Maximum Permissible Exposure to RF (MPE), CFR 1.1310 (e)

The maximum exposure level to the public from the RF power of the EUT shall not exceed a power density, **S** as per the respective limits in Table 1 below, at a distance, d, of 20 cm (Mobile condition) from the EUT.

TABLE 1—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)
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

f = frequency in MHz * = Plane-wave equivalent power density

Therefore, for:

MPE for 2404 MHz – 2480 MHz for BLE:

Limit: 1.0 mW/cm^2

Peak Power (dBuV/m @ 3m) = 94.81 dBuV/m = -0.45 dBm
Peak Power (Watts) = 0.0011 W
Gain of Transmit Antenna = -0.5 dB_i = 0.89 numeric

d = Distance = 20 cm = 0.2 m

$S = (PG/ 4\pi d^2)$ = EIRP/4A = 0.0011 (0.89)/4*π*0.2*0.2
= 0.0010/0.5030 = 0.0019 W/m^2
= (0.0019 W/m^2) (1m^2/W) (0.1 mW/cm^2)
= 0.0002 mW/cm^2

which is << less than S = 1.0 mW/cm^2

MPE for 2412 MHz – 2462 MHz for WiFi:

Limit: 1.0 mW/cm^2
Peak Power (dBm) = 13.0 dBm
Peak Power (Watts) = 0.020 W
Gain of Transmit Antenna = -0.5 dB_i = 0.89 numeric(Highest Gain Antenna)
d = Distance = 20 cm = 0.2 m

$S = (PG/ 4\pi d^2)$ = EIRP/4A = 0.020(0.89)/4*π*0.2*0.2
= 0.0178/0.5030 = 0.0354 W/m^2
= (0.0354 W/m^2) (1m^2/W) (0.1 mW/cm^2)
= 0.00354 mW/cm^2

which is << less than S = 1.0 mW/cm^2

MPE for 2400 MHz – 2483.5 MHz for Ultralow BLE:

Limit: 1.0 mW/cm^2
Peak Power (dBm) = 38.72 dBuV/m = -56.5 dBm
Peak Power (Watts) = 0.001 W
Gain of Transmit Antenna = +7.0 dB_i = 5.01 numeric(Highest Gain Antenna)
d = Distance = 20 cm = 0.2 m

$S = (PG/ 4\pi d^2)$ = EIRP/4A = 0.001(5.01)/4*π*0.2*0.2
= 0.0050/0.5030 = 0.0010 W/m^2
= (0.0010 W/m^2) (1m^2/W) (0.1 mW/cm^2)
= 0.0001 mW/cm^2

which is << less than S = 1.0 mW/cm^2

RSS-102, 2.5.2 compliance for 433.164 MHz – 435.324 MHz:

At or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

for 2404 MHz – 2480 MHz:

Limit= $1.31 \times 10^{-2} \times 2440^{0.6834}$ = 2.7 Watts

Max EIRP for BLE = -0.45 dBm + -0.5 dBi = -0.95 dBm = 0.80 mW << 2700 mW

RSS-102, 2.5.2 compliance for 2412 MHz – 2462 MHz:

Limit= $1.31 \times 10^{-2} \times 2440^{0.6834}$ = 2.7 Watts

Max EIRP for WiFi = 13.0 dBm + -0.5 dBi = 12.5 dBm = 17.78 mW << 2700 mW

RSS-102, 2.5.2 compliance for 2400 MHz – 2482.5 MHz:

Limit= $1.31 \times 10^{-2} \times 2440^{0.6834}$ = 2.7 Watts

Max EIRP for WiFi = -56.5 dBm + 7.0 dBi = -49.5 dBm = 0.001 mW << 2700 mW

All calculations performed by:
Date: 8-26-22
Test Engineer: George Yang

Signature: 

Simultaneous Transmission Collocation considerations:

Please either confirm that the transmitters operate standalone per KDB 447498 D01 v06 section 7.1 or, if the transmitters can transmit simultaneously, include the necessary calculations for simultaneous transmission per KDB 447498 D01 v06 section 7.2.

Please either confirm that the transmitters operate standalone or, if the transmitters can transmit simultaneously, include the necessary calculations for simultaneous transmission per ISED RSS-102 issue 5 section 3.1.2.

The Transmitters **do** simultaneously broadcast at the same frequency band, 2400-2483.5 MHz. The device has three radios on board, however two of the radios are ultra low energy transmitters and the last radio is Wi-Fi or BLE combo radio and not both can transmit at the same time. The radios that operate at the same time is either the Wi-Fi and ultra low energy transmitters or BLE and ultra low energy transmitters.

The Wi-Fi and BLE radio share a common antenna. The ultra low energy transmitter has it's own transmit antenna.

Calculations for simultaneous transmission per KDB 447498 D01 v06 section 7.2 is provided here to show that Simultaneous transmission MPE test exclusion applies since the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0.

Per ISED RSS-102 (I5) section 3.1.2 other recognized methods can be used to show compliance, therefore this method is used to show compliance to RSS-102.

Total Sum of MPE:

Sum of the total MPE for both frequency bands =
0.0002/1 mW/cm^2 + 0.0035/1.0 mW/cm^2 + 0.0001/1.0 mW/cm^2 = 0.0038 which is << less than 1.0

The EUT was tested with all radios ON and active. The emissions generated with a single radio ON and active versus all radios ON and active did not produce additional unwanted spurious emissions or intermodulation that would require additional testing. The radios can be collocated as designed.