

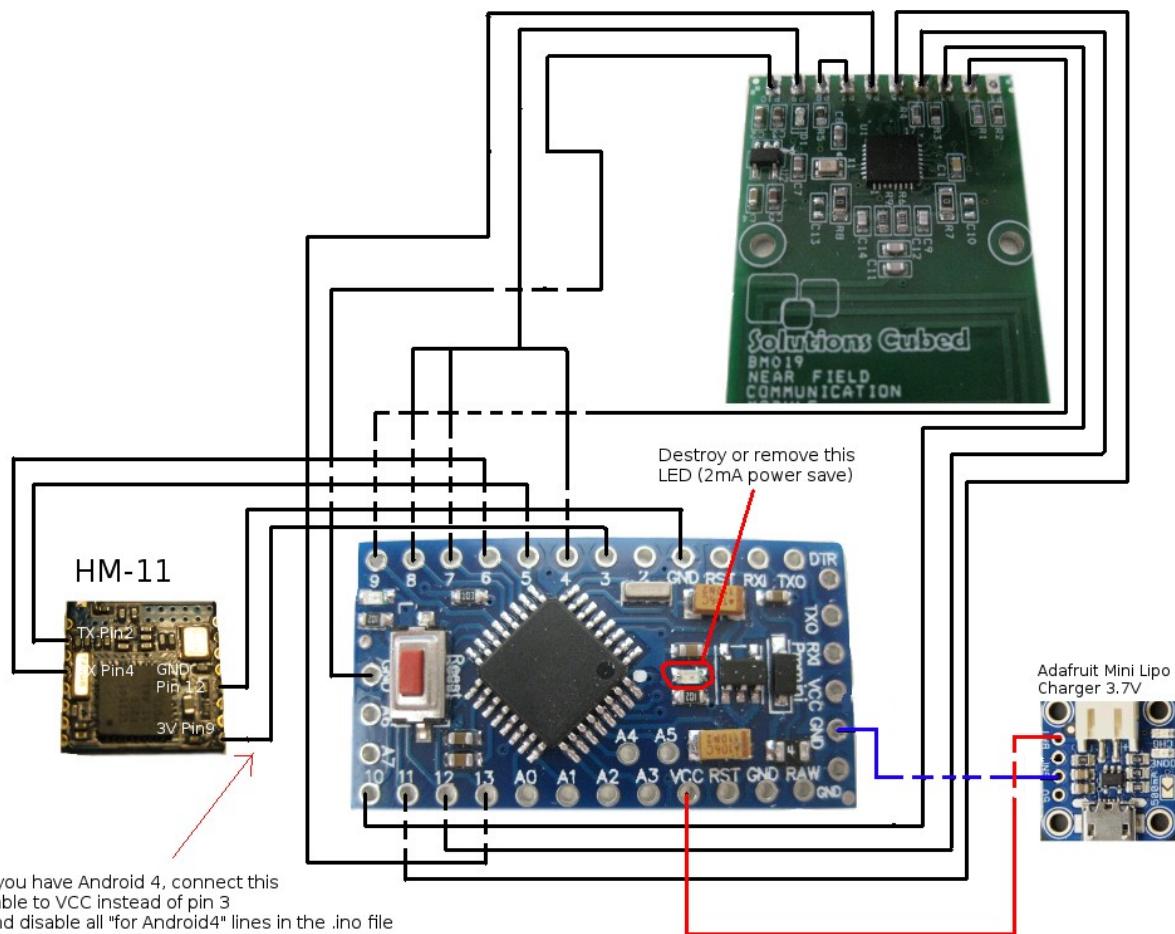
DISCLAIMER: LimiTTeR is an experimental DIY project. By building your own transmitter, you are responsible yourself for what you have done. The authors and maintainers of this project cannot be made responsible for any damage or actions.
Don't make any medical decisions based on the data of your sampled 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)
- Smartphone with Android 4.3 at the minimum
- Better to have Android >= 5.0 to save maximum battery power and build a thinner box.
- Arduino pro-mini 3V 8Mhz
- USB to TTL Serial Adapter Module
- Solutions Cubed BM019 NFC Module
- HM-11 Bluetooth Module (Seeedstudio)
- Lipo battery 3.7V 220mAh 40x17x6mm if Android 4.3 or 4.4 is installed (BLE always ON)
Lipo battery 3.7V 100mAh 25x12x6mm if Android >= 5.0 is installed (BLE OFF on pin 3)
- Lipo charger (Adafruit Micro w/MicroUSBJack)
- Small power switch (Only when 220mAh lipo is assembled – it needs space)
- A box 40x40x15mm (220mAh battery) or 40x40x10mm (100mAh battery).
- AWG 30 silicone-cable
- Soldering iron
- Helping Hand
- 2K epoxy glue
- Dremel like multitool with grinding wheel



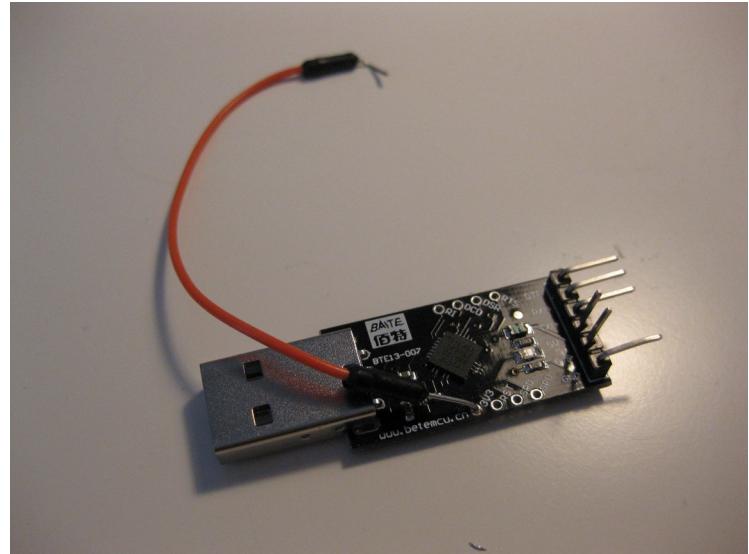
You may wonder why pin 4,7,8 are going into the Vin of BM019. It's because i need to power off this module completely and when it wakes up for reading and spi comes up, the power consumption raises to 80mA. So i just split this into 3 ports to spare the Arduino.

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:

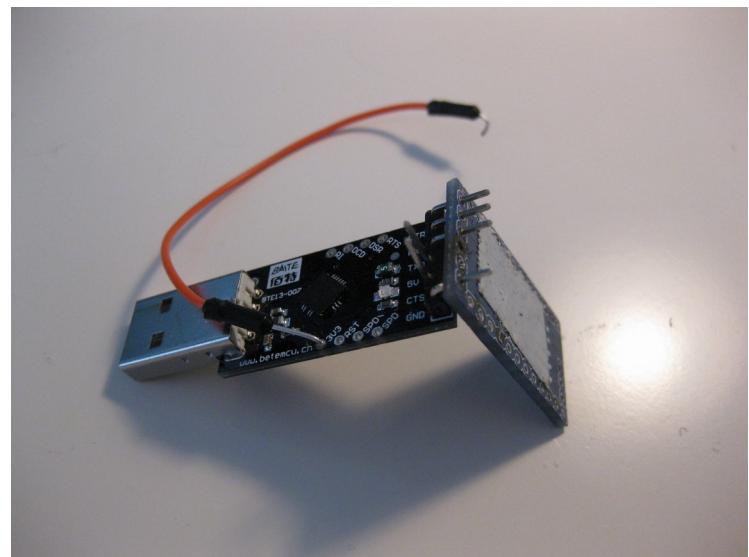
<https://www.arduino.cc/en/Main/Software>

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.



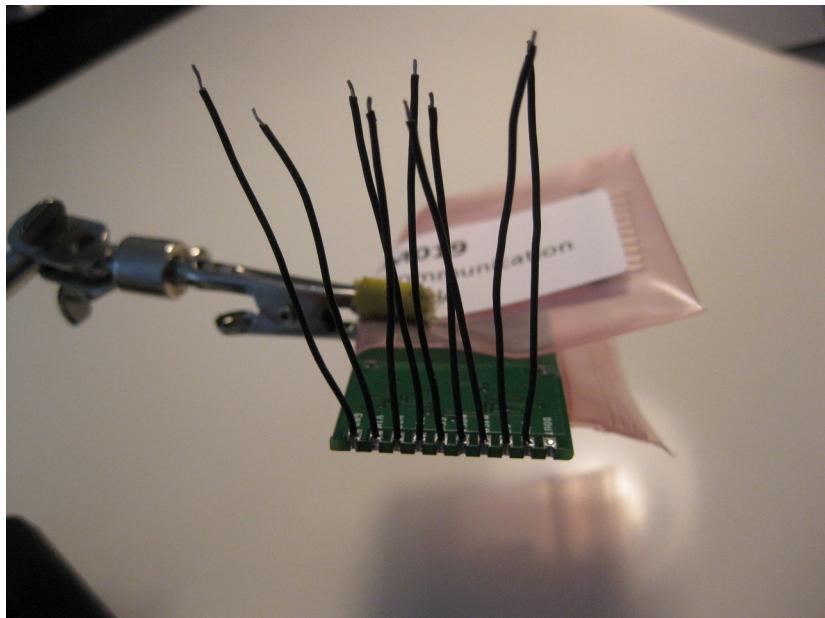
Plug the adapter into the Arduino and connect it with the USB jack to your computer. Now you are ready for program the board. Click on the Upload button and hold the 3V wire on a VCC pin of the Arduino. Yes, it's a bit tricky. Of course you can temporarily solder it on that pin ;) When there is no error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



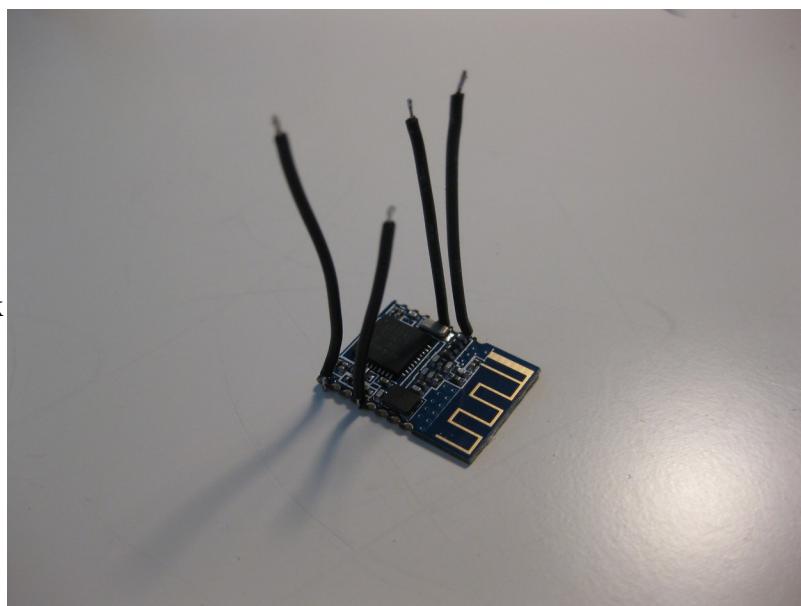
Now the hardware:

First the big version with a 220mAh lipo (Android 4.3 + 4.4 – BLE always ON)

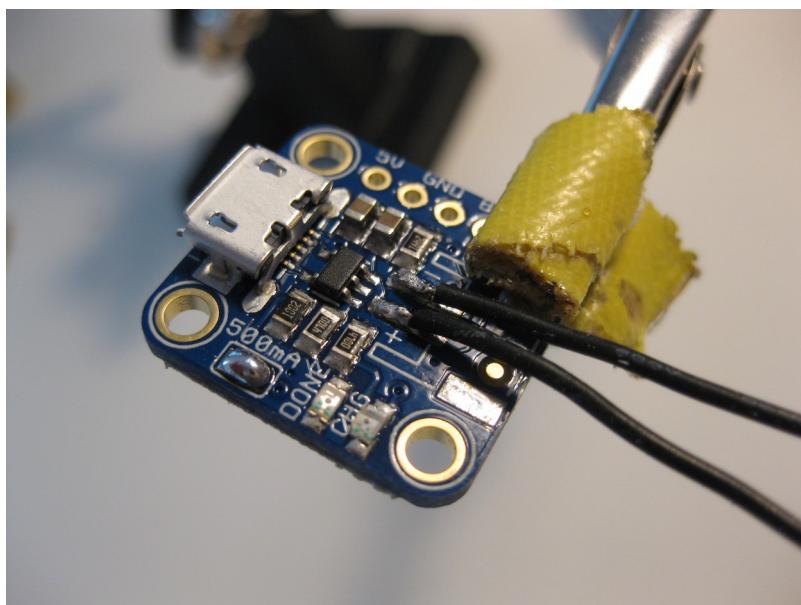
Solder the 9 wires (40mm long) into the BM019 contact holes.
Connect P7 with P8.



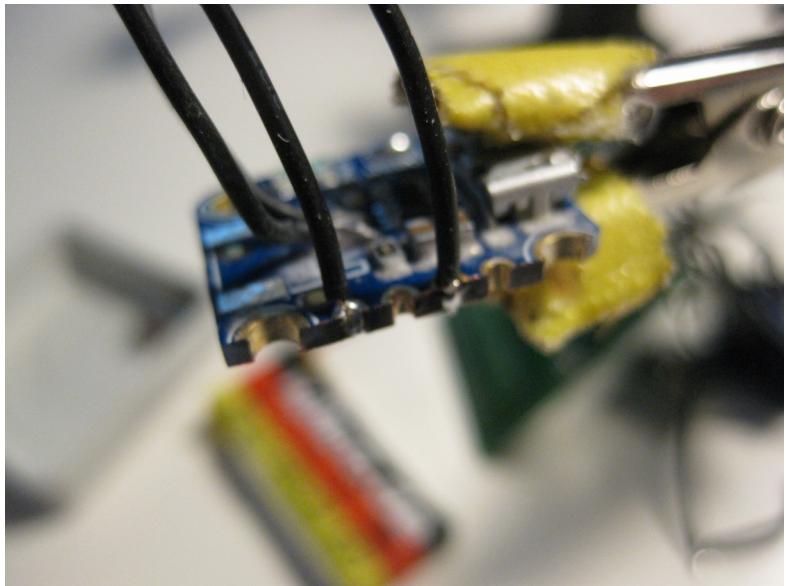
Solder 4 wires on the HM11 module. This is bit tricky, because the contacts are really tiny. I recommend that you first fill the four half holes with blank solder and then hold the wires end on that and heat it.



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.



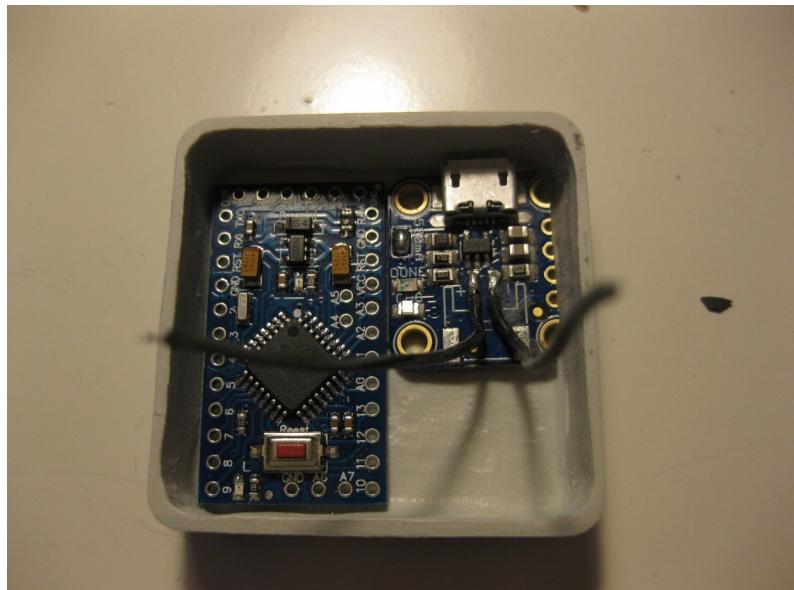
If you have a space problem to get the arduino and the charger side by side (like me), you can grind away one side. Here you have to solder 2 wires (BAT) + (GND).



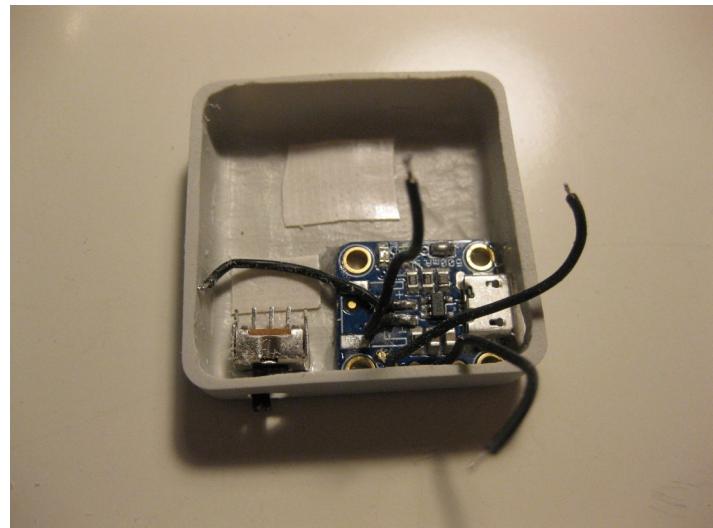
Prepare your box that it can contain all components. Mostly you have to grind away some things :)



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.



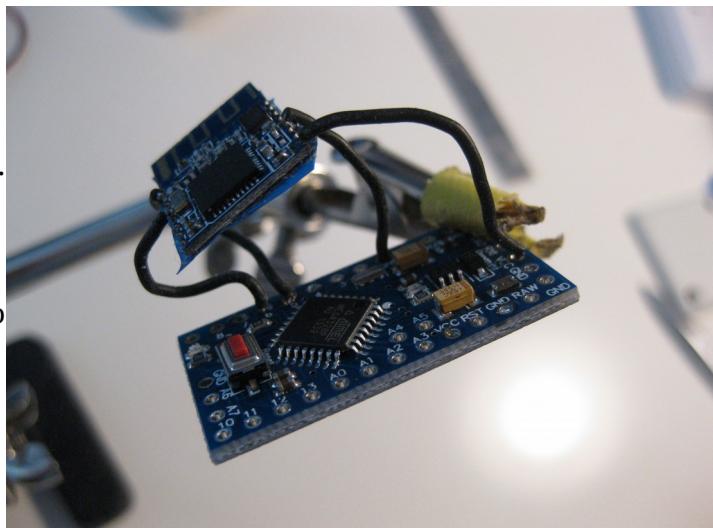
... and for the power switch, too.



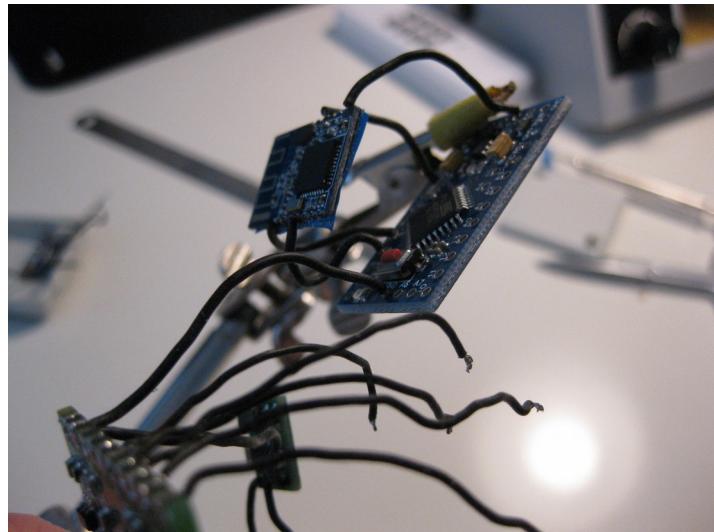
Mix a small blob of the epoxy glue and put it on 4 points in the box to fix the charger and put a small blob under the power switch. The glue begins to harden after approx. 5 minutes. Then make a last fixation and wait for 30 minutes.



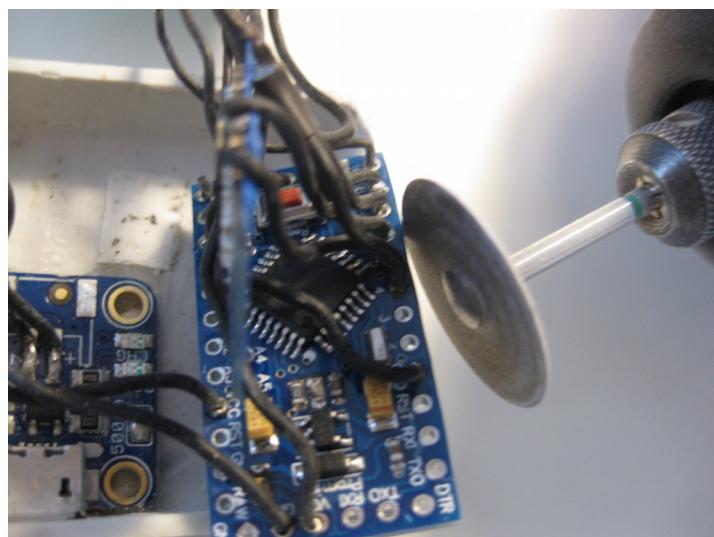
Now it's time to bring it all together. I suggest to fill all needed holes on the arduino with solder. Then begin with the HM-11. Desolder or destroy the power led of the arduino as you see in the wiring pic. We don't need this and this saves 2mA of power.



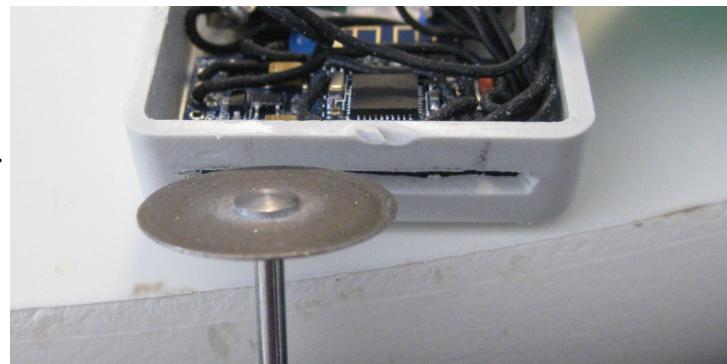
Then go on with the NFC module.



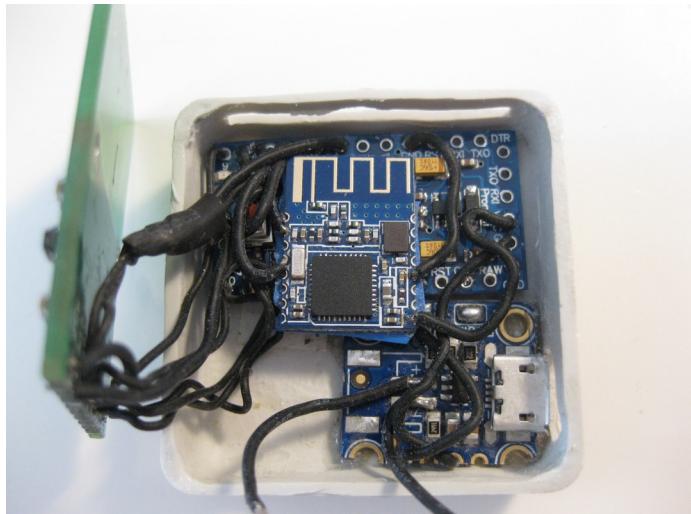
And now the lipo charger ...
You can grind the sides of the
Arduino, if you have a space
problem (like me).



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

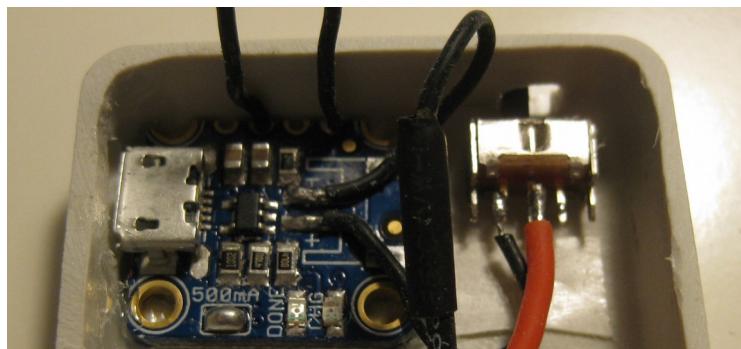
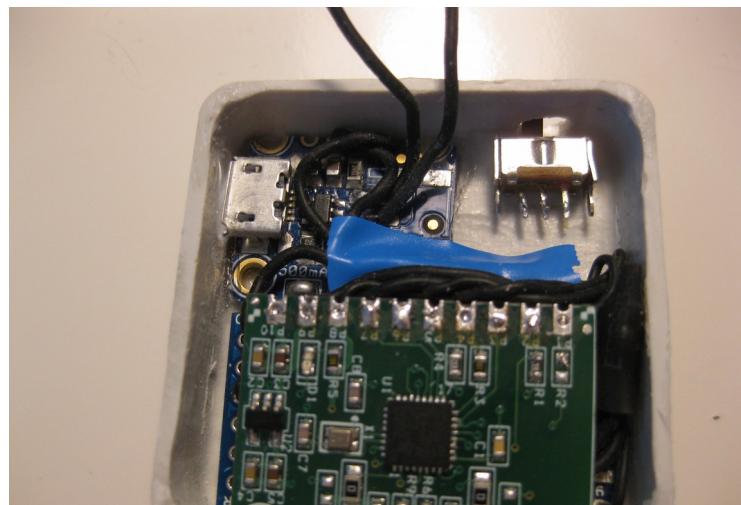


Place the HM-11 on the arduino ...



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





Solder the Lipo to the switch

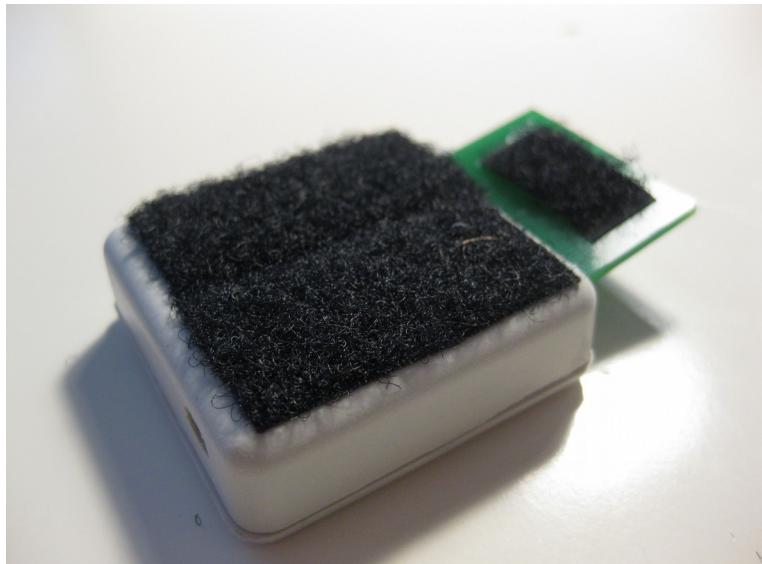


...and place it on the charger/
switch

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

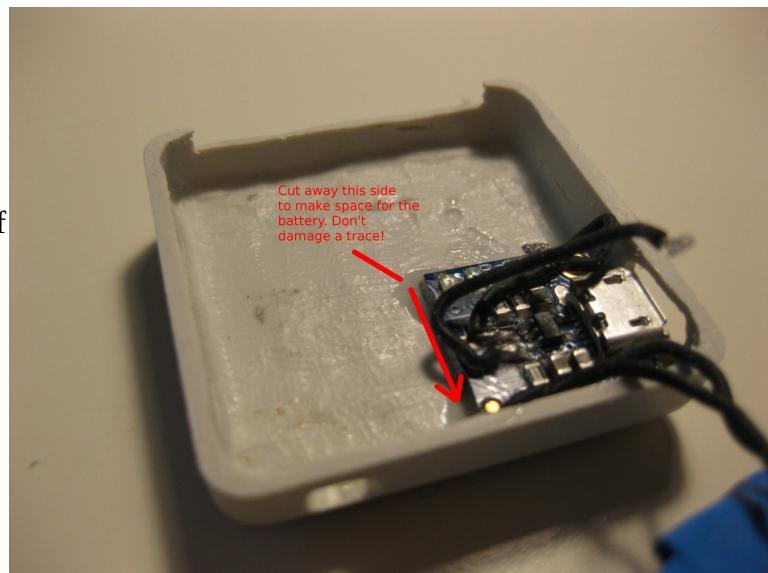


To place and fix the LimiTTe on your skin near the sensor you can use velcro tape on the box as you see here. You can buy it simply in your local DIY market. You can see my current mounting technique some pages below.

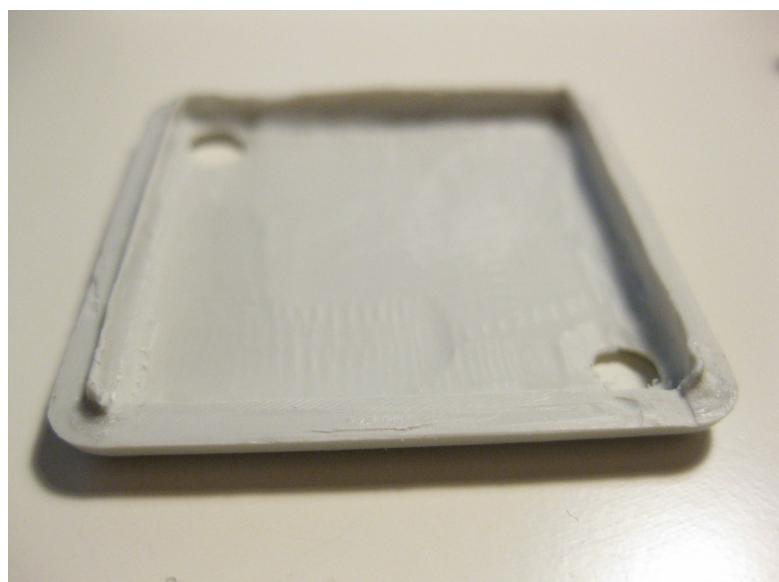


If you have Android \geq 5.0 on your phone, you should build a slim version with a 100mAh lipo. Here are the next steps to handle this:

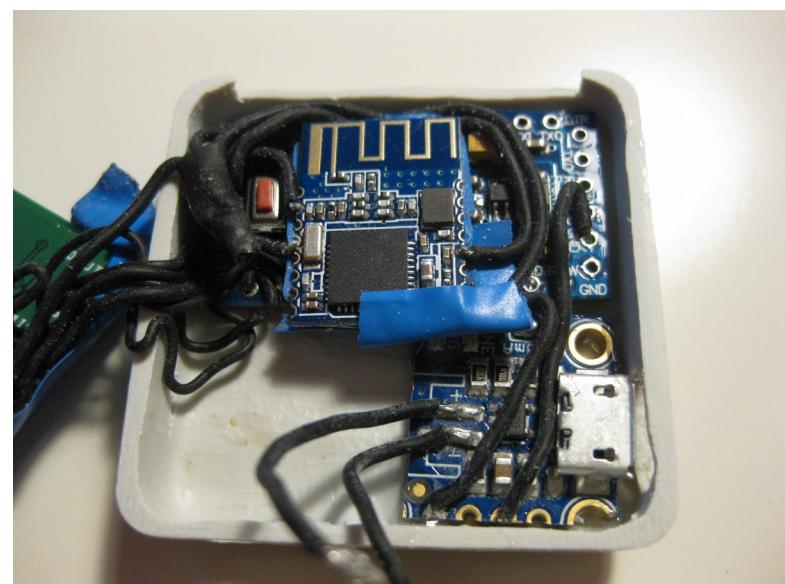
Grind the complete body on sand paper to reduce it's height to 7mm. You have to grind the bottom side of the lipo charger as you can see here. Have a look at the trace at the back side and grind near to that.



Grind away the small wall of one side of the lid.



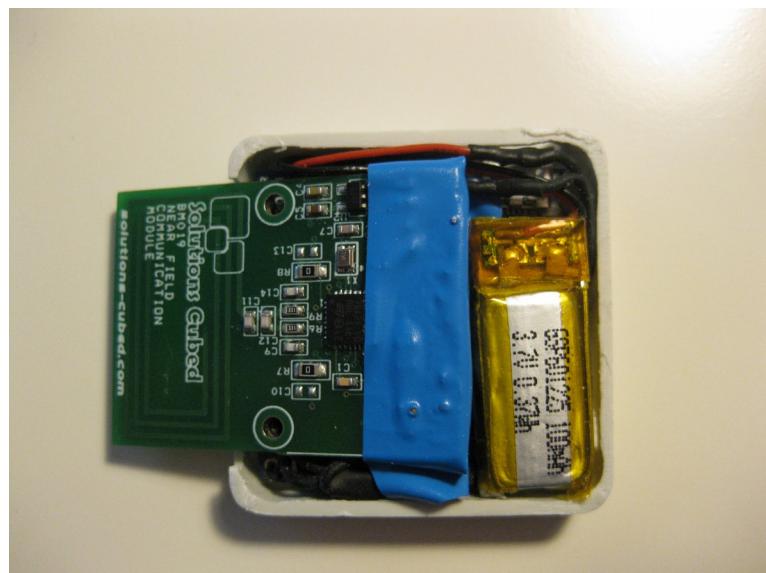
Place the components inside the body.



Sort the cables of the BM019 to make space under it ...

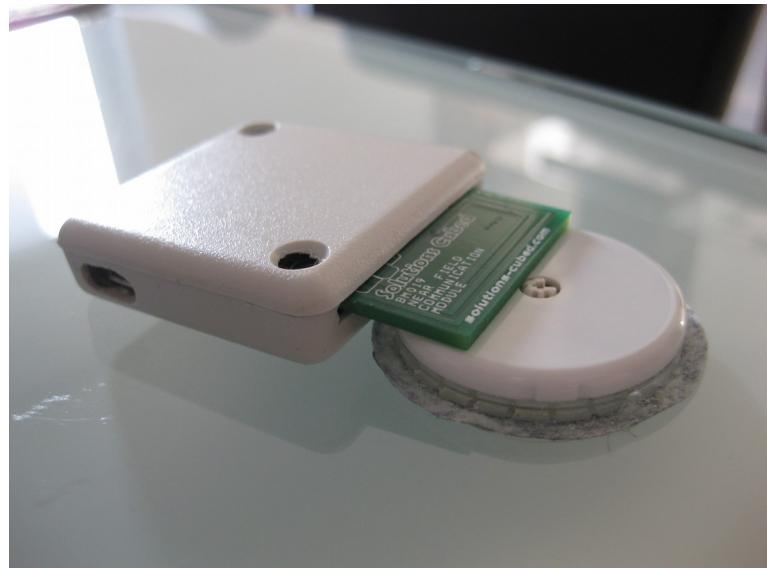


...and connect the tiny lipo with the lipo charger.



Add a tiny blob of superglue on all 4 corners and close the box under pressure for 1 minute.

Finished! :)

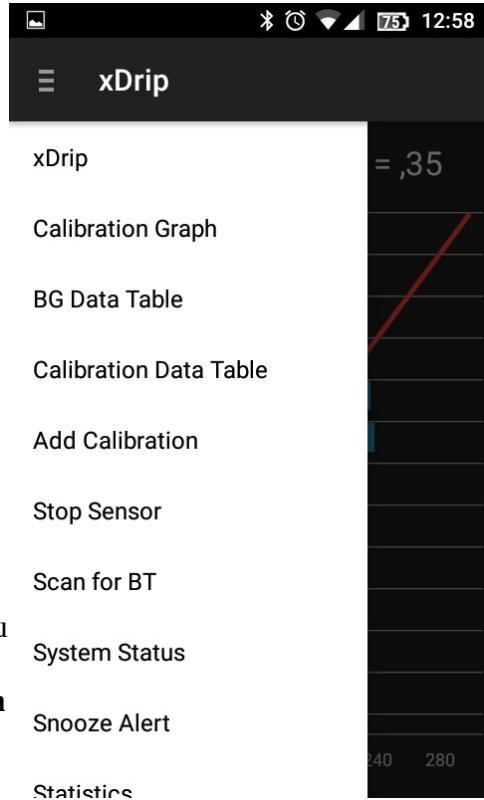


Preparing the leg for a mounting point (velcro tape on Fixomull Stretch) ...



... and stick it.



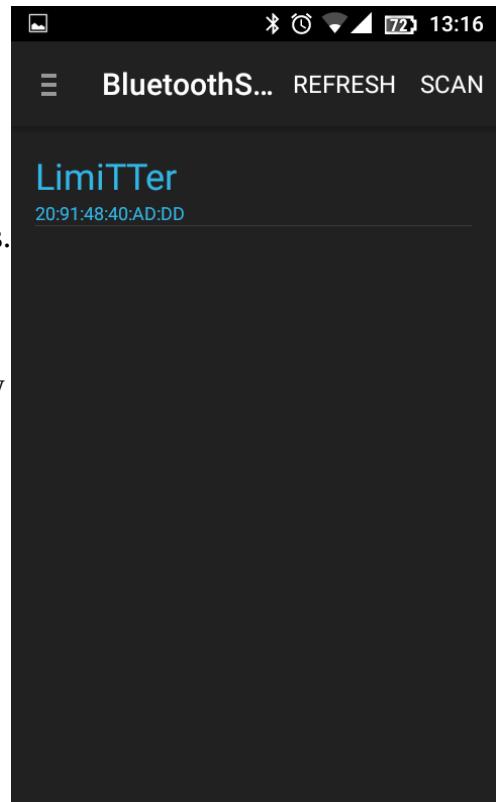


Finally download and install xDrip. You will find a link on the main page (xDrip.md).

Maybe you have to enable the option to install apps from a unknown 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**. Select a few hours or 1 day 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 the current value from your LibreReader and tap on **Done**. Now xDrip should show you every 5 minutes a value.

The app will notify you after 1 hour to enter a new calibration. You can ignore this and you should disable calibration notifications in xDrip settings. It's only necessary if the reading is way off or if you want to enter a reading from your bg meter to compensate this to the value of the LibreReader. Read below for more informations.

Acquaint yourself with xDrip. It's a great and matured app with many features. Have a look at the **Settings Menu**.

Here you see the calibration graph. The only interesting value for the Libre is the intercept. This is the offset with the raw incoming value from the LimiTTer. Here you see an offset of +0.35 points. You can modify the intercept by making a calibration. As an example:

If your bg meter shows you 135mg/dl and the Libre 105mg/dl, you can make a calibration and enter 135. Then the intercept will change to ~30,0 and xDrip will show you ~135mg/dl, too. Every incoming value will be offset with that intercept and then be displayed on the graph in the main screen.

The LimiTTers power consumption is 0.16mA @ sleep. With a 100mAh lipo it should last ~48hrs but charging it every 24hrs is recommended. Charging time: 25min. If you have Android 4 you must solder the 3V line of the bluetooth module to vcc pin on the Arduino and disable all lines containing „for Android 4“ in the Limitter.ino file. Have a look to the sketches description. The problem of Android 4 is the reconnect after turning off Bluetooth completely. So in that case you must add a bigger battery (240mAh) and unfortunately build a bigger box.

