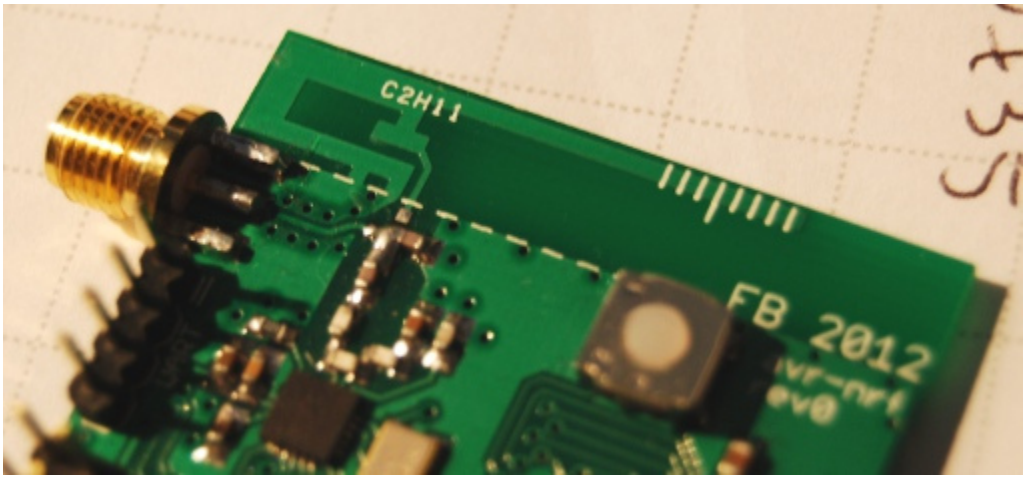
2.4 GHZ INVERTED F ANTENNA EAGLE LIBRARY

ISM radios for microcontroller are becoming quite popular in last years, and if you are designing with wireless radios you have a wide choice of transceiver in both sub-gigahertz an 2.4 GHz bandwidth.

If you choose to go for 2.4 GHz, you'll have the benefits of a wide choice of radios, relaxed constraints in protocol design and a small size antenna.

Focusing on the antenna, 2.4 GHz radios usually have a differential output which have to be adapted to a 50 Ohm single-ended signal suitable for Wi-Fi antennas, which can be connected to the radio using an RP-SMA connector or directly embedded into the PCB.

This post shows a printed antenna design, kindly provided by TI/Chipcon, suitable for 2.4 GHz ISM radios. You'll also find a link for an Eagle library with some tuning variant.

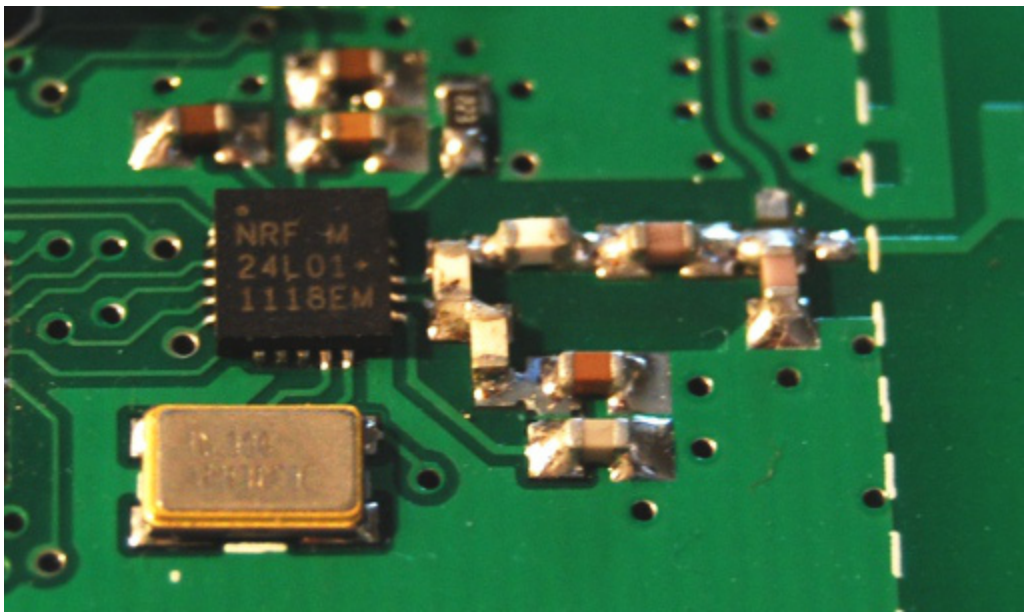


2.4 GHz Transceivers

All major microcontroller manufacturer provides radio-enable MCU or external radios. Using an external SPI-driven radio simplify software design, as you can reuse the same code on nodes with different architectures, creating a mix of nodes using microcontroller, SoC and standard PCs.

Most 2.4 GHz radios are designed for use with IEEE 802.15.4 stacks (including ZigBee and 6LoWPAN) but others are explicitly designed to simplify the implementation of a custom stack (like the Nordic nRF24 series).

Independently of the radio chip, if you are using a general purpose 2.4 GHz antenna, you have to include the hardware necessary to adapt the output of the radio to a single-ended 50 Ohm line as specified by device's datasheet. That's what every external antenna and most printed antennas use.



Antenna designs

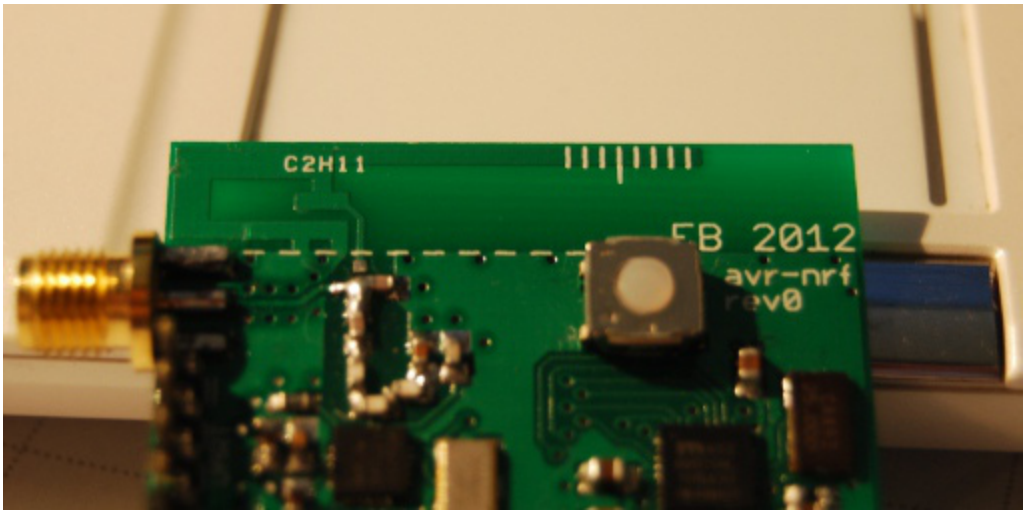
2.4 GHz signals imply a quarter-wave of about 31mm (that's 1.22 inches for you, imperial friends), so that's going to be about the major size of most unfolded printed antennas, like the one showed in this post. If your design has tighter size constraints look for a folded-design, which is what is commonly used in usb-keys.

When using a printed antenna, you have to be sure that the design matches your board stackup – or is stackup-independent at all. That can be a problem as most dual-layer printed antennas are designed for thin stackups, while hobbyist PCBs are usually standard 1.6mm thick.

One of the better place to get free information about printed antenna designs is the Application Note section of TI's website. Here you'll find some really good design for both a folded and unfolded antenna and a comparrison chart of all their antenna designs.

TI/Chipcon IFA (Inverted F Antenna)

This is an implementation of TI's Inverted F Antenna (DN007) which I'm currently using with an AVR-driven Nordic nRF24L01+ general-purpose radio.



The symbol is provided with the main element tunable from the suggested design from -3mm to +5mm. That's because tuning is influenced by many external factors, and have to be done with the antenna in the working environment to be correct.

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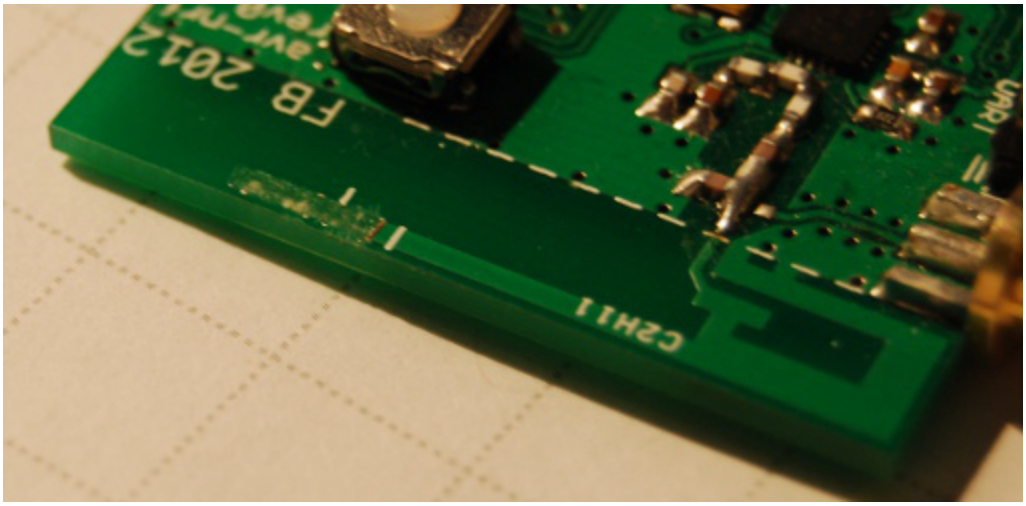
Tuning

Antenna tuning is really easy, <irony>you just need a friend with a network analyzer capable of doing SWR analysis!</irony>

If you have that, you probably already know what to do: just design the board with the longer variant of the antenna, connect the analyzer and cut down the antenna until the natural resonance matches the desired range, usually 2.4 to 2.5 GHz. The easiest way to strip the antenna is to remove some of the solder mask, slice out the part to be removed, and then heat up the excess copper using a solder iron until it detach itself from the PCB.
In my design, I had to cut the antenna down to the -2 marker.

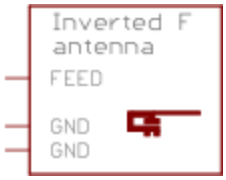


That’s how the cut antenna looks like. You can see from the picture that the layout provide a path from the antenna feed point to an RP-SMA connector, used for tuning.

If you don’t have such instrumentation available, it’s probably better to just use the default tuning (the +0 variant).

Eagle Library

The eagle library is part of a board I designed recently to test the Nordic radio transceiver. You can find the lbr file with just the antenna here.



The layout has been tuned to pass BatchPCB DRC bot, so you can easily use this design with low-cost PCB manufacturing services.

Further Resources

TI probably has the best free application notes for printed antenna design, including also some differential layout which requires no matching network for their CC-series chips. Just point to the page of one of their 2.4 GHz productand grab all the PDFs you can.

Nordic Semiconductor also has an antenna design guide, which is really basic, but is worth reading anyway.

Source : http://fabiobaltieri.com/2012/05/06/2-4-ghz-inverted-f-antenna-eagle-library/