

FCC RF Exposure Analysis

Revision	Report Date	Reason for Revision
Ø	July 22, 2021	Initial Issue.
1	August 9, 2021	Review Updates.
1.1	April 01, 2023	Review Updates.

FCC RF Exposure Evaluation of Devices

RF Exposure Requirements: §1.1307(b)(1) and §1.1307(b)(2): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: §1.1310: As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) 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
(ii) 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

RF Exposure Limits

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S = Power Density (mW/cm²)

P = Power Input to antenna (mW)

G = Antenna Gain (numeric value)

R = Distance (cm)

For Antenna Gain $dBi = 10 \log(\text{Numeric})$

Test Results:

Band	Frequency	Maximum Conducted Power	Tune-Up Tolerance	Tune-up Conducted Power	Antenna Gain	Antenna Gain	Power Density	Limit	Margin	Distance	Result
	(MHz)	(dBm)	-	(mW)	(dBi)	(Numeric)	(mW/cm2)	(mW/cm2)	-	(cm)	-
GSM 850	831.5	26	±1dB	501.182	2.56	1.803	0.180	0.554	-0.0792	20	Pass
GSM 1900	1880.0	23	±1dB	251.188	6.10	4.074	0.204	1	-0.2486	20	Pass
WCDMA B2	1880.0	25	±1dB	398.107	6.10	4.074	0.323	1	-0.1296	20	Pass
WCDMA B5	836.5	25	±1dB	398.107	2.56	1.803	0.143	0.558	-0.1172	20	Pass
LTE B2	1880.00	25	±1dB	398.107	6.10	4.074	0.323	1	-0.1296	20	Pass
LTE B4	1732.5	25	±1dB	398.107	6.10	4.074	0.323	1	-0.105	20	Pass
LTE B5	836.5	25	±1dB	398.107	2.56	1.803	0.143	0.558	-0.1172	20	Pass
LTE B12	707.5	25	±1dB	398.107	-0.32	0.929	0.074	0.472	-0.1581	20	Pass
LTE B13	782.0	25	±1dB	398.107	-0.32	0.929	0.074	0.521	-0.1745	20	Pass
LTE B25	1882.5	25	±1dB	398.107	6.10	4.074	0.323	1	-0.13	20	Pass
LTE B26	831.5	25	±1dB	398.107	2.56	1.803	0.143	0.554	-0.1162	20	Pass
LTE B41	2506.0	25	±1dB	398.107	3.46	2.218	0.176	1	-0.3748	20	Pass
LoRa	915.0	12	±1dB	19.952	2.56	1.803	0.00716	0.61	-0.26954	20	Pass
BT/WLAN 2.4 GHz	2437.0	15	±1dB	39.817	3.46	2.218	0.0176	1	-0.5228	20	Pass
WLAN 5 GHz	5180.0	14	±1dB	31.622	2.40	1.738	0.0109	1	-0.8938	20	Pass

MPE Calculation for Bands

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Note: Results are based on KDB 447498 D01 (Section 7.2) Transmitters used in mobile devices exposure conditions for simultaneous transmission operations.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modeled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

Cellular & LoRa & BT/WiFi can transmit simultaneously, the formula for calculating the simultaneous MPE is

$$CPD1/LPD1 + CPD2/LPD2 + \dots + CPDn/LPDn < 1$$

CPD: Calculated Power Density

LPD: Limit of Power Density

Simultaneous Transmission

Case 1

	Power Density	Limit	Ratio		
Cellular	0.18	0.554	0.3249		
LoRa	0.0071	0.61	0.0117		
BT/WiFi 2.4G	0.0176	1	0.0176		
SUM	NA	NA	0.3542	< 1	Pass

Case 2

	Power Density	Limit	Ratio		
Cellular	0.18	0.554	0.3249		
LoRa	0.0071	0.61	0.0117		
WiFi 5G	0.0109	1	0.0109		
SUM	NA	NA	0.3475	< 1	Pass