



MPE TEST REPORT

Applicant Espressif System (Shanghai) Co.,Ltd.
FCC ID 2AC7Z-ESPPICOMINI
Product Wi-Fi & Bluetooth Internetof Things
 Module
Model ESP32-PICO-MINI-02;
 ESP32-PICO-MINI-02U
Report No. R2106A0560-M1
Issue Date September 26, 2021

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC 47 CFR Part 1 1.1310**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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1 Test Laboratory

1.1 Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

1.3 Testing Location

Company: TA Technology (Shanghai) Co., Ltd.
Address: No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China
City: Shanghai
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1.4 Laboratory Environment

Temperature	Min. = 18°C, Max. = 25 °C
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5 Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

2 Description of Equipment under Test

Client Information

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

General Technologies

Model	ESP32-PICO-MINI-02; ESP32-PICO-MINI-02U
Lab internal SN	R2106A0560/S01
Hardware Version	V1.0
Software Version	V179
Date of Sample Received	July 26 , 2021
<p>Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.</p> <p>2. All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.</p>	

Differences between the two models		
Model	ESP32-PICO-MINI-02	ESP32-PICO-MINI-02U
Antenna	PCB Antenna	External Antenna
Antenna Gain	3.96dBi	2.33dBi
Others	The same	The same

3 Maximum conducted output power (measured) and antenna Gain

The numeric gain (G) of the antenna with a gain specified in dB is determined by

$$\text{Numeric gain (G)} = 10^{(\text{antenna gain}/10)}$$

ESP32-PICO-MINI-02

Band	Maximum Conducted Output Power		Antenna Gain (dBi)	Numeric gain
	(dBm)	(mW)		
Wi-Fi 2.4G	18.00	63.096	3.96	2.489
Bluetooth	8.00	6.310	3.96	2.489

ESP32-PICO-MINI-02U

Band	Maximum Conducted Output Power		Antenna Gain (dBi)	Numeric gain
	(dBm)	(mW)		
Wi-Fi 2.4G	18.00	63.096	2.33	1.710
Bluetooth	8.00	6.310	2.33	1.710

4 Test Result

According to section 1.1310 of FCC 47 CFR Part 1, limits for maximum permissible exposure (MPE) are as following

TABLE 1 – 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
3-30	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

Note1. 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.

Note2: 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.



The maximum permissible exposure for 1500~100,000MHz is 1.0.So

Band	The maximum permissible exposure (mW/cm ²)
Wi-Fi 2.4GHz	1.000
Bluetooth	1.000

**RF Exposure Calculations:**

The following information provides the minimum separation distance for the highest gain antenna provided. This calculation is based on the conducted power, considering maximum power and antenna gain. The formula shown in KDB 447498 D01 is used in the calculation.

Equation from KDB 447498 D01 General RF Exposure Guidance v06 (10/23/2015) is:

$$S = PG / 4\pi R^2$$

Where: S = power density (in appropriate units, e.g. mW/cm²)

P = Time-average maximum tune up procedure (in appropriate units, e.g., mW)

G = the numeric gain of the antenna

R = distance to the center of radiation of the antenna (20 cm = limit for MPE)

ESP32-PICO-MINI-02

Band	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	PG (mW)	Test Result (mW/cm ²)	Limit Value (mW/cm ²)
Wi-Fi 2.4GHz	3.960	18.000	21.960	157.036	0.031	1.000
Bluetooth	3.960	8.000	11.960	15.7036	0.003	1.000
Note: R = 20cm π = 3.1416						

ESP32-PICO-MINI-02U

Band	Antenna Gain (dBi)	Maximum Power (dBm)	Maximum EIRP (dBm)	PG (mW)	Test Result (mW/cm ²)	Limit Value (mW/cm ²)
Wi-Fi 2.4GHz	2.330	18.000	20.330	107.895	0.021	1.000
Bluetooth	2.330	8.000	10.330	10.7895	0.002	1.000
Note: R = 20cm π = 3.1416						

BT antenna and Wi-Fi 2.4G antenna can't transmit simultaneously.

*****END OF REPORT *****



ANNEX A: The EUT Appearance

The EUT Appearance are submitted separately.