FCC ID:	2A9FM-TSEB240VT6
Contains FCC ID:	2AC7Z-ESP32WROOM32U

RF Exposure Evaluation

Limits

The criteria listed in the following table shall be used to evaluate the environment 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

Friis transmission formula: **$Pd = (Pout*G)/(4*pi*r^2)$**

Where

Pd = power density in mW/cm^2, **Pout** = output power to antenna in mW;

G = gain of antenna in linear scale, **Pi** = 3.1416;

R = distance between observation point and center of the radiator in cm

Pd id the limit of MPE, 1 mW/cm^2. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

Test Procedure

Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

Test Result of RF Exposure Evaluation

433.92MHz

Channel	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
433.92MHz	-29.07	0.00124	0.0000004	0.29	PASS

Remark: antenna gain=2dBi

According to ANSI C63.10

30MHz＜F＜1GHz: EIRP[dBm] =E[dBuV/m] - 95.2- 4.7

So Output power =EIRP-antenna gain =72.83-95.2-4.7-2=-29.07dBm

13.56MHz

Channel	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
13.56MHz	-51.39	0.00001	0.000000002	0.98	PASS

Remark: antenna gain=2dBi

According to ANSI C63.10

F＜30MHz: EIRP[dBm] =E[dBμ V/m] - 95.2- 6

So Output power =EIRP-antenna gain =51.81-95.2-6-2=-51.39dBm

Contains FCC ID:2AC7Z-ESP32WROOM32U						
Mode	Antenna gain(dBi)	Output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm2)	Limit (mW/cm2)	Result
WIFI 2.4G	2.33	15.90	38.905	0.0132	1.0	PASS
BT	2.33	2.79	1.901	0.0006	1.0	PASS
BLE	2.33	1.08	1.282	0.0004	1.0	PASS

433.92MHz, 13.56MHz, 3G,4G, BT and WIFI Simultaneous Transmission:

$$\sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k}$$

433.92MHz+13.56MHz+WIFI 2.4G+BT =(0.0000004/0.29)+(0.000000002/0.98) +(0.0132/1) +(0.0006/1)= 0.000001379+0.000000002+0.0132+0.0006=0.0138<1

The max power density is less than MPE exempt limit, so it is compliance.