ESP-WROOM-02D

User Guide

Version 1.0

About This Guide

This document takes ESP-WROOM-02D as examples to introduce how to use the ESP8266 SDK. The contents include preparations before compilation, SDK compilation and firmware download.

Release Notes

Date	Version	Release notes
2017.11	V1.0	First release.

Table of Contents

1. ESP-WROOM-02D Overview

The ESP-WROOM-02D is a new ESP8266EX-based module developed by Espressif. It differs from the ESP-WROOM-02 in that it is compatible both with 150-mil and 208-mil flash (with 150-mil flash embedded by default). The ESP-WROOM-02D also features optimized antenna and RF performance.

> 📖 ***Note:***
>
> *For more information on ESP8266EX, please refer to ESP8266EX Datasheet.*

Table 1-1. ESP-WROOM-02D Specifications

Categories	Items	Specifications
Wi-Fi	Wi-Fi protocols	802.11 b/g/n
	Frequency range	2.4 GHz ~ 2.5 GHz (2400M ~ 2483.5M)
Hardware	Peripheral interface	UART/HSPI/I2C/I2S/IR Remote Control
		GPIO/PWM
	Operating voltage	2.7V ~ 3.6V
	Operating current	Average: 80 mA
	Minimum current delivered by power supply	500 mA
	Operating temperature range	-40°C ~ 85°C
	Storage temperature	-40°C ~ 85°C
	Package size	(18±0.2) mm x (20±0.2) mm x (3.2±0.15) mm
	External interface	-
Software	Wi-Fi mode	Station/SoftAP/SoftAP+Station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware upgrade	UART Download/OTA (via network)/Download and write firmware via host
	Software development	Supports Cloud Server Development/SDK for custom firmware development
	Network protocols	IPv4, TCP/UDP/HTTP/FTP
	User configuration	AT Instruction Set, Cloud Server, Android/iOS app

2. ESP-WROOM-02D Pin Description

Figure 2-1 shows the pin distribution of the ESP-WROOM-02D.

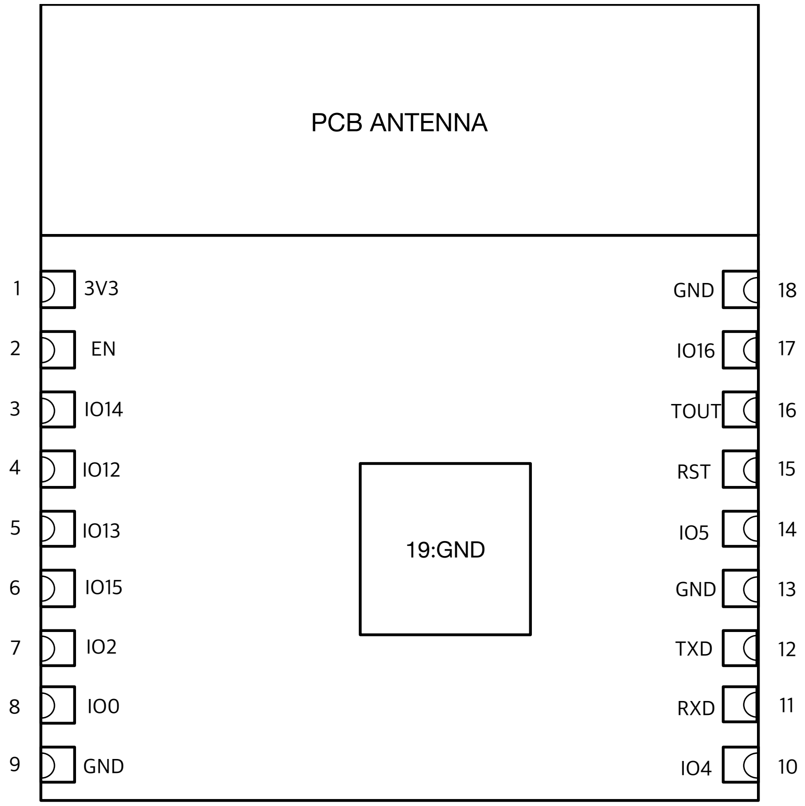


Figure 2-1. ESP-WROOM-02D Pin Layout

ESP-WROOM-02D has 18 pins. Please see the pin definitions in Table 2-1.

Table 2-1. ESP-WROOM-02D Pin Definitions

No.	Pin Name	Functional Description
1	3V3	3.3V power supply (VDD) 📖 ***Note:*** *It is recommended the maximum output current a power supply provides be of 500 mA or above.*
2	EN	Chip enable pin. Active high.
3	IO14	GPIO14; HSPI_CLK
4	IO12	GPIO12; HSPI_MISO
5	IO13	GPIO13; HSPI_MOSI; UART0_CTS
6	IO15	GPIO15; MTDO; HSPICS; UART0_RTS Pull down.

No.	Pin Name	Functional Description
7	IO2	GPIO2; UART1_TXD Floating (internal pull-up) or pull up.
8	IO0	GPIO0 • UART download: pull down. • Flash boot: floating or pull up.
9	GND	GND
10	IO4	GPIO4
11	RXD	UART0_RXD, receive end in UART download; GPIO3
12	TXD	UART0_TXD, transmit end in UART download, floating or pull up; GPIO1
13	GND	GND
14	IO5	GPIO5
15	RST	Reset
16	TOUT	It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin6). These two functions cannot be used simultaneously.
17	IO16	GPIO16; used for Deep-sleep wake-up when connected to RST pin.
18	GND	GND

3. Hardware Preparation for Compiling ESP-WROOM-02D

3.1. Hardware Preparation

- ESP-WROOM-02D module
- USB-to-TTL converter (FT232R recommended)
- PC for programming: Windows XP or Windows 7 OS is recommended, with enough RAM to run a Linux virtual machine.
- Micro-USB cable

3.2. Hardware Connection

1. Lead out the pins of the ESP-WROOM-02D, as shown in Table 2-2.

Table 2-2. ESP-WROOM-02D Pins

Pin	Pin status
EN	Pull up
3V3	3.3V power supply (VDD)
IO15	Pull down
IO0	UART download: pull down; Flash boot: floating/pull up
GND	GND
RXD	Receive-end in UART download
TXD	Transmit-end in UART download; floating/pull up

2. Connect ESP-WROOM-02D to the USB-to-TTL converter, using Dupont lines, as shown in Figure 2-1.

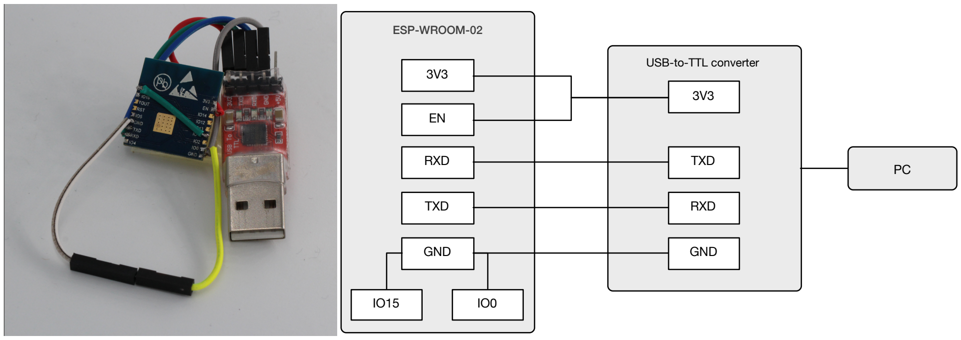


Figure 2-1. ESP-WROOM-02D Download Mode

3. Connect the USB-to-TTL converter to the PC.
4. Download firmware to flash with the ESP8266 DOWNLOAD TOOL.

> ***Note:***
>
> *On how to download firmware, please refer to Chapter 4, "Flash Maps" and Chapter 6, "Downloading the Firmware".*

5. After downloading, switch ESP-WROOM-02U to working mode.
   Set `IO0` as floating or pull-up.
6. Power on ESP-LAUNCHER again and the chip will read and run programs from the flash.

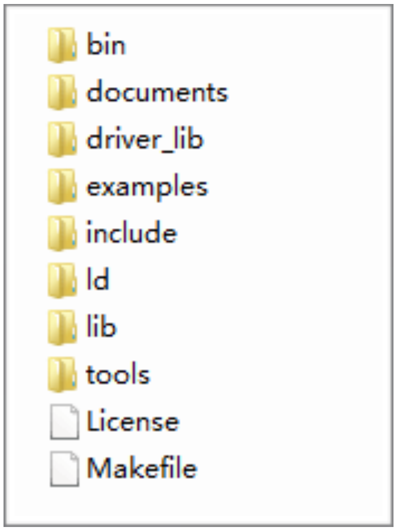
— — END

> ***Notes:***
>
> - `IO0` *is an internal pull-up pin.*
> - *For more information on ESP-WROOM-02U hardware, please refer to ESP8266 System Description and ESP-WROOM-02 Datasheet.*

4. Software Preparation for Compiling ESP-WROOM-02D

Users can download the non-OS SDK (including application examples) from: http://www.espressif.com/en/support/download/sdks-demos?keys=&field_type_tid%5B%5D=14.

Figure 3-1 shows the directory structure of the non-OS SDK.



bin
documents
driver_lib
examples
include
ld
lib
tools
License
Makefile

Figure 3-1. Non-OS SDK Directory Structure

- ***bin***: compiled binaries to be downloaded directly into the flash.
- ***documents***: SDK-related documents or links.
- ***driver_lib***: library files that drive peripherals, such as UART, I2C and GPIO.
- ***examples***: sample codes for secondary development, for example, IoT Demo.
- ***include***: header files pre-installed in SDK. The files contain relevant API functions and other macro definitions. Users do not need to modify them.
- ***ld***: linker scripts. We suggest users not modifying them without any specific reasons.
- ***lib***: library files provided in SDK.
- ***tools***: tools needed for compiling binaries. Users do not need to modify them.

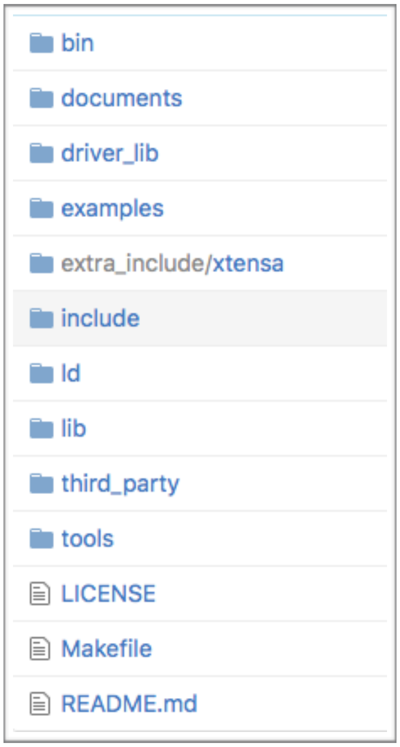
4.1. RTOS SDK

Users can download RTOS SDK and its application examples (ESP8266_IOT_PLATFORM) from:

- RTOS SDK
  https://github.com/espressif/ESP8266_RTOS_SDK

- ESP8266_IOT_PLATFORM
  https://github.com/espressif/ESP8266_IOT_PLATFORM

Table 3-2 shows the directory structure of the RTOS SDK.



bin
documents
driver_lib
examples
extra_include/xtensa
include
ld
lib
third_party
tools
LICENSE
Makefile
README.md

Figure 3-2. RTOS SDK Directory Structure

- ***bin***: boot and initialization firmware.
- ***documents***: ESP8266_RTOS_SDK files.
- ***driver_lib***: sample codes of drivers.
- ***examples***: sample codes for Espressif's application programs.
  - ***openssl_demo***: sample codes of the openssl API function.
  - ***project_template***: sample codes of project templates.
  - ***smart_config***: sample codes of SmartConfig.
  - ***spiffs_test***: sample codes of the spiffs file system function.
  - ***websocket_demo***: sample codes of web socket.
- ***include***: header files of ESP8266_RTOS_SDK, including software interfaces and macro functions for users to use.
- ***ld***: link files used when compiling; users do not need to modify them.
- ***lib***: library file of ESP8266_RTOS_SDK.
- ***third_party***: third-party library of Espressif's open-source codes, currently including free RTOS, JSON, lwIP, mbedTLS, noPoll, OpenSSL, spiffs, and SSL.
- ***tools***: tools needed for compiling binaries; users do not need to modify them.

4.2. ESP8266 Toolkit

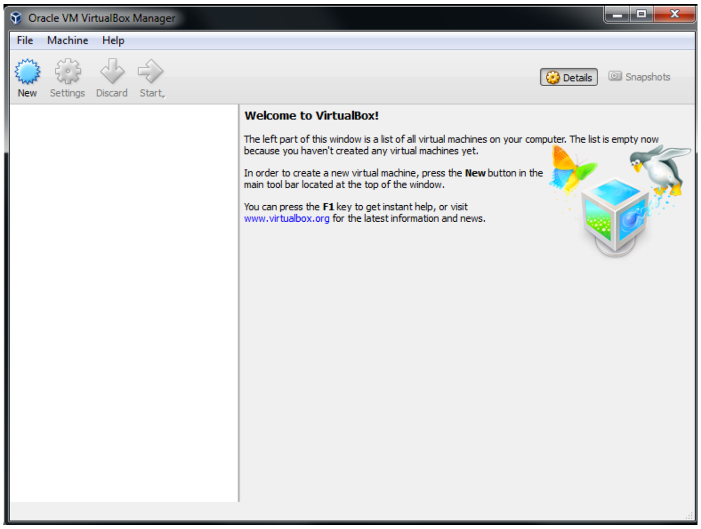
4.2.1. Compiler

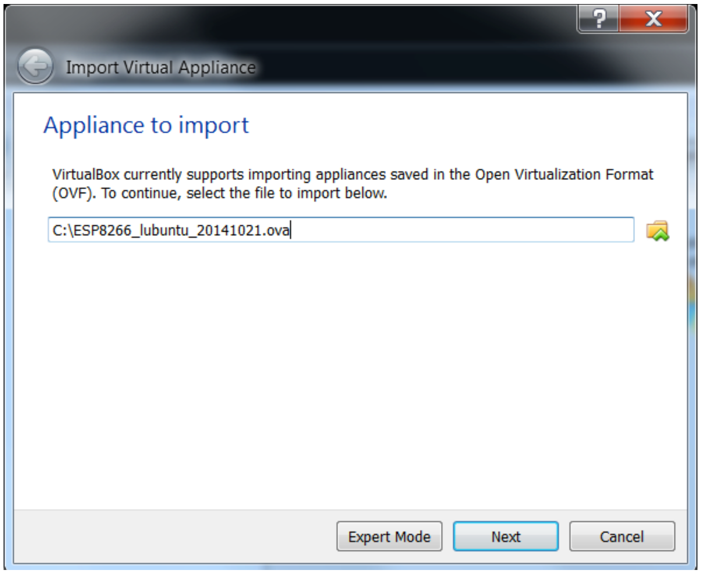
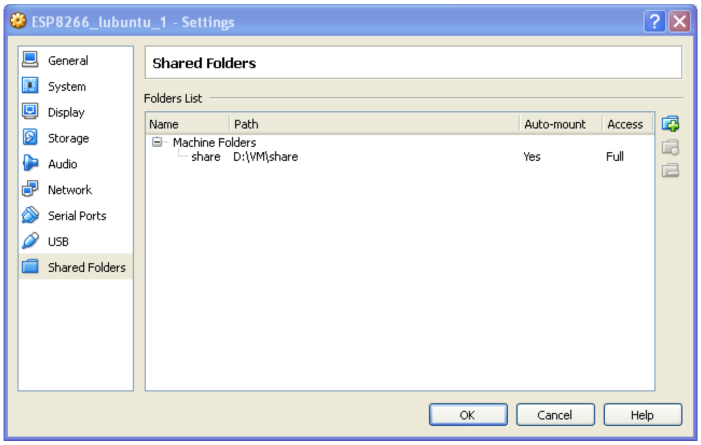
Please download VirtualBox from: https://www.virtualbox.org/wiki/Downloads.

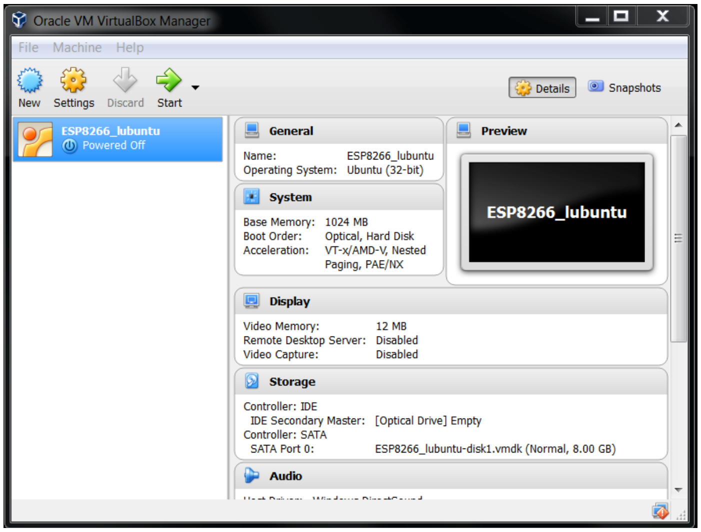
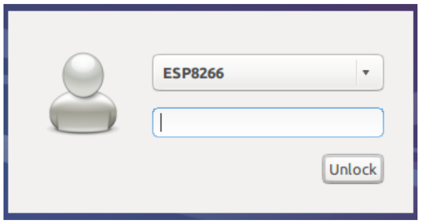
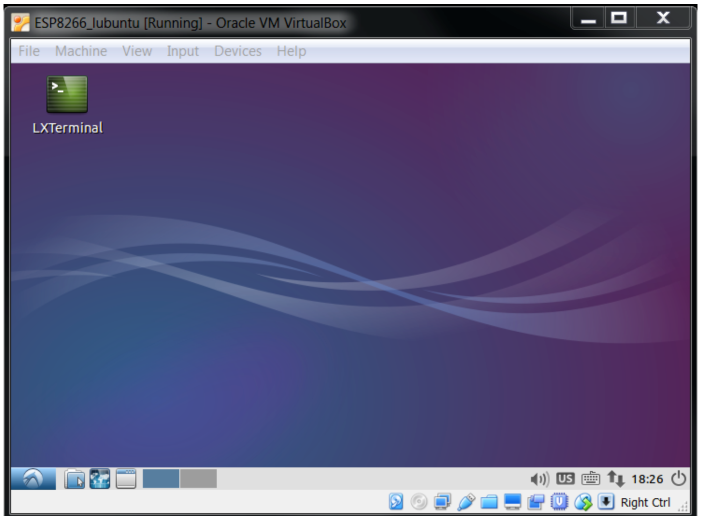
> 📖 ***Note:***
>
> *Please choose the right version of VirtualBox according to the host machine's OS.*

Please download the compiler ***ESP8266_lubuntu_20141021.ova*** from:

http://downloads.espressif.com/FB/ESP8266_GCC.zip

Steps	Results
1. Start Windows OS and install the virtual machine.	
• Double-click ***VirtualBox-5.0.16-105871-Win.exe*** and install VirtualBox. 📖 ***Note:*** *VirtualBox has different versions. We are using Windows V.5.0.16 as an example.* • Double-click ***Oracle VM VirtualBox.exe*** to run the program, and the system will show the main menu 👉. 💬 ***Tip:*** *The ESP8266 virtual machine takes up much space (memory). Please reserve enough space for it.*	 Oracle VM VirtualBox Manager File Machine Help New Settings Discard Start Details Snapshots **Welcome to VirtualBox!** The left part of this window is a list of all virtual machines on your computer. The list is empty now because you haven't created any virtual machines yet. In order to create a new virtual machine, press the **New** button in the main tool bar located at the top of the window. You can press the **F1** key to get instant help, or visit www.virtualbox.org for the latest information and news.
2. Import the image file.	

Steps	Results
• Select ***File > Import Appliance***, and a dialog box will show up 👉. • Select the image file to import, for example, ***C:\ESP8266_lubuntu_20141021.ova***, and click ***Next***. • Click ***Import*** to confirm the settings.	 Import Virtual Appliance Appliance to import VirtualBox currently supports importing appliances saved in the Open Virtualization Format (OVF). To continue, select the file to import below. C:\ESP8266_lubuntu_20141021.ova
3. Create a shared folder.	
• Create a new folder named ***D:\VM\share***. • Select ***Machine > Settings > Shared Folders…***, and a dialog box will show up 👉. • Select the shared folder in ***Machine Folders***, for example, ***D:\VM\share***.	 ESP8266_lubuntu_1 - Settings General System Display Storage Audio Network Serial Ports USB Shared Folders Shared Folders Folders List Name | Path | Auto-mount | Access Machine Folders share | D:\VM\share | Yes | Full
4. Run the virtual machine.	

Steps	Results
- After importing, a virtual machine named ***ESP8266_lubuntu*** shows up 👉. - Double-click ***ESP8266_lubuntu*** or ***Start*** to run the virtual machine.	 Oracle VM VirtualBox Manager File Machine Help New Settings Discard Start Details Snapshots ESP8266_lubuntu Powered Off Preview ESP8266_lubuntu General Name: ESP8266_lubuntu Operating System: Ubuntu (32-bit) System Base Memory: 1024 MB Boot Order: Optical, Hard Disk Acceleration: VT-x/AMD-V, Nested Paging, PAE/NX Display Video Memory: 12 MB Remote Desktop Server: Disabled Video Capture: Disabled Storage Controller: IDE IDE Secondary Master: [Optical Drive] Empty Controller: SATA SATA Port 0: ESP8266_lubuntu-disk1.vmdk (Normal, 8.00 GB) Audio
- The system shows the ESP8266 virtual machine 👉. - If a dialog box like the one below 👇 shows up, please enter the password: ***espressif***.  	 ESP8266_lubuntu [Running] - Oracle VM VirtualBox File Machine View Input Devices Help LXTerminal US 18:26 Right Ctrl

4.2.2. Firmware Download Tool

Please download the ESP8266 DOWNLOAD TOOL from:

http://www.espressif.com/support/download/other-tools.

5. Compiling the SDK

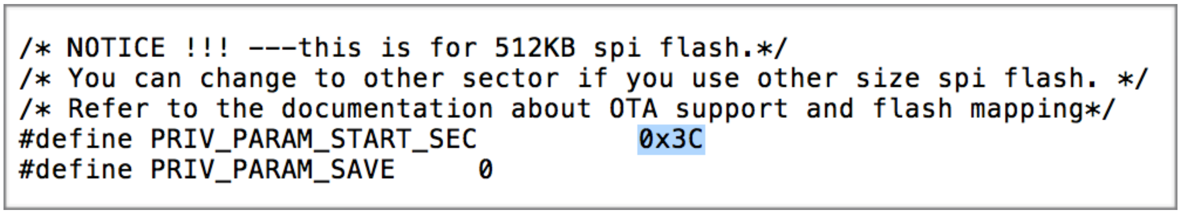
5.1. Preparations

1. Modifying SDK Files

> 📖 ***Note:***
>
> *Users need to modify the SDK files if using the OTA firmware.*

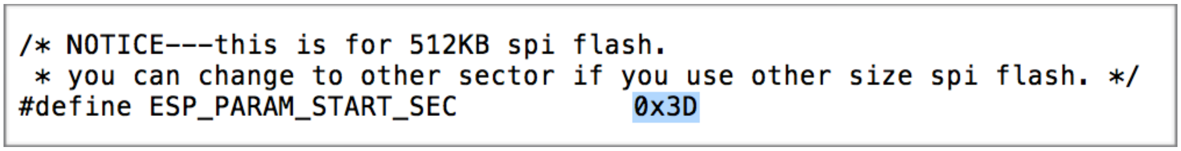
1. Start Windows OS.
2. Modify files in ***ESP8266_NONOS_SDK/examples/IoT_Demo/include*** according to the flash map.

   - Modify `#define PRIV_PARAM_START_SEC` in ***user_light.h*** and ***user_plug.h***.



```
/* NOTICE !!! ---this is for 512KB spi flash.*/
/* You can change to other sector if you use other size spi flash. */
/* Refer to the documentation about OTA support and flash mapping*/
#define PRIV_PARAM_START_SEC          0x3C
#define PRIV_PARAM_SAVE     0
```

   - Modify `#define ESP_PARAM_START_SEC` in ***user_esp_platform.h***.



```
/* NOTICE---this is for 512KB spi flash.
 * you can change to other sector if you use other size spi flash. */
#define ESP_PARAM_START_SEC           0x3D
```

Table 5-1 lists the modified values.

Table 5-1. Modify the Field Values in the "include" File (unit: kB)

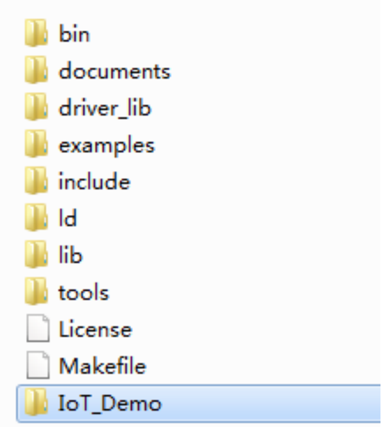
Default value (512)	Modified values							
	512	1024	2048 (512+512)	2048 (1024+1024)	4096 (512+512)	4096 (1024+1024)	8192 (1024+1024)	16384 (1024+1024)
0x3C	-	0x7C	0x7C	0xFC	0x7C	0xFC	0xFC	0xFC
0x3D	-	0x7D	0x7D	0xFD	0x7D	0xFD	0xFD	0xFD

> 📖 ***Note:***
>
> *Users need not modify the SDK files if using a 512-KB flash.*

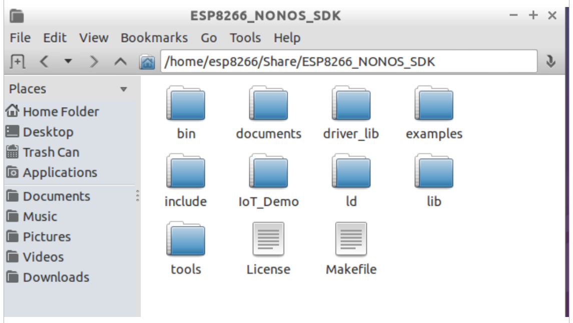
2. Downloading SDK Files

1. Start Linux OS.
2. Run LXTerminal on the desktop of the virtual machine.

3. Copy the files to be compiled to the shared folder.

Steps	Results
• Copy ***ESP8266_NONOS_SDK*** folder to the shared directory, for example, ***C:\VM\share***. • Copy ***IoT_Demo*** folder to ***C:\VM\share\ESP8266_NONOS_SDK***, as shown in the figure on the right 👉.	 bin documents driver_lib examples include ld lib tools License Makefile IoT_Demo

4. Download shared directory.

Steps	Results
• Execute `./mount.sh`. • Input the password: ***espressif***. Downloading shared files is completed. • Open the shared directory ***ESP8266_NONOS_SDK*** in the virtual machine and confirm whether the download has been successful. - If successful, the directory contains such files as those in the figure on the right 👉. - If not, the directory will be empty, and users will need to go over this step again.	 ESP8266_NONOS_SDK File Edit View Bookmarks Go Tools Help Places Home Folder Desktop Trash Can Applications Documents Music Pictures Videos Downloads /home/esp8266/Share/ESP8266_NONOS_SDK bin documents driver_lib examples include IoT_Demo ld lib tools License Makefile

> ⚠️ ***Notice:***
>
> *If users use the RTOS SDK, please continue with the following steps; if use the non-OS SDK, please skip Step 5.*

5. Set the variable PATH to point to SDK and binaries.

```
export SDK_PATH=~/Share/ESP8266_RTOS_SDK

export BIN_PATH=~/Share/ESP8266_RTOS_SDK/bin
```

> 📖 ***Note:***
>
> *Users can add it to **.bashrc** file, otherwise Step 5 needs to be repeated each time the compiler is restarted.*

5.2. Compilation

5.2.1. Compile ESP8266_NONOS_SDK_v0.9.5 and Later Versions

2. Switch to the ***/Share/ESP8266_NONOS_SDK/IoT_Demo*** directory in the terminal.

```
cd /home/esp8266/Share/ESP8266_NONOS_SDK/IoT_Demo

./gen_misc.sh
```

The system shows the following information:

```
gen_misc.sh version 20150511

Please follow below steps(1-5) to generate specific bin(s):
```

3. Select the required options as shown in Figure 5-1.

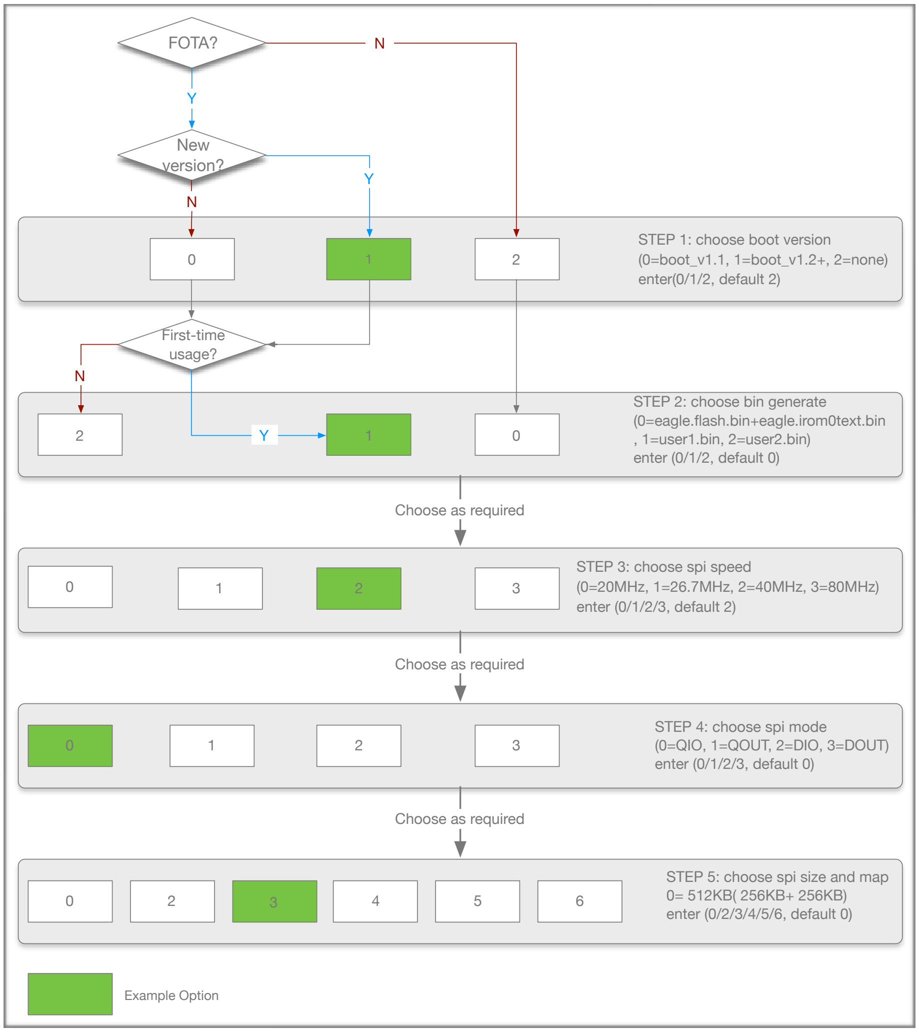

FOTA?
N
Y
New version?
Y
N
0
1
2
STEP 1: choose boot version
(0=boot_v1.1, 1=boot_v1.2+, 2=none)
enter(0/1/2, default 2)
First-time usage?
N
2
Y
1
0
STEP 2: choose bin generate
(0=eagle.flash.bin+eagle.irom0text.bin
, 1=user1.bin, 2=user2.bin)
enter (0/1/2, default 0)
Choose as required
0
1
2
3
STEP 3: choose spi speed
(0=20MHz, 1=26.7MHz, 2=40MHz, 3=80MHz)
enter (0/1/2/3, default 2)
Choose as required
0
1
2
3
STEP 4: choose spi mode
(0=QIO, 1=QOUT, 2=DIO, 3=DOUT)
enter (0/1/2/3, default 0)
Choose as required
0
2
3
4
5
6
STEP 5: choose spi size and map
0= 512KB(256KB+ 256KB)
enter (0/2/3/4/5/6, default 0)
Example Option

Figure 5-1. Compile SDK

> 📖 ***Notes:***
>
> - *The sample options are marked in green. Users can select the right options as needed.*
> - *For OTA and non-OTA firmware, please refer to Section 1.4, "ESP8266 FW".*
> - *Only sdk_v1.1.0 + boot 1.4 + flash download tool_v1.2 and higher versions support options 5 and 6 in Step 5.*
> - *After compiling **user1.bin**, execute `make clean` first to clear the temporary files generated by the last compilation, and then compile **user2.bin**.*
> - *For the flash map in Step 5, please refer to Chapter 4, "Flash Maps".*

4. After compilation, the generated binaries and the addresses in flash are shown as follows:

```
Generate user1.2048.new.3.bin successfully in folder bin/upgrade.

boot.bin------------>0x00000

user1.2048.new.3.bin--->0xSupport boot_v1.2 and +

01000

!!!
```

> 📖 ***Note:***
>
> *Users can open the **/home/esp8266/Share/ESP8266_NONOS_SDK/bin** directory and check the compiled binaries.*

— — END

5.2.2. ESP8266_NONOS_SDK_v0.9.4 and Earlier Versions

For ESP8266_NONOS_SDK_v0.9.4 and previous versions, the compilation process is as follows:

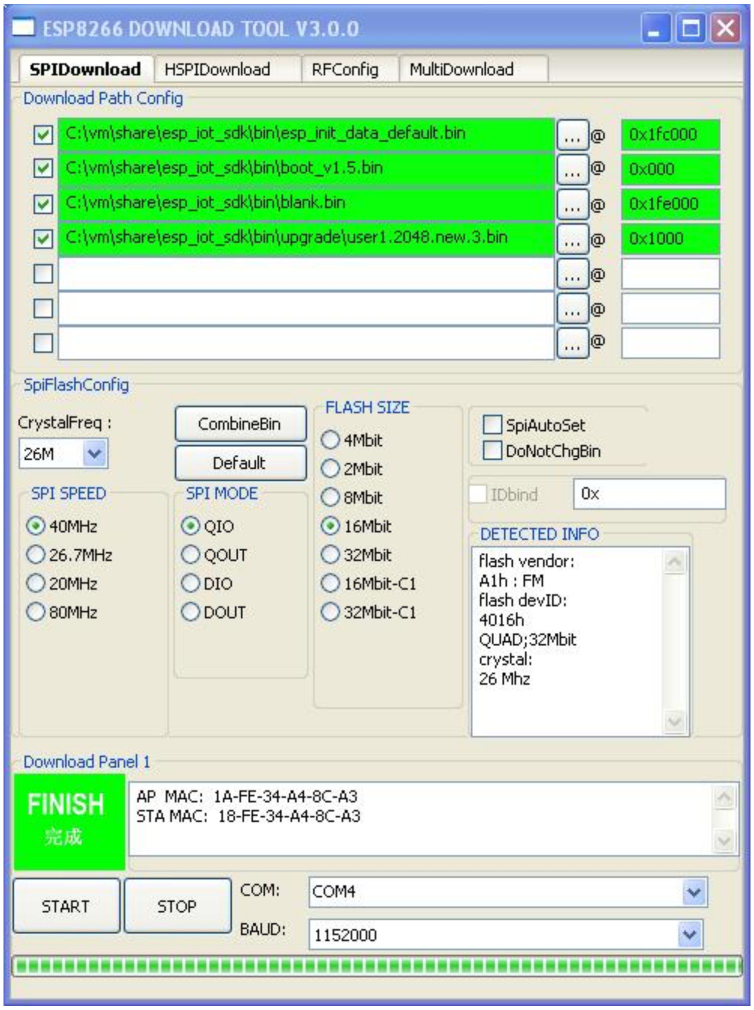
1. Execute `./gen_misc_plus.sh 1` to generate ***user1.bin*** under the ***/ESP8266_NONOS_SDK/bin/upgrade*** path.
2. Execute `make clean` to clear previous compilation data.
3. Execute `./gen_misc_plus.sh 2` to generate ***user2.bin*** under the ***/ESP8266_NONOS_SDK/bin/upgrade*** path.

> 📖 ***Note:***
>
> *ESP8266_NONOS_SDK_v0.7 and earlier are non-OTA firmware.*

6. Downloading the Firmware

6.1. Download Procedure

1. Start Windows OS.
2. Double-click ***ESP_DOWNLOAD_TOOL.exe*** to open Flash tool.



☑ C:\vm\share\esp_iot_sdk\bin\esp_init_data_default.bin @ 0x1fc000
☑ C:\vm\share\esp_iot_sdk\bin\boot_v1.5.bin @ 0x000
☑ C:\vm\share\esp_iot_sdk\bin\blank.bin @ 0x1fe000
☑ C:\vm\share\esp_iot_sdk\bin\upgrade\user1.2048.new.3.bin @ 0x1000
□ @
□ @
□ @

CrystalFreq : 26M

SPI SPEED: ● 40MHz ○ 26.7MHz ○ 20MHz ○ 80MHz

SPI MODE: ● QIO ○ QOUT ○ DIO ○ DOUT

FLASH SIZE: ○ 4Mbit ○ 2Mbit ○ 8Mbit ● 16Mbit ○ 32Mbit ○ 16Mbit-C1 ○ 32Mbit-C1

□ SpiAutoSet
□ DoNotChgBin
□ IDbind 0x

DETECTED INFO

```
flash vendor:
A1h : FM
flash devID:
4016h
QUAD;32Mbit
crystal:
26 Mhz
```

Download Panel 1

```
AP  MAC:  1A-FE-34-A4-8C-A3
STA MAC:  18-FE-34-A4-8C-A3
```

COM: COM4

BAUD: 1152000

Figure 6-1. ESP8266 DOWNLOAD TOOL—SPIDownload

SPIDownload	For SPI Flash download.
HSPIDownload	For HSPI Flash download.
RFConfig	RF initialization Configuration.
MutiDownload	For multi-mother boards download.

3. Double-click [...] in ***Download Path Config*** panel to select the binaries to be downloaded. Set the corresponding download addresses in ***ADDR***.
4. Configure SPIDownload.

> 📖 ***Note:***
>
> *The binaries to be downloaded and the corresponding addresses vary with different SPI Flash sizes and actual demands. For details, please refer to Chapter 4, "Flash Maps".*

Table 6-1. SPIDownload Configuration

Items	Description
SPI FLASH CONFIG	
CrystalFreq	Select the crystal frequency according to the crystal oscillator used.
CombineBin	Combine the selected binaries into ***target.bin*** with the address 0x0000.
Default	Set the SPI Flash to the default value.
SPI SPEED	Select SPI read/write speed with the maximum value of 80 MHz.
SPI MODE	Select SPI mode according to the SPI Flash used. If the flash is Dual SPI, select ***DIO*** or ***DOUT***. If the flash is Quad SPI, select ***DIO*** or ***DOUT***. ⚠️ ***Notice:*** *If ISSI Flash is used, please refer to Appendix, "Configure ISSI & MXIC Flash QIO Mode".*
FLASH SIZE	Select the flash size according to the flash type. 📖 ***Note:*** ***16Mbit-C1*** *refers to 1024+1024 flash map and* ***32Mbit-C1*** *1024+1024 flash map as well.*
SpiAutoSet	We recommend not checking ***SpiAutoSet***, but configuring the flash manually as needed. If users select ***SpiAutoSet***, the binaries will be downloaded according to the default flash map. The flash map of 16 Mbit and 32 Mbit will be 512 KByte + 512 KByte.
DoNotChgBin	• If users select ***DoNotChgBin***, the flash working frequency, mode, and flash map will be based on the configuration when compiling. • If users do not select ***DoNotChgBin***, the flash working frequency, mode, and flash map will be defined by the final configuration of the compiler.
Download Panel	
START	Click ***START*** to start download. When the download completes, ***FINISH*** will appear in the green area on the left.
STOP	Click ***STOP*** to stop download.
MAC Address	If download is successful, the system will show the MAC addresses of ESP8266 STA and ESP8266 AP.
COM PORT	Select the actual COM port of ESP8266.

Items	Description
SPI FLASH CONFIG	
BAUDRATE	Select the baud rate of downloading. The default value is 115200.

5. After downloading, turn `GPIO0` Control on ESP-LAUNCHER to the outer side and power the board on to enable the working mode.

6.2. Check Log File

After downloading firmware, users can check the log printed in the terminal by using the serial port debug tool.

Users need to configure the settings of the serial port debug tool, as follows:

Table 6-2. Serial Port Debug Tool Configuration

Items	Configuration Description
Protocol	Serial port.
Port number	Set the port number according to the connected device.
Baud rate	The baud rate at which the device is running, related to the crystal oscillator. • 69120 (24 M crystal oscillator) • 74880 (26 M crystal oscillator) • 115200 (40 M crystal oscillator) The ESP8266 AT example supports the baud rate of 115200 by default. Users cannot modify it. The ESP8266 IOT Demo example supports the baud rate of 74880. Users can modify it.
Data bit	8
Calibration	None.
Flow control	None.

6.2.1. ESP8266 IOT Demo

If users download ESP8266 IOT Demo firmware, the system in working mode will show the initialization information including the SDK version, etc. “Finish” means the firmware works properly.

```
SDK version:X.X.X(e67da894)

IOT VERSION = v1.0.5t45772(a)

reset reason: 0

PWM version: 00000003

mode: sta(18:fe:34:a4:8c:a3) + softAP(1a:fe:34:a4:8c:a3)
```

```
add if0

add if1

dhcp server start:(ip:192.168.4.1,mask:255.255.255.0,gw:192.168.4.1)

bcn 100

finish
```

6.2.2. ESP8266 AT

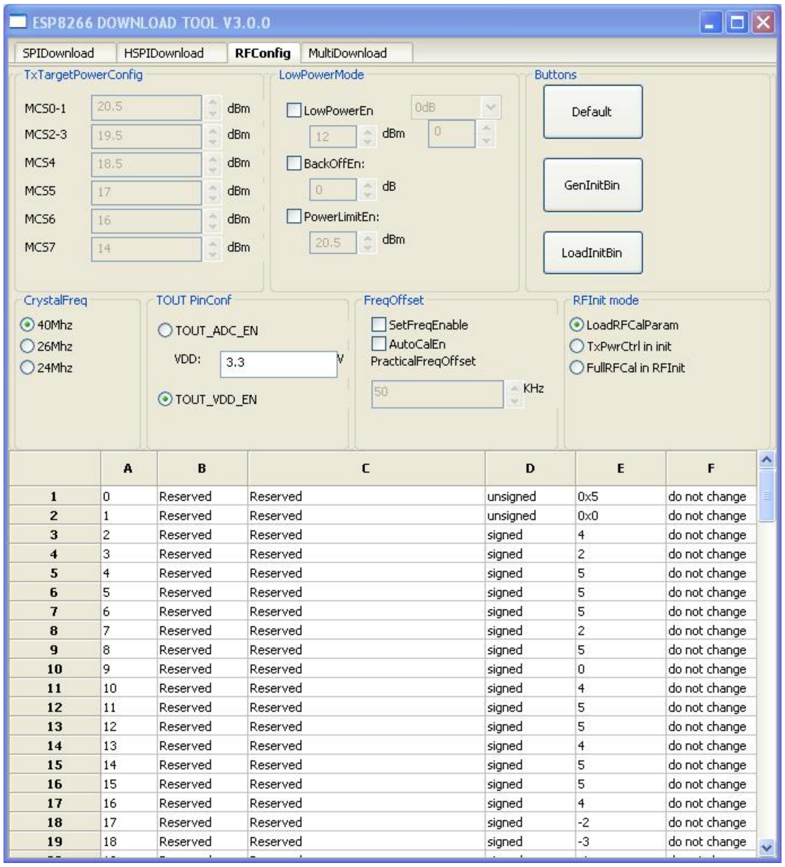
If users download the ESP8266 AT firmware, or the default firmware in ESP-LAUNCHER or ESP-WROOM-02U, the system in working mode will display “Ready” at the end. Input command “AT” in the terminal and the system will return “OK”, which means that the firmware works properly.

📖 ***Notes:***

- The baud rate in AT firmware is configured as 115200 manually, however, the default baud rate of ESP8266 is 74880, due to this discrepancy, the system initialization information will be displayed as mojibake. It is a normal phenomenon as long as the system shows “Ready” at the end.
- For more information on AT commands, please refer to *ESP8266 AT Instruction Set*.

6.3. Configuration of RF initialization (Optional)

Before downloading binaries to flash, users can modify the RF initialization settings in the ***RF InitConfig*** tab. The newly-generated ***esp_init_data_setting.bin*** can be downloaded to the flash instead of ***esp_init_data_default.bin***. Users can configure both the options and the parameters of the RF settings.



TxTargetPowerConfig

MCS0-1 20.5 dBm

MCS2-3 19.5 dBm

MCS4 18.5 dBm

MCS5 17 dBm

MCS6 16 dBm

MCS7 14 dBm

LowPowerMode

□ LowPowerEn 0dB

12 dBm 0

□ BackOffEn:

0 dB

□ PowerLimitEn:

20.5 dBm

CrystalFreq

● 40Mhz

○ 26Mhz

○ 24Mhz

TOUT PinConf

○ TOUT_ADC_EN

VDD: 3.3 V

● TOUT_VDD_EN

FreqOffset

□ SetFreqEnable

□ AutoCalEn

PracticalFreqOffset

50 KHz

RFInit mode

● LoadRFCalParam

○ TxPwrCtrl in init

○ FullRFCal in RFInit

	A	B	C	D	E	F
1	0	Reserved	Reserved	unsigned	0x5	do not change
2	1	Reserved	Reserved	unsigned	0x0	do not change
3	2	Reserved	Reserved	signed	4	do not change
4	3	Reserved	Reserved	signed	2	do not change
5	4	Reserved	Reserved	signed	5	do not change
6	5	Reserved	Reserved	signed	5	do not change
7	6	Reserved	Reserved	signed	5	do not change
8	7	Reserved	Reserved	signed	2	do not change
9	8	Reserved	Reserved	signed	5	do not change
10	9	Reserved	Reserved	signed	0	do not change
11	10	Reserved	Reserved	signed	4	do not change
12	11	Reserved	Reserved	signed	5	do not change
13	12	Reserved	Reserved	signed	5	do not change
14	13	Reserved	Reserved	signed	4	do not change
15	14	Reserved	Reserved	signed	5	do not change
16	15	Reserved	Reserved	signed	5	do not change
17	16	Reserved	Reserved	signed	4	do not change
18	17	Reserved	Reserved	signed	-2	do not change
19	18	Reserved	Reserved	signed	-3	do not change

Figure 6-2. ESP8266 DOWNLOAD TOOL - RF InitConfig

6.3.1. Configuration of RF InitConfig Options

RF InitConfig options are listed in the upper part of Figure 6-2. Please refer to Table 6-3 for a description of this configuration.

Table 6-3. Configuration of RF InitConfig Options

Items	Description
TxTargetPowerConfig	Users need not configure this. It varies with the options in LowPowerMode.
LowPowerMode	Configure the low power mode as required. • *LowPowerEn*: enable low power mode, set a power value for all data rates. • *PowerLimtEn*: set a limit for output power. • *BackOffEn*: set backoff value for each data rate. 📖 ***Note:*** *Users cannot configure LowPowerEn and PowerLimtEn at the same time.*
CrystalFreq	Select the crystal oscillator frequency according to the crystal oscillator used. 📖 ***Note:*** *If a different option is selected when downloading, it will override this configuration.*

Items	Description
TOUT PinConf	Configure the TOUT pin according to the actual TOUT pin status. We recommend the default value. • *TOUT_ADC_EN*: When the TOUT pin connects to an external circuit, measure the external voltage (0V - 1V) through the internal ADC. • *TOUT_VDD_EN*: When TOUT pin is left floating, measure VDD33 voltage through uint16 system_get_vdd33(void). ⚠ ***Notice:*** • *Users cannot configure TOUT_ADC_EN and TOUT_VDD_EN at the same time.* • *When users use TOUT_ADC_EN, they need to input the actual voltage on VDD3P3 pin 3 and pin 4.*
FreqOffset	• *SetFreqEnable*: Set the frequency offset manually. - *PracticalFreqOffset*: the option is valid when selecting *SetFreqEnable*. • *AutoCalEn*: Set the frequency offset automatically.
RFInt mode	Users can select the RF initialization mode: • *LoadRFCalParam*: During the RF initialization, RF data are loaded directly from the flash without any calibration. It takes about 2 ms and the least initial current. • *TxPwrCtrl in init*: During the RF initialization, only Tx Power calibration will be performed, and other data are loaded from flash. It takes about 20 ms and small initial current. • *FullRFCal in RFInit*: All calibrations are performed during the RF initialization. It takes 200 ms and large initial current.

6.3.2. Configuration of RF InitConfig Parameters

RF InitConfig parameters are listed in the lower part of Figure 6-2. The description of parameters' configuration is shown in Table 6-4.

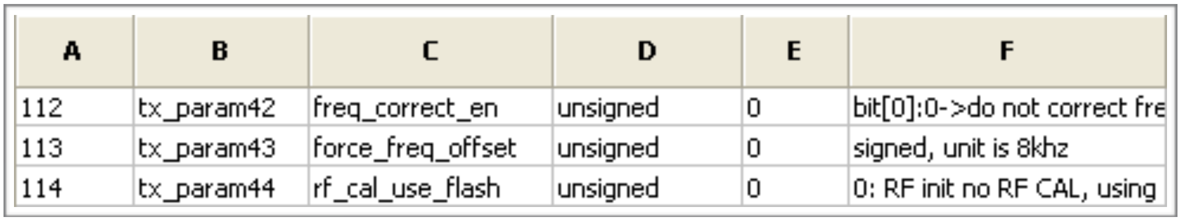
Table 6-4. Configuration of RF InitConfig Parameters

Items	Description
A	The byte in ***esp_init_data_setting.bin*** (0 ~ 127 byte). For example, A = 0 represents Byte 0 in ***esp_init_data_setting.bin***.
B	The item name. Users cannot modify it if marked as Reserved.
C	The item name. Users cannot modify it if marked as Reserved.
D	Data types of configuration items, including unsigned and signed data types.
E	The hexadecimal value of a configuration item.

⚠ ***Notice:***

Please do not modify the parameters marked as Reserved.

The following section introduces how to modify the 112 ~ 114 byte parameters. Figure 6-3 shows the initial configuration.



A	B	C	D	E	F
112	tx_param42	freq_correct_en	unsigned	0	bit[0]:0->do not correct fre
113	tx_param43	force_freq_offset	unsigned	0	signed, unit is 8khz
114	tx_param44	rf_cal_use_flash	unsigned	0	0: RF init no RF CAL, using

Figure 6-3. 112 ~ 114 Byte Parameters

Modify the RF Initialization Parameters

Byte 114 is used to control THE RF initialization when ESP8266 is powered on. Table 6-5 provides the parameter configuration.

> 📖 ***Note:***
>
> *Supported by ESP8266_NONOS_SDK_V1.5.3 and ESP8266_RTOS_SDK_V1.3.0 and higher.*

Table 6-5. Modify RF Initialization Parameters

Option	Description
byte 114 = 0	Only a VDD33 calibration is performed during the RF initialization. It takes about 2 ms and the least initial current.
byte 114 = 1	The default value is 1. VDD33 and TX power calibrations are performed during the RF initialization. It takes about 18 ms and small initial current.
byte 114 = 2	The same as when " byte 114 = 0".
byte 114 = 3	All calibrations are performed during the RF initialization. It takes about 200 ms and large initial current.

Correct Frequency Offset

Byte 112 and byte 113 relate to the frequency offset correction. Table 6-6 provides the parameter configuration.

> 📖 ***Note:***
>
> *Supported by ESP8266_NONOS_SDK_V1.4.0 and ESP8266_RTOS_SDK_V1.3.0 and higher.*

Table 6-6. Options for Frequency Offset Correction

Option	Description
The default value of byte 112 is 0.	
bit 0	This bit is of the highest priority. • bit 0 = 0: frequency offset cannot be corrected. • bit 0 = 1: frequency offset can be corrected.

Option	Description
	The default value of byte 112 is 0.
bit 1	When value = 0, it means that the bbpll is 168 M. Both positive and negative frequency offsets can be corrected. However, this may effect the digital peripheral performance and, therefore, it is not recommended. When value = 1, it means that the bbpll is 160 M. Only the positive frequency offset can be corrected.
{bit 3，bit 2}	When value = 0, it means that the chip will track and correct the frequency offset automatically. The initial correction value is 0. When value = 1, it means that the chip is manually programmed to change the frequency offset to that of byte 113, so the chip will not track and correct the frequency offset automatically. When value = 2, it means that the chip will track and correct the frequency offset automatically. The initial correction value is that of byte 113.
	The default value of byte 113 is 0.
113 byte	It is the value when the frequency offset is corrected manually or the initial correction value in frequency tracking. The data type is sign int8, in multiples of 8 kHz.

6.3.3. Configuration Examples

The configuration of bytes 112 and 113 depends depends on users' specific needs. We provide some examples below:

1. **The module works at ambient temperature, and needs no correction of the frequency offset.**
   - Set byte 112 = 0, byte 113 = 0.
2. **The module works at ambient temperature and needs no automatic tracking and correction of the frequency offset; yet the frequency offset is large. In this case, a manual correction of the frequency offset is recommended.**
   - If the frequency offset is +160 KHz (at ambient temperature), users can set byte 112 = 0x07, byte 113 = (256 - 160/8) = 236 = 0xEC.
   - If the frequency offset is -160 KHz (at ambient temperature), users can set byte 112 = 0x05, byte 113 = 160/8 = 20 = 0x14. This may effect the digital peripheral performance, so we do not recommend it.
3. **Applications, such as smart lights, work at a wide temperature range of -40 °C to 125 °C, and need to track and correct the frequency offset automatically. The frequency offset at ambient temperature is small, so the initial offset correction value is not needed.**
   - Set byte 112 = 0x03, byte 113 = 0.

4. **Applications, such as smart lights, work at a wide temperature range of -40 °C to 125 °C, and need to track and correct the frequency offset automatically. The frequency offset at ambient temperature is large, so the initial offset correction value is needed.**
    - If the frequency offset is +160 kHz (at ambient temperature), users can set byte 112 = 0x0B, byte 113 = (256 - 160/8) = 236 = 0xEC.
    - If the frequency offset is -160 kHz (at ambient temperature), users can set byte 112 = 0x09, byte 113 = 160/8 = 20 = 0x14. But this may effect the digital peripheral performance and needs substantive tests, so we do not recommend it.

We recommend Example 3.

When the configuration of RF initialization is done, click ***GenInitBin*** button to generate

esp_init_data_setting.bin.

In addition, users can click ***Default*** button to set the value of frequency offset to default, or click ***LoadInitBin*** button to import a binary file for configuration.

Espressif IOT Team

www.espressif.com

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FCC Label: The FCC ID is on the front of the device. It is easily visible.

The device FCC ID is 2AC7Z-ESPWROOM02D.

A label with the following statements must be attached to the host end product:

This device contains FCC ID: 2AC7Z-ESPWROOM02D.

The manual provides guidance to the host manufacturer will be included in the documentation that will be provided to the OEM.

The module is limited to installation in mobile or fixed applications.

The separate approval is required for all other operating configurations, including portable configurations and different antenna configurations.

The OEM integrators are responsible for ensuring that the end-user has no manual or instructions to remove or install module.

The module is limited to OEM installation ONLY.

Module grantee (the party responsible for the module grant) shall provide guidance to the host manufacturer for ensuring compliance with the Part 15 Subpart B requirements.

The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with the Part 15 Subpart B requirements, the host manufacturer is required to show compliance with the Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions) with the Radio essential requirements. The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in the Part 15 Subpart B or emissions are complaint with the Radio aspects.

CAUTION:
Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.

FCC RF Exposure Requirements

This device complies with FCC RF radiation exposure limits set forth for an uncontrolled enviroment.

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter and must be installed to provide a separation distance of at least 20cm from all persons.

FCC Regulations

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

Canada Regulations:

This device complies with Industry Canada’s licence-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

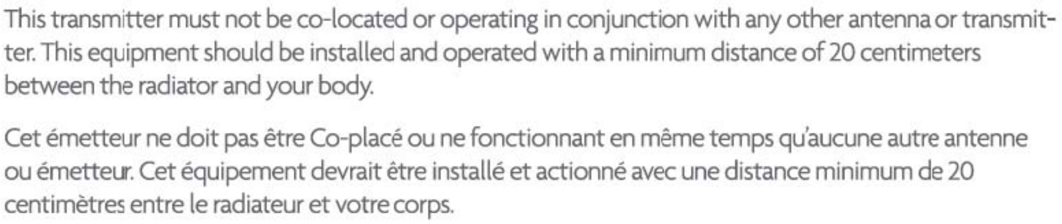
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Le présentappareilestconforme aux CNR d’Industrie Canada applicables aux appareils radio exempts de licence. L’exploitationestautorisée aux deux conditions suivantes :

(1) l’appareil ne doit pas produire de brouillage;

(2) l’utilisateur de l’appareildoit accepter tout brouillageradioélectriquesubi, mêmesi le brouillageest susceptible d’encompromettre le fonctionnement.

Caution：



This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

Cet émetteur ne doit pas être Co-placé ou ne fonctionnant en même temps qu’aucune autre antenne ou émetteur. Cet équipement devrait être installé et actionné avec une distance minimum de 20 centimètres entre le radiateur et votre corps.

A label with the following statements must be attached to the host end product: This device contains IC: 21098-ESPWROOM02D.

The manual provides guidance to the host manufacturer will be included in the documentation that will be provided to the OEM.

The module is limited to installation in mobile or fixed applications.

The separate approval is required for all other operating configurations, including portable configurations and different antenna configurations.

The OEM integrators are responsible for ensuring that the end-user has no manual or instructions to remove or install module.

The module is limited to OEM installation ONLY.

Une étiquette avec les instructions suivantes doit être attachée au produit final hôte:

Cet appareil contient IC: 21098-ESPWROOM02D.

Le manuel fournit des conseils au fabricant hôte sera inclus dans la documentation qui sera fournie à l'OEM.

Le module est limité à l'installation dans des applications mobiles ou fixes.

L'approbation distincte est requise pour toutes les autres configurations de fonctionnement, y compris les configurations portables et différentes configurations d'antenne.

Les intégrateurs OEM sont responsables de s'assurer que l'utilisateur n'a pas de manuel ou d'instructions pour retirer ou installer le module.

Le module est limité à l'installation OEM SEULEMENT.