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Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
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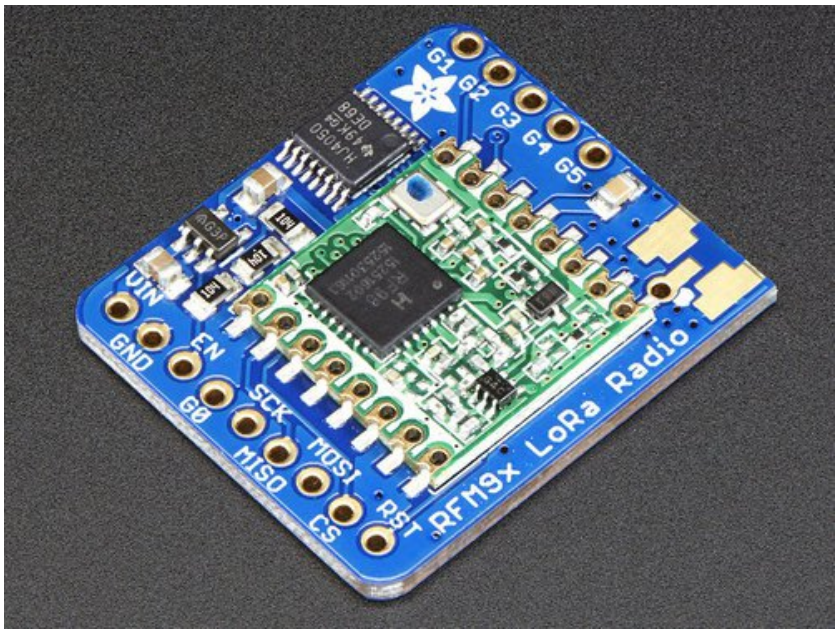
Adafruit RFM69HCW and RFM9X LoRa Packet Radio Breakouts

Created by lady ada



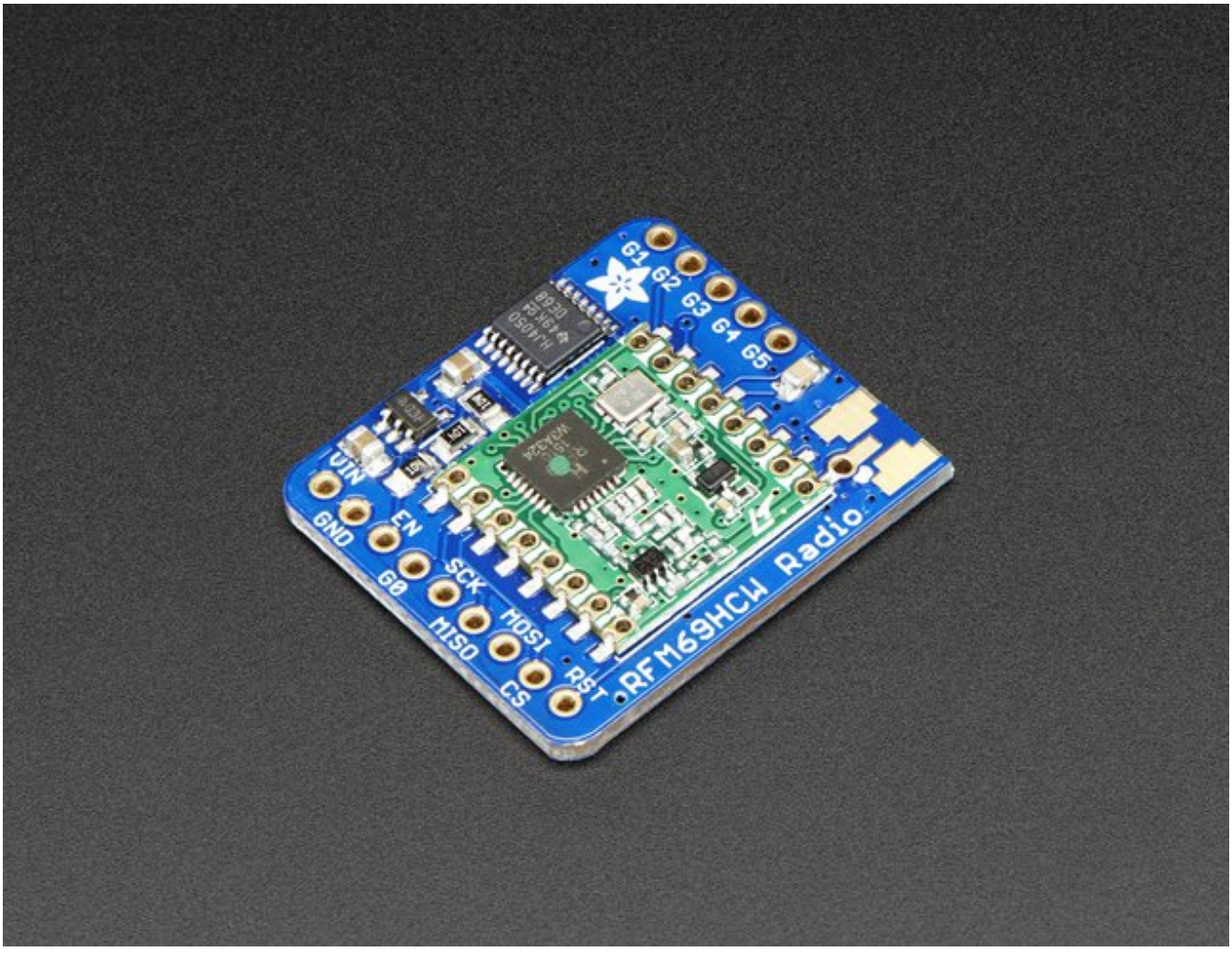
Last updated on 2017-04-03 04:21:12 AM UTC

Guide Contents

Overview

"You see, wire telegraph is a kind of a very, very long cat. You pull his tail in New York and his head is meowing in Los Angeles. Do you understand this? And radio operates exactly the same way: you send signals here, they receive them there. The only difference is that there is no cat."

Sending data over long distances is like magic, and now you can be a magician with this range of powerful and easy-to-use radio modules. Sure, sometimes you want to talk to a computer (a good time to use WiFi) or perhaps communicate with a Phone (choose Bluetooth Low Energy!) but what if you want to send data very far? Most WiFi, Bluetooth, Zigbee and other wireless chipsets use 2.4GHz, which is great for high speed transfers. If you aren't so concerned about streaming a video, you can use a lower license-free ISM frequency bands (http://adafru.it/mOE) such as 433MHz in ITU Europe or 900 MHz in ITU Americas. You can't send data as fast but you can send data a lot *farther*.



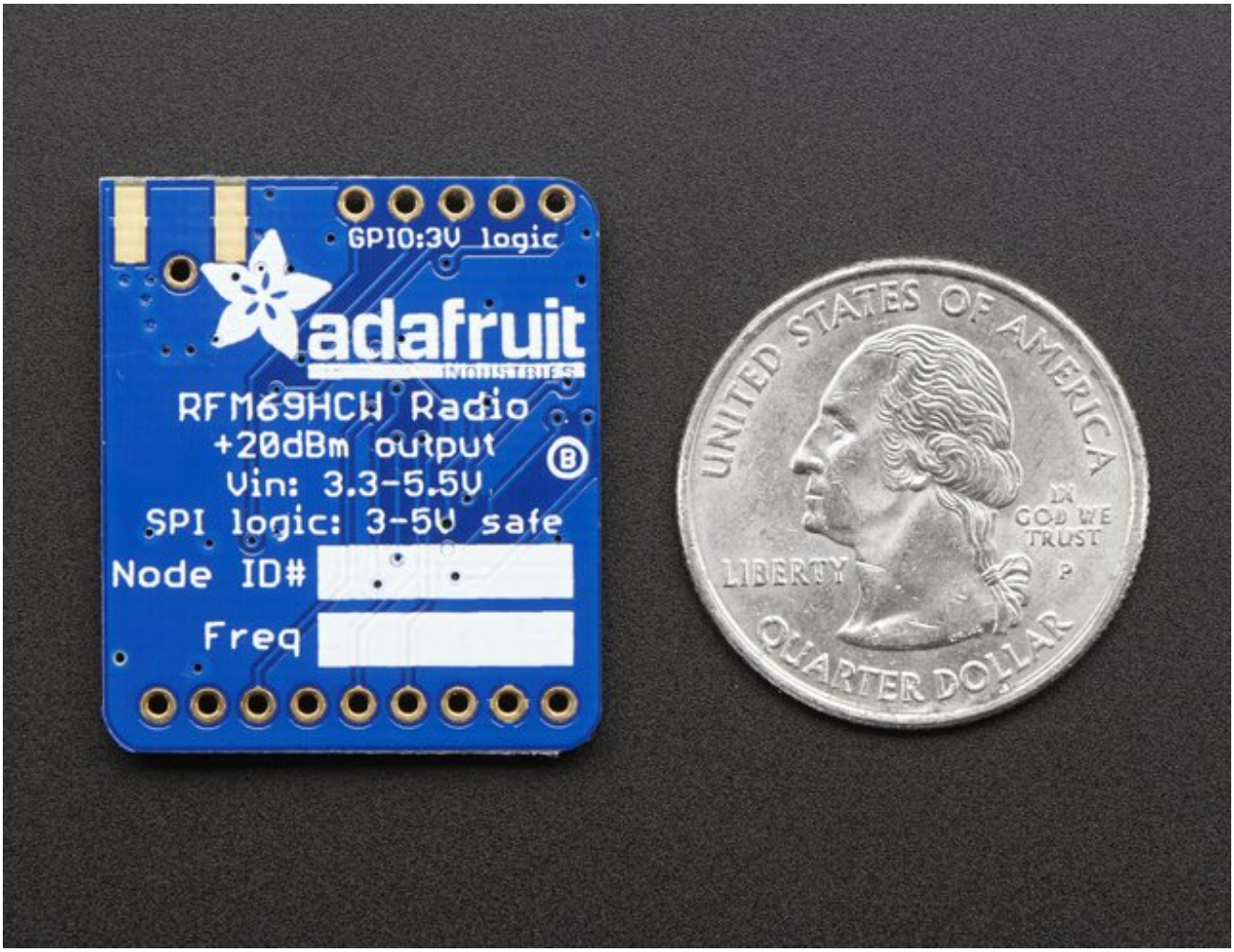
Also, these packet radios are simpler than WiFi or BLE, you dont have to associate, pair, scan, or worry about connections. All you do is send data whenever you like, and any other modules tuned to that same frequency (and, with the same encryption key) will receive. The receiver can then send a reply back. The modules do packetization, error correction and can also auto-retransmit so its not like you have worry about *everything* but less power is wasted on maintaining a link or pairing.

These modules are great for use with Arduinos or other microcontrollers, say if you want a sensor node nework or transmit data over a campus or town. The trade off is you need two or more radios, with matching frequencies. WiFi and BT, on the other hand, are commonly included in computers and phones.

These radio modules come in **four variants** (two modulation types and two frequencies) The RFM69's are easiest to work with, and are well known and understood. The LoRa radios are exciting and more powerful but also more expensive.

All variants are:

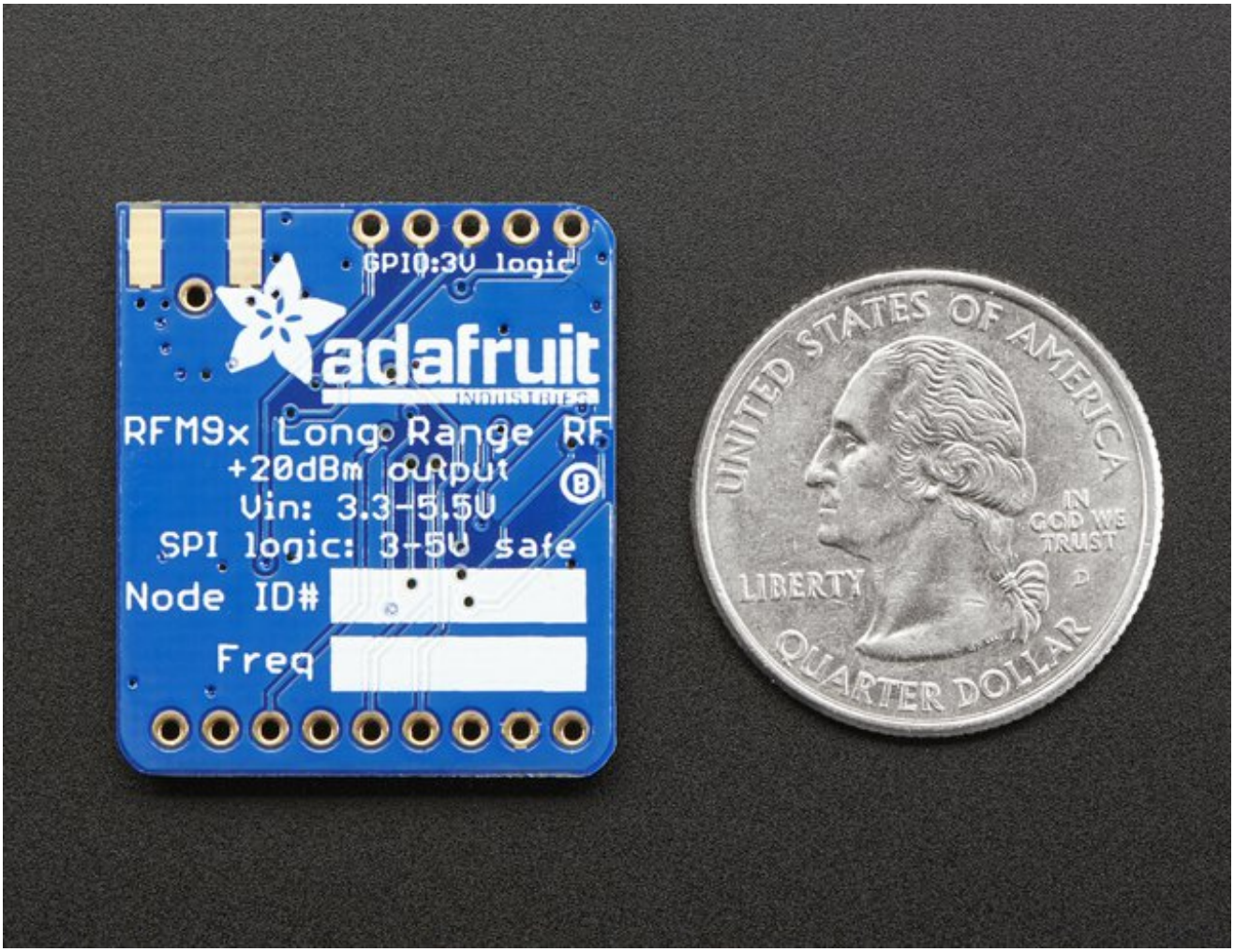
- Packet radio with ready-to-go Arduino libraries
- Uses the amateur or license-free ISM bands (http://adafru.it/mOE): 433MHz is ITU "Europe" license-free ISM or ITU "American" amateur with limitations. 900MHz is license free ISM for ITU "Americas"
- Use a simple wire antenna or spot for uFL or SMA radio connector



RFM69HCW in either 433 MHz or 868/915MHz

These are +20dBm FSK packet radios that have a lot of nice extras in them such as encryption and auto-retransmit. They can go about 200-500 meters line-of-sight using simple wire antennas, probably up to 5Km with well-tuned directional antennas, perfect line-of-sight, and settings tweakings

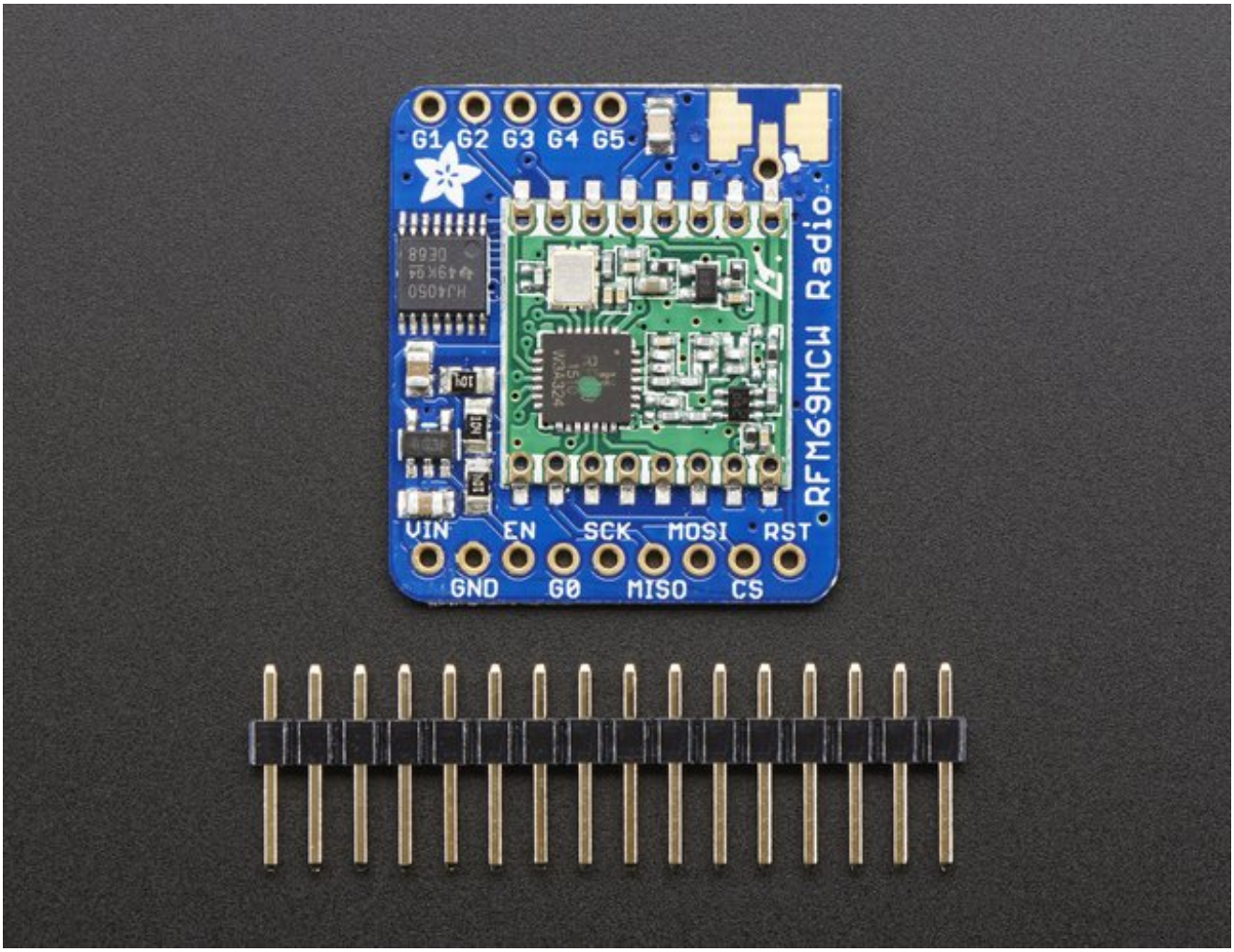
- SX1231 based module with SPI interface
- +13 to +20 dBm up to 100 mW Power Output Capability (power output selectable in software)
- 50mA (+13 dBm) to 150mA (+20dBm) current draw for transmissions, ~30mA during active radio listening.
- The RFM69 radios have a range of approx. 500 meters**line of sight** with tuned uni-directional antennas. Depending on obstructions, frequency, antenna and power output, you will get lower ranges - *especially* if you are not line of sight.
- Create multipoint networks with individual node addresses
- Encrypted packet engine with AES-128



RFM9x LoRa in either 433 MHz or 868/915MHz

These are +20dBm LoRa packet radios that have a special radio modulation that is not compatible with the RFM69s *but* can go much much farther. They can easily go 2 Km line of sight using simple wire antennas, or up to 20Km with directional antennas and settings tweakings

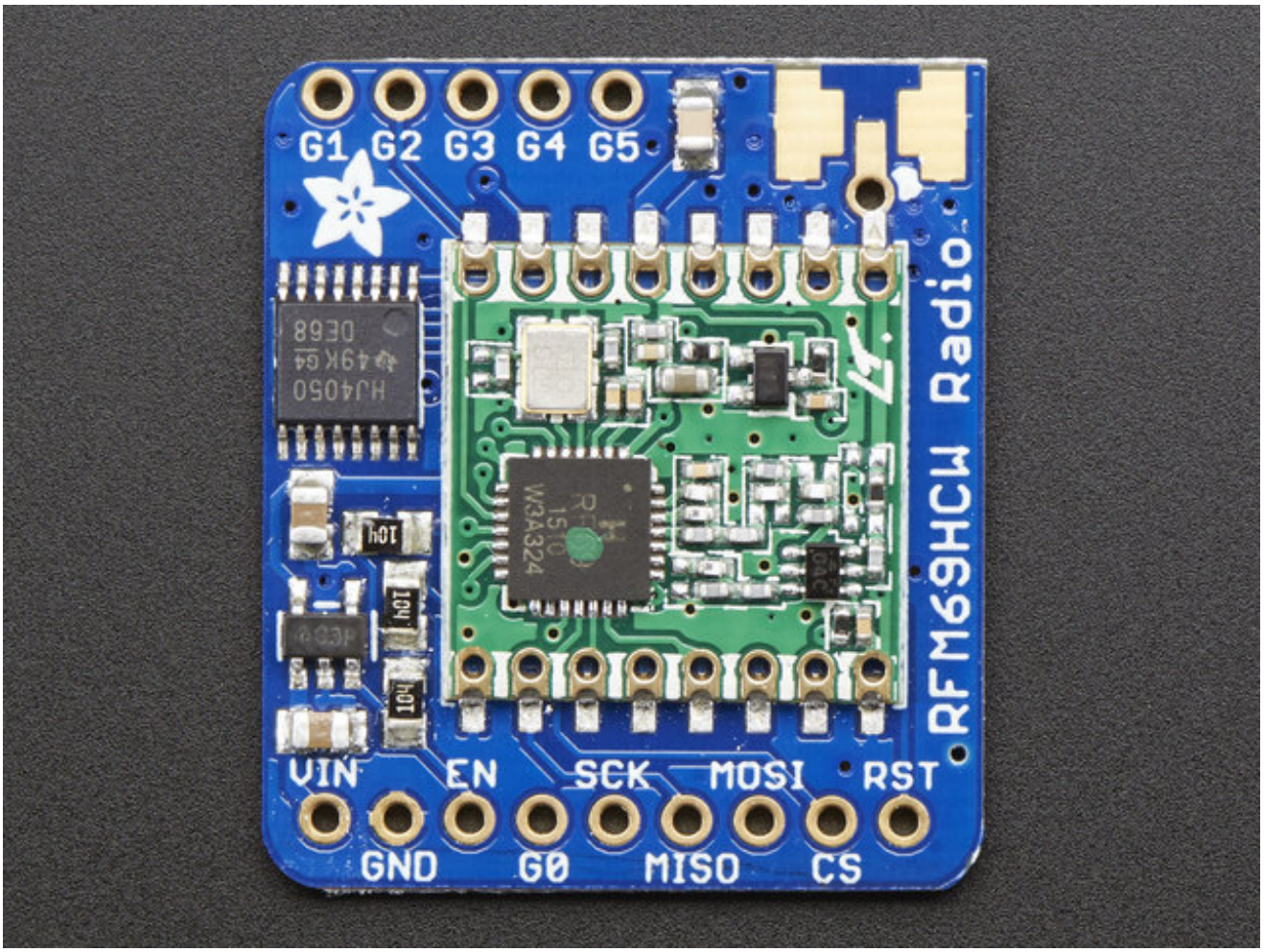
- SX1276 LoRa® based module with SPI interface
- +5 to +20 dBm up to 100 mW Power Output Capability (power output selectable in software)
- ~100mA peak during +20dBm transmit, ~30mA during active radio listening.
- The RFM9x radios have a range of approx. 2 km **line of sight** with tuned uni-directional antennas. Depending on obstructions, frequency, antenna and power output, you will get lower ranges - *especially* if you are not line of sight.



All radios are sold individually and can only talk to radios of the same part number. E.g. RFM69 900 MHz can only talk to RFM69 900 MHz, LoRa 433 MHz can only talk to LoRa 433, etc.

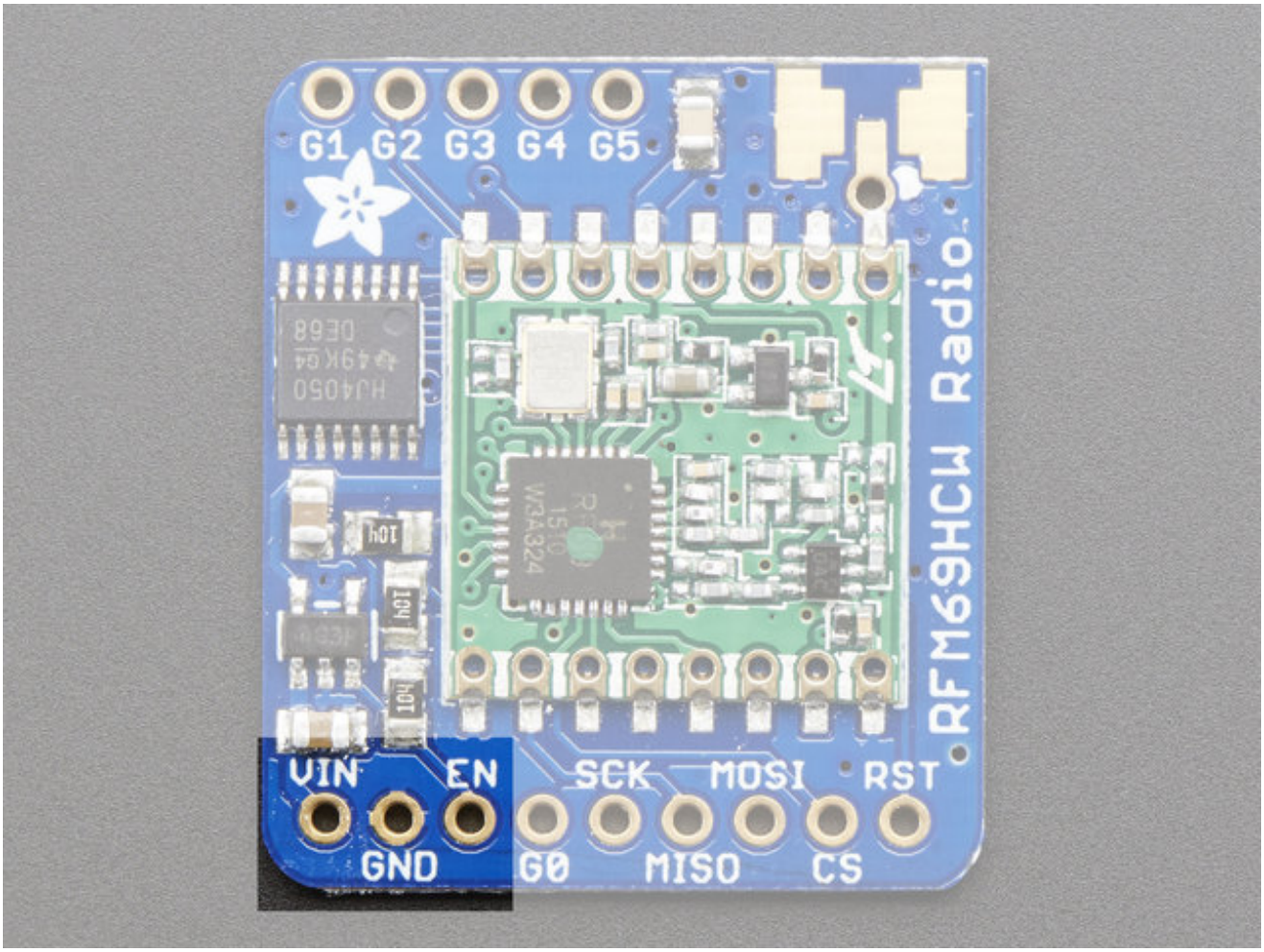
Each radio comes with some header, a 3.3V voltage regulator and levelshifter that can handle 3-5V DC power and logic so you can use it with 3V or 5V devices. Some soldering is required to attach the header. You will need to cut and solder on a small piece of wire (any solid or stranded core is fine) in order to create your antenna. Optionally you can pick up a uFL or SMA edge-mount connector and attach an external duck.

Pinouts



Both RFM69 and RFM9x LoRa breakouts have the exact same pinouts. The silkscreen will say RFM69HCW or LoRa depending on which variant you have. If there's a green or blue dot on top of the module, its 900 MHz. If there's a red dot, its 433 MHz

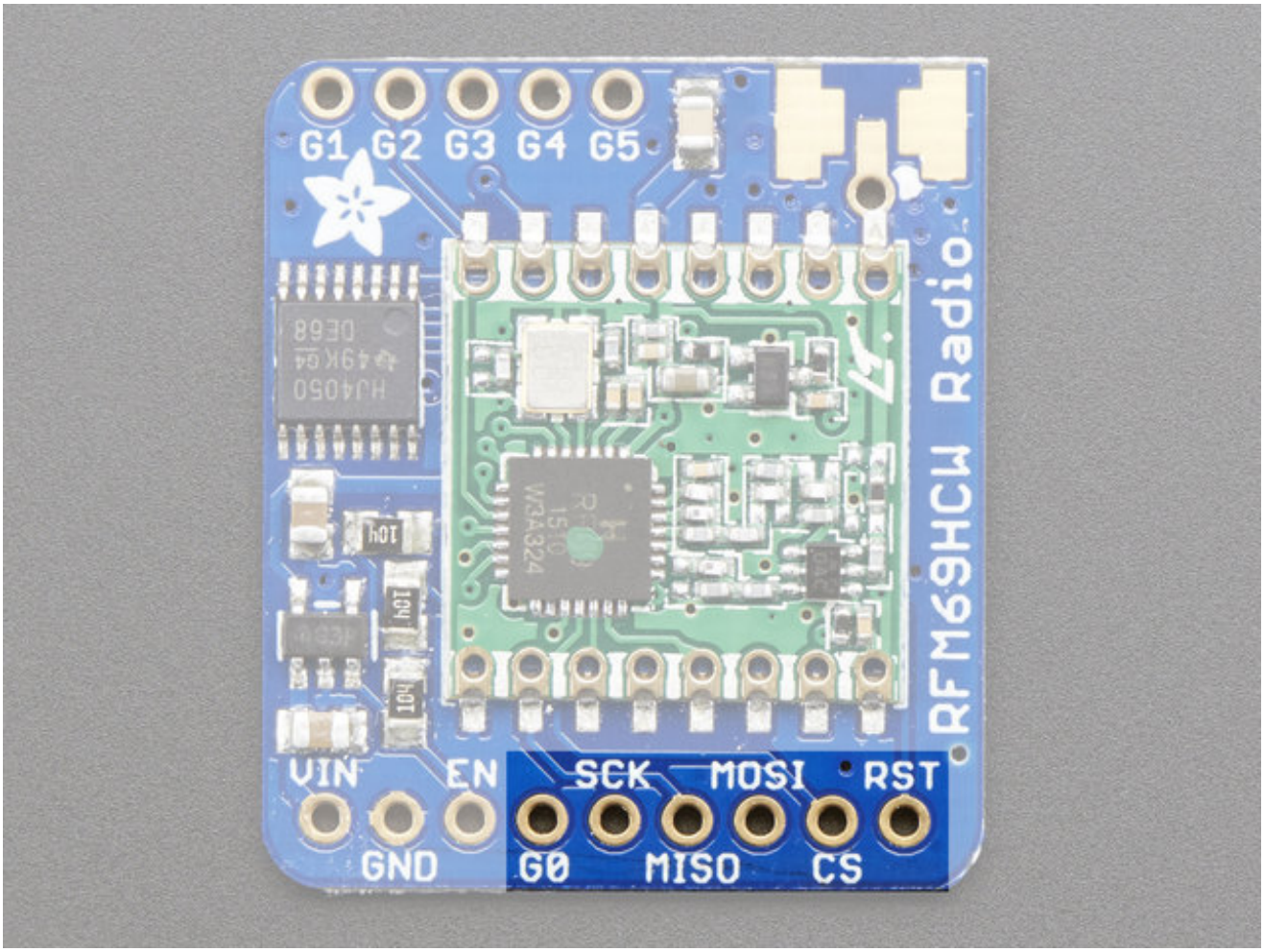
Power Pins



The left-most pins are used for power

- **Vin** - power in. This is regulated down to 3.3V so you can use 3.3-6VDC in. Make sure it can supply 150mA since the peak radio currents can be kinda high
- **GND** - ground for logic and power
- **EN** - connected to the enable pin of the regulator. Pulled high to **Vin** by default, pull low to completely cut power to the radio.

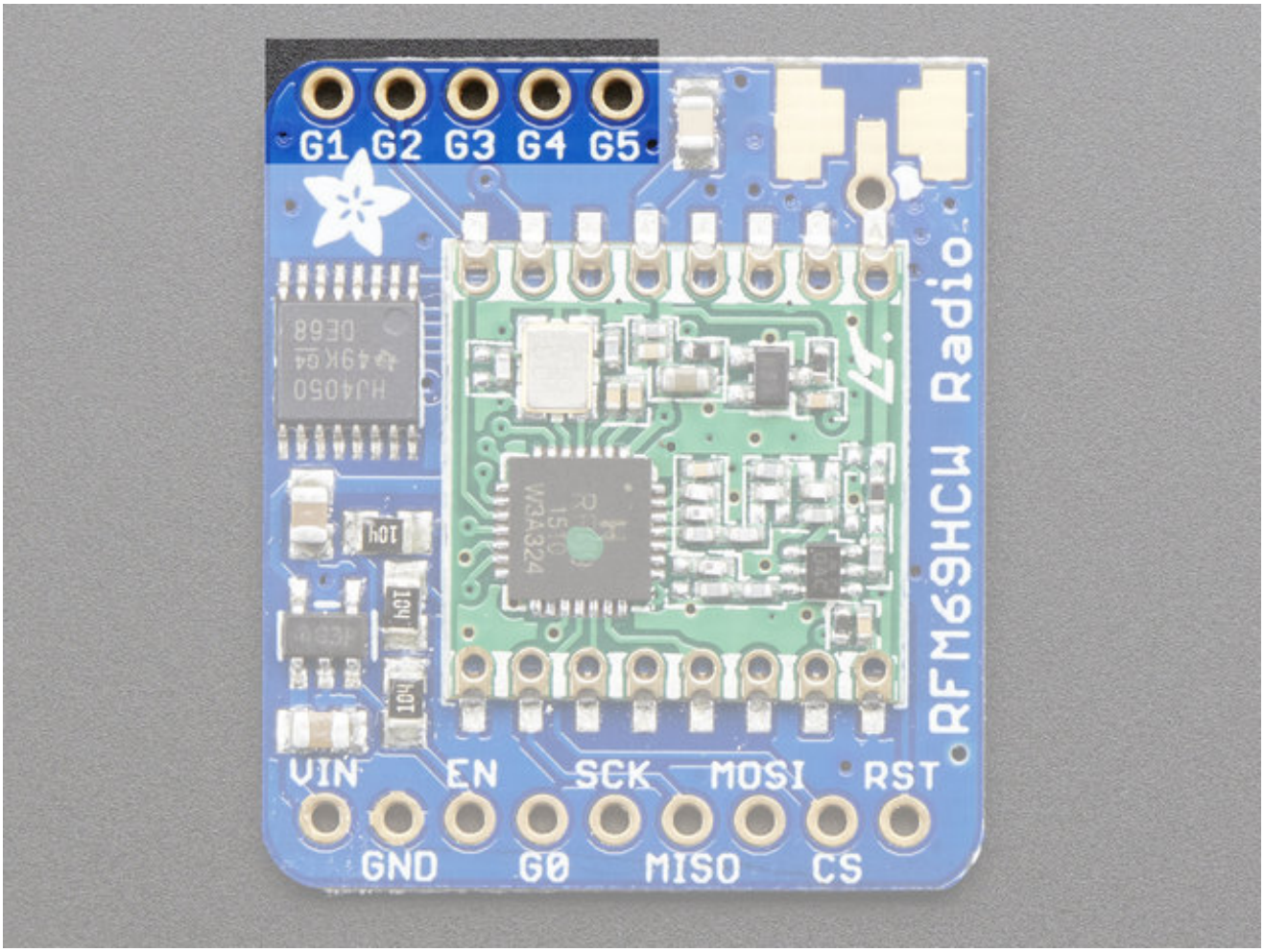
SPI Logic pins:



All pins going into the breakout have level shifting circuitry to make them 3-5V logic level safe. Use whatever logic level is on **Vin!**

- **SCK** - This is the **S**PI **C**lo**k** pin, its an input to the chip
- **MISO** - this is the **M**aster **I**n **S**lave **O**ut pin, for data sent from the radio to your processor, 3.3V logic level
- **MOSI** - this is the **M**aster **O**ut **S**lave **I**n pin, for data sent from your processor to the radio
- **CS** - this is the **C**hip **S**elect pin, drop it low to start an SPI transaction. Its an input to the chip
- **RST** - this is the **Reset** pin for the radio. It's pulled high by default. Pull down to ground to put it into reset
- **G0** - the radio's "GPIO 0" pin, also known as the **IRQ** pin, used for interrupt request notification from the radio to the microcontroller, 3.3V logic level

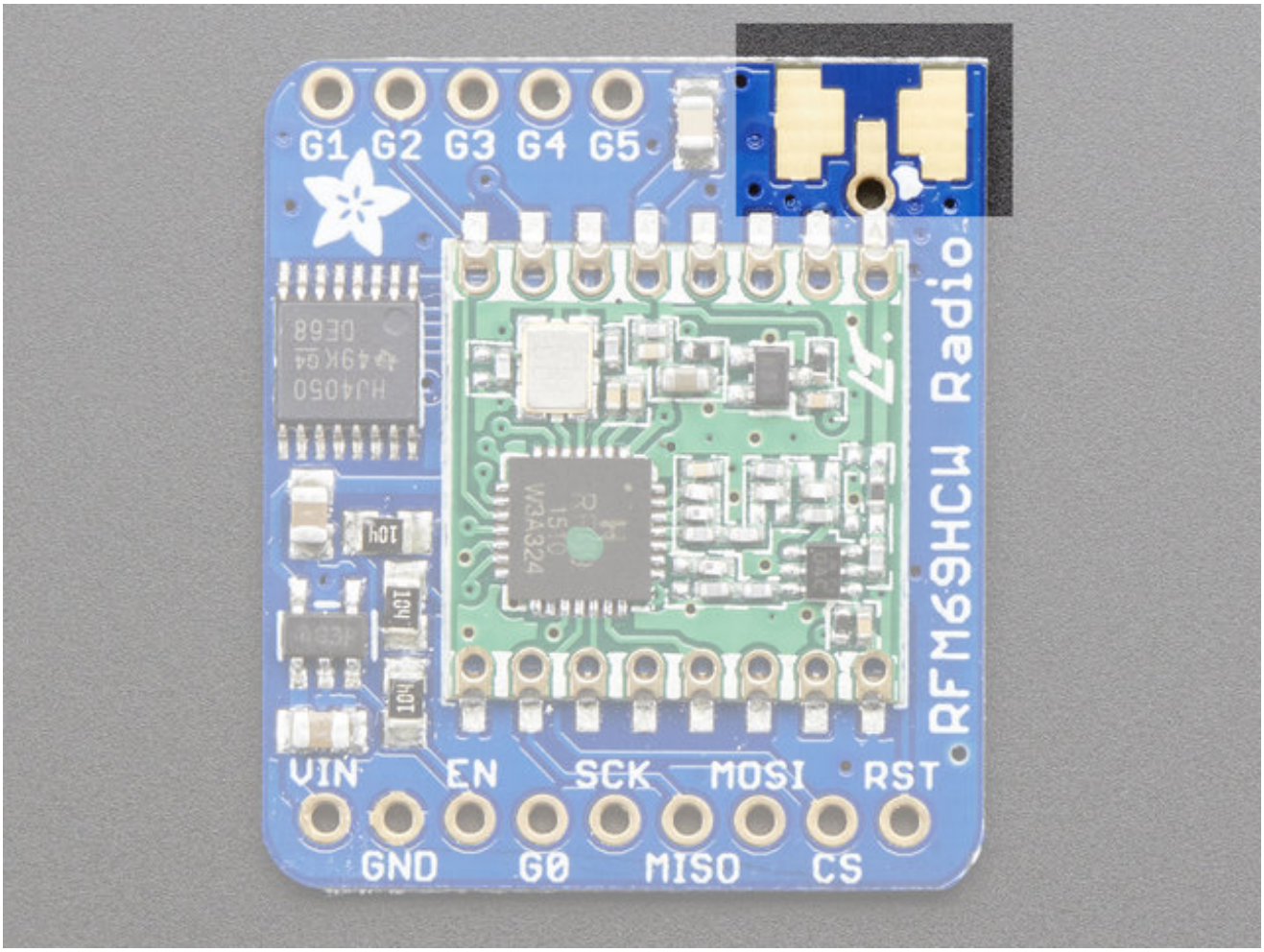
Radio GPIO



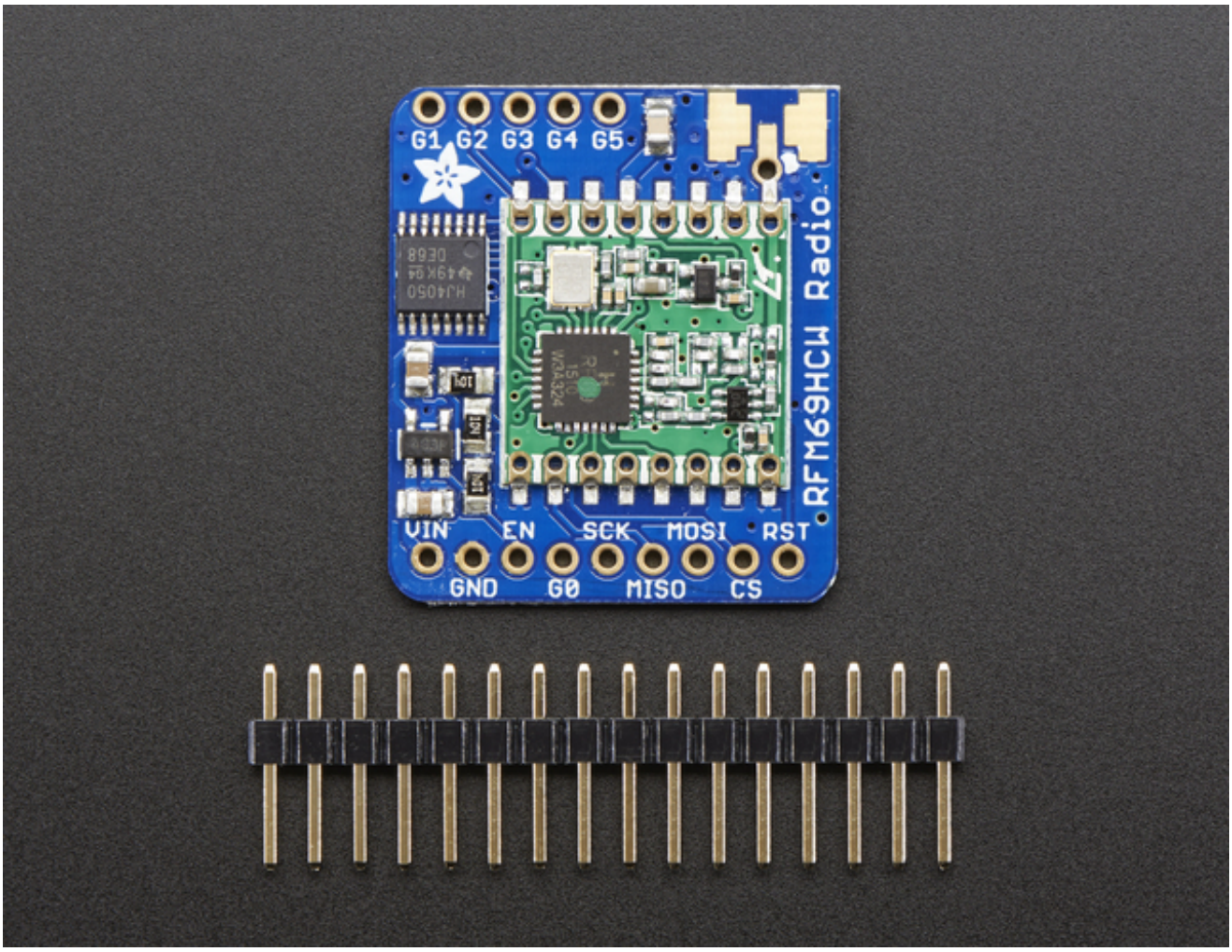
The radio's have another 5 GPIO pins that can be used for various notifications or radio functions. These aren't used for the majority of uses but are available in case you want them! All are 3.3V logic with no level shifting

Antenna Connection

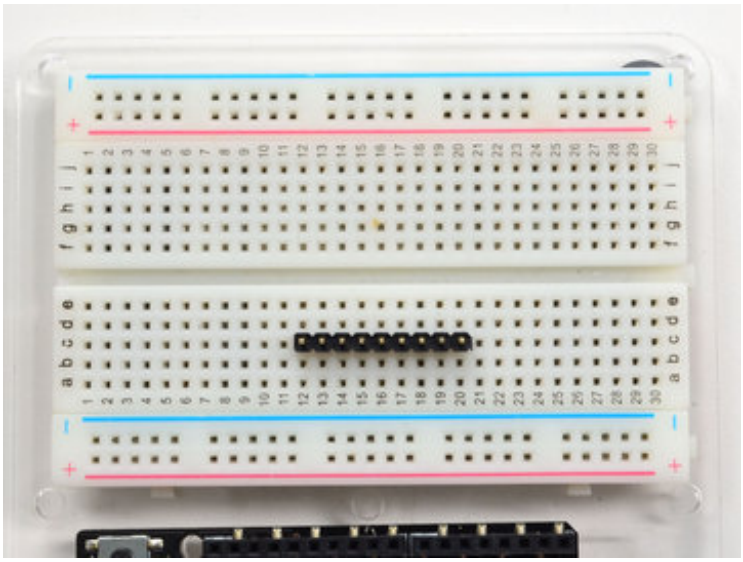
This three-way connection lets you select which kind of Antenna you'd like, from the lowest cost wire dipole to the fanciest SMA


G1 G2 G3 G4 G5
RFM69HCW Radio
VIN EN SCK MOSI RST
GND G0 MISO CS

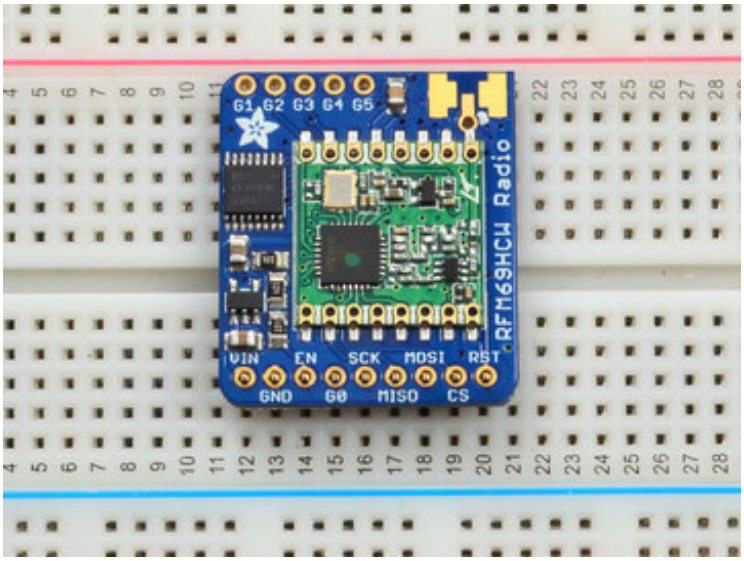
Assembly



Prepare the header strip:

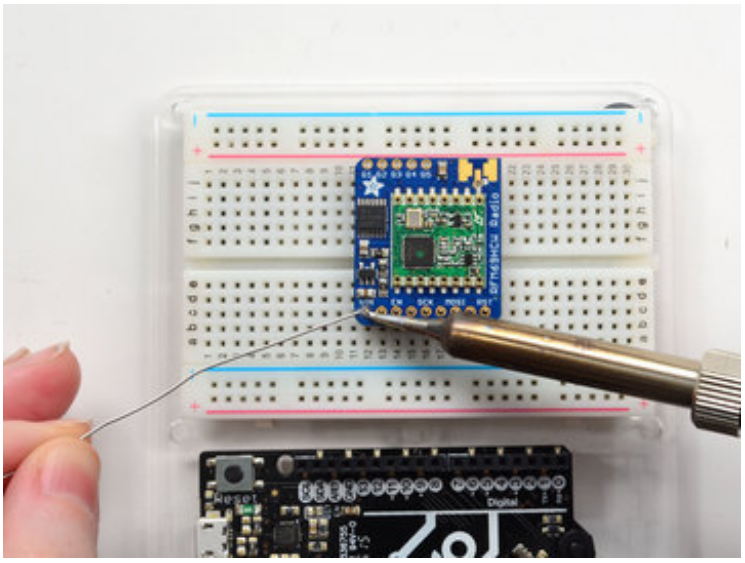
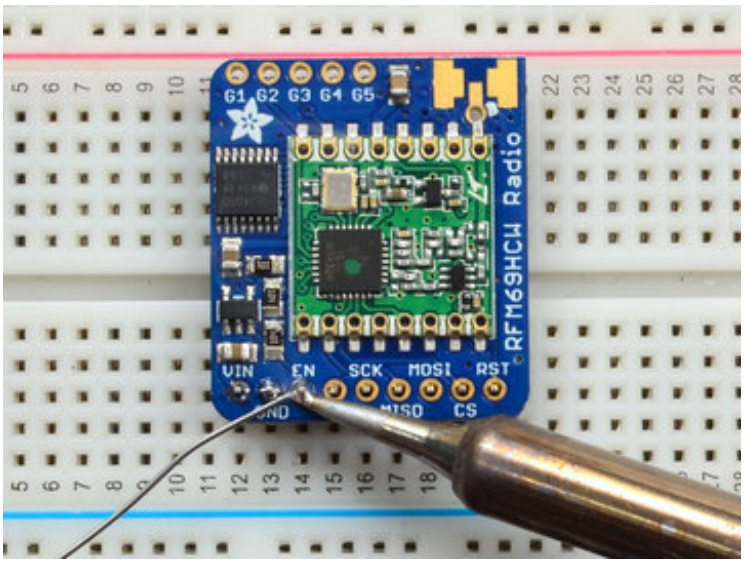
- 

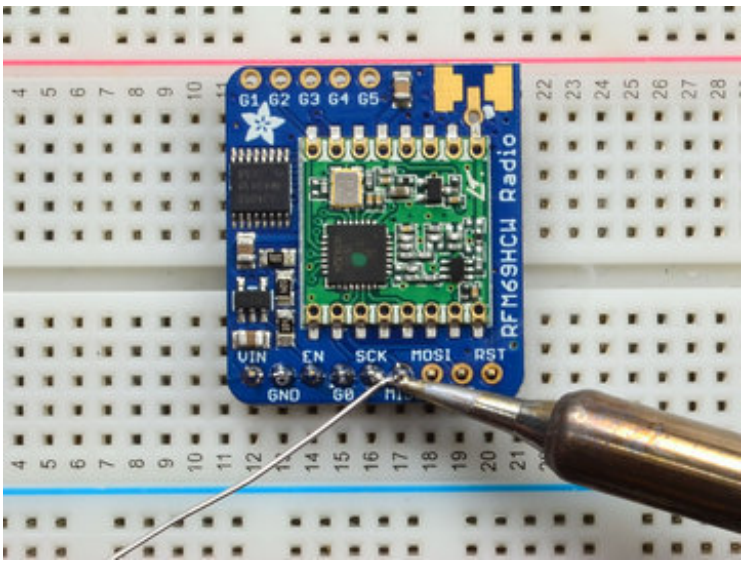
Cut the strip to length if necessary. It will be easier to solder if you insert it into a breadboard - **long pins down**

- 

Add the breakout board:

Place the breakout board over the pins so that the short pins poke through the breakout pads

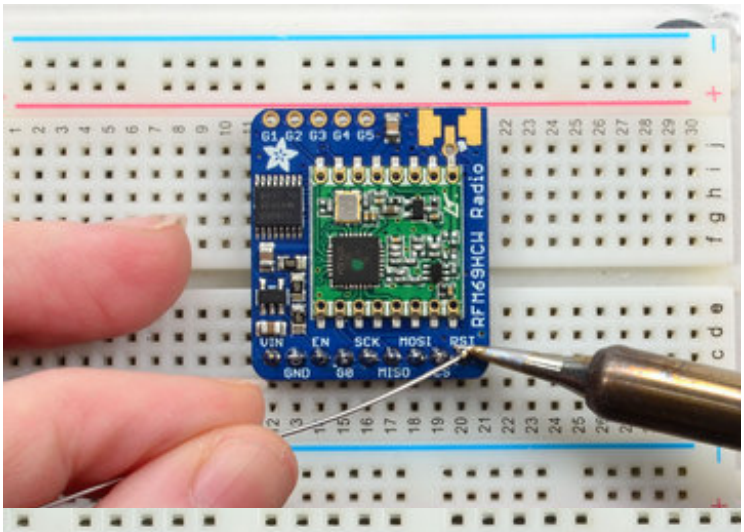
- 
- 

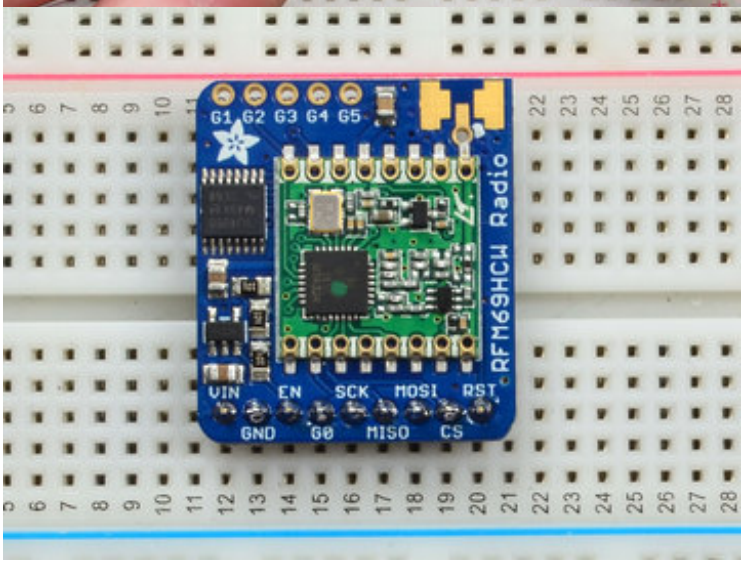
- 

And Solder!

Be sure to solder all pins for reliable electrical contact.

(For tips on soldering, be sure to check out our [Guide to Excellent Soldering](http://adafru.it/aTk)).

- 

- 

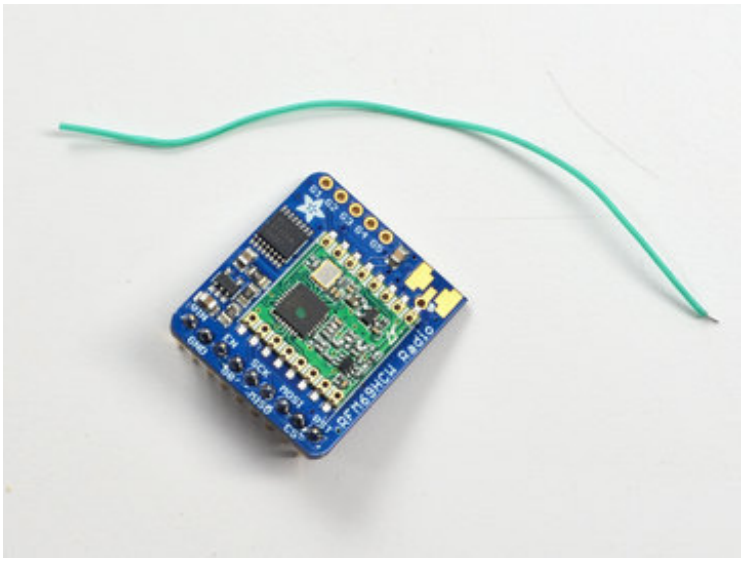
You're done! Check your solder joints visually and continue onto the next steps

Antenna Options

These radio breakouts do not have a built-in antenna. Instead, you have three options for attaching an antenna. For most low cost radio nodes, a wire works great. If you need to put the radio into an enclosure, soldering in uFL and using a uFL to SMA adapter will let you attach an external antenna. You can also solder an SMA edge-mount connector directly

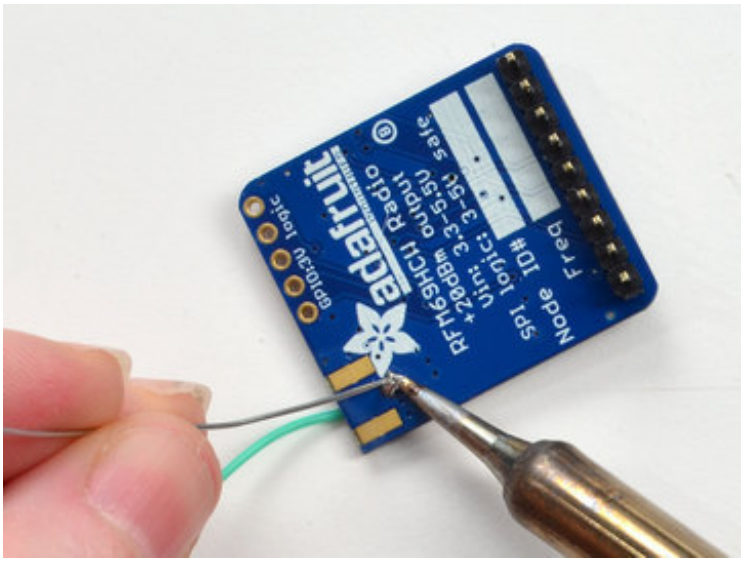
Wire Antenna

A wire antenna, aka "quarter wave whip antenna" is low cost and works very well! You just have to cut the wire down to the right length.

- 

Cut a stranded or solid core wire the the proper length for the module/frequency

- **433 MHz** - 6.5 inches, or 16.5 cm
- **868 MHz** - 3.25 inches or 8.2 cm
- **915 MHz** - 3 inches or 7.8 cm

- 

Strip a mm or two off the end of the wire, tin and solder into the **ANT** pad.
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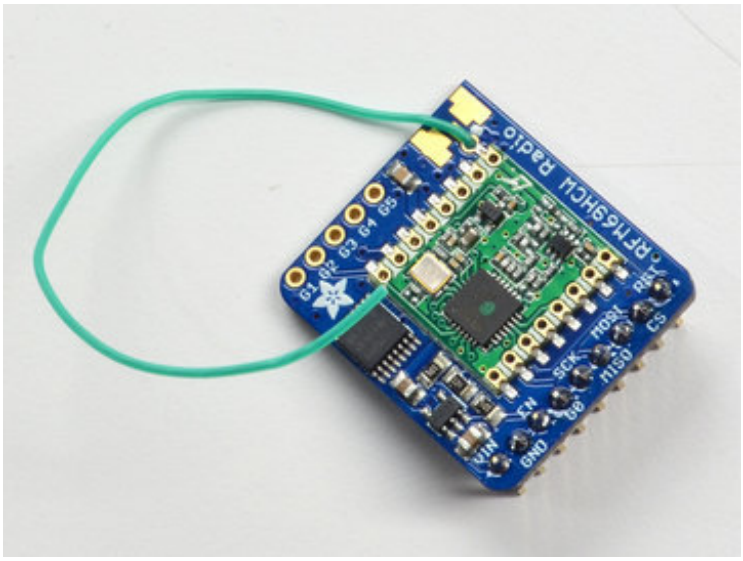
- 

That's pretty much it, you're done!

uFL Connector

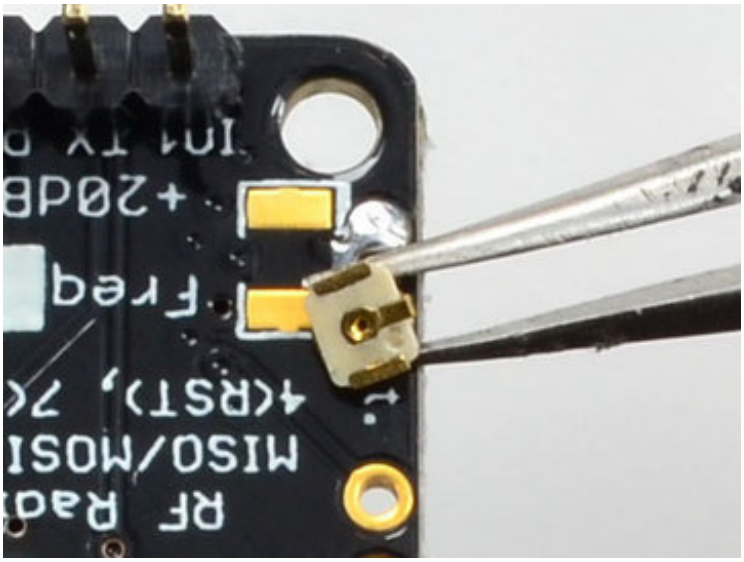
If you want an external antenna that is a few inches away from the radio, you need to do a tiny bit more work but its not too difficult.

You'll need to get an SMT uFL connector, these are fairly standard (http://adafru.it/1661)

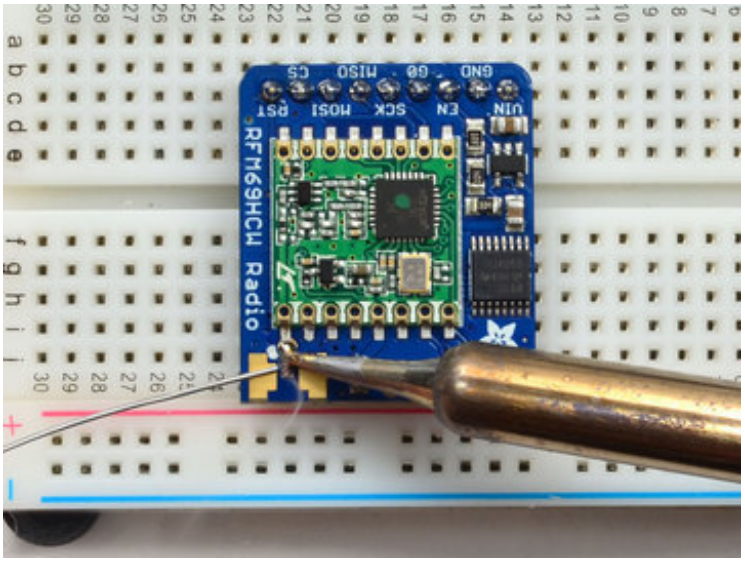
You'll also need a uFL to SMA adapter (http://adafru.it/851) (or whatever adapter you need for the antenna you'll be using, SMA is the most common

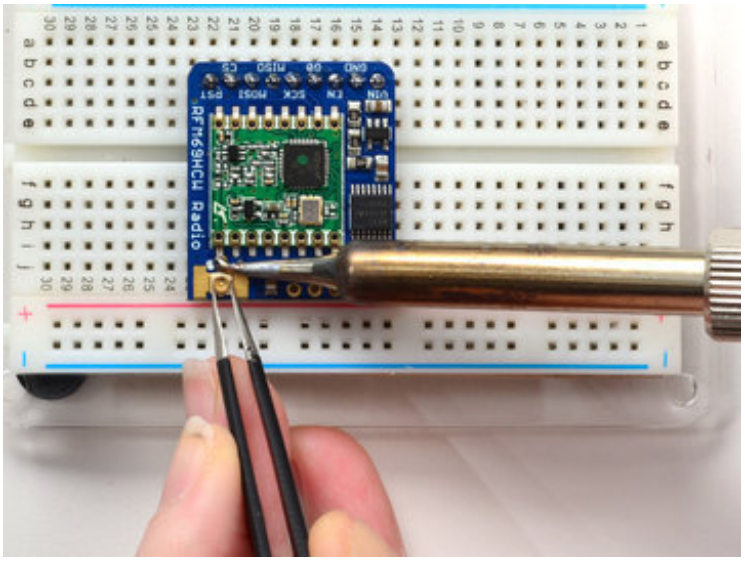
Of course, you will also need an antenna of some sort, that matches your radio frequency

uFL connectors are rated for 30 connection cycles, but be careful when connecting/disconnecting to not rip the pads off the PCB. Once a uFL/SMA adapter is connected, use strain relief!

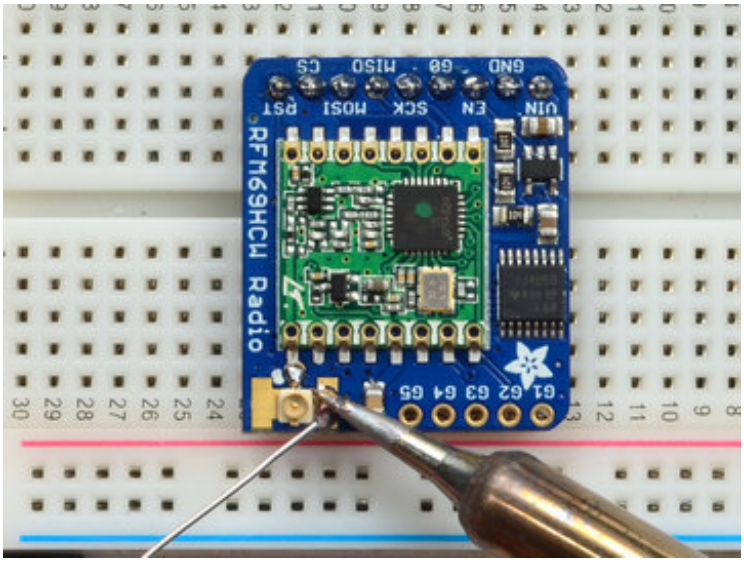
- 

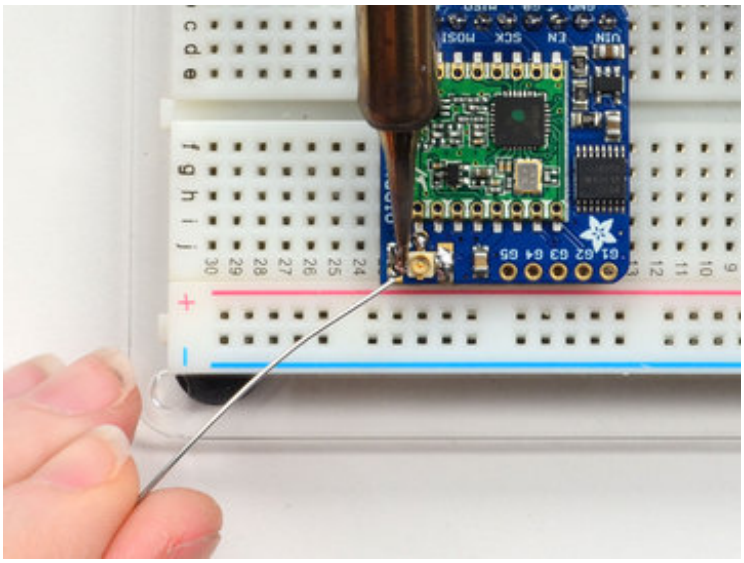
Check the bottom of the uFL connector, note that there's two large side pads (ground) and a little inlet pad. The other small pad is not used!

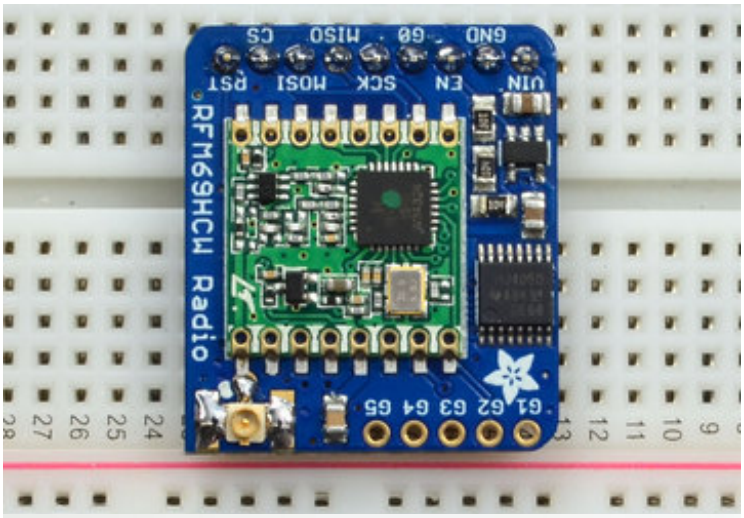
- 

Put down a touch of solder on the signal pad
- 

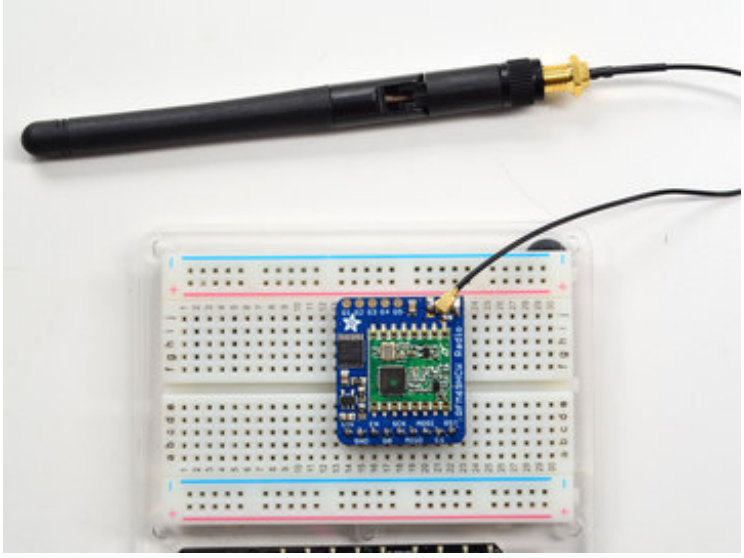
Solder in the first pad while holding the uFL steady

- 

Solder in the two side pads, they are used for signal and mechanical connectivity so make sure there's plenty of solder
- 



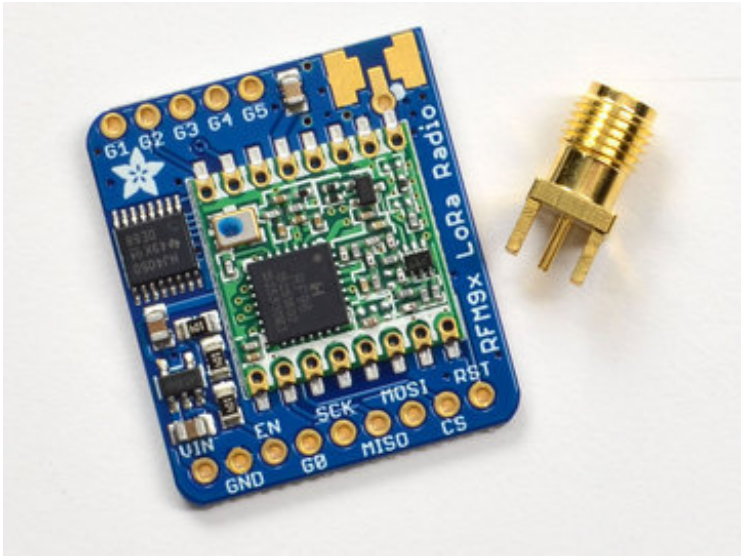
Once done, check your work visually

- 

Once done attach your uFL adapter and antenna!

SMA Edge-Mount Connector

OK so

- 

You'll need an SMA (or, if you need RP-SMA for some reason) Edge-Mount connector with 1.6mm spacing

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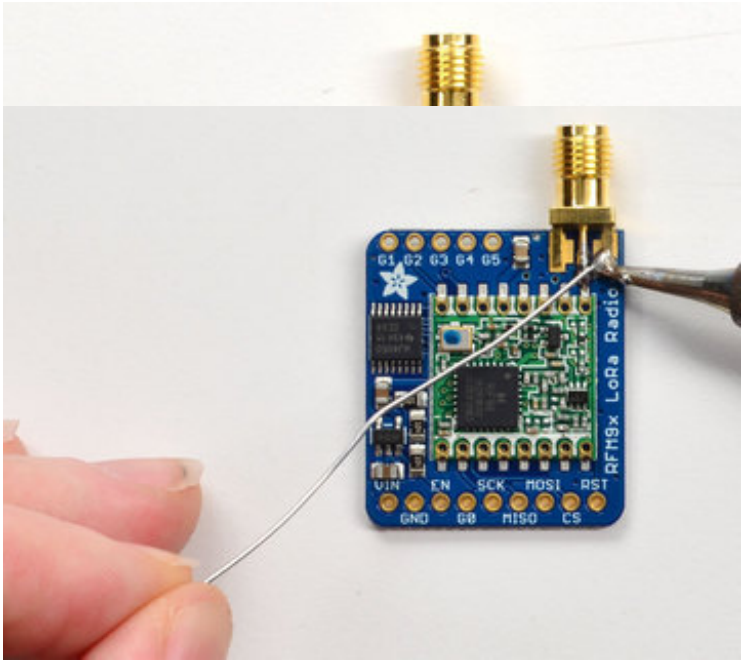
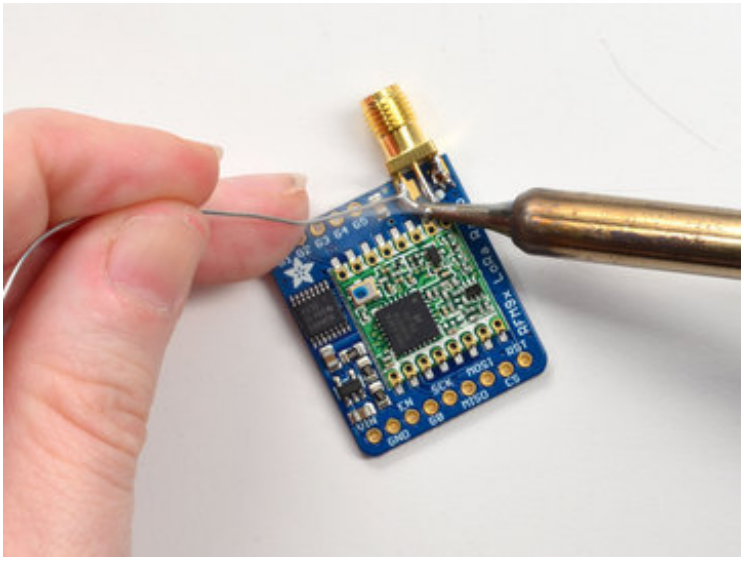
The SMA connector 'slides on' the top of the PCB

Once lined up, solder the center contact first

- 

- 

Solder in the two side ground pads. Note you will need a lot of heat for this, because the connector is an excellent heat sink and its got a huge ground plane