

ESP8266

Hardware Matching Guide



Version 1.0
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About This Guide

This document introduces frequency offset tuning and antenna impedance matching for ESP8266 in order to achieve optimum RF performance.

Chapter	Title	Subject
Chapter 1	Overview	Relevance of frequency offset adjustment and impedance matching.
Chapter 2	Frequency Offset Tuning	Introduction to frequency offset testing and tuning methods.
Chapter 3	Antenna Matching	Introduction to antenna impedance matching.

Release Notes

Date	Version	Release note
2016.06	V1.0	First release.

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1.

Overview

ESP8266 is the most integrated System-on-a-Chip (SoC) with only 7 external components. In order to achieve the optimum performance of the chip, customers only need to tune the frequency offset and match the antenna impedance according to the crystal oscillator and antenna.

The lack of frequency offset tuning and antenna impedance matching may reduce the RF performance, resulting in AP scanning issue, unstable connection and unstable data transmission.



2. Frequency Offset Tuning

2.1. Testing Frequency Offset

The frequency offset can be tested in one of the following ways:

1. GPIO0 outputs crystal oscillator clock signals by default. Customers can compare the calculated frequency against the standard frequency and get the offset value.
2. Customers can use AT command firmware and send AT + CWLAP command. The last parameter is the offset value. However, it is a relative value. Customers can use a standard device for comparison.
3. Customers can use FCC/CE test firmware to send standard wave and get the offset value with IQView equipment. IQView equipment is as shown in Figure 2-1. FCC/CE certification and test document can be downloaded from:

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



Figure 2-1. IQView Equipment

2.2. Adjusting Frequency Offset

The frequency offset can be adjusted in two ways:

1. Adjust the regulating capacitors on both sides of crystal oscillator.
 - Increase capacitance if the frequency offset is positive, for example +50 ppm.
 - Decrease capacitance if the frequency offset is negative, for example -50 ppm.
 - Generally, the capacitances should be matched and adjusted at the same time.
2. Modify the frequency offset in ESP8266 DOWNLOAD TOOL. Click **LoadInitBin** to load **esp_init_data_default.bin**, modify **PracticalFreqOffset** and click **GenInitBin** to generate a new **esp_init_data_default.bin** to download to Flash. Please refer to Figure 2-2.



ESP8266 DOWNLOAD TOOL V3.3.4

SPIDownload HSPIDownload **RFConfig** MultiDownload

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
☐ BackOffEn: 0 dB
☐ PowerLimitEn: 20.5 dBm

Buttons

Default
GenInitBin
LoadInitBin

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	
1	0	Reserved	Reserved	unsigned	0x5	dc
2	1	Reserved	Reserved	unsigned	0x0	dc
3	2	Reserved	Reserved	signed	4	dc
4	3	Reserved	Reserved	signed	2	dc
5	4	Reserved	Reserved	signed	5	dc
6	5	Reserved	Reserved	signed	5	dc
7	6	Reserved	Reserved	signed	5	dc
8	7	Reserved	Reserved	signed	2	dc
9	8	Reserved	Reserved	signed	5	dc
10	9	Reserved	Reserved	signed	0	dc
11	10	Reserved	Reserved	signed	4	dc
12	11	Reserved	Reserved	signed	5	dc
13	12	Reserved	Reserved	signed	5	dc
14	13	Reserved	Reserved	signed	4	dc

Figure 2-2. ESP8266 DOWNLOAD TOOL - RFConfig Tab

Note:

ESP8266 DOWNLOAD TOOL can be downloaded from:
<http://www.espressif.com/en/support/download/other-tools>.



3. Impedance Matching

The impedance of ESP8266 PA output end is $39+j6\ \Omega$, so the matched impedance is $39-j6\ \Omega$ (from antenna to the chip).

For EMC test, the π -type impedance matching circuit of external antenna should be as shown in Figure 3-1.

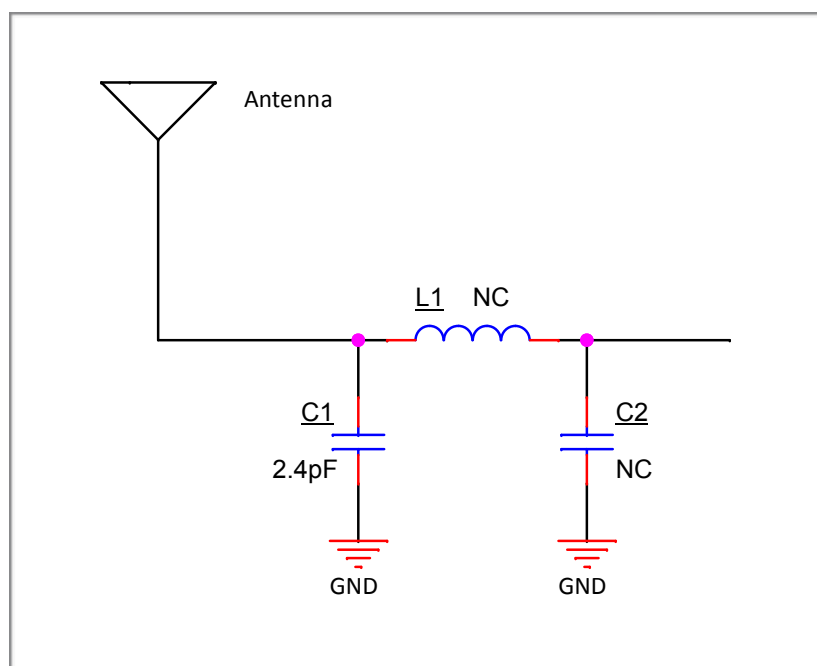


Figure 3-1. Antenna Impedance Matching

Notes:

- *C1 must be a 2.4 pF capacitor for filtering harmonics twice.*
- *L1, C2, along with C1 perform $39-j6\ \Omega$ impedance matching for antenna.*
- *L1 and C2 can be inductors or capacitors as required.*



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