Hoverboard Disassembly

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1 Introduction

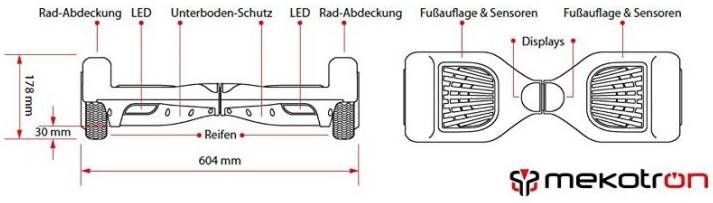
A seemingly broken hoverboard was found near a local trashcan. Taking it apart was obviously necessary.

2 The Hoverboard

The hoverboard can still be found on Amazon at the time of writing this. It is called Hoverboard 6 from MEKOTRON. The price is listed as 190€.

The hoverboard can reach speeds of up to 15 km/h. Two motors of 250 W each are mounted, one on each side. The battery is 36V. All in all the hoverboard weighs about 10 kg.

This is the product information from Amazon. It is in german.



Mekotron - HoverBoard 6 BT v2

Max. Geschwindigkeit:	bis zu 15 km/h
Motorleistung:	2 x 250 W
Batterie:	Li-Ion, 2Ah, 36V
Ladedauer:	3-4 h

Material:	Kunststoff (Kratz-Resistent)
Größe:	60.4 x 18.6 x 17.8 cm
Farbe:	Gehäuse: Schwarz Matt / Fußpads: Rot

Figure 1: Amazon Product Info

Figure 2: Label on the Hoverboard

3 The Outside

There is only one image of the outside, because the inside was much more interesing and thus leading to the destruction of the hoverboard.

Figure 3: Top View

And the one from Amazons product page.

Figure 4: Amazon Product Image

4 Electronics and Engineering Choices Inside

4.1 Power Button and LED Indicator Lights

The power button is build into the outer shell. Next to it a charging port is screwed in. Both seem to be standard parts that are fixed by screwing a nut against it from the inside. To fix the nut from coming loose, an excessive amount of hot glue was used. This seems to be a common practice. It looks cheap at first glance, but it is used to secure the connections against strain from vibrations. The vibrations in this case are probably a lot, since the wheels are made of very hard rubber and riding over pavement will shake the whole hoverboard.

For indicating the power and battery state LED indicator lights are used. Those are placed next to the axle of the pivot, one on each side.

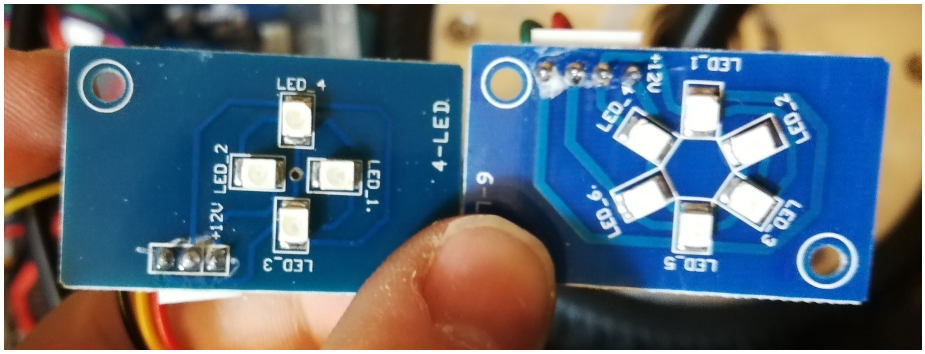


Figure 5: Indicator LEDs

4.2 Power LEDs

Keeping with the LED topic, a few more are used to illuminate the street in front of the hoverboard. Or the back?

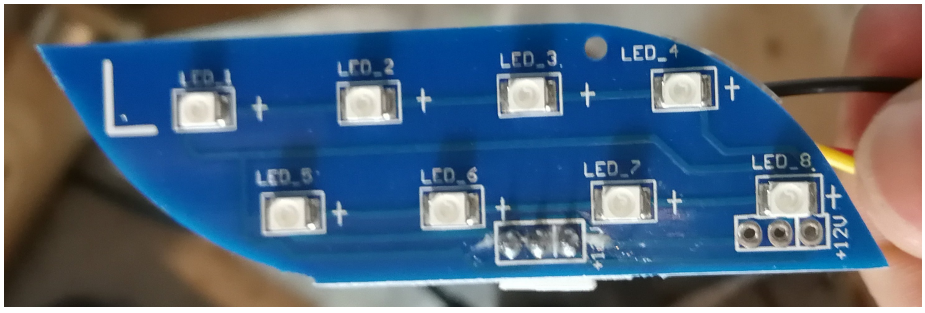


Figure 6: PCB of the Backlight

Figure 7: Mounting of the Backlight PCB

They are mounted again on a small PCB. The PCB is labled "L" for the left side and "R" for the right side, because they are not the same, but symmetric to each other. There are placed 8 LEDs per side. On the PCB there is also a label for 12V, the supply voltage for the LEDs.

Again, liberal amounts of hot glue secure the PCB to the case. There are screw holes in both the case and on the mounting brakets, but still only hot glue was used.

4.3 Rider Detection

To avoid the hoverboard driving away when the driver falls off, some sort of rider presence detection is necessary. In this case, the detection is done using a kind of pressure sensor under the rubber pads where the user stands on.

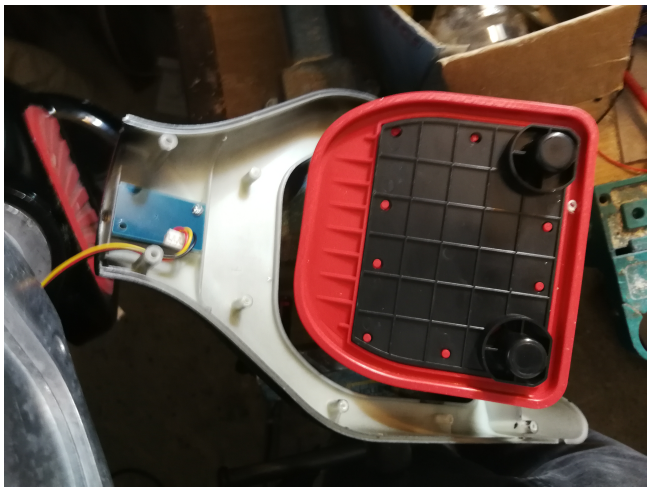


Figure 8: Rubber Pad on which the Rider stands

The rubber pads are placed on top of a plastic plate. That plate is used to spread the weight more evenly. The plate has two stubs at the bottom. Those stubs press against another rubber or silicone seal, which is constructed similar to the rubber domes from keyboards. When there is enough pressure, the dome plopps inside and breaks the beam of the infrared light barrier. The presence detection is therefore only a digital value: is there a user or not.

Figure 9: Rider Detection

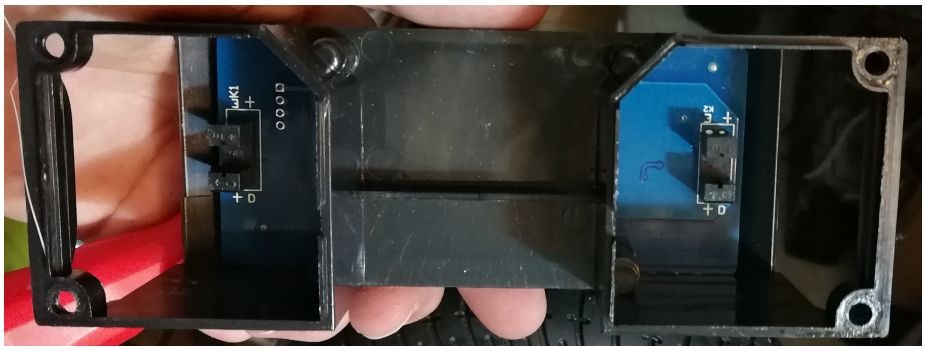


Figure 10: Light Barrier for Rider Detection

4.4 Mechanical Construction

The main mechanical construction is an aluminum frame. The frame is divided into two sides, the both halves, connected with a axle which the sides pivot around.

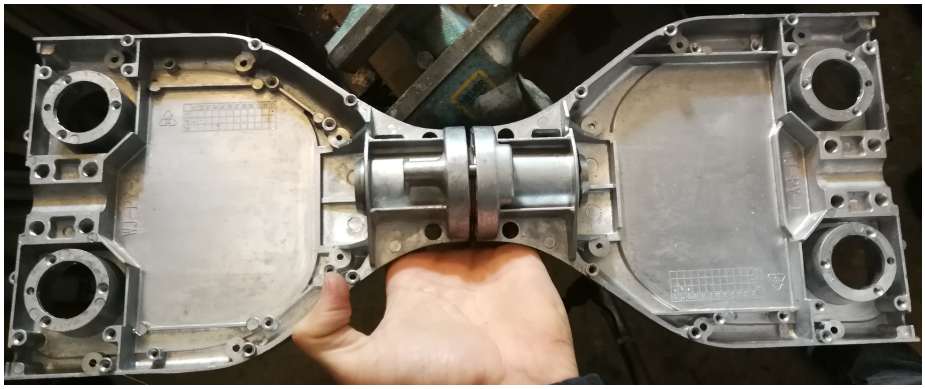


Figure 11: Aluminum Main Frame Construction

The frame seems to be cast. There are mounting holes for screwing in the shell and the electronics. Additional holes are used to get the rider detection through to the infrared barrier.

Both halves pivot around a center axle. It is a steel pipe of about 30 mm diameter.

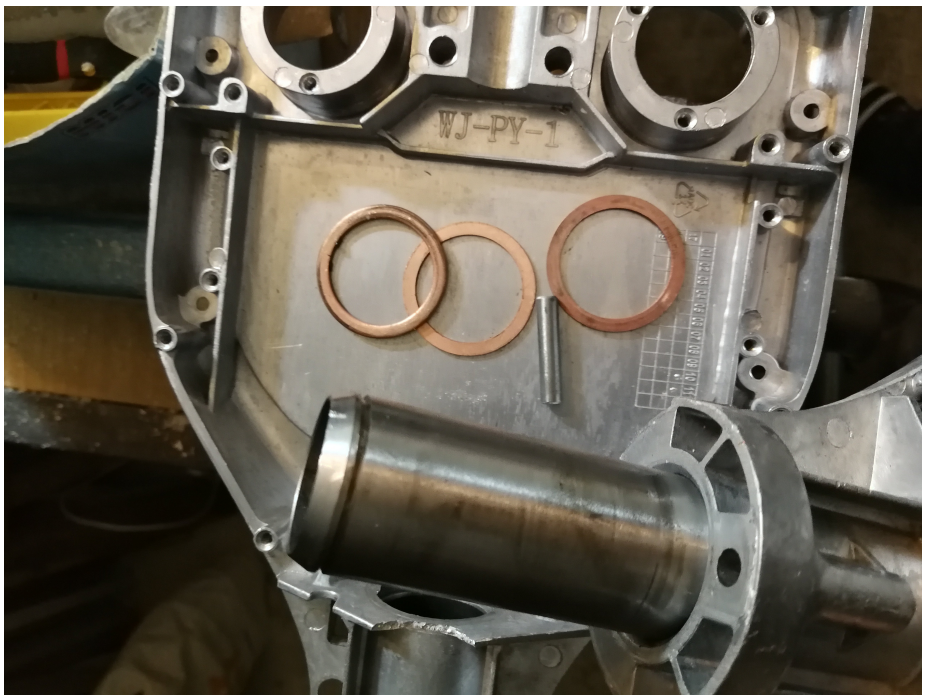


Figure 12: Axle and Copper Bushings

The pipe is held in place by a retaining ring on each side. Those slide against copper plates to reduce friction. The maximum angle is limited by a steel pin which extends from the one side and fits into a slot on the other side.

Figure 13: Steel Pin limiting Axle Angle

The cables connecting the electronics from one side to the other are guided through the main axle. Namely these connections are:

- Battery power
- Motor power
- Motor encoder feedback
- Feedback from the pressure sensor
- LED control

All cables are shielded by an extra layer of tape or heatshrink tube to reduce mechanical wear.

4.5 The Motors

The motors are mounted inside the wheels. The axis is flat on one side to stop them from spinning freely. An aluminum plate is pressed on the axis by four bolts. The motor wires and the encoder feedback cables are guided through the axis itself.

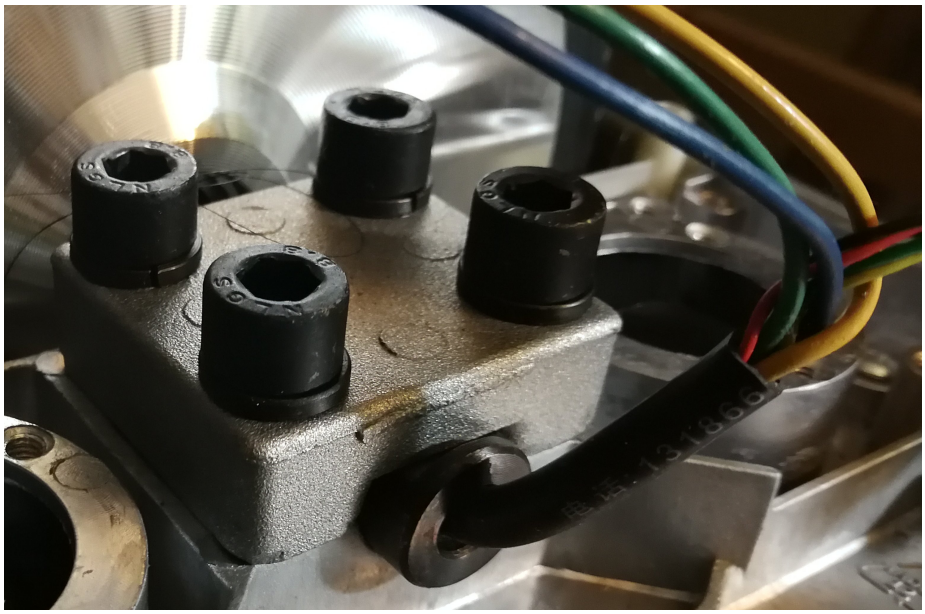


Figure 14: Motor Mount

The motors themself are rated for 36V, which can be read as a print on the motor. Wheel diameter is 6.5” or about 160 mm.

Figure 15: Motor Label

4.6 Motor Drivers

The motor drivers are both on the same PCB. They are implemented as discrete mosfets, controlled by the main MCU.

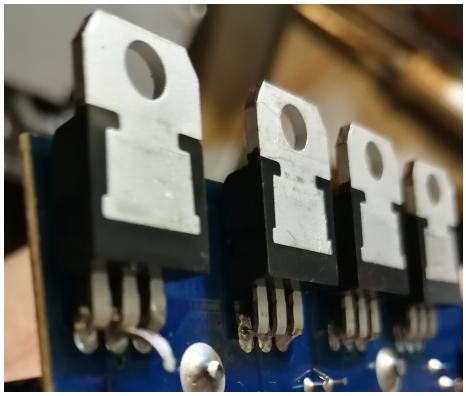


Figure 16: Mosfets on the Main PCB

There is a bit of solder standing off of one of the mosfet pins. It does not short to anything, but it is an indication of the build quality.

To cool the mosfets, a large aluminum plate is screwed to the bottom of all of them. The mosfets are insulated by a large pad.

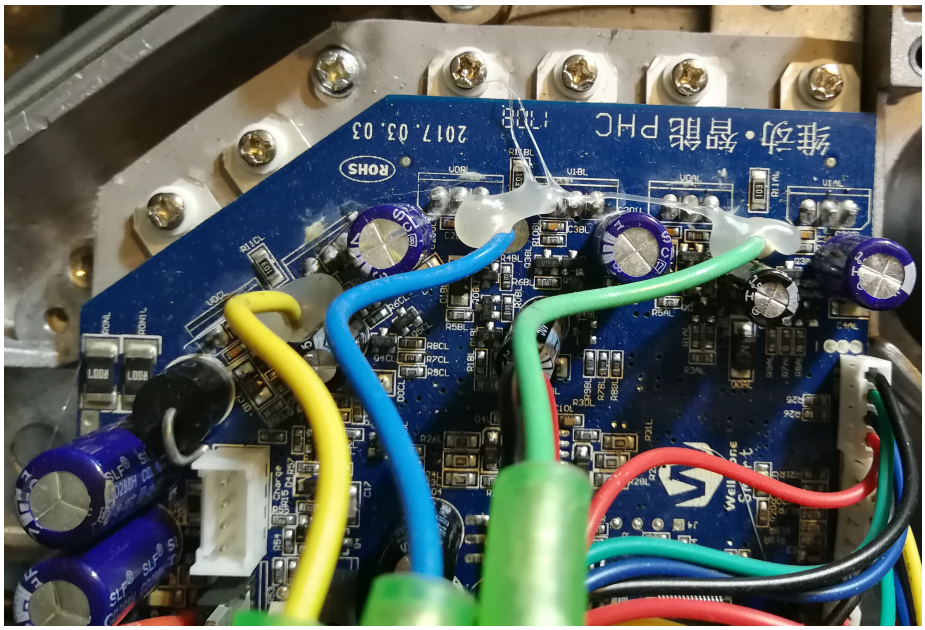


Figure 17: Mosfet Mounting and Cooling

4.7 Mainboard

Most cables connect to the mainboard. Instead of connectors with sockets on the PCB the connectors are directly soldered on. Probably for the same reason the hot glue is used: to reduce the chance of something coming loose.

Included on the mainboard are:

- Motor drivers
- Voltage regulators
- The MCU controlling the hoverboard
- A Piezo buzzer

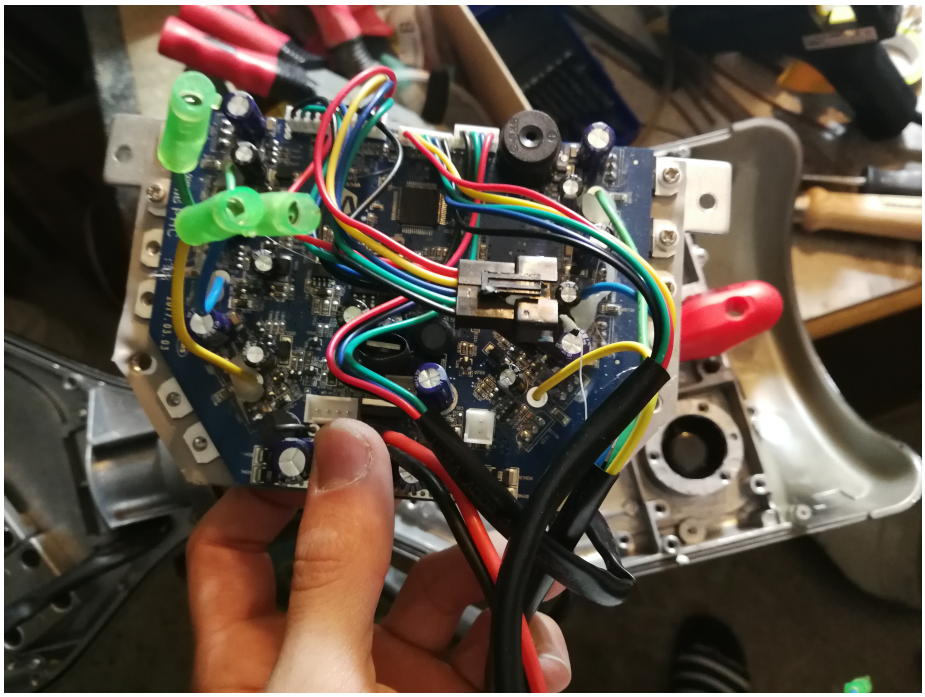


Figure 18: Mainboard

The main microcontroller is a GD32F103 from Gigadevice, which is not actually a STM clone, but a legit part. It is very similar to the SMT one since both are build on an ARM Cortex M3, but the GD one offers higher clock speeds and more memory (if configured).

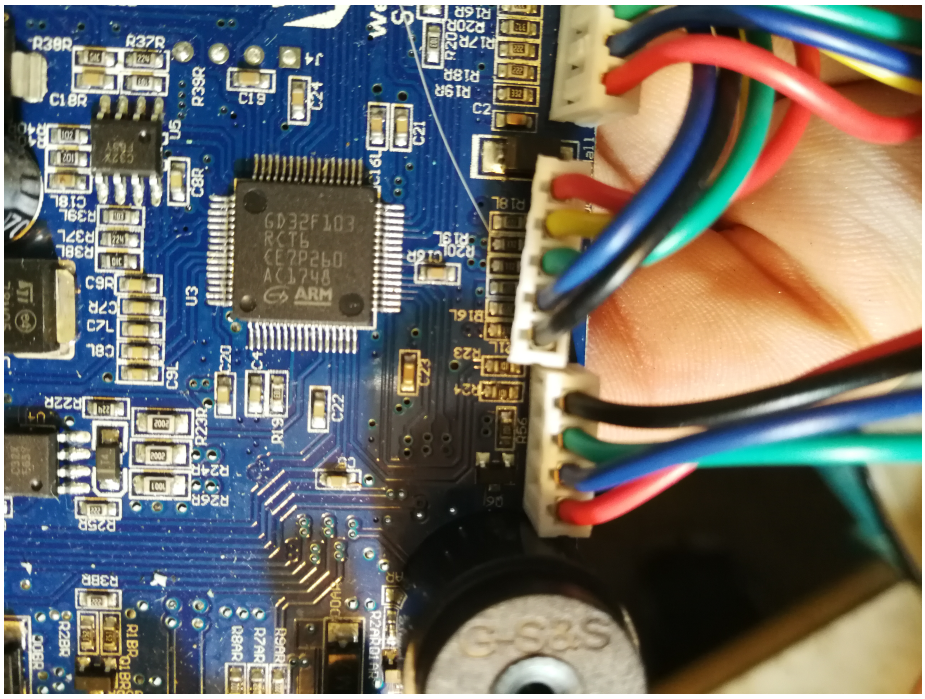


Figure 19: GD32F103 Mircocontroller

4.8 Battery

Figure 20: Batterypack

The battery in the hoverboard is build of 18650 Lithium Ion cells. The blue heatshrink tubing comprises 20 cells. 10 in series and two of those packs in parallel. Therefore a voltage of $10 * 3.6V = 36V$. The capacity calculates to $2 * 2000mAh = 4000mAh$. Giving the battery a rated power of 114 Wh.

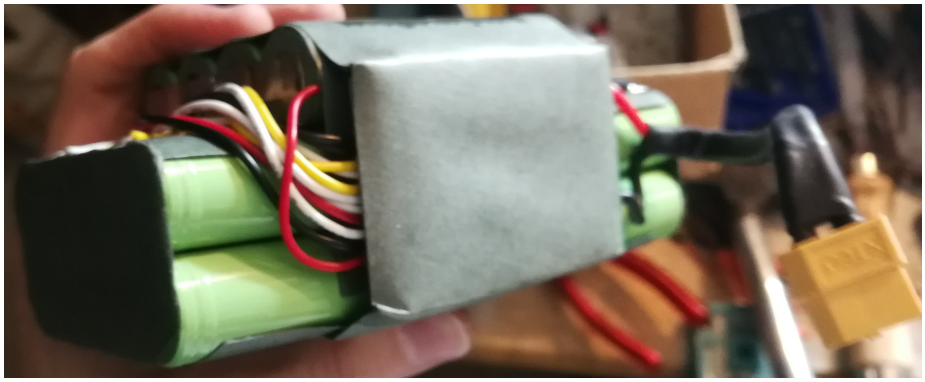


Figure 21: Inside the Batterypack

There is only a single cable with an XT60 connector coming from the battery. The balance charging is done via the internal battery management system. It

is included in the heatshrink tubing. Also included in the battery management system is overcurrent, overcharging and overdischarge protection.

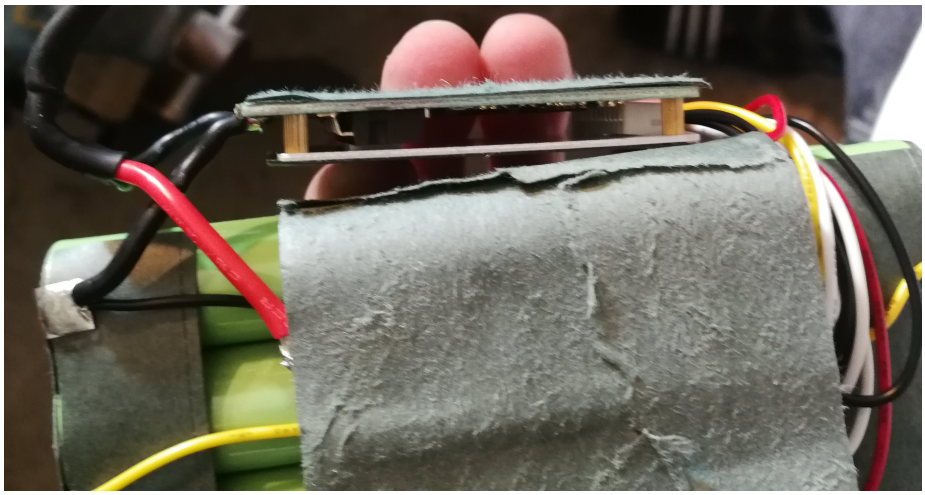


Figure 22: The Battery Management System

5 Final Thoughts

I think I will have to rip appart my electric wheelbarrow project in order to get the O-Drive from there. Then I can build an electric Bobby Car or some other vehicle of such sorts. Also for the 1st of May it would be nice to have a self propelled cart carrying all the beer, although the size comparison of the wheels does not quite want to match...

The next step would be testing the motors. Both turn fine and connecting the wires applies a breaking force, meaning the internal connections seem fine at first glance.

Figure 23: Wheel size comparison