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

5.5.1. 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.

5.5.2. **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/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

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

5.5.3. **RF Evaluation**

Separation distance specified by Manufacturer is 31cm, the power density and MPE ratio are calculated for this distance

Configuration 1: Alert Labs RN2903 radio-Standalone

Frequency (MHz)	Equivalent Output Conducted Power (mW)	Maximum Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Distance, r (cm)	Power Density, S (mW/cm^2)	MPE Limit (mW/cm^2)	Margin (mW/cm^2)	RN2903 MPE Ratio
903	81	2.33	21.41	138.36	31	0.0114	0.602	-0.590	0.019

Configuration 2: Co-location

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.

As per the Manufacturer the EUT Alert Labs RN2903, can simultaneously transmit with either the cellular radio (SARA-U260) or Wifi radio (Espressif Systems WROOM Module)

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Configuration 2.1- EUT (RN2903) co-location with Cellular radio module- SARA-U260 GSM/UMTS Module
FCC ID: XPYSARAU260
IC: 8595A-SARAU260

Frequency (MHz)	Equivalent Output Conducted Power (mW)	Maximum Antenna Gain (dBi)	EIRP (mW)	Distance (cm)	SARA-U260 Power Density (mW/cm^2)	FCC MPE Limit (mW/cm^2)	SARA-U260 MPE Ratio	RN2903 MPE Ratio	SARA-U260 and RN2903 MPE Ratio Sum
848.8	1256.03	3.50	2811.90	31	0.233	0.566	0.411	0.019	0.430
1850.2	629.51	3.10	1285.29	31	0.106	1.000	0.106	0.019	0.125
846.6	1258.93	3.50	2818.38	31	**0.233**	0.564	0.414	0.019	**0.433**
846.6	251.19	3.50	562.34	31	0.047	0.564	0.083	0.019	0.102
836.6	251.19	3.50	562.34	31	0.047	0.558	0.083	0.019	0.102
1852.4	251.19	3.10	512.86	31	0.042	1.000	0.042	0.019	0.061
1907.6	251.19	3.10	512.86	31	0.042	1.000	0.042	0.019	0.061
1880.0	251.19	3.10	512.86	31	0.042	1.000	0.042	0.019	0.061

Configuration 2.2- EUT(RN2903) co-location with Wifi radio module- Espressif Systems WROOM Wi-Fi Module
FCC ID: 2AC7Z-ESPWROOM02
IC: 21098-ESPWROOM02

Frequency (MHz)	Equivalent Output Conducted Power (mW)	Maximum Antenna Gain (dBi)	EIRP (mW)	Distance (cm)	WROOM Wi-Fi Power Density (mW/cm^2)	FCC MPE Limit (mW/cm^2)	WROOM Wi-Fi MPE Ratio	RN2903 MPE Ratio	WROOM Wi-Fi and RN2903 MPE Ratio Sum
2412.0	225	2.00	356.45	31	0.030	1.000	0.030	0.019	0.049

* The test data of the radio modules represented in the above tables are the worst-case configuration (maximum MPE ratio) derived from the original radio modules MPE reports. Refer to these reports for details.

Verdict: The user manual specified distance of 31 cm is sufficient to meet the MPE exposure limits ie, Sum of MPE ratio $\leq$1.