RF Exposure Evaluation Report

APPLICANT	**:**	**Espressif Systems (Shanghai) Co.,Ltd.**
EQUIPMENT	**:**	**2.4GHz Wi-Fi IoT Module**
BRAND NAME	**:**	**ESPRESSIF**
MODEL NAME	**:**	**ESP32-S2-SOLO-2U**
FCC ID	**:**	**2AC7Z-ESPS2SOLO2U**
STANDARD	**:**	**47 CFR Part 2.1091**

The product evaluation date was started from Sep. 30, 2022 and completed on Sep. 30, 2022. We, Sporton International Inc. (Kunshan), would like to declare that the device has been evaluated in accordance with 47 CFR Part2.1091/47 CFR Part 1.1307, and pass the limit. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.

Approved by: Si Zhang

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA262717	Rev. 01	Initial issue of report.	Oct. 10, 2022

1. Administration Data

1.1. Testing Laboratory

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory			
Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	SAR01-KS	CN1257	314309

Applicant	
Company Name	Espressif Systems (Shanghai) Co.,Ltd.
Address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

Manufacturer	
Company Name	Espressif Systems (Shanghai) Co.,Ltd.
Address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

2. Guidance Applied

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC 47 CFR Part 2.1091
- KDB 447498 D04 Interim General RF Exposure Guidance v01

3. Description of Equipment Under Test (EUT)

Product Feature & Specification	
EUT Type	2.4GHz Wi-Fi IoT Module
Model Name	ESP32-S2-SOLO-2U
FCC ID	2AC7Z-ESPS2SOLO2U
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz
Mode	WLAN 2.4GHz 802.11b/g/n HT20/HT40
Antenna Gain	WLAN2.4GHz: 2.33 dBi
Antenna Type	WLAN: external Antenna
HW Version	V1.0
SW Version	V1.1.3.0
EUT Stage	Production Unit

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

Comments and Explanations:
1. The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.
2. The maximum RF output tune up power, antenna gain also the safe distance used for evaluate RF exposure were declared by manufacturer.

4. Maximum RF average output tune up power among production units

<2.4GHz WLAN >

Mode		Maximum Average Power (dBm)
2.4GHz	802.11b	14.0
	802.11g	17.5
	802.11n-HT40	17.5
	802.11n-HT20	15.0

5. RF Exposure Limit Introduction

1. Per 1.1307(b)(3), (i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

   (A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

   (B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:

$$\mathrm{P}_{th}\ (\mathrm{mW}) = \begin{cases} \mathrm{ERP}_{20\,cm}\ (\mathrm{d}/20\ \mathrm{cm})^{x} & d \le 20\ cm \\ \mathrm{ERP}_{20\,cm} & 20\ cm < d \le 40\ cm \end{cases} \quad [1]$$

$$\text{Where} \quad \mathrm{x} = -\log_{10}\left(\frac{60}{ERP_{20\,cm}\sqrt{f}}\right) \text{ and f is in GHz} \quad [2]$$

$$\text{and} \quad \mathrm{ERP}_{20\,cm}\ (\mathrm{mW}) = \begin{cases} 2040\mathrm{f} & 0.3\ GHz < f \le 1.5\ GHz \\ 3060 & 1.5\ GHz < f \le 6\ GHz \end{cases} \quad [3]$$

   (C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value)

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2
1.34-30	3,450 R^2 /f^2
30-300	3.83 R^2
300-1,500	0.0128 R^2 f
1,500-100,000	19.2 R^2

2. For multiple RF sources: Multiple RF sources are exempt if:

(A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

(B) In the case of ¦xed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{j=1}^{b} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

a. a = number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for *P*th, including existing exempt transmitters and those being added.

b. b = number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.

c. c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.

d. *Pi,* the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source *i* at a distance between 0.5 cm and 40 cm (inclusive)

e. *P*th,*i* the exemption threshold power (*P*th) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source *i*.

f. *ERPj* the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source *j*.

g. *ERP*th,*j* exemption threshold ERP for fixed, mobile, or portable RF source *j*, at a distance of at least λ/2π, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.

h. *Evaluatedk* the maximum reported SAR or MPE of fixed, mobile, or portable RF source *k* either in the device or at the transmitter site from an existing evaluation.

i. *Exposure Limitk* either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources RF source k, as applicable from § 1.1310 of this chapter.

j. The relationship between EIRP and ERP is: ERP (dBm) = EIRP - 2.15, Where EIRP is the sum of the conducted power (dBm) and the antenna gain (dBi)

The sum of the ratios of the applicable terms for SAR-based, MPE-based and measured SAR or MPE shall be less than 1, to determine simultaneous transmission exposure compliance

6. Radio Frequency Radiation Exposure Evaluation

6.1. Standalone assessment

Band	Antenna Gain (dBi)	Maximum Conducted Power (dBm)	Maximum EIRP (dBm)	Maximum ERP (dBm)	Maximum ERP (mW)	Separation Distance (cm)	Part1.1307 option(b) Threshold (mW)
WLAN2.4GHz Band	2.33	17.50	19.83	17.68	58.61	20	3060.000

Conclusion:

According to 47 CFR §1.1307 (b)(3)(i)(B), the RF exposure analysis concludes that the RF Exposure is FCC compliant.

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