RF Exposure

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	June 16, 2021	Initial Issue.

Electromagnetic Compatibility Emission Criteria

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/cm^2)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

For Antenna Gain → **dBi = 10log(Numeric)**

Technology	TX Frequency Range	Peak Gain	Type
LTE CAT-M1 Band 2	1850 – 1910 MHz	4.3 dBi	FPC Embedded Antenna
LTE CAT-M1 Band 4	1710 – 1755 MHz	4.3 dBi	FPC Embedded Antenna
LTE CAT-M1 Band 5	814 – 849 MHz	2.9 dBi	FPC Embedded Antenna
LTE CAT-M1 Band 13	777 – 787 MHz	2.9 dBi	FPC Embedded Antenna

Table 1.. EUT Antenna Gain Specifications

Technology	TX Frequency Range	Maximum Conducted Output Power
LTE CAT-M1 Band 2	1850 – 1910 MHz	22 (-3 ~ +1dB) = 23.0 dBm
LTE CAT-M1 Band 4	1710 – 1755 MHz	22 (-3 ~ +1dB) = 23.0 dBm
LTE CAT-M1 Band 5	814 – 849 MHz	22 (-3 ~ +1dB) = 23.0 dBm
LTE CAT-M1 Band 13	777 – 787 MHz	22 (-3 ~ +1dB) = 23.0 dBm

Table 2. Tune up Power

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm2)	Limit (mW/cm2)	Margin	Distance (cm)	Result
LTE Band 2	1850	23	199.53	4.3	2.692	0.107	1	0.893	20	Pass
LTE Band 4	1710	23	199.53	4.3	2.692	0.107	1	0.893	20	Pass
LTE Band 5	814	23	199.53	2.9	1.950	0.077	0.543	0.465	20	Pass
LTE Band 13	777	23	199.53	2.9	1.950	0.077	0.518	0.441	20	Pass

Table 3. MPE Calculation for Cellular Bands

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

		FCC		
	Frequency (MHz)	57000	71000	
PG	Declared Max Power (EIRP)	-2.1	-2.1	dBm
R	Distance	20	20	cm
S	MPE limit for uncontrolled exposure	1	1	mW/cm2
	Calculated Power Density	0.0001	0.0001	mW/cm2

Table 4. MPE Calculation for Radar

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 and Radar radios can transmit simultaneously.

T the formula for calculating the simultaneous MPE is

CPD1/LPD1 + CPD2/LPD2 + „„ CPDn/LPDn < 1

CPD: Calculated Power Density
LPD: Limit of Power Density

Simultaneous MPE =	**Cellular**	**+**	**Radar**
	=	0.077/0.518	+	0.0001/1
	=	0.148	+	0.0001
	= 0.1481			

Result: 0.1481 < 1 (Pass)

END OF REPORT