G mode: ANT1 & ANT2 SISO

Band 1

Channel	Output power to antenna (dBm)		Output power to antenna (mW)		Power Density at R=20cm (mW/cm ²)		Limit (mW/cm ²)	Result
	ANT1	ANT2	ANT1	ANT2	ANT1	ANT2		
802.11a	10.289	10.264	10.6881	10.6267	0.00345	0.00343	1.0	PASS
802.11ac HT20	10.325	10.78	10.7771	11.9674	0.00695	0.00772	1.0	PASS
802.11 ac HT40	10.096	9.577	10.2235	9.0719	0.00660	0.00585	1.0	PASS
802.11 ac HT80	9.944	10.066	9.8719	10.1531	0.00637	0.00655	1.0	PASS
802.11n HT20	10.309	10.324	10.7374	10.7746	0.00693	0.00695	1.0	PASS
802.11n HT40	9.492	9.514	8.8961	8.9413	0.00574	0.00577	1.0	PASS

Remark: antenna gain=2.10dBi

Directional Gain=2.10dBi+10log(2)=5.11dBi.

Band 4

Channel	Output power to antenna (dBm)		Output power to antenna (mW)		Power Density at R=20cm (mW/cm ²)		Limit (mW/cm ²)	Result
	ANT1	ANT2	ANT1	ANT2	ANT1	ANT2		
802.11a	9.001	9.253	7.9451	8.4198	0.00256	0.00272	1.0	PASS
802.11ac HT20	8.587	8.59	7.2227	7.2277	0.00466	0.00466	1.0	PASS
802.11 ac HT40	8.947	8.905	7.8469	7.7714	0.00506	0.00501	1.0	PASS
802.11 ac HT80	8.651	8.628	7.3299	7.2912	0.00473	0.00470	1.0	PASS
802.11n HT20	8.913	8.944	7.7857	7.8415	0.00502	0.00506	1.0	PASS
802.11n HT40	9.053	9.047	8.0408	8.0297	0.00519	0.00518	1.0	PASS

Remark: antenna gain=2.10dBi

Directional Gain=2.10dBi+10log(2)=5.11dBi.

For BLE

Field strength (dBuV/m)	EIRP (dBm)	Max tune-up (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
84.46	-10.7	0.0851	0.00002	1.0	PASS

Remark: antenna gain= 0.98dBi

For EDR

Field strength (dBuV/m)	EIRP (dBm)	Max tune-up (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
84.63	-10.53	0.0885	0.00002	1.0	PASS

Remark: antenna gain= 0.98dBi

For Simultaneous transmitting, 1): The sum of the ratios of the spatially averaged results to the applicable frequency dependent MPE limits = $0.00477/1+0.00472/1+0.00695/1+0.00772/1+0.00259/1+0.00519/1+0.00518/1=0.03712< 1$ Since the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in the device is ≤ 1.0 , the EUT is considered to satisfy MPE compliance for simultaneous transmission operations.