Development/Prototype history

USB-C-PD Soldering Pen for Weller RT Tips

by Thomas Leputsch

1. Prototype 1

The requirement at the starting point was to build a breadboard circuit which can readout temperature and regulate the tips and require a low number of components. A NUCLEO-32 STML031 was used controlling the circuit. I've spent a lot of time to evaluate the behavior of the thermocouple inside the tips and measuring temperatures with a type K thermocouple mounted to a tip. After everything worked I started searching for components.

Unfortunately, I did not made photos at this stage. But for better imagination of this setup: It was built on a big and a small breadboard and looked kind of messy due to my focus on functionality and not how nice it looks.

2. Prototype 2

Basic requirements at this stage were:

- Finding proper components
- Drawing schematics and layout according to circuit made in stage 1
- Development of a compact and simple UI (user-interface)
- Development of the software based on the Stage 1 outcome
- Powered from a laboratory supply

Due to the requirement to keep it as small as the diameter of the tip. I have chosen BGA components for the controller, dual-fet and OPA because these are the smallest available. It took many time to optimize PCB, to reduce crossings and finding the optimum placement at this time. The UI was mainly developed at this stage and consist three LED's and two buttons. The software was adapted from the STM32L0 to an STM32F031 controller and also many improvements in terms of measurement, regulation and safety were made. USB-C power delivery was also considered as an option at this stage. So, I have drawn an additional PCB with USB-C controller. The idea was to solder this together, to archive a perfect alignment of the USB-C and tip-connector. Some mid mount USB-C connectors are available, but all of them need more PCB space. At this point, the housing was an 3ml syringe which had the perfect diameter, as you can see on the photos.

Here are some photos of this prototype:

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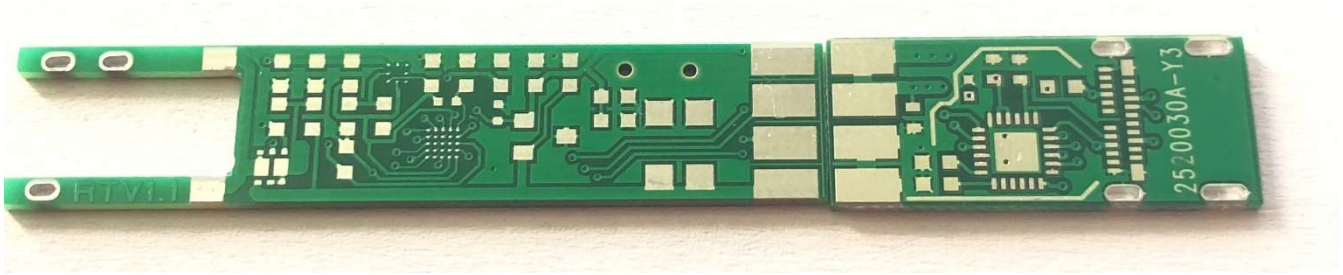
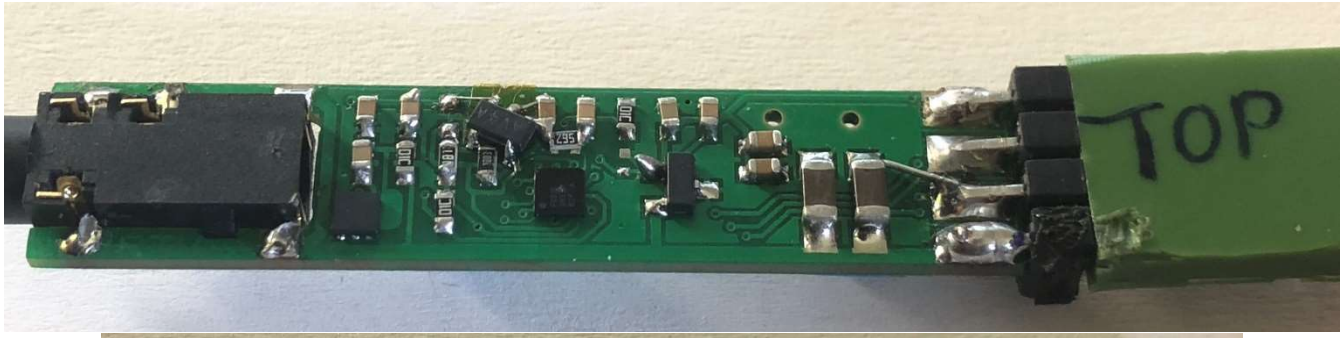
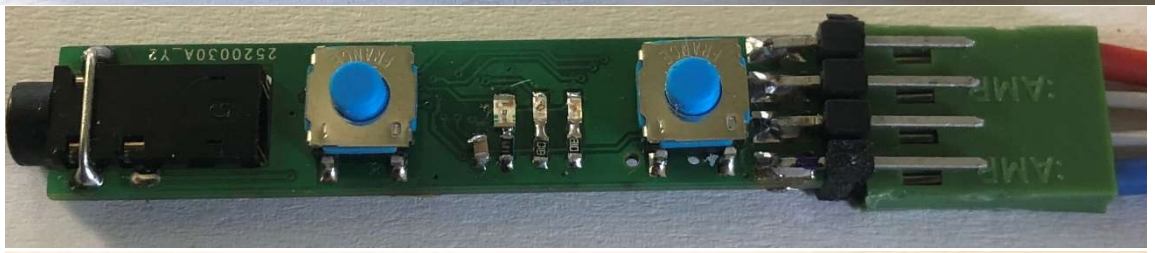
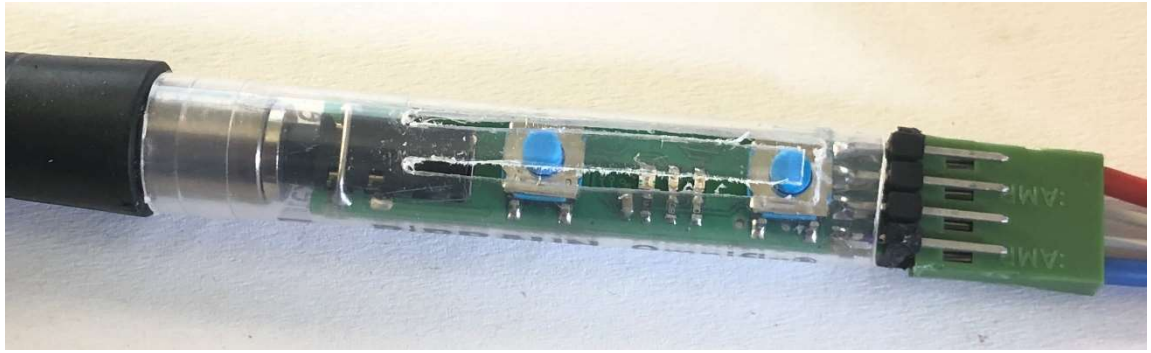








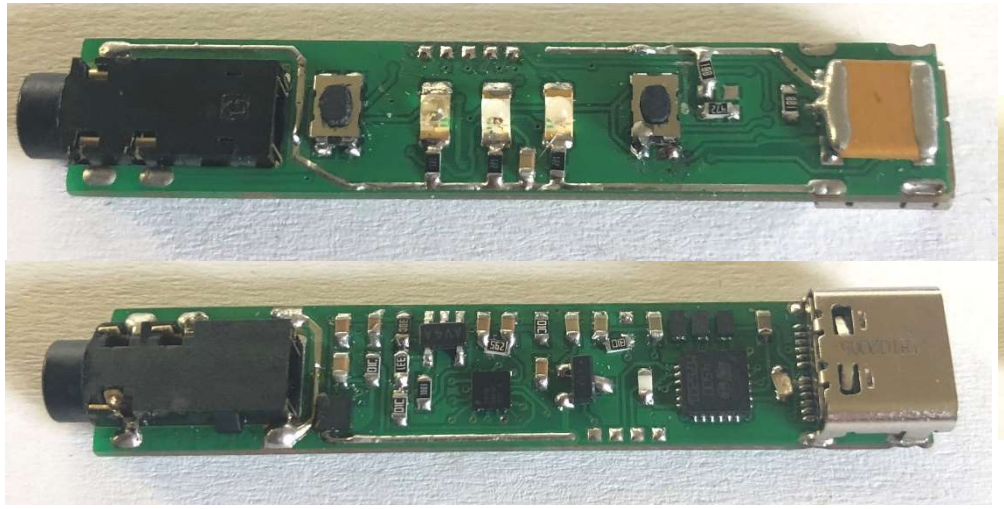
3. Prototype 3

Basic requirements at this stage were:

- Lowering the switches and align with the LED's for optimal insertion into the housing
- Designing the USB-Controller into the main PCB.
- Adding a bigger puffer Capacitor which also is used to avoid spinning the PCB in the housing
- Screwless assembly (because it saves space)
- Removing solder resist on high current tracks to reduce power loss
- Changing the OPA to a SOT23 due to make it easier for hand soldering

The USB-C controller has to be programmed with an GUI provided from ST over an STM32F072RB NUCLEO. It takes me a lot of time to handle the different early versions from ST right. The first housing was designed in SketchUp, next Versions are drawn in Fusion 360. As you can see the OPA on the photos of the first prototype is already replaced due to the really hard soldering process. Finally, this version already worked well. By an inspection with a thermal imaging camera, I noticed that the very small dual-fet gets quite hot by heating from 25°C to 420°C. So I decided to use a bigger one for better thermal removal.

Here are some photos of this Prototype and two versions of housings:



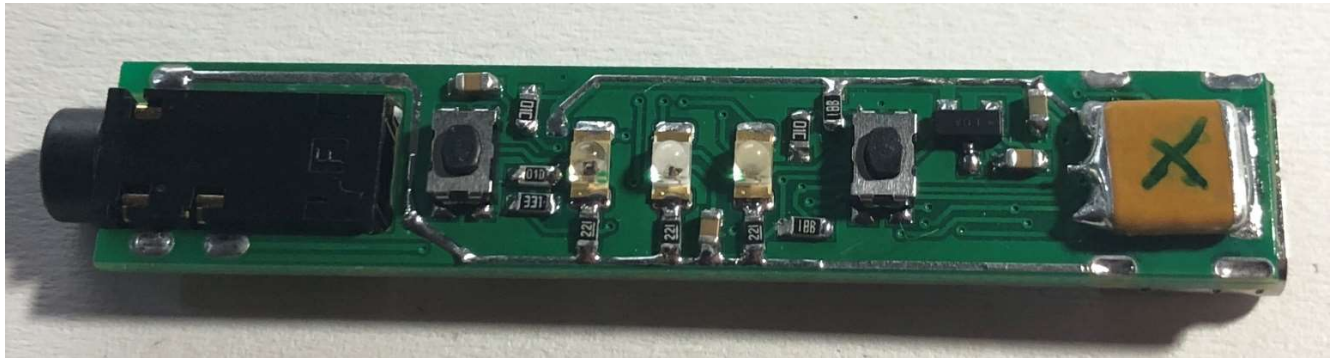
4. Prototype 4

Tasks and requirements at this stage were:

- Changing the dual-fet and also the controller to a bigger housing for better hand soldering
- Implementation of the FFC connector to easy program both chips and read out over USB or UART
- Change OPA to a more accurate one
- Adding something for motion detection
- Some adjustments in the USB-C-PD circuit
- Software improvements and finishing the full implementation of UI concept
- Making an adapter PCB to the FFC connector

Making the new PCB was quite easy because everything was already placed good. I found the -quite expensive- vibration sensors which are likely to be used in an original Weller. The Sensor has a little conductive lose ball in it which connects and disconnects both pins by any movement. The software permanent reads and counts the sensing input. If there ist no movement, the pin voltage does not change and Standby or Auto-off appears after some time. The programming unit can program the STM32 of the soldering pen with onboard ST-Link, the STM32F072RB (recommended for programming the USB-C controller) handle's the communication the PC to USB-C controller.

Here are some photos of this Prototype, a variation of a few housings and the programming unit:



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