ESP8266

Hardware Matching Guide

Version 1.0

About This Guide

This document introduces the frequency offset tuning and antenna impedance matching for ESP8266, which are necessary for achieving optimum RF performance.

Chapter	Title	Subject
Chapter 1	Overview	Impact of frequency offset adjustment and impedance matching.
Chapter 2	Frequency Offset Tuning	Presentation of frequency offset testing and tuning methods.
Chapter 3	Antenna Matching	Description of the antenna impedance matching.

Release Notes

Date	Version	Release note
2016.06	V1.0	First release.

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1. Overview

ESP8266 is a highly integrated System-on-a-Chip (SoC) with only seven 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 the antenna.

The lack of frequency offset tuning and antenna impedance matching may reduce the RF performance, resulting in AP-scanning issues, 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 to the standard frequency, and get the offset value.
2. Customers can use the AT command 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 the FCC/CE test firmware to send a standard wave and get the offset value with an IQView equipment. The IQView equipment is shown in Figure 2-1. The 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 capacitors on both sides of the crystal oscillator.
   - Increase the capacitance if the frequency offset is positive, for example +50 ppm.
   - Decrease the 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 the ESP8266 DOWNLOAD TOOL. Click ***LoadInitBin*** to load ***esp_init_data_default.bin***, modify ***PraticalFreqOffset*** and click ***GenInitBin*** to generate a new ***esp_init_data_default.bin*** to be downloaded to the flash. Please refer to Figure 2-2.

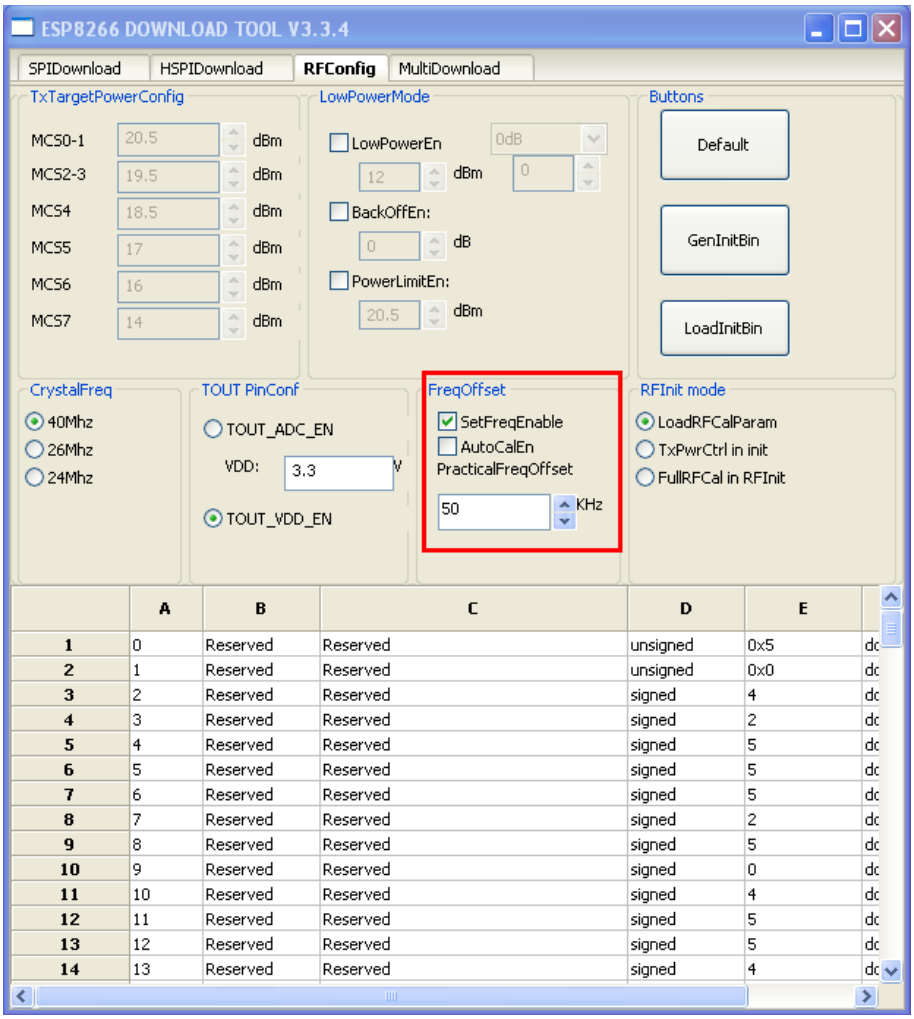

Figure 2-2. ESP8266 DOWNLOAD TOOL—RFConfig Tab

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

3. Impedance Matching

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

For the Electromagnetic Compatibility (EMC) testing, the π-type impedance matching circuit of the external antenna should be as is shown in Figure 3-1.

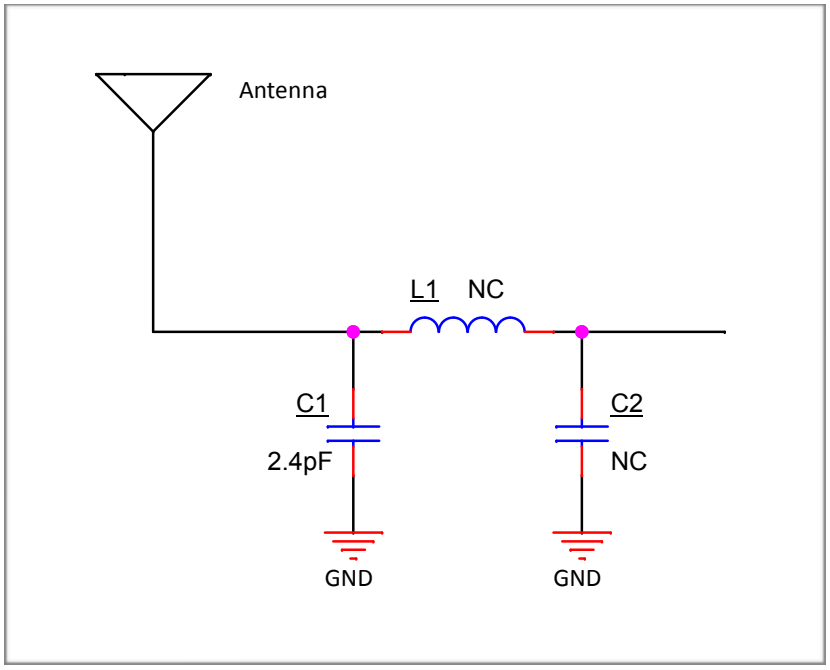

Figure 3-1. Antenna Impedance Matching

📖 ***Notes:***

- *C1 must be a 2.4 pF capacitor for filtering harmonics twice.*
- *L1, C2, along with C1, perform a (39-j6)Ω impedance matching for the antenna.*
- *L1 and C2 can be either inductors or capacitors, depending on different requirements.*

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