

RF EXPOSURE EVALUATION

Limits

According KDB 447498 D01 General RF Exposure Guidance v06.

The RF exposure evaluation requirements of §2.1091 for mobile device exposure conditions subject to MPE limits: Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular § 1.1307(b).

For purposes of this section, the definitions in § 1.1307(b)(2) of this chapter shall apply. A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the RF source's radiating structure(s) and the body of the user or nearby persons. In this context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location while transmitting. Transmitting devices designed to be used by consumers or workers that can be easily re-located, such as wireless devices associated with a personal desktop computer, are considered to be mobile devices if they meet the 20-centimeter separation requirement.

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: $Pd = (Pout \cdot G) / (4 \cdot \pi \cdot r^2)$

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.

Test Result of RF Exposure Evaluation

BLE:

Mode	Output power to antenna (dBm)	Tune UP tolerance (dBm)	Max Tune UP power (dBm)	Max Tune UP power (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
GFSK	-3.61	3±1	-2	0.63	0.0002	1.0	PASS

Antenna gain: 2.43dBi

EDR

Mode	Output power to antenna (dBm)	Tune UP tolerance (dBm)	Max Tune UP power (dBm)	Max Tune UP power (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
GFSK	0.53	0±1	1	1.26	0.0004	1.0	PASS
π/4-DQPSK	-0.71	0±1	1	1.26	0.0004	1.0	PASS
8-DPSK	-0.46	0±1	1	1.26	0.0004	1.0	PASS

Antenna gain: 2.43dBi

WIFI2.4G:

Mode	Output power to antenna (dBm)	Tune UP tolerance (dBm)	Max Tune UP power (dBm)	Max Tune UP power (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11b	16.8	16±1	17	50.12	0.0174	1.0	PASS
802.11g	16.11	16±1	17	50.12	0.0174	1.0	PASS
802.11n20	16.03	16±1	17	50.12	0.0174	1.0	PASS
802.11n40	15.99	15±1	16	39.81	0.0139	1.0	PASS

Antenna gain: 2.43dBi

WIFI5.1G:

Mode	Output power to antenna (dBm)	Tune UP tolerance (dBm)	Max Tune UP power (dBm)	Max Tune UP power (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11a	13.06	13±1	14	25.12	0.008	1.0	PASS
802.11n20	12.89	12±1	13	19.95	0.0063	1.0	PASS
802.11n40	12.84	12±1	13	19.95	0.0063	1.0	PASS
802.11ac20	12.84	12±1	13	19.95	0.0063	1.0	PASS
802.11ac40	12.24	12±1	13	19.95	0.0063	1.0	PASS
802.11ac80	12.54	12±1	13	19.95	0.0063	1.0	PASS

Antenna gain: 2.03dBi

WIFI5.8G:

Mode	Output power to antenna (dBm)	Tune UP tolerance (dBm)	Max Tune UP power (dBm)	Max Tune UP power (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
802.11a	12.95	12±1	13	19.95	0.0093	1.0	PASS
802.11n20	11.99	11±1	12	15.85	0.0074	1.0	PASS
802.11n40	11.93	11±1	12	15.85	0.0074	1.0	PASS
802.11ac20	11.97	11±1	12	15.85	0.0074	1.0	PASS
802.11ac40	12.37	12±1	13	19.95	0.0093	1.0	PASS
802.11ac80	11.45	11±1	12	15.85	0.0074	1.0	PASS

Antenna gain: 3.71dBi

Remark: The same antenna cannot transmit at the same time, ANT1 & ANT2 can transmit at the same time, So the worst simultaneous transmitting consideration:

The ratio = $\text{ANT1 MPE}_{(\text{MAX})} / \text{limit} + \text{ANT2 MPE}_{(\text{MAX})} / \text{limit} = 0.0004 / 1.0 + 0.0093 / 1.0 = 0.0097 < 1.0$.