

5.6. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]

5.6.1. Limits

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental 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

* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

5.6.2. Method of Measurements

Calculation Method of Power Density/RF Safety Distance:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where,
 P: power input to the antenna in mW
 EIRP: Equivalent (effective) isotropic radiated power.
 S: power density mW/cm²
 G: numeric gain of antenna relative to isotropic radiator
 r: distance to centre of radiation in cm

5.6.3. RF Evaluation

Remark(s):

The EUT contained ZigBee/ BLE and WiFi radio modules with the following operating conditions:

- BLE and WiFi may transmit at the same time
- Zigbee and WiFi may transmit at the same time
- BLE and Zigbee will NOT transmit at the same time

Pursuant to KDB 447498 D01 General RF Exposure Guidance v06, Section 7.2:

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 sum of the MPE ratios for all simultaneously transmitting antennas incorporated in the EUT is ≤ 1.0 as calculated in the following table.

EUT Co-located MPE for BLE/Zigbee with WiFi Radio								
Transmitter	Frequency Band (MHz)	Frequency	Max. EIRP (dBm)	Max. EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm ²)	Power Density Limit (mW/cm ²)	Power Density MPE Ratio
BLE	2402-2480	2402	25.53	357.273	20	0.071	1.0	0.071
Zigbee	2405-2480	2405	25.47	352.371	20	0.070	1.0	0.070
802.11b	2412-2462	2412	28.36	685.488	20	0.136	1.0	0.136
802.11g	2412-2462	2412	28.83	763.836	20	0.152	1.0	0.152
802.11n	2412-2462	2412	28.65	732.825	20	0.146	1.0	0.146
Worst Case Combination (BLE with WiFi 802.11g mode) :								0.223

ULTRATECH GROUP OF LABS

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
 Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: <http://www.ultratech-labs.com>

File #: 18MMBN004_FCC15C247B
 November 29, 2018

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)