2.4GHz PCB antenna reference design

Model:

Version: V1.1

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1 Introduction

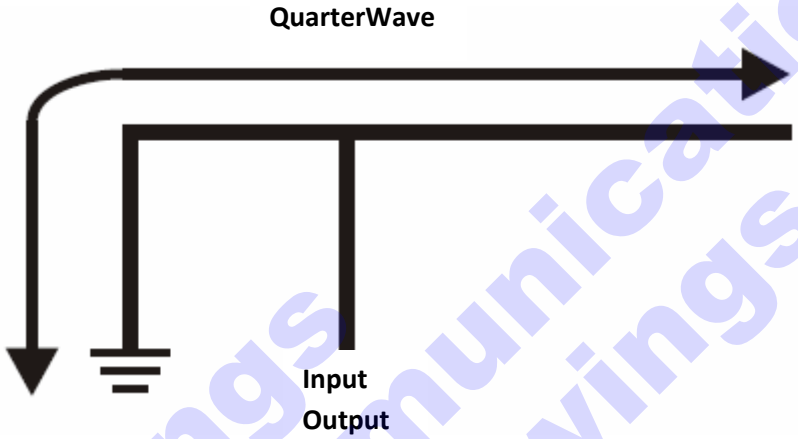
This document outlines two types of Printed Circuit Board (PCB) antenna used by FreeWings, which can be used with 2.4GHz radios such as Bluetooth WiFi.

2 type antennas will be discussed here:

1) Inverted-F

2) Meander Line

2 Inverted-F Antenna

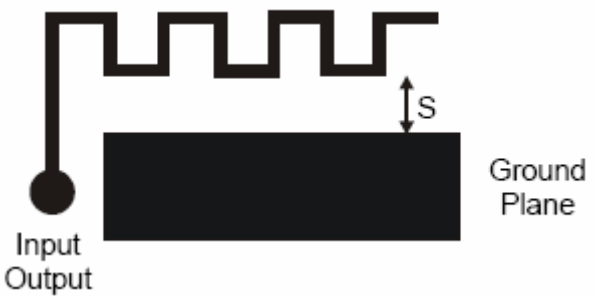


The inverted-F is a quarterwave antenna. It is bent into an L-shape. The shorter side is connected to earth. The longer side is left open-circuit at the end. The feed point is located somewhere between the earth end and the open end. The resulting structure resembles the letter F and possesses the properties of both a loop antenna due to the circulating current from the feed point to ground and a whip antenna due to the open circuited straight section.

In the PCB version, the antenna is printed on the top layer and a ground plane is placed near the antenna on the top layer. There must not be a ground plane underneath the antenna.

The aim is to make the quarterwave section resonate at the midband frequency (which is 2441 MHz for 2.4GHz ISM radios). The feed point (which is the input/output connection) is connected to the L-shape at the point corresponding to 50 Ω. Experiment with measurement to determine the correct location for the feed point and length of this antenna.

3 Meander Line Antenna



The length of the meander line antenna is difficult to predict. It is usually a bit longer than a quarterwave but dependent on its exact geometry and proximity to the ground plane.

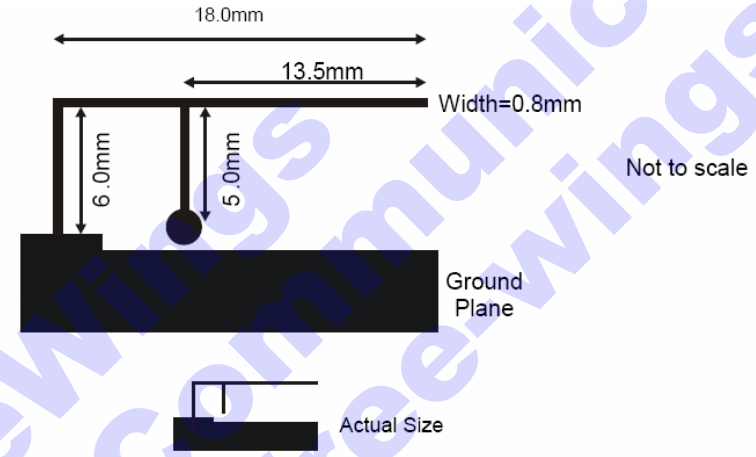
Note:

In the figure the ground plane is shown in black. S is the distance from the ground plane.

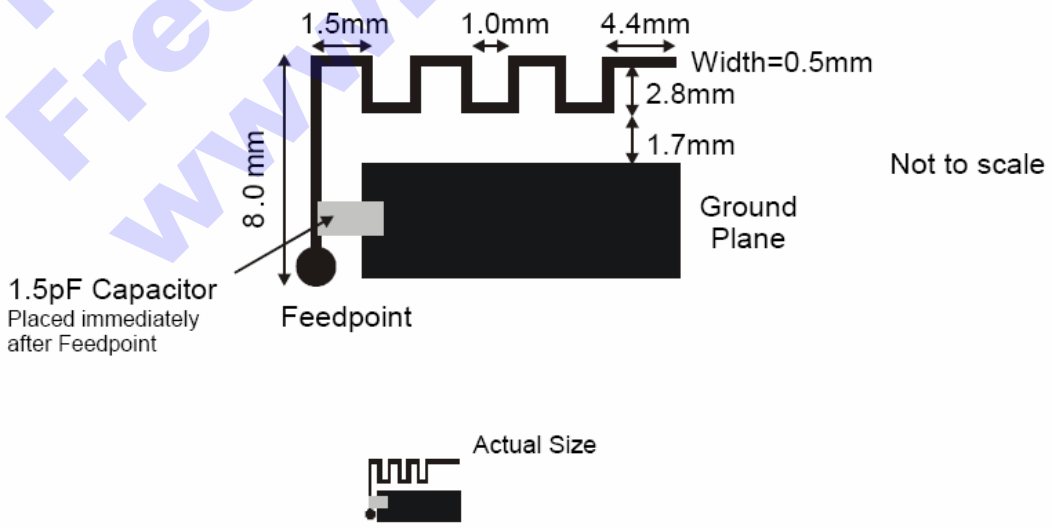
This type of antenna is always a PCB version. The antenna is printed on the top layer and a ground plane is placed near the antenna on the top layer. There must be no ground plane underneath the radiating section of the antenna.

The real part of the impedance of this antenna is about 15 Ω to 25 Ω, depending on geometry and proximity to the ground plane. The impedance matching is done by adjusting the length of the antenna until the input impedance is at the unity conductance circle in Smith chart, in the top half of smith chart. A shunt capacitor is then connected between the antenna input and ground to match to 50 Ω. Experimental measurement is used to determine the correct design.

4 Real Designs



Type 1 Inverted-F antenna

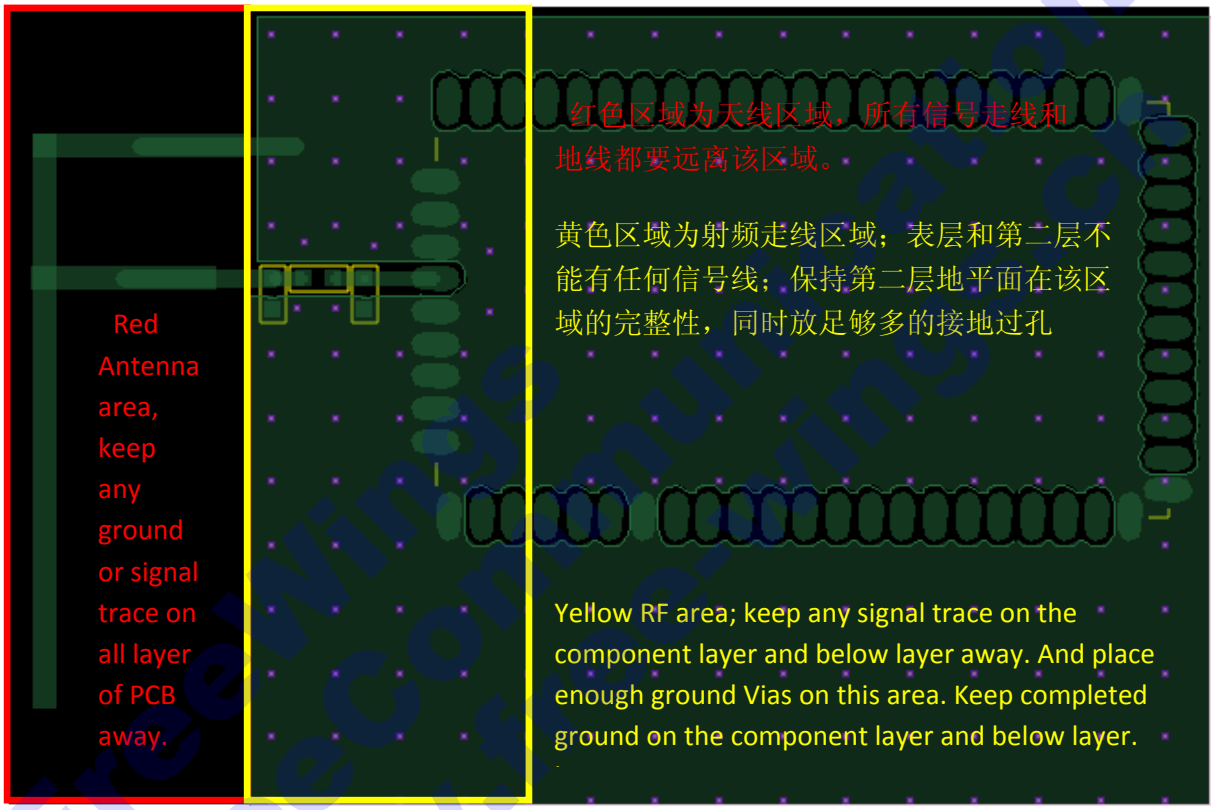


Type 2 Meander line antenna

5 Recommended RF PCB Layout and Mounting Pattern

Placement and PCB layout are critical to optimize the performances of a module without on-board antenna designs. The trace from the antenna port of the module to an external antenna should be 50Ω and must be as short as possible to avoid any interference into the transceiver of the module. The location of the external antenna and RF port of the module should be kept away from any noise sources and digital traces. A matching network might be needed in between the external antenna and RF port to better match the impedance to minimize the return loss.

As indicated in Figure below, RF critical circuits of the module should be clearly separated from any digital circuits on the system board. All RF circuits in the module are close to the antenna port. The module, then, should be placed in this way that module digital part towards your digital section of the system PCB.



General design recommendations are:

- The length of the trace or connection line should be kept as short as possible.
- 保持射频走线的长度尽可能短。
- Distance between connection and ground area on the top layer should at least be as large as the dielectric thickness.
- 射频走线和地平面的间距要大于PCB介质的厚度。
- Routing the RF close to digital sections of the system board should be avoided.
- 应避免有数字信号尤其是高速信号和时钟信号走到射频区域。
- To reduce signal reflections, sharp angles in the routing of the micro strip line should be avoided. Chamfers or fillets are preferred for rectangular routing; 45-degree routing is preferred over Manhattan style 90-degree routing.
- 为了减小射频信号的反射，应避免走锐角的射频线，最好是用45度走线，或者用弧形走线。
- Use as many vias as possible to connect the ground planes.
- 在射频区域保证足够数量的接地过孔。

Record of Changes

Data	Revision	
2011-8-24	V1.0	Original publication of this document.
2012-2-18	V1.1	Add the recommended of RF PCB placement and layout .

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