

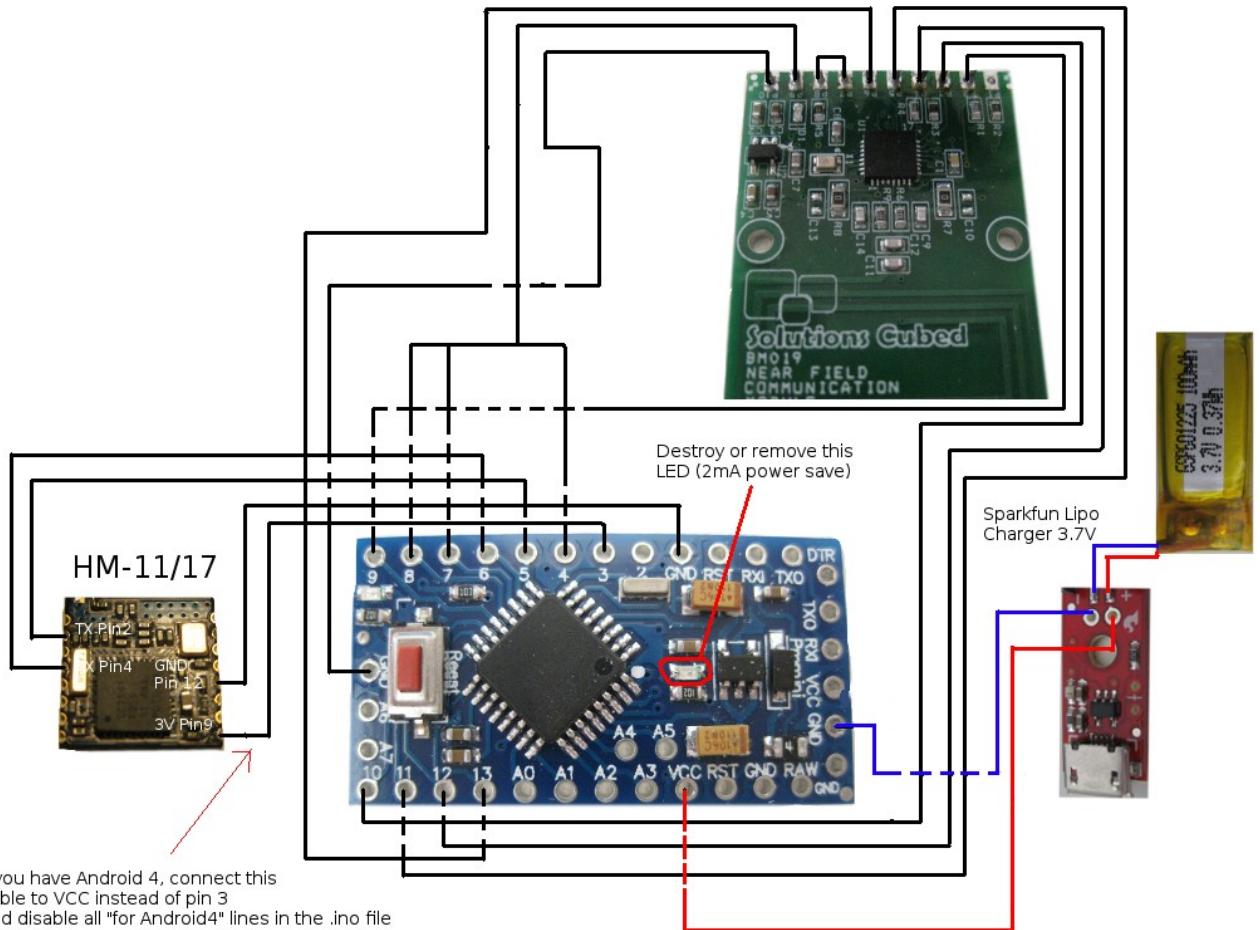
DISCLAIMER: LimiTTER is an experimental DIY project. By building your own transmitter, you are responsible yourself for what you have done. The authors and maintainers of this project cannot be made responsible for any damage or actions.
Don't make any medical decisions based on the data of your sampled 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 or LibreLink app (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 or HM-17 Bluetooth Module
- Lipo battery 3.7V 220mAh 40x17x6mm if Android 4.3 or 4.4 is on your phone
Lipo battery 3.7V 100mAh 28x12x5mm if Android >= 5.0 is on your phone
- Lipo charger (Sparkfun Lipo Charger Basic)
- A box 40x40x15mm (big & slim model) or 35x35x15mm (tiny model) (Hammond Manufacturing)
- AWG 30 silicone-cable
- Soldering iron
- Helping Hand
- 2K epoxy glue (Syringe)
- Dremel like multitool with grinding wheel and some cutters



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.

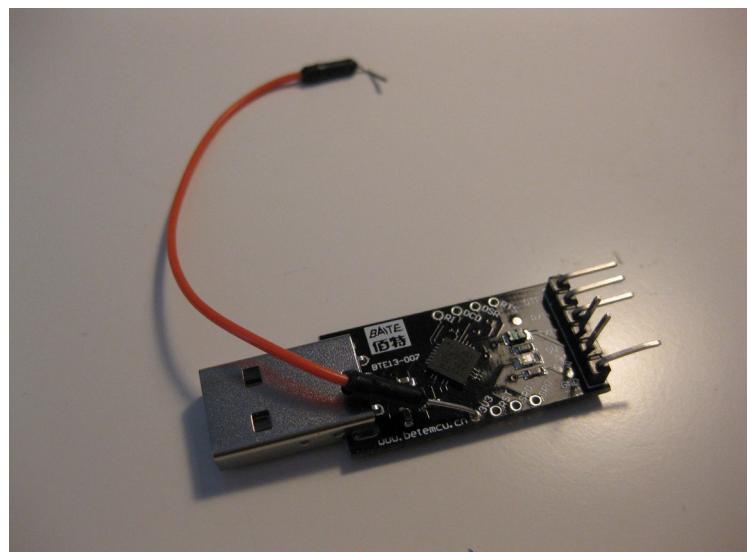
First download LimiTTe.ino and save it to your desktop.
Then you have to download and install the Arduino IDE.
You will find it here:

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

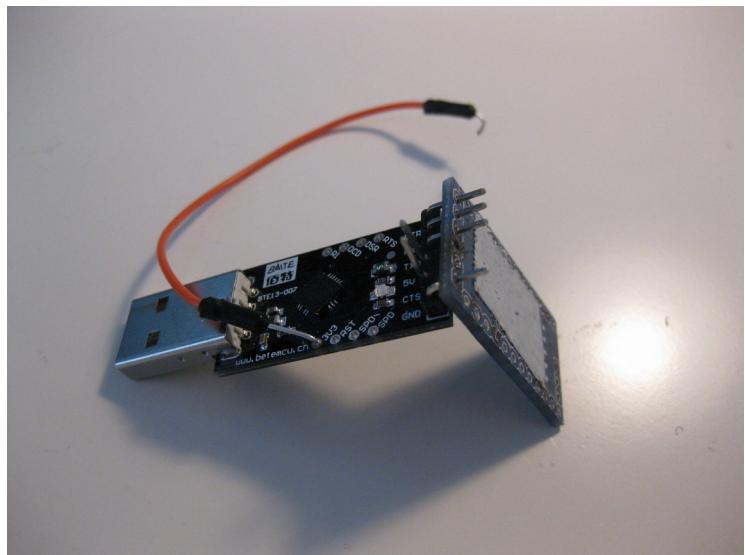
Start the IDE and navigate to the tools → board menu. Select „Arduino Pro or Pro Mini. From „Processor“ choose „ATmega328 (3.3V, 8MHz)“.

Now open the LimiTTe.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.



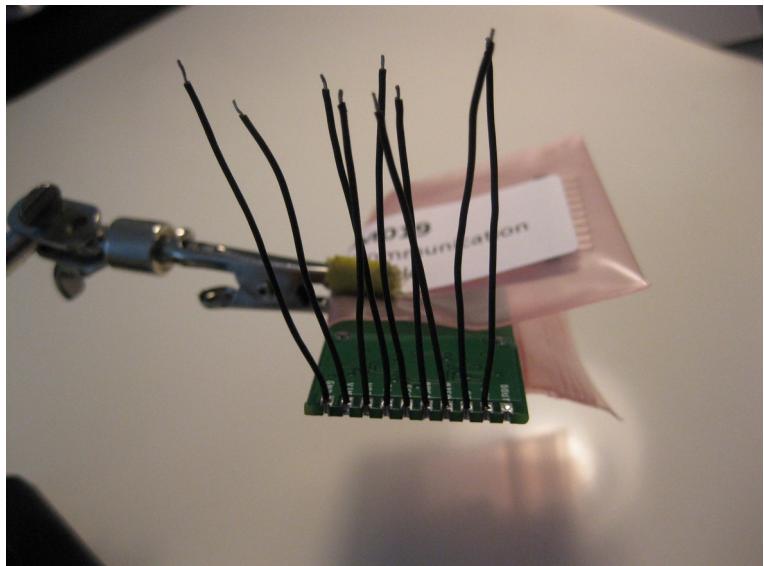
Now the hardware ...
I will show you 3 models to build:

1. The big one 40x40x15mm
2. The slim one 40x40x10mm
3. The tiny one 35x35x10

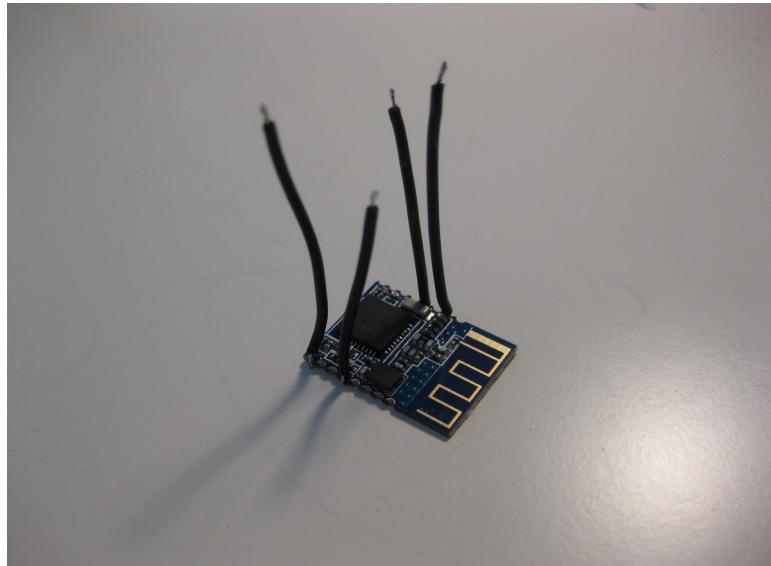
For all 3 models i have used cases made by Hammond Manufacturing.

First **the big one** 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.

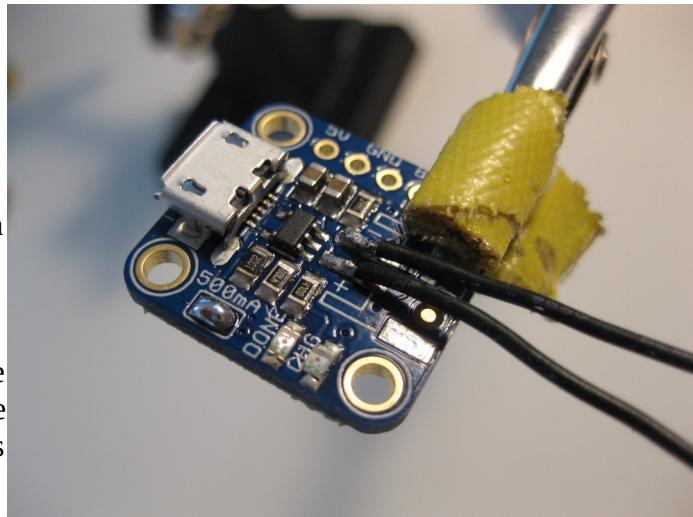


Solder 4 wires on the HM11 module. This is bit tricky, because the contacts are really tiny. I recommend that you first fill the four half holes with blank solder and then hold the wires end on that and heat it. The cables you see on the pic are a bit short. Longer is better.

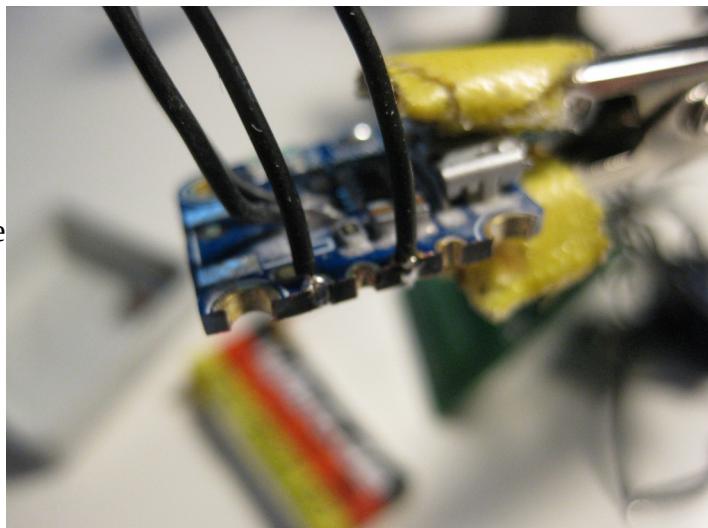


CHARGER UPDATE: I recommend to use the Sparkfun Lipo charger. It's smaller and there is no need to grind the pcb and the Arduino to match into the case. You will see the Sparkfun below where i show you how to build a 35x35mm case. On these pics you see the obsolete charger.

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



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).



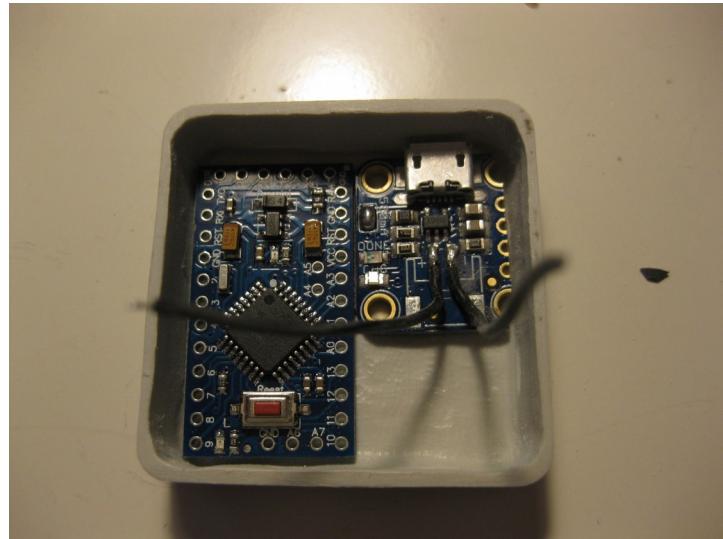
Prepare your box that it can contain all components. Mostly you have to grind away some things :)

UPDATE: NO NEED TO GRIND THE SIDES WITH SPARK CHARGER



Fits perfect ... now! ;)

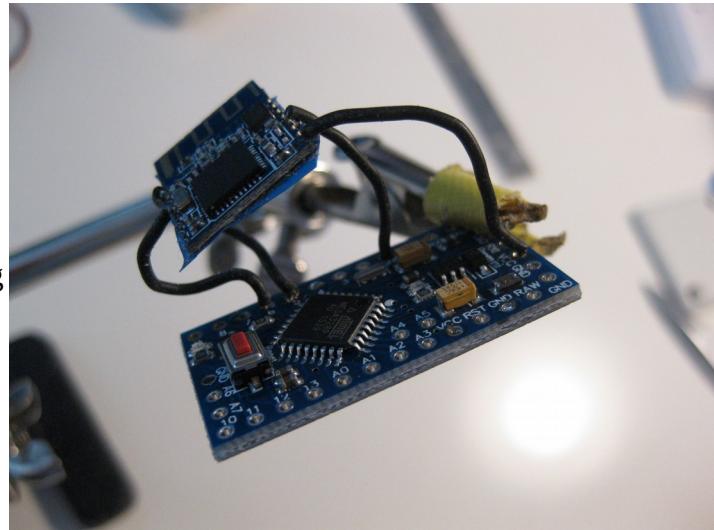
Now you know the exact position of the loading jack. Mark it and take out the components to grind a small hole into the box.



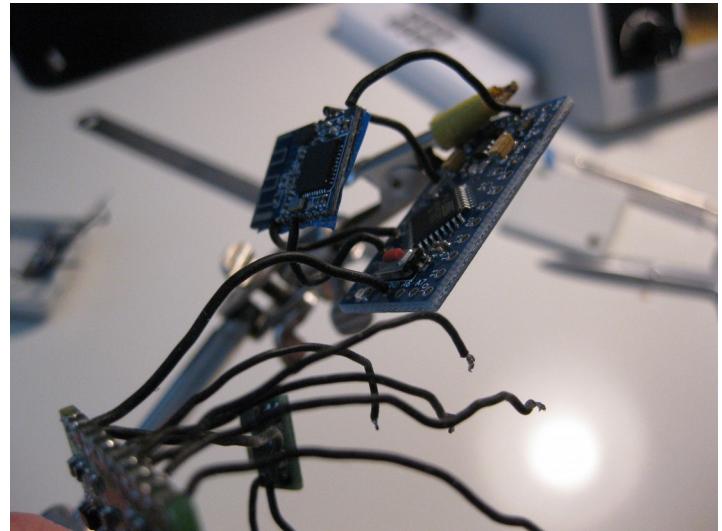
Mix a small blob of the epoxy glue and put it on 4 points in the box to fix the charger and put a small blob under the power switch. The glue begins to harden after approx. 5 minutes. Then make a last fixation and wait for 30 minutes.



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.

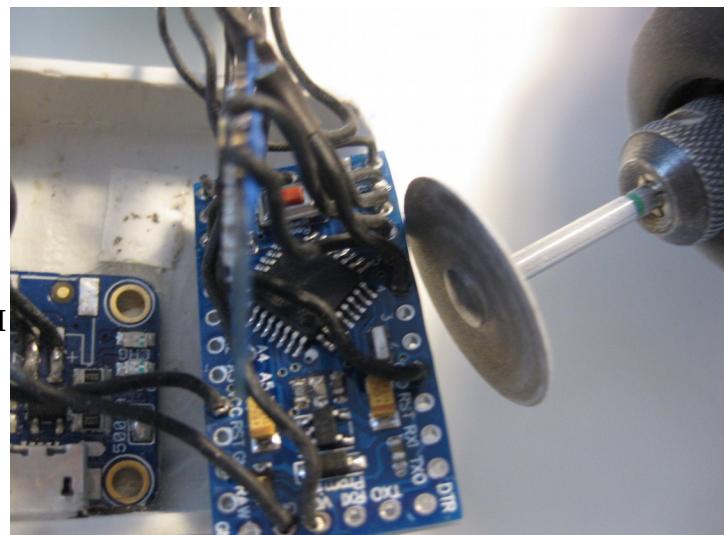


Then go on with the NFC module.



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

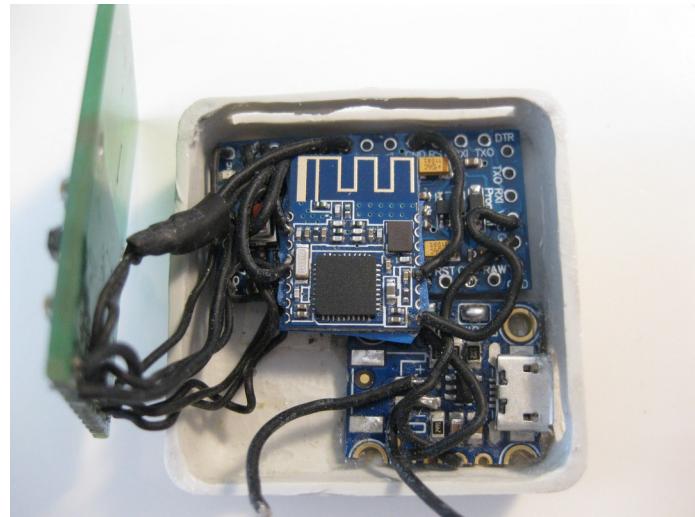
UPDATE: NO NEED TO GRIND WITH SPARK CHARGER



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



Place the HM-11 / 17 on the Arduino ...



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



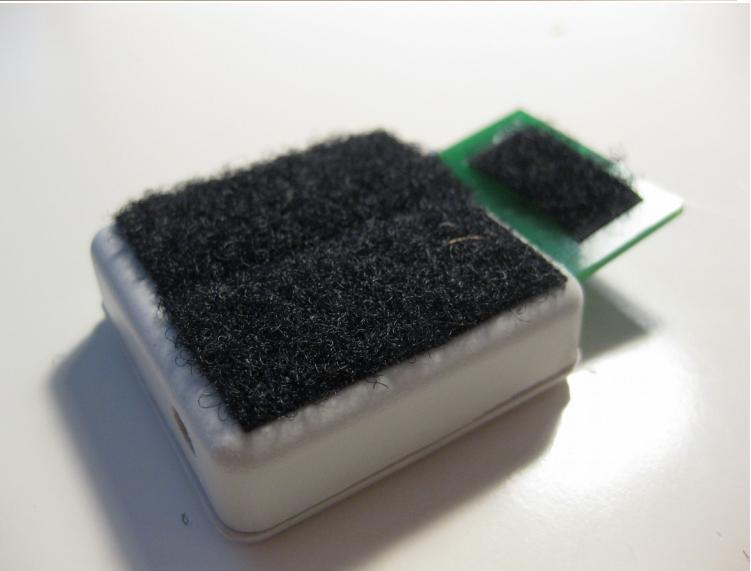
Place the lipo on the charger



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 on the box as you see here. You can buy it simply in your local DIY market. You can see my



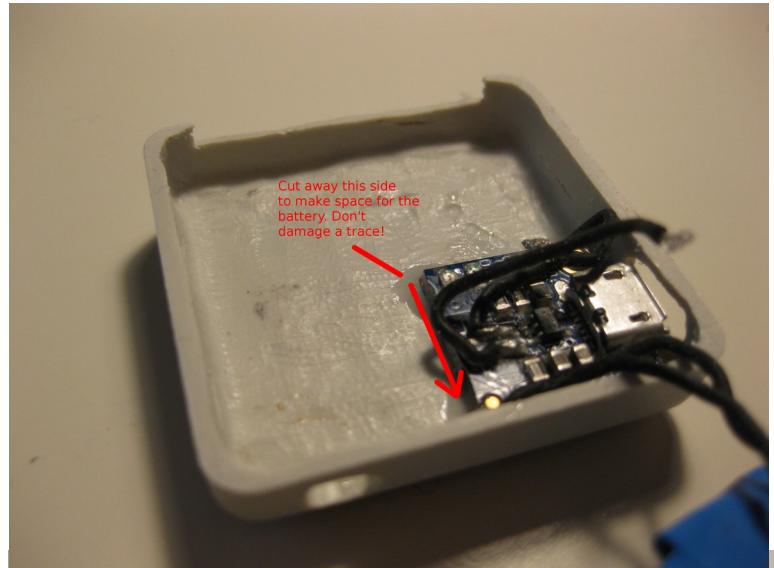
current mounting technique some pages below.

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

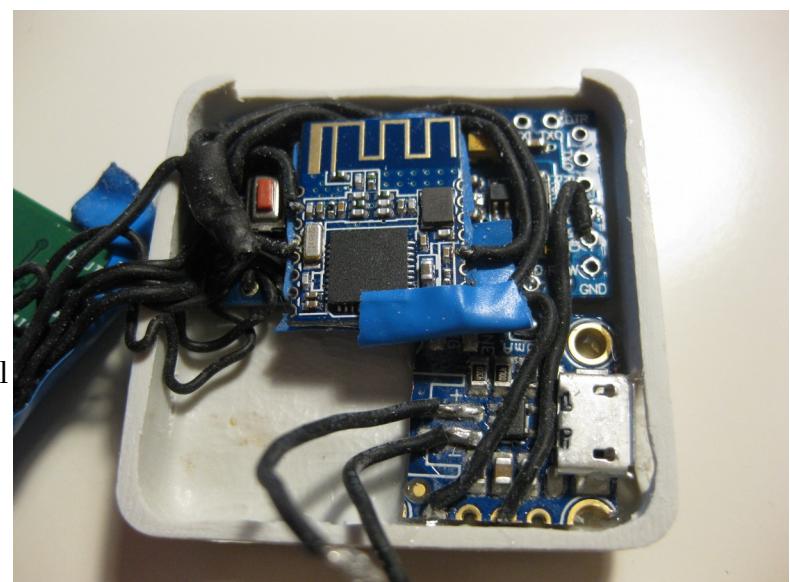
the slim one:

Grind the complete body on sand paper to reduce it's height to 7mm.

UPDATE: NO NEED TO CUT WITH SPARK CHARGER



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



Place the components inside the body. You can also stick the HM-Module with double-sided tape at the backside of the BM019. You will see a pic of that below.

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) ...

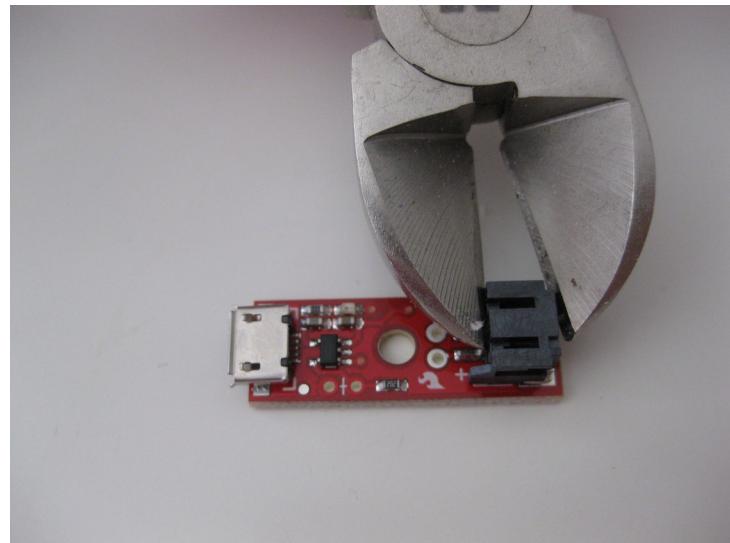


... and stick it.



Now the tiny one:

Cut away the jack of the Spark charger with a pliers.



This is a new black case 35x35x15mm made by Hammond. I have white-painted it later. It is available grey-coloured, too from the manufacturer.



Let's grind away the inlay stuff.



...and grind below to make space.
There is no need for a huge wall thickness. I have filled the 2 holes with epoxy and grinded the top area on sandpaper after hardened.



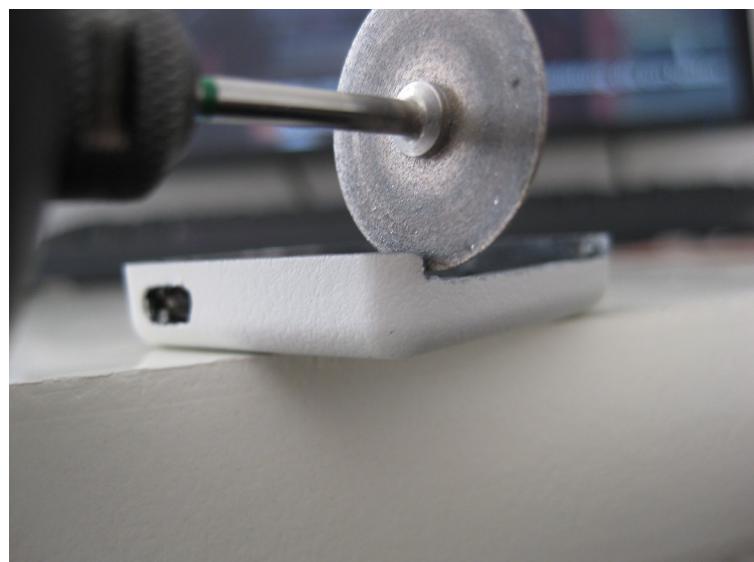
Take a pencil and draw a marking line around the case. 7mm measured from the ground. Grind around above the line with a grinding wheel.



Trim the case by rubbing on sandpaper.
Take care not to grind below the marking line.



Put in the charger and mark its position of the jack. Take out the charger and grind a hole at that position.



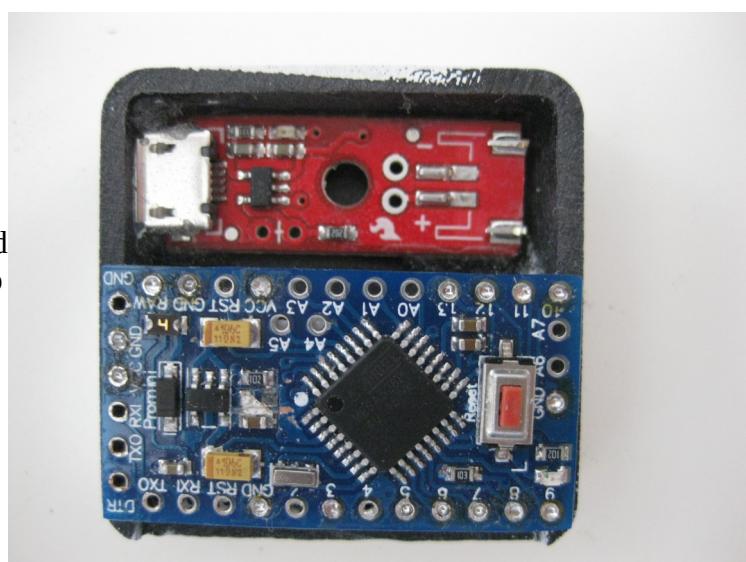
Grind a recess of 2mm into the front wall.



Glue the charger with 2k-epoxy into the case. You see, that the ground has been grinded, too. This is necessary but very tricky. The ground plate and the lid plate must be thin to establish space for pcb's and cables.



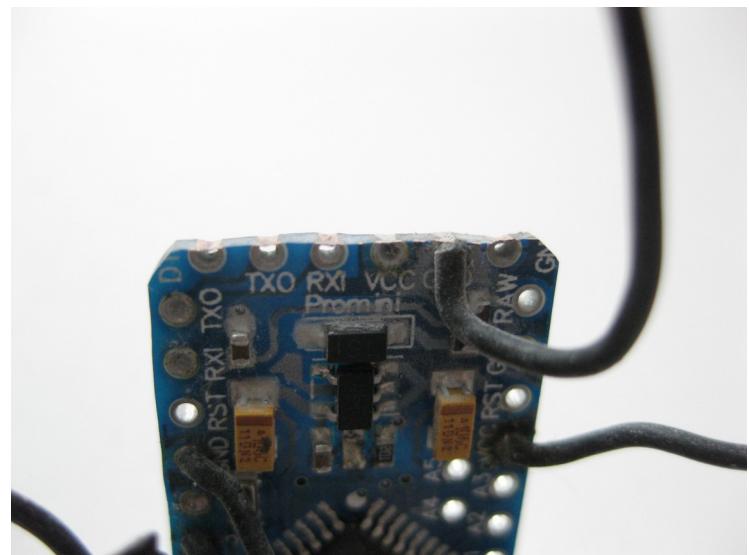
Here you can see that the Arduino board doesn't match into the case. You have to shorten it and grind the inside of the case.



Grinding both walls to establish space for your Arduino.



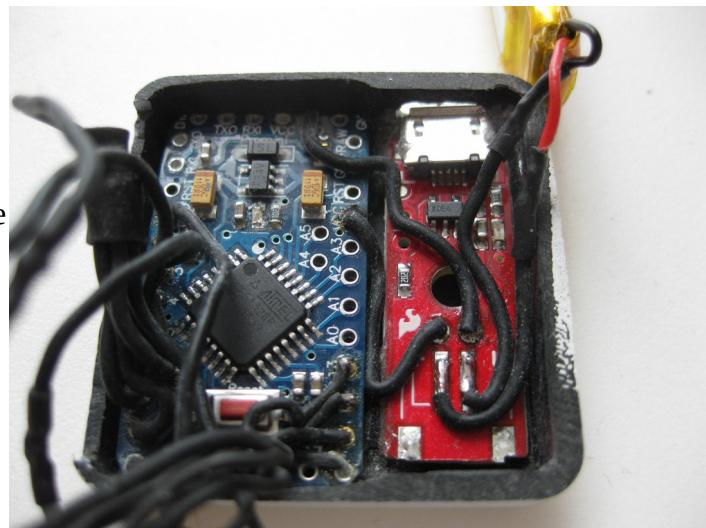
Should be enough space. You have to
grind the edges of the hardened
epoxy glue, too.



Grind both short sides of the Arduino and it's corners.
Do this slowly and frequently check out, if it matches with
the case



Now it matches into the box. Solder the VCC and GND wire of the Arduino to the charger. Solder both wires from the lipo battery, too



Place the battery onto the charger.



Stick the HM Module on the back side of the BM019 with double-sided tape.



Place the BM019 in the case on the cables.
Take care that it doesn't press the reset
button of the Arduino under pressure.



You have to grind away the front plank
completely to the ground.



Put some blobs of superglue on the lower portion and stick the lid under pressure.



Charge your LimiTTer.

10-15minutes = 24hrs



Finished. Put on the velcro tape as shown before.

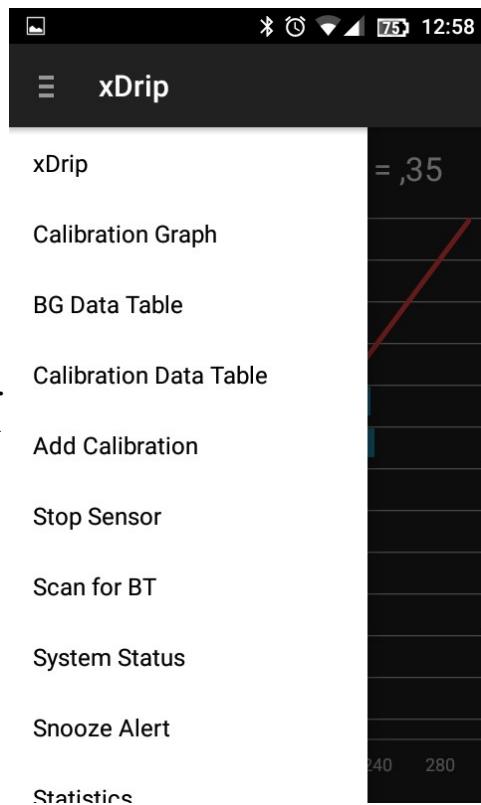


Finally download and install xDrip. You will find a link on the main page (xDrip.md).

Maybe you have to enable the option to install apps from a unknown source.

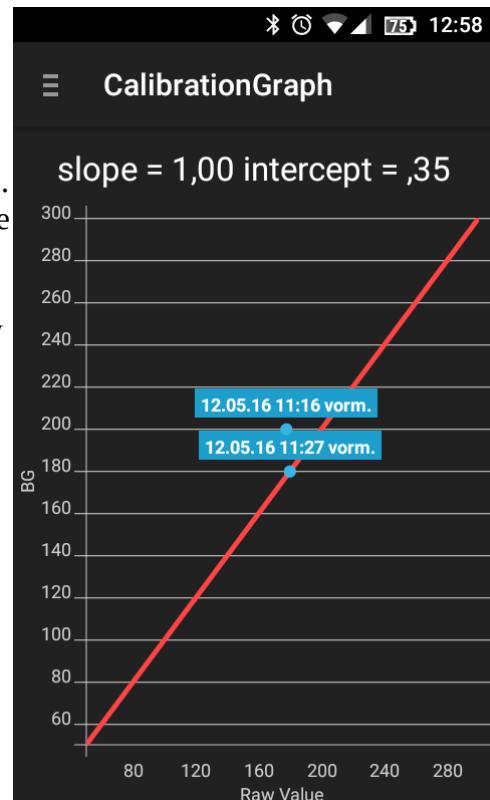
Then activate bluetooth on your smartphone and start xDrip. Click on the xDrip menu (left upper corner) and select **Scan for BT**.

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. The first time you should see a „HMSoft“ device. Don't connect to it. When it awakes the second time you should see „LimiTTer“.



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.

