# ESP32 Certification and Test Guide



Version 1.0 Copyright © 2016

# **About This Document**

This document provides instructions on how to test ESP32 to meet the certification requirements. The document is structured as follows:

Chapter	Title	Subject	
Chapter 1	Overview	Introduction to test procedures.	
Chapter 2	Test Preparation	Presentation of test preparations.	
Chapter 3	Connecting Device	Instruction on how to connect devices.	
Chapter 4	Adaptivity Test	Presentation of adaptivity testing procedures.	
Chapter 5	Wi-Fi/BT Operation Commands	Explanation of Wi-Fi/BT operation commands.	

#### **Release Notes**

Date	Version	Release notes
2016.12	V1.0	Initial release.

# **Table of Contents**

1.	Overv	view		1
2.	Test F	Prepara	tion	2
	2.1.	Hardwa	are Connection and Configuration	2
	2.2.		are Boot Mode	
		2.2.1.		
		2.2.2.		
	2.3.	Antenn	a Impedance Matching Requirement	2
3.	Conn	ecting [	Device	4
			Port Configuration Tool	
			Tool Introduction	
		3.1.2.		
	3.1.3	. Downlo	oad Tool	6
		3.1.4.		
		3.1.5.	Procedure	
		3.1.6.	Configuration Instructions	
4.	Adap	tivity Te	est	9
	4.1.	_	ols	
	4.2.		eps	
			Downloading the Binaries	
		4.2.2.	Connecting ESP32 to AP	
		4.2.3.		
5.	Wi-Fi	/BT Ope	eration Command	12
			est Commands	
			Command for Selecting Tx 11n Mode 20 Mbps or 40 Mbps	
		5.1.2.	Selection of the Certification Test Mode	
		5.1.3.	Tx Command	12
		5.1.4.	Tx Stop Command	13
		5.1.5.	Rx Command	
		5.1.6.	Rx Stop Command	
		5.1.7.	SCW Tx Command	
	5.2.	BT Test	t Commands	15
		5.2.1.	BR/EDR Tx Command	
		5.2.2.		
		5.2.3.		
		5.2.4.	Rx Start Command	
		5.2.5.	Rx Stop Command	
		5.2.6.	SCW Tx Command	16



# Overview

This document intends to give guidance on how to test ESP32 to meet certification requirements. We provide the following two binary files for the tests, as shown in Table 1-1.

Table 1-1. Test Procedure Binary Files

Name	Test Item	
ESP32_Adaptivity_20161129.bin	Adaptivity (baud rate 115200)	
ESP32_FCC_WIFI_BT_20161129.bin	Wi-Fi/BT performance (baud rate 115200) (for 40M crystal oscillator)	

#### Notice:

Please make sure you distinguish between these two testing procedures. You need to have two testing boards with the relevant two binary files separately installed on them, in order to meet the certification requirements. You can carry out the tests in separate labs simultaneously.



# 2.

# **Test Preparation**

## 2.1. Hardware Connection and Configuration

Please follow the instructions below:

Table 2-1. Pin Configuration Instruction

Pin	Configuration Instruction		
3V3/CH_EN	Connect to 3.3V power.		
RXD/TXD/GND	Lead the three pins out to serial lines for the communication between the PC and ESP32 and for the control of ESP32.		
GPIO0 GPIO2	These two pins can switch the boot mode of the ESP32.		

### 2.2. Hardware Boot Mode

#### 2.2.1. Download Mode

When GPIO0=0, GPIO2=0, ESP32 is in the Download mode and you can download the firmware to the external flash.

#### 2.2.2. Flash Mode

When GPIO0=1, ESP32 is in the Flash mode. ESP32 will automatically read and run programs from flash during power-on.



Download mode is for downloading the firmware. Flash mode is the normal working mode.

### 2.3. Antenna Impedance Matching Requirement

For the EMC test, the  $\pi$  impedance matching circuit of the external antenna should meet the following requirements.



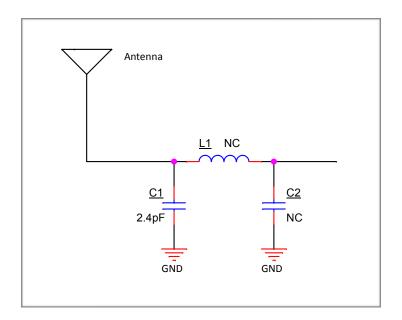


Figure 2-1.  $\pi$  Impedance Matching Circuit of External Antenna

#### Note:

C1 must be a 2.4-pF capacitor. L1, C2, along with C1 perform a  $50\Omega$  impedance matching for the Antenna. The value depends on the antenna impedance.



# 3.

# **Connecting Device**

## 3.1. Serial Port Configuration Tool

#### 3.1.1. Tool Introduction

#### Note:

In this chapter a SecureCRT has been used as a serial port configuration tool. Users need to pre-download and install the application.

SecureCRT can be used for configuring the serial COM port between ESP32 and PC.

#### 3.1.2. Procedure

Please follow the steps below.

1. Double-click *SecureCRT.exe* to run the application. The system shows the main interface as in Figure 3-1.

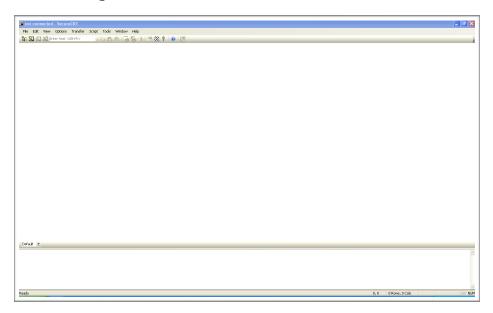


Figure 3-1. Main Interface of SecureCRT

2. Select "File >Quick Connect..." or click on the button . The system will then show the "Quick Connect" dialog box.

Espressif Systems 4/17 2016.12



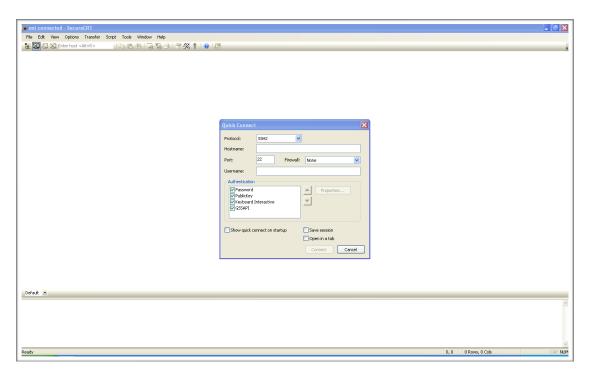


Figure 3-2. Quick Connect Dialog Box

3. Select "Serial" in the "Protocol" drop-down menu to select the required configuration options for connecting devices.

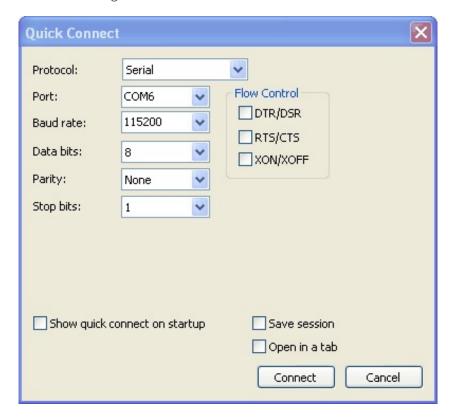


Figure 3-3. Configuration Options



Port	Select a port in the "Port" dropdown menu, such as "COM6".
Baud Rate	Type 115200 in the "Baud rate" dropdown menu.
Flow Control	Deselect "RTS/CTS".

4. Click the "Connect" button. A new session of Serial-COM6 has been set up, as Figure 3-4 shows.

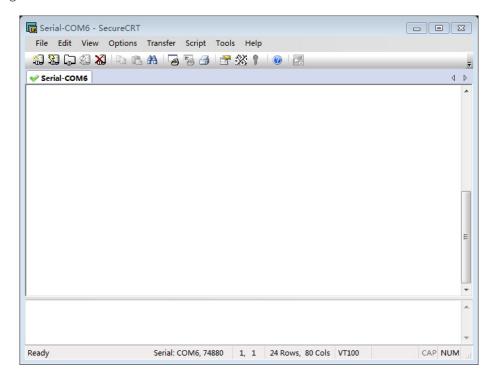


Figure 3-4. New Session of Serial-COM6

### 3.1.3. Download Tool

#### 3.1.4. Tool Introduction

Note:

The ESP Flash Download Tool (hereinafter termed as Flash Download Tool) has been used in this chapter. You need to download the tool from: <a href="http://www.espressif.com/en/support/download/other-tools">http://www.espressif.com/en/support/download/other-tools</a>.

#### 3.1.5. Procedure

Please follow the steps below:

 Run the Flash Download Tool.
 Make sure ESP32 works in the Download mode and that the port number of the serial port is not used by other applications.



- Select the file path of the binary file in the "SPIDownload" menu box, and deselect
  the other paths that you do not use.
   If the path is valid, it appears against a green background; if the path is invalid, then it
  appears against a red background.
- 3. Enter the starting address in the OFFSET text box, such as "0X000" or "0x1000". The download addresses of the two binary files that we provide both start from "0X000" or "0x1000".
- 4. Configure the respective options according to the specific ESP32 features.
- 5. Click the "START" button to download the files.

  If the configuration is incorrect, the Flash Download Tool will show this in the status bar under "Download Panel 1", and a specific type of error in the command prompt window beside the status bar.
- 6. After the download is complete, the status bar displays "FINISH", as Figure 3-5 shows.

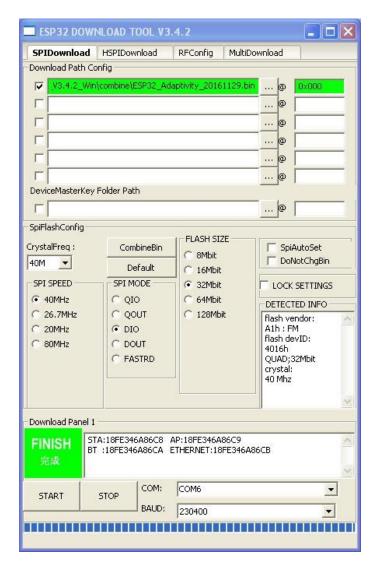


Figure 3-5. Flash Download Tool



### 3.1.6. Configuration Instructions

Table 3-1 shows the configuration instructions.

Table 3-1. Parameter Configuration

Option	Description	Configuration Instruction		
CrystalFreq	The type of external crystals	Select the CrystalFreq according to the crystal type that ESP32 is using. Select the option "40M".		
CombineBin	Combine the binary files	Combine several binary files into one.		
SPI Speed	SPI speed Select the SPI speed of ESP32. The options are 26.7 MHz, 20 MHz and 80 MHz.			
SPI Mode	SPI mode	Select the SPI connecting mode of ESP32. The options are: QIO, QOUT, DIO and DOUT.		
Flash Size	The size of the flash	Select the flash size that ESP32 uses.		
COM	The port number of the device	e Select the port number of ESP32.		
Ralidrate Ralid rate		Select the downloading speed of the binary file. The default option is 115200.		
MAL Address MAL Saddress		After the downloading is complete, the system will show the MAC address where the binary files are saved.		



# **Adaptivity Test**

#### **Test Tools** 4.1.

- ESP32 module + backplane
- Binaries to download (ESP32\_Adaptivity\_20161129.bin)
- One UART
- A PC with a Windows operating system (and serial port tools installed)
- A network debugging tool
- One AP

# 4.2. Test Steps

#### 4.2.1. **Downloading the Binaries**

Table 4-1 shows the download addresses.

Table 4-1. Download Addresses for the Binaries

Binaries	Download Address		
ESP32_Adaptivity_20161129.bin	0x000		



#### Notice:

Select DIO for flash\_mode.

### 4.2.2. Connecting ESP32 to AP

Open the serial port tool (set the baud rate to 115200). Input ssc command and connect ESP32 to the specified AP. The connection steps and the corresponding ssc commands are shown below:

Table 4-2. AP Connection Steps

Step	ssc Command		
1. Set ESP32 to Station mode.	op - S -o 1		
2. Connect ESP32 to the specified AP.	sta -C -s <ap ssid=""> -p <ap password=""></ap></ap>		



If the AP is open, you only need to input sta -C -s <AP SSID>.



#### 4.2.3. Ping Packets

- 1. Install a network debugging tool on the PC and connect the PC to the same AP to which ESP32 is connected.
- 2. Run the network debugging tool to set up the UDP server.
- 3. Input the local IP address and port number on the network debugging tool to complete the configuration.

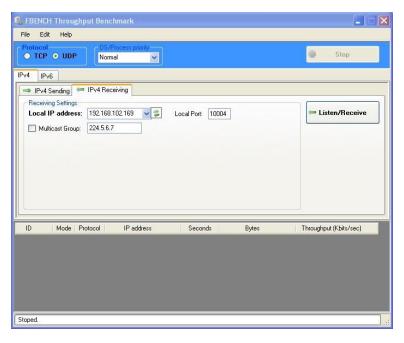


Figure 4-1. Receiving Settings of UDP Transmission

- 4. In the serial tool, input the ssc command to connect the socket with the PC or test machine and ping packets.
  - Configure parameter:

```
gpiotmp -C -e 1 -c <value>
```

value should be a number between 40 ~ 64; the default value is 50.

- Example:

• Configure UDP packets:

```
soc -B -t UDP
soc -S -s <socket_id> -l <pkt len> -i <server IP _addr> -p
<server port> -n <pkt num> -j <send pkt delay>
```

- Example:

```
soc -B -t UDP
soc -S -s 0 -l 1000 -i 255.255.255.255 -p 10004 -n 2000 -j
10
```



5. Use the "FBENCH Throughput Benchmark" software installed on the PC to receive the UDP packets.

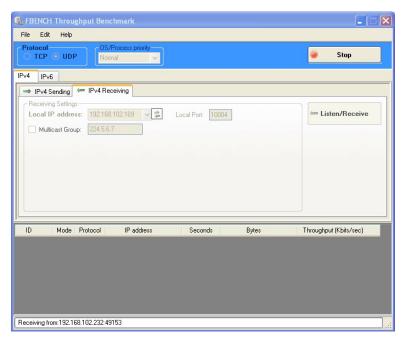


Figure 4-2. Receiving the UDP Packets

6. Click "Stop" to end the receiving of UDP packets.

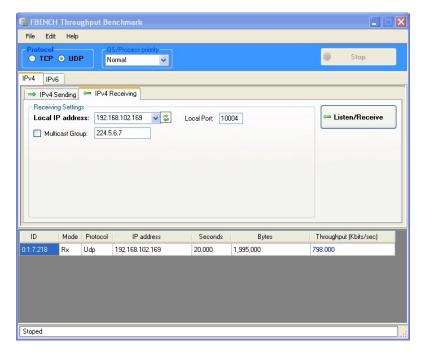


Figure 4-3. Result of the UDP Transmission



# Wi-Fi/BT Operation Command

When testing the EMC/RF item, please download ESP32\_FCC\_WIFI\_BT\_20161129.bin.



The case-sensitive commands should be input in the interactive window of SecureCRT. You need to select "Chat Window" in the "View".

### 5.1. Wi-Fi Test Commands

#### Note:

The baud rate is 115200.

#### 5.1.1. Command for Selecting Tx 11n Mode 20 Mbps or 40 Mbps

tx\_cbw40m\_en <Parameter1>

• Command for selecting the 11n HT20 mode:

```
tx cbw40m en 0
```

Print: tx cbw40m en: 0

• Command for selecting the 11n HT40 mode:

```
tx cbw40m en 1
```

Print: tx\_cbw40m\_en: 1

#### 5.1.2. Selection of the Certification Test Mode

- Command for the FCC certification mode: fcc\_mode\_sel 0
   Print: fcc\_mode\_sel=0, FCC Certification start!!!
- Command for the EMC certification mode: fcc\_mode\_sel 1
   Print: fcc mode sel=1,EMC Certification start!!!
- Command for the RF certification mode: fcc\_mode\_sel 2

```
Print: fcc_mode_sel=2, RF test start!!!
```

#### Note:

Generally, the FCC certification mode is used in the certification test. The duty cycle of the RF test is about 50%, which is not suitable for certification. The RF test is more suitable for lab equipment test.

#### 5.1.3. Tx Command

wifitxout <Parameter1> <Parameter2> <Parameter3>



<Parameter1>: Select the Tx channel from 1 ~ 14.

<Parameter2>: Select the Tx data rate according to Table 5-1.

<Parameter3>: It is an 8-bit signed operand that indicates Tx power attenuation. The unit is 0.25 dB. For example, 4 means an attenuation of 1 dB.

Table 5-1. Parameter2 and Tx Data Rate

11b		11g		11n	
Parameter	Data rate	Parameter	Data rate	Parameter	Data rate
0x0	1 Mbps	0xb	6 Mbps	0x10	6.5 Mbps / MCS0
0x1	2 Mbps	Oxf	9 Mbps	0x11	13 Mbps / MCS1
0x2	5.5 Mbps	0xa	12 Mbps	0x12	19.5 Mbps / MCS2
0x3	11 Mbps	0xe	18 Mbps	0x13	26 Mbps / MCS3
-	-	0x9	24 Mbps	0x14	39 Mbps / MCS4
-	-	0xd	36 Mbps	0x15	52 Mbps / MCS5
-	-	0x8	48 Mbps	0x16	58.5 Mbps / MCS6
-	-	0xc	54 Mbps	0x17	65 Mbps / MCS7

#### Notice:

After sending data packets, you need to input the Stop command to end the process.

#### • Example:

wifitxout 1 0x0

Print: Wifi tx out: channel=1, rate=0x0, BK=0

Send the packets through channel 1 (2412 MHz) with a data rate of 1 Mbps.

#### 5.1.4. Tx Stop Command

cmdstop

Print: Tx Over



#### Notice:

After sending data packets, you need to input the Stop command to switch the channel or data rate.

#### 5.1.5. Rx Command

esp\_rx <Parameter1> <Parameter2>

<Parameter1>: Select the Bx channel from 1 ~ 14.

<Parameter2>: Select the Rx data rate according to Table 5-1.

**Espressif Systems** 13/17 2016.12



#### Notice:

After receiving data packets, you need to input Stop command to end the process.

• Example:

```
esp_rx 1 0x0
```

Print: wifi rx start: channel is 1, rate is 0x0

Receive the packets in channel 1 (2412 MHz) with a data rate of 1 Mbps.

#### 5.1.6. Rx Stop Command

cmdstop

Print: Correct: 0 Desired: 0 RSSI: 0

Correct indicates the number of received packets.

Desired indicates the number of received packets with the corresponding data rate of <Parameter2>.

RSSI indicates the average power of the Desired packets received.

#### 5.1.7. SCW Tx Command

wifiscwout <Parameter1> <Parameter2> <Parameter3>

<Parameter1>: SCW Tx enable signal, 1 = send; 0 = stop.

<Parameter2>: Select the SCW Tx channel from 1 ~ 14.

<Parameter3>: SCW power attenuation. The unit is 0.25 dB. For example, 4 indicates an attenuation of 1 dB.

#### Example:

• SCW Tx example:

wifiscwout 1 14 0

Print: wifi single carrier tx out

Transmit SCW in channel 14 (2484 MHz)

• SCW Tx stop example:

wifiscwout 0 14 0

Print: wifi single carrier tx stop

Stop SCW transmission.



### 5.2. BT Test Commands

Note:

Baud rate is 115200.

#### 5.2.1. BR/EDR Tx Command

fcc\_bt\_tx <Parameter1> <Parameter2> <Parameter3> <Parameter4> <Parameter5>

<Parameter1>: Tx power attenuation. The range is  $0 \sim 9$ . The unit is 2 dB. Normally the value is 4.

<Parameter2>: Frequency modulation enable. 1: enable; 0: disable.

<Parameter3>: Select the Tx channel. Input channel number 0 ~ 78.

<Parameter4>: Select the modulation mode. 1: 1M; 2: 2M; 3: 3M.

<Parameter4>: Select the DH type. 1: DH1; 3: DH3; 5: DH5.

#### 5.2.2. LE Tx Command

fcc le tx <Parameter1> <Parameter2> <Parameter3>

<Parameter1>: Tx power attenuation. The range is  $0 \sim 9$ . The unit is 2 dB. Normally the value is 4.

<Parameter2>: Select the Tx channel. Input channel number 0 ~ 39.

<Parameter3>: Select the payload length. The range is  $0 \sim 255$ . The unit is byte. Normally the value is 250.

#### 5.2.3. Stop Command

cmdstop

#### 5.2.4. Rx Start Command

rw rx per <Parameter1> <Parameter2>

<Parameter1>: 0: BR; 1: EDR.

<Parameter2>: Select the Rx channel from  $0 \sim 78$ . 0 to 39 represent even-numbered channels, and 40 to 78 represent odd-numbered channels. For example, if Parameter2 is 0, channel 0 is selected; if Parameter2 is 1, channel 2 is selected; if Parameter2 is 2, channel 4 is selected, and so on. So if Parameter2 is 39, channel 78 is selected. In contrast, if Parameter2 is 40, channel 1 is selected; if Parameter2 is 41, channel 3 is selected; if Parameter2 is 42, channel 5 is selected, and so on. So if Parameter2 is 78, channel 77 is selected.

Input cmdstop command to stop receiving packets and the serial port will print the number of packets received.

Espressif Systems 15/17 2016.12



The second digit represents the number of packets received in this process.

#### 5.2.5. Rx Stop Command

cmdstop

### 5.2.6. SCW Tx Command

bt\_tx\_tone <Parameter1> <Parameter2> <Parameter3>

<Parameter1>: SCW Tx enable signal, 1 = send; 0 = stop.

<Parameter2>: Select the SCW Tx channel from 0 ~ 78.

<Parameter3>: SCW power attenuation. The unit is 0.25 dB. For example, 4 indicates an attenuation of 1 dB.

• SCW Tx example:

bt\_tx\_tone 1 0 0

Print: BT TX TONE START!

Transmit SCW in channel 14 (2402 MHz)

• SCW Tx stop example:

bt\_tx\_tone 0 0 0

Print: BT TX TONE STOP!

Stop SCW transmission.

Espressif Systems 16/17 2016.12



www.espressif.com

#### Disclaimer and Copyright Notice

Information in this document, including URL references, is subject to change without notice.

THIS DOCUMENT IS PROVIDED AS IS WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NON-INFRINGEMENT, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION OR SAMPLE.

All liability, including liability for infringement of any proprietary rights, relating to use of information in this document is disclaimed. No licenses express or implied, by estoppel or otherwise, to any intellectual property rights are granted herein.

The Wi-Fi Alliance Member logo is a trademark of the Wi-Fi Alliance. The Bluetooth logo is a registered trademark of Bluetooth SIG.

All trade names, trademarks and registered trademarks mentioned in this document are property of their respective owners, and are hereby acknowledged.

Copyright © 2016 Espressif Inc. All rights reserved.