Environmental evaluation and exposure limit according to FCC CFR 47part 1, §1.1307, §1.1310

The Controller is classified as a mobile device. The Controller includes 915MHz transmitter, Wi-Fi & Bluetooth module approved under FCC ID: 2AC7Z-ESP32WROVERE and Cellular module approved under FCC ID: XMR201910BG95M3.
The Controller can work together or 915MHz and approved Wi-Fi module or
915MHz and approved Cellular module.
* Wi-Fi and BLE won't work together as it's the same chipset and antenna

The FCC limit for power density for general population/uncontrolled exposure is f/1500 mW/cm^2 for 300 – 1500 MHz frequency range:

$P = 912.75/1500 = 0.61\ mW/cm^2$

The power density **$P\ (mW/cm^2) = P_T / 4\pi r^2$**

PT is the transmitted power, which is equal to the peak transmitter output power 13.16 dBm plus maximum antenna gain 0.9 dBi, the maximum equivalent isotopically radiated power EIRP is

P_T = 13.16 dBm +0.9 dBi = 14.06dBm = 25.46mW

The power density at 20 cm (minimum safe distance, required for mobile devices), calculated as follows:

Compliance with FCC limit: $25.46\ mW / 4\pi\ (20\ cm)^2 = 0.005\ mW/cm^2 << 0.61\ mW/cm^2$

1) **<u>The variant when Controller (915MHz) work together with approved Cellular module.</u>**

Maximum conducted power given in FCC ID: XMR201910BG95M3 module's grant is:
124.0mW (20.93dBm) in band 2 (1850-1915 MHz),
124.0mW (20.93dBm) in band 4 (1710-1755 MHz),
116.0mW (20.64dBm) in band 12 (699-716 MHz),
115.0mW (20.61dBm) in band 13 (777-787 MHz).

Limit for power density for general population/uncontrolled exposure is $1mW/cm^2$ for 1500 -100000 MHz frequency range.

Limit for power density for general population/uncontrolled exposure is f/1500 mW/cm^2
for 300 – 1500 MHz frequency range.

The power density **$P\ (mW/cm^2) = P_T / 4\pi r^2$**

$P = 699/1500 = 0.466\ mW/cm^2$ (the worst case limit)

*Only the above bands in use according to manufacturer declaration.

The maximum module's antenna gain is 6dBi for all of the use's bands.

The maximum equivalent isotropic radiated power EIRP is for bands 12:

PT = 20.64dBm + 6dBi = 26.64dBm = 461.31mW

The power density at 20 cm (minimum safe distance, required for mobile devices), calculated as follows:

$461.31mW / 4\pi (20\ cm)^2 = 0.092mW/cm^2 << 0.466mW/cm^2$

Assessment of RF hazard from BLE and LTE wireless module

S1/limit + S2/limit ≤ 1, i.e
0.005/0.61 + 0.092/0.466 = 0.0081 + 0.197 = 0.205 ≤ 1

The aggregate ratio of transmit power to the relevant power limits does not exceed 100% and meets the safety requirements.

2) <u>The variant when Controller (915MHz) work together with approved Wi-Fi module.</u>

Maximum conducted power given in FCC ID: 2AC7Z-ESP32WROVERE module's grant is:
459mW (26.62dBm) in band 2412 – 2462MHz

Limit for power density for general population/uncontrolled exposure is $1mW/cm^2$ for 1500 -100000 MHz frequency range.

The power density $\mathbf{P\ (mW/cm^2) = P_T / 4\pi\ r^2}$

The maximum module antenna gain is 3.4dBi.

The maximum equivalent isotropic radiated power EIRP for band 2412 – 2462MHz:

PT = 26.62dBm + 3.4dBi = 30.02dBm = 1004.61mW

The power density at 20 cm (minimum safe distance, required for mobile devices), calculated as follows:

$$1004.61\text{mW} / 4\pi\ (20\ \text{cm})^2 = 0.199\text{mW/cm}^2 << 1\text{mW/cm}^2$$

Assessment of RF hazard from BLE and LTE wireless module

$$S1/\text{limit} + S2/\text{limit} \leq 1, \text{ i.e}$$
$$0.005/0.61 + 0.199/1 = 0.0081 + 0.199 = 0.207 \leq 1$$

The aggregate ratio of transmit power to the relevant power limits does not exceed 100% and meets the safety requirements.