

RF Exposure Evaluation

Limits

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

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.

Test Result of RF Exposure Evaluation

Band	Frequency	Max output power (dBm)	Output power (mW)	Antenna gain (dBi)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Verdict
2.4G	2441MHz	-1.03	0.79	-1.8	0.00010	1.0	PASS
BLE	2440MHz	7.40	5.50	-1.8	0.00072	1.0	PASS

According to ANSI C63.10

Where:

$EIRP\ (dBm) = E(dBuV/m) - 95.2$

$E = \text{Field Strength (dBuV/m)}$

So 2.4G output power = $EIRP - \text{Antenna gain} = 92.37 - 95.2 + 1.8 = -1.03dBm$

RF Exposure Evaluation

According to 447498 D04 Interim General RF Exposure Guidance v01

Per § 1.1307(b)(3)(i)(A), a single RF source is exempt RF device (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.

This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

Frequency(MHz)	Field Strength (dBuv/m)	erp(mW)	limit (mW)
13.56	47.45	0.000041	1

according to ANSI C63.10

where:

$F < 30\text{MHz}$: $\text{EIRP}[\text{dBm}] = E[\text{dBuV/m}] - 95.2 + 6$

$\text{ERP} = \text{EIRP} - 2.15\text{dB}$

$E = \text{Field Strength (dBuV/m)}$

$\text{ERP} = 47.45 - 95.2 + 6 - 2.15 = -43.9\text{dBm}$

Simultaneous Transmission:

$$\sum_{k=1}^c \frac{\text{Evaluated}_k}{\text{Exposure Limit}_k}$$

$\text{BLE} + 2.4\text{G} + \text{NFC} = (0.00010/1) + (0.000072/1) + (0.000041/1) = 0.00010 + 0.00072 + 0.000041 = 0.000861 < 1$

Then SAR evaluation is not required