

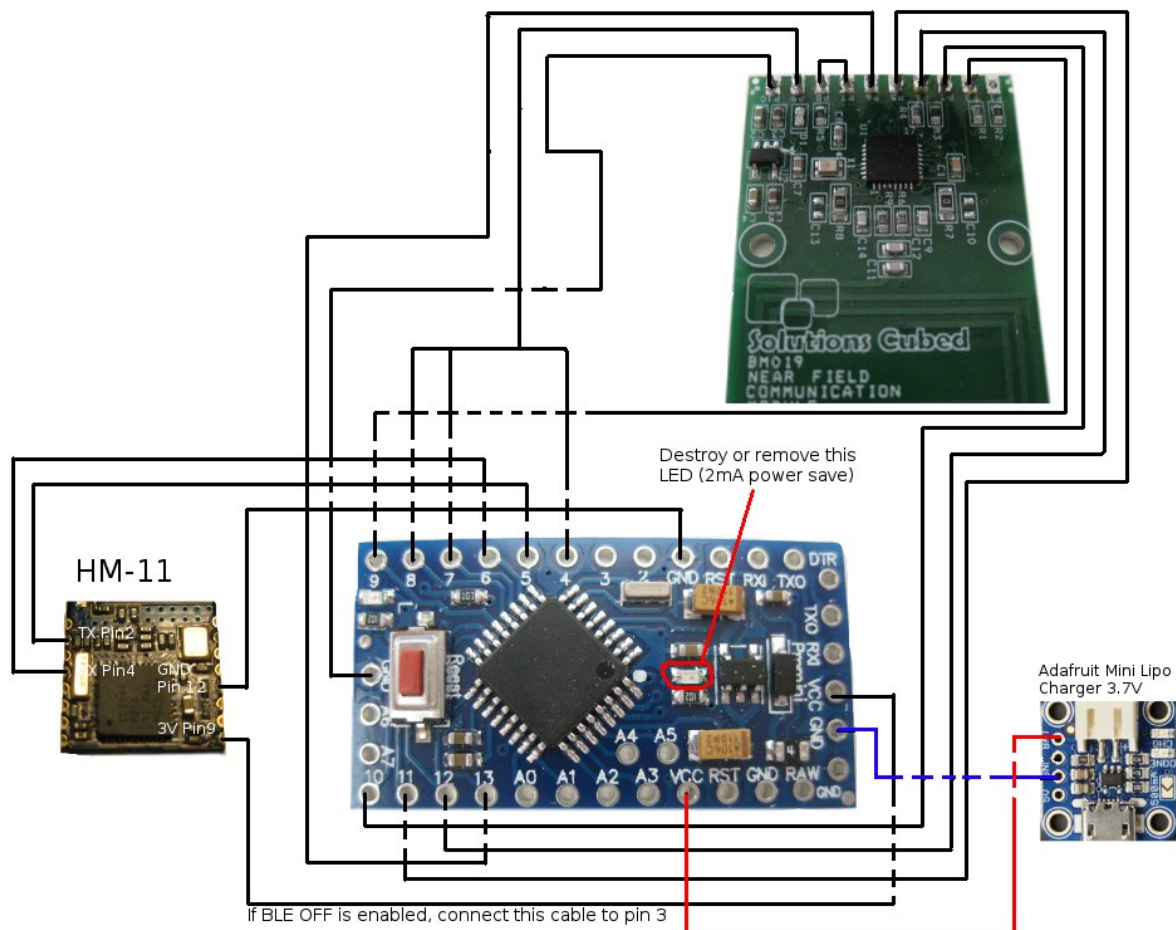
DISCLAIMER: LimiTter is a experimental DIY project. By building your own transmitter, you are responsible yourself for what you have done. The authors and maintainers of this project cannot be made responsible for any damage or actions. Don't make any medical decisions based on the data of your sampled device.

Please Note: LimiTter is **not** maintained by Abbott. It's only an experimental DIY guide.

Let's get started.

You will need the following things:

- Libre Reader (for starting a new sensor)
- Arduino pro-mini 3V 8Mhz
- USB to TTL Serial Adapter Module
- Solutions Cubed BM019 NFC Module
- HM-11 Bluetooth Module (Seeedstudio)
- Lipo battery $\geq 3.7V$ 220mAh 40x17x6mm (When BLE OFF enabled, 100mAh suffices)
- Lipo charger (Adafruit Mini micro-usb)
- Small power switch
- A box 40x40x12mm
- AWG 30 silicone-cable
- Soldering iron
- Helping Hand
- 2K epoxy glue
- Dremel like multitool with grinding wheel



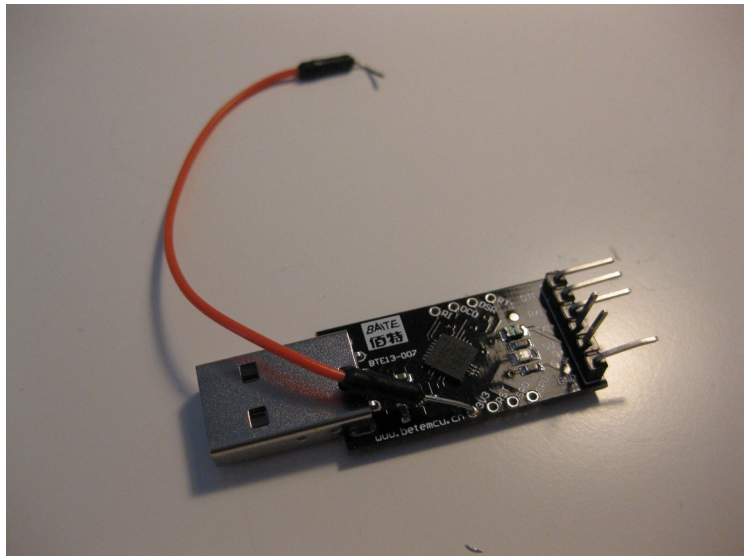
You may wonder why pin 4,7,8 are going into the Vin of BM019. It's because i need to power off this module completely and when it wakes up for reading and spi comes up, the power consumption raises to 80mA. So i just split this into 3 ports to spare the Arduino.

First download LimiTTer.ino and save it to your desktop.
Then you have to download and install the Arduino IDE.
You will find it here:

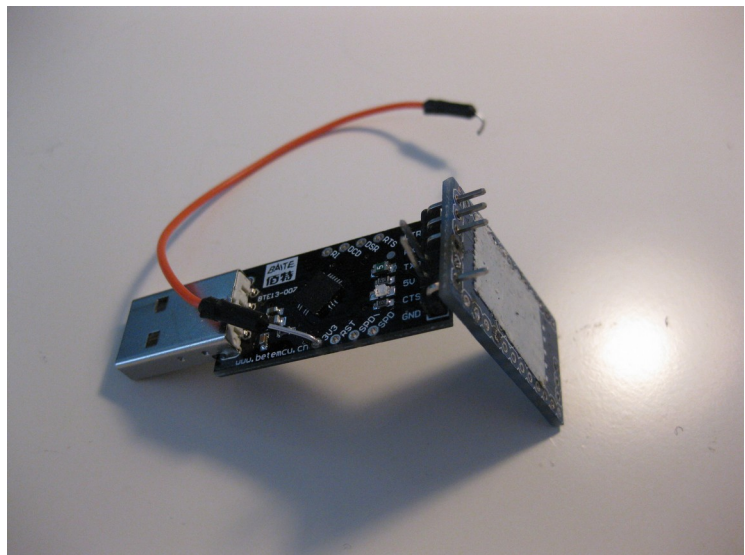
<https://www.arduino.cc/en/Main/Software>

Start the IDE and navigate to the tools → board menu. Select „Arduino Pro or Pro Mini. From „Processor“ choose „ATmega328 (3.3V, 8MHz)“.
Now open the LimiTTer.ino file and prepare your Arduino:

Solder a cable to the 3V3 pin and bend up the 5V and CTS pins.

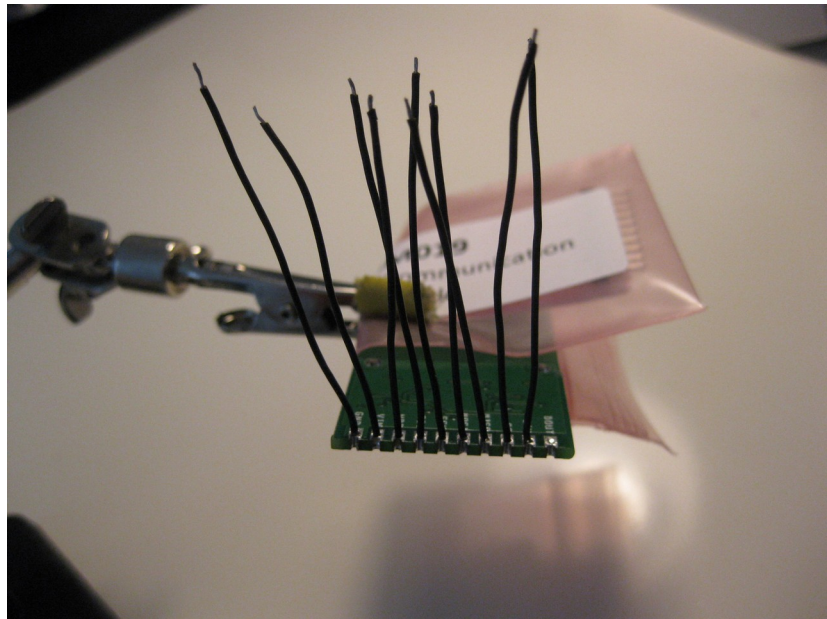


Plug the adapter into the Arduino and connect it with the USB jack to your computer. Now you are ready for program the board. Click on the Upload button and hold the 3V wire on a VCC pin of the Arduino. Yes, it's a bit tricky. Of course you can temporarily solder it on that pin ;) When there is no error message and you see „Done uploading“ you can pull it out of the computer.

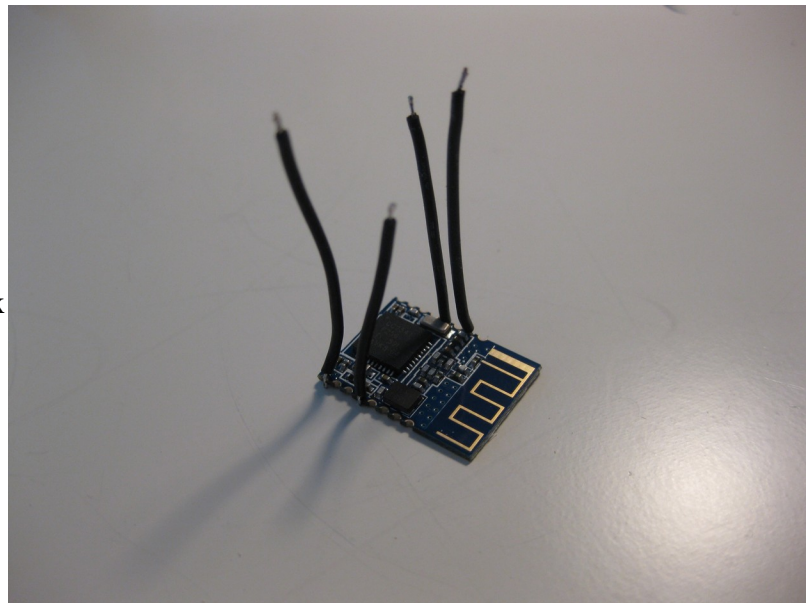


Now the hardware:

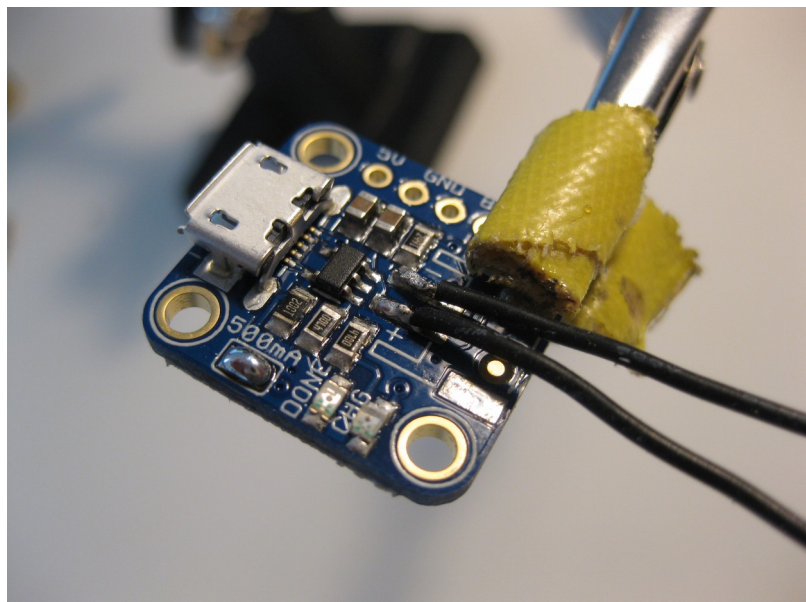
Solder the 9 wires (40mm long) into the BM019 contact holes. Connect P7 with P8.



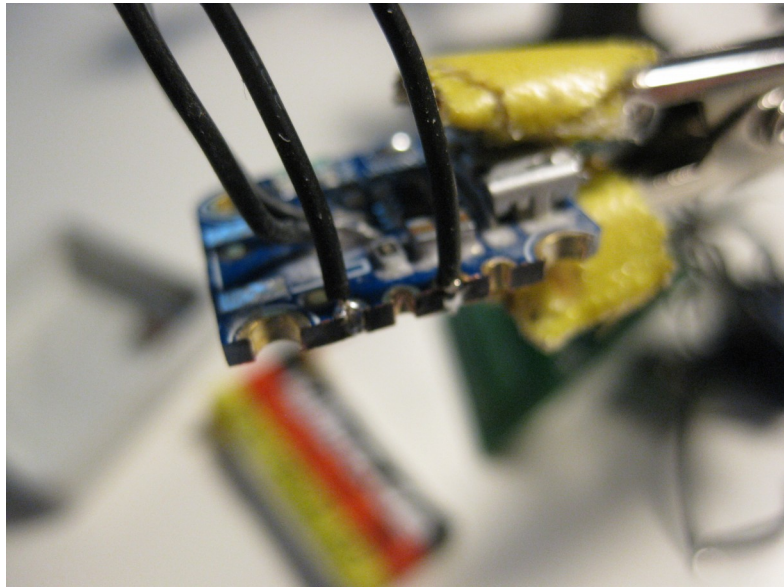
Solder 4 wires on the HM11 module. This is bit tricky, because the contacts are really tiny. I recommend that you first fill the four half holes with blank solder and then hold the wires end on that and heat it.



Next is the lipo charger. I've removed the white cable jack with a pliers because we need space for the battery. Solder 2 wires on the contacts and close the 500mA bridge with solder to enable quick loading.



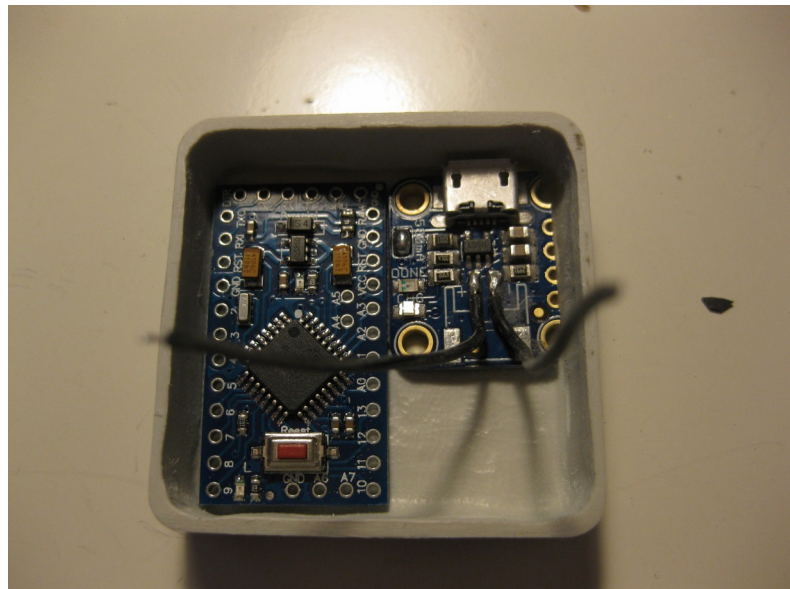
If you have a space problem to get the arduino and the charger side by side (like me), you can grind away one side. Here you have to solder 2 wires (BAT) + (GND).



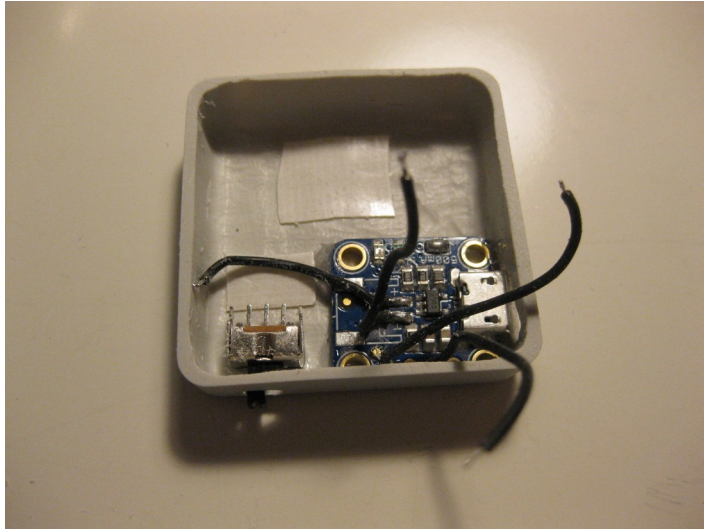
Prepare your box that it can contain all components. Mostly you have to grind away some things :)



Fits perfect ... now! ;)
Now you know the exact position of the loading jack. Mark it and take out the components to grind a small hole into the box.



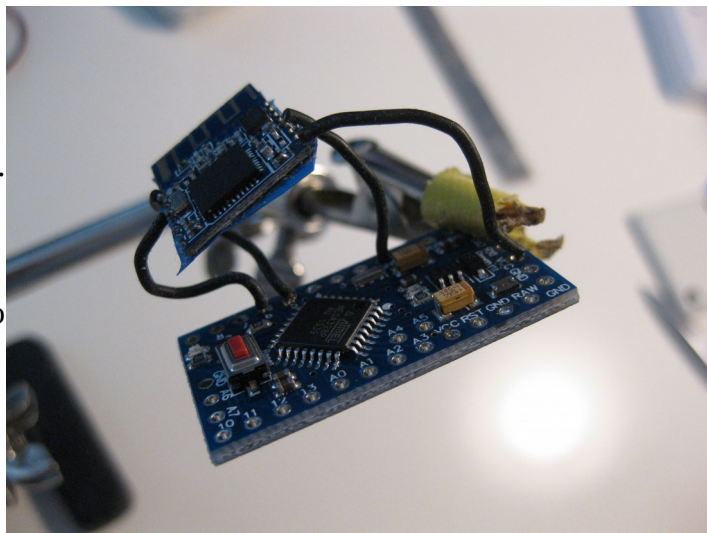
... and for the power switch, too.



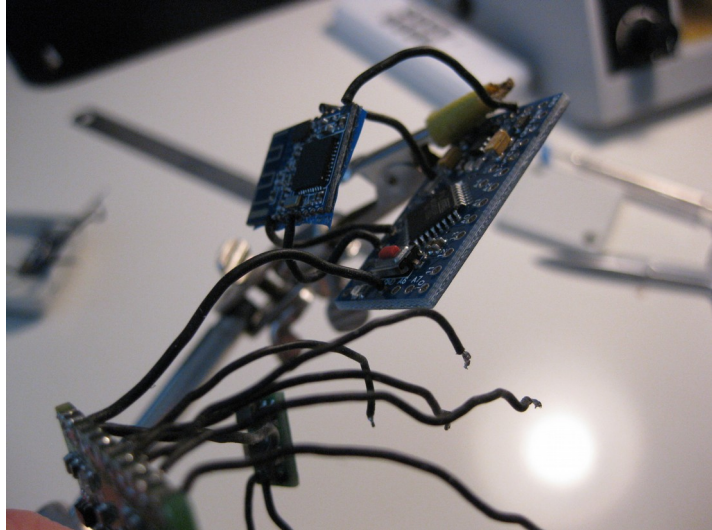
Mix a small blob of the epoxy glue and put it on 4 points in the box to fix the charger and put a small blob under the power switch. The glue begins to harden after aprox. 5 minutes. Then make a last fixation and wait for 30 minutes.



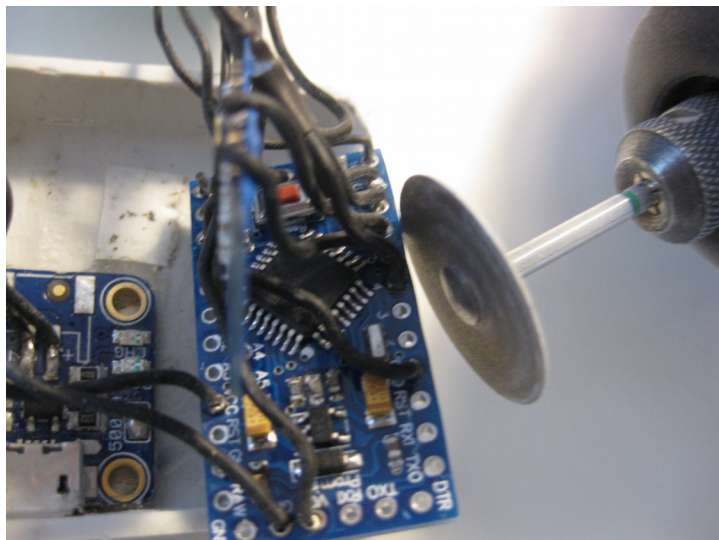
Now it's time to bring it all together. I suggest to fill all needed holes on the arduino with solder. Then begin with the HM-11. Desolder or destroy the power led of the arduino as you see in the wiring pic. We don't need this and this saves 2mA of power.



Then go on with the NFC module.



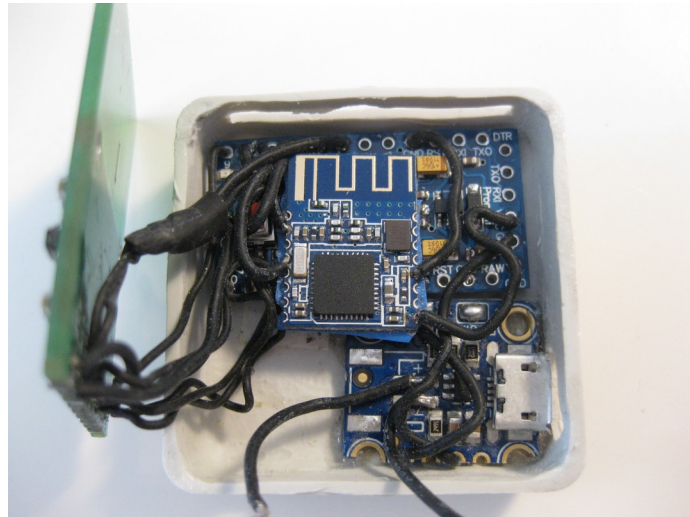
And now the lipo charger ...
You can grind the sides of the
Arduino, if you have a space
problem (like me).



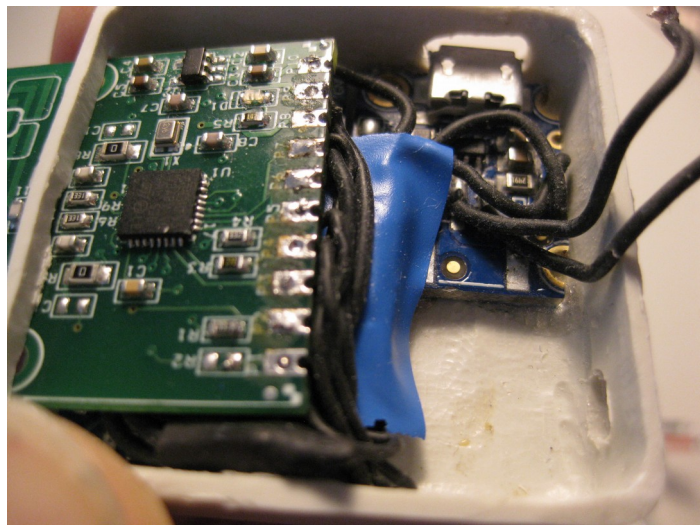
All 4 PCB's are now wired together.
It's time for the recess.

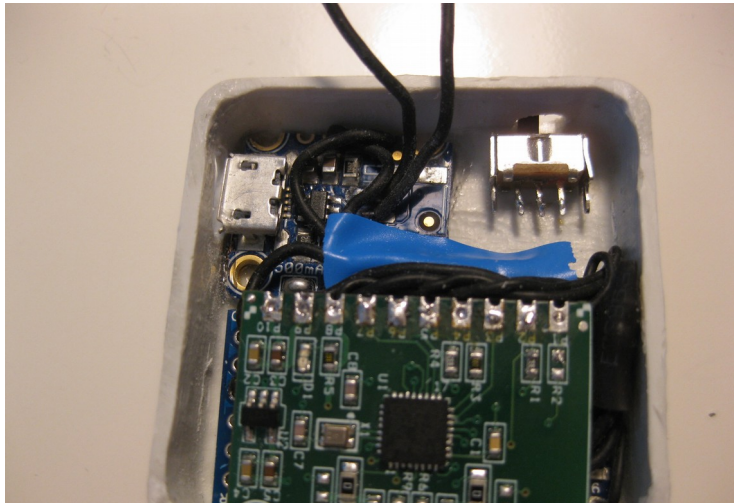


Place the HM-11 on the arduino ...

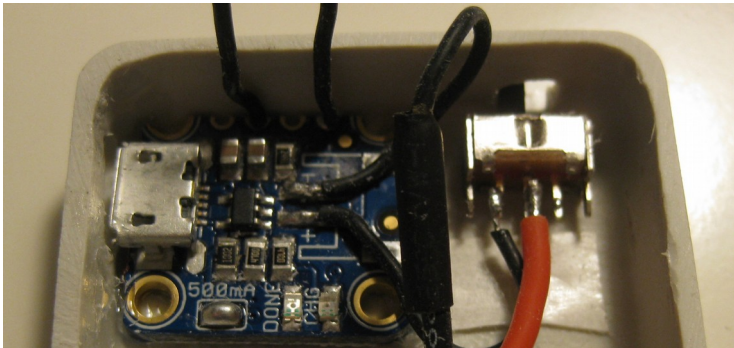


...and push the BM019 through the recess ...

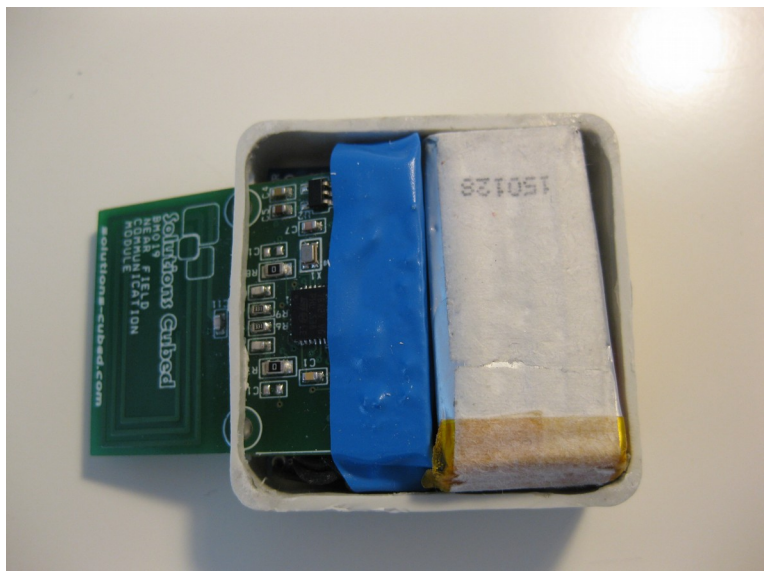




Solder the Lipo to the switch



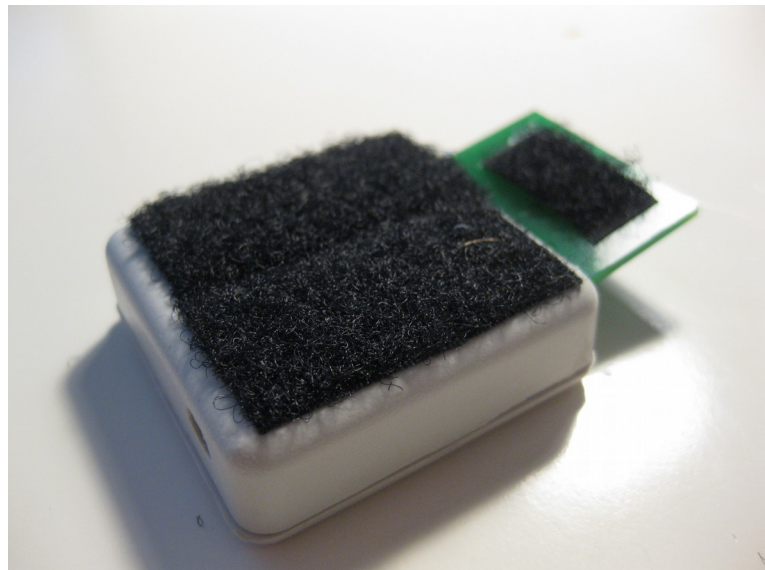
...and place it on the charger/
switch



Close the box and fix the lid with superglue on it's corner points. Add only tiny blobs of the glue.



To place and fix the LimiTter on your skin near the sensor you can use Velcro tape or the very thin dual lock from 3M.



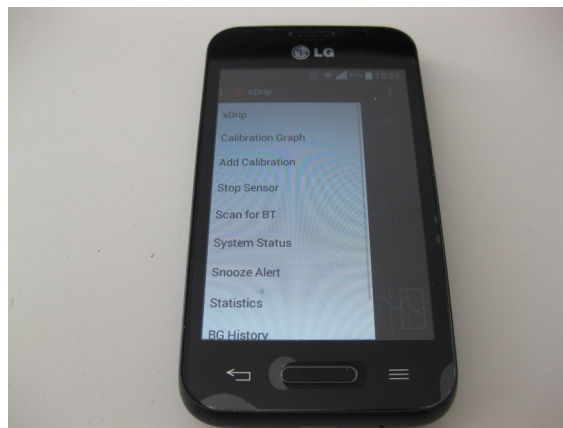
Turn on the power switch and place it near the sensor.
Finally download and install xDrip. You will find it here:

<https://github.com/StephenBlackWasAlreadyTaken/xDrip/wiki/xdrip-beta>

Download and install the latest beta .apk file. Maybe you have to enable the option to install apps from a unsave source.

Then activate bluetooth on your smartphone and start xDrip. Click on the xDrip menu (left upper corner) and select **Scan for BT**.

Click on **scan** and you should see your box. If you don't see it, there is something wrong with your wiring ... or you are using the BLE OFF wiring. Then it sleeps and will wake up the next 4 minutes ... check it out and tap on **scan** several times.



Tap on LimiTter and it will connect to it. After this you have to tap on **Start Sensor**. Just select a few hours in the past to avoid the 120minutes waiting. We don't need this. Now xDrip waits for 2 readings (10 minutes). When they are received you will see **Enter 2 Calibrations**. Tap on the menu and then on **Add double Calibration**. Enter your glucose value twice and tap on **Done**. Now xDrip should show you every 5 minutes a value.



Acquaint yourself with xDrip. It's a great and matured app with many features. Have a look at the **Settings Menu**. With xDrip you can set an offset to the gluco value. That means if you know the difference between the libre reader and your real gluco from your meter, you can check the **Calibration Graph** and check the **intercept** value. As a sample my reader mostly shows a value that is -30mg/dl compared to my meter value. My intercept is 32.55. That means xDrip calculates +32.55 to that value coming in from the LimiTter and then display it. You can change the intercept with **Add Calibration**. So when you have entered a calibration and checked the intercept and it doesn't match yours, tap on **Override Calibration**, re-calculate the value and check the intercept again.



When you take off the transmitter for charging and apply it again it is sometimes necessary to tap on **Forget Device** in the **System Status** menu. After this you have to **Scan for BT** and tap on LimiTter again to reconnect the device.

The LimiTters power consumption is 8.8mA @ sleep because Bluetooth is always on. With a 220mAh lipo you must load it every 24hrs. Charging time: about 40-45min. If you have Android >= 5.x you can try to solder the BLE OFF circuit and enable all lines in the Limitter.ino file that contains BLE OFF. Have a look to the sketches description. The problem is the reconnect after turning off Bluetooth completely. With that circuit, power consumption is 0.16mA @ sleep for 4 minutes. Then it wakes

up and waits 60sec for the reconnect. If this works stable for you, then you can use a smaller lipo (80-100mA) and reduce the height of the box. (2-3mm thinner).
So check it out ...