

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

The Sensor Unit Rev 2.0-V2X contains

- 1) single modular Wi-Fi module FCC ID:2AE3B-AEX-AR95X of VoxMicro according to section 15E,
- 2) single modular approved transmitter FCC ID:NUK-VTX3012 (V2X DSRC module),
- 3) single modular approved transmitter FCC ID:2AVKZRM68-NTA
- 4) and single modular approved transmitter FCC ID:2AC7Z-ESP32WROOM32U, used for maintenance only, does not operate concurrently with 3 other modules.

The Sensor Unit is classified as fixed device. The simultaneous transmission of 3 first above mentioned modules is evaluated.

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

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

- 1) Wi-Fi module (5 GHz) –reference to MPE information from FCC database, FCC ID:2AE3B-AEX-AR95X
 P_T is the transmitted power, which is equal to the peak transmitter output power 18.5 dBm plus maximum antenna gain 2.5 dBi, the maximum equivalent isotropically radiated power EIRP is

$$P_T = 18.5 \text{ dBm} + 2.5 \text{ dBi} = 21 \text{ dBm} = 126 \text{ mW}.$$

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

$$126 \text{ mW} / 4\pi (20 \text{ cm})^2 = 0.025 \text{ mW/cm}^2 \ll 1 \text{ mW/cm}^2$$

- 2) V2X DSRC module (5 GHz): –reference to RF Exposure Evaluation Report from FCC database, FCC ID:NUK-VTX3012

P_T is the transmitted power, which is equal to the peak transmitter output power 19.98 dBm plus maximum antenna gain 5.5 dBi, the maximum equivalent isotropically radiated power EIRP is

$$P_T = 19.98 \text{ dBm} + 5.5 \text{ dBi} = 25.48 \text{ dBm} = 353.2 \text{ mW}.$$

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

$$353.2 \text{ mW} / 4\pi (20 \text{ cm})^2 = 0.07 \text{ mW/cm}^2 \ll 1 \text{ mW/cm}^2$$

- 3) Maximum EIRP given in FCC ID:2AVKZRM68-NTA module grant is 681 mW (28.33 dBm).

The power density at 20 cm is calculated as follows:

$$681 \text{ mW} / 4\pi (20 \text{ cm})^2 = 0.135 \text{ mW/cm}^2 < 1 \text{ mW/cm}^2$$

Summation

When all the antennas are at least 20 cm away from the user but individual antennas cannot be separated by 20 cm from each other, the following equation shall be fulfilled

$$\begin{aligned} S1/\text{Limit} + S2/\text{Limit} + S3/\text{Limit} &< 1, \text{ i.e.} \\ 0.025 \text{ mW/cm}^2 / 1 \text{ mW/cm}^2 + 0.07 \text{ mW/cm}^2 / 1 \text{ mW/cm}^2 + 0.135 \text{ mW/cm}^2 / 1 \text{ mW/cm}^2 &= 0.025 + 0.07 + 0.135 = \\ &= 0.23 < 1 \end{aligned}$$

Therefore, the Sensor Unit including 3 approved modules complies with FCC RF exposure limit for general population.