**Designing a soldering station**

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# Introduction

The goal of this project was to build a soldering station. This project starts by following the guide created by elector. This guide gives an example of a soldering station. The reason for choosing this device is that due to following the guide from elector, there already was a full electric schematic available. The soldering station is used to power a soldering iron, it can also read and set temperature, and display the temperature on a display.

This application note will focus on the creation of PCB and the case. More specific it will focus on the design of the PCB, the design and creation of the case and the methods and materials used.

# Material and methods

Altium designer was used or the design of the PCB. This was used because it is a professional tool used by many big companies. Throughout the PCB design a lot of SMD components were used because these are smaller, easier to attach and these are more supported than through hole components. Still a few components are through hole because this is stronger for bigger components or components that have a force applied to them.

Fusion 360 was used for the design of the case because this is a free alternative to the more expensive Autodesk Inventor. Then a model was made using the dimensions of the PCBs and other components. This was then 3D printed using PLA on an FDM printer (CR-10 MAX). 3d Printing was used instead of other methods because it is easier to make any shape, it is very cheap and it was (readily) available during the creation of the project.

The design process starts with clearly defining the requirements of the project. After that the right tools are chosen based on the requirements. Next a loop of adding, improving and changing is used until the end product is achieved. The end is determined by looking if the product meets all the requirements. It is also possible that the requirements change during the creation process but this does not change the flow.

When the design process is done, the production process can begin. In this case it is after designing the PCB and the case. The production process follows a similar flow as the design process but the loop is normally much shorter. This is because every loop requires something to be made and this can become very expensive. Ideally the product is only made once, but this is very difficult, especially when working with 3D printing where the usual workflow is a lot of trial and error. Testing is also done during the production process for 3D printing. But not for the PCB, the PCB has to be correct on the first try due to long delivery times, so there is no room for error.

The bill of materials, as seen below, contains every component used in the creation of the soldering station. The total price of the construction is around 150 euro (not including shipping). This price can be reduced a lot by buying in bulk and having a working 3D printed case. Most components were ordered on LCSC and Mouser because these have a lot of different components at very low costs when compared to other supplier like Gotron and Kiwi electronics.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Item | Amount | Price per 1 | Total price | Supplier | Delivery date |
| Resistors |  |  |  |  |  |
| 18 Kohm | 3 | € 0,00 | € 0,00 | LCSC | 05/04/2023 |
| 1 Mohm | 1 | € 0,00 | € 0,00 | LCSC | 05/04/2023 |
| 68 Kohm | 1 | € 0,00 | € 0,00 | LCSC | 05/04/2023 |
| 5,6 Kohm | 4 | € 0,00 | € 0,00 | LCSC | 05/04/2023 |
| 10 Kohm | 6 | € 0,00 | € 0,01 | LCSC | 05/04/2023 |
| 100 ohm | 3 | € 0,00 | € 0,01 | LCSC | 05/04/2023 |
| 10 Mohm | 1 | € 0,00 | € 0,00 | LCSC | 05/04/2023 |
| 4,7 Kohm | 6 | € 0,00 | € 0,01 | LCSC | 05/04/2023 |
| Inductor |  |  |  |  |  |
| Choke 10 uH | 1 | € 0,15 | € 0,15 | LCSC | 05/04/2023 |
| Common mode choke | 1 | € 2,40 | € 2,40 | LCSC | 05/04/2023 |
| Capacitor |  |  |  |  |  |
| 4700 uF | 1 | € 0,96 | € 0,96 | LCSC | 05/04/2023 |
| 10 uF | 3 | € 0,02 | € 0,06 | LCSC | 05/04/2023 |
| 100 nF | 6 |  | € - | LCSC | 05/04/2023 |
| 100 uF | 2 | € 0,17 | € 0,34 | LCSC | 05/04/2023 |
| 10 nF | 7 | € 0,00 | € 0,02 | LCSC | 05/04/2023 |
| Semiconductors |  |  |  |  |  |
| 1n4007 | 1 | € 0,01 | € 0,01 | LCSC | 05/04/2023 |
| Zener diode | 1 | € 0,01 | € 0,01 | LCSC | 05/04/2023 |
| 1n14148 | 1 | € 0,01 | € 0,01 | LCSC | 05/04/2023 |
| Bridge rectifier | 2 | € 0,29 | € 0,58 | LCSC | 05/04/2023 |
| BC847C | 3 | € 0,01 | € 0,04 | LCSC | 05/04/2023 |
| MOSFET-P | 1 | € 0,33 | € 0,33 | LCSC | 05/04/2023 |
| BC857C | 1 | € 0,02 | € 0,02 | LCSC | 05/04/2023 |
| DC/DC | 1 | € 7,05 | € 7,05 | Mouser | 05/04/2023 |
| MCP6002-E/MS | 1 | € 0,44 | € 0,44 | Mouser | 05/04/2023 |
| Microcontroller | 1 | € 1,82 | € 1,82 | Mouser | 05/04/2023 |
| relay | 1 | € 5,38 | € 5,38 | Mouser | 05/04/2023 |
| IC2 7seg | 1 | € 0,17 | € 0,17 | LCSC | 05/04/2023 |
| encoder | 1 | € 1,66 | € 1,66 | LCSC | 05/04/2023 |
| 7 segment display | 1 | € 2,26 | € 2,26 | LCSC | 06/04/2023 |
| Connectors |  |  |  |  |  |
| Terminal block 2 way | 4 | € 0,40 | € 1,60 | Gotron | 25/03/2023 |
| 40 pin header | 1 | € 1,00 | € 1,00 | Kiwi electronics | 04/04/2023 |
| 10 way box header | 2 | € 0,75 | € 1,50 | Gotron | 25/03/2023 |
| Miscellaneous |  |  |  |  |  |
| transformer | 1 | € 49,03 | € 49,03 | Farnell |  |
| fuse 630 mA | 5 | € 0,21 | € 1,05 | Conrad | 05/04/2023 |
| fuse 1,25 A | 5 | € 0,18 | € 0,90 | Conrad | 05/04/2023 |
| IEC connector 42R | 1 | € 9,99 | € 9,99 | Conrad | 05/04/2023 |
| 10 way idc receptable | 2 | € 0,56 | € 1,12 | Gotron | 25/03/2023 |
| 10 way flat cable | 1 | € 1,16 | € 1,16 | Gotron | 25/03/2023 |
| fuse holder | 2 | € 1,49 | € 2,98 | Conrad | 05/04/2023 |
| Other |  |  |  |  |  |
| Alligator clips | 1 | € 5,00 | € 5,00 | Gotron | 25/03/2023 |
| Soldering iron | 1 | € 30,00 | € 30,00 | Gotron | 25/03/2023 |
| Screws | 1 | € 4,00 | € 4,00 | Gotron | 25/03/2023 |
| PLA | 0,3 | € 25,00 | € 7,50 | 123-3D | 12/10/2022 |
| PCB | 1 | € 15,00 | € 15,00 | PCBway | 22/05/2023 |

# Results

## PCB

### Electrical schematic

The electrical schematic is based on the design of elector. The current design is slightly modified version because some part needed to be different. The design of elector uses only through hole components but this design uses a lot of SMD components. The reason for this is because they are smaller and they are more used.

### PCB design

The PCB design consists of 2 parts, first the PCB with the microcontroller and the other logic, and second the PCB with the controls and the display. The first PCB consists of 4 parts: power supply, microcontroller, thermocouple and PWM module.

A picture containing text, diagram, plan, parallel

Description automatically generated

Figure 1: Power supply

The power supply converts the incoming voltage of 12V AC to 5V DC. The incoming voltage is provided by a 230VAC to 12VAC transformer that is connected to the net.

A picture containing text, diagram, plan, schematic

Description automatically generated

Figure 2: Microcontroller

The microcontroller takes charge of all essential operations, including tasks like deciding what information to display and constantly monitoring the temperature of the soldering iron, among other important functions.

A picture containing text, diagram, plan, map

Description automatically generated

Figure 3: Thermocouple

The measurement of the soldering iron’s temperature is facilitated by utilizing a thermocouple, which serves as a dedicated sensor for this purpose.

A diagram of a circuit

Description automatically generated with low confidence

Figure 4: PWM module

The PWM module is used to control the temperature of the soldering iron.

A picture containing text, diagram, plan, schematic

Description automatically generated

Figure 5: Display

The display PCB has a 4-digit 7 segment display that displays the temperature. It also has a potentiometer to control the temperature.

A computer screen shot of a circuit board

Description automatically generated with medium confidence

Figure 6: Main PCB design

The Main PCB design measures 136mm by 63mm, offering ample room for potential optimization. However, a decision was made to maintain its current size in order to strike a balance between complexity and functionality. With its two-layer configuration, the design successfully fulfils the intended requirements.

A picture containing text, screenshot, diagram, circuit

Description automatically generated

Figure 7: Display PCB design

### Features

The soldering station has a rotary knob to regulate the temperature and a display to show the temperature. It works on net voltage and is capable of powering a 15W soldering iron. It also has the possibility of hooking a backup battery to it. This battery could be for shutting everything down safely in case of a power outage. This could also power other safety features, but they are not implemented yet.

## Case

### Design

The case design is made to look like a futuristic but industrial machine. The case is made up of aluminium pipes for strength, transparent plexiglass to make the PCB visible but still protect it and PLA which is 3D printed to connect everything. The reason it is a in the shape of a tetrahedron is because this is a very stable shape; the chance of this falling over is very low. Aluminium pipes are used as an outer shell to make it stronger and protect it in case it would fall.

A picture containing triangle, design

Description automatically generated

Figure 8: 3D render of case design

# Discussion

The design of the PCB was without problems as it is a copy of the design from elector, but creating the PCB (soldering the components on the PCB) went less smooth. During the soldering process, a few errors were encountered, resulting is complications such as short circuits and inadequate connections. As a consequence, it took considerably longer than anticipated. In the future it would be faster, cheaper and better to order the PCB with the components already soldered to it.

The design of the case was not without problems. Since it is mostly 3d printed it has the problems of not always being 100% accurate so it took a few iterations to get a working design that fit the pcb. The aluminium pipes ordered also had some problems, the pipes were ordered with dimensions 20mm outer diameter, 18mm inner diameter and 250mm in length but the pipes received were 20mm, 16mm and 252 mm. This resulted in the 3d printed frame having a 2mm gap at the connections. This problem was fixed by printing small connectors to fill the gaps.

If I were to make this again, I would change a lot of things in the process. First, I would study the electrical schematic better so I would know exactly how everything works. This would also give me the opportunity to change things. Secondly, like mentioned earlier, I would I order the PCB with the components already on it. I would also design the PCB with the case in mind, so I don’t have to struggle to make a case that fits the PCB. Thirdly I would start with the case design earlier, so I have more time to make small adjustments and more iterations. And finally, if I had to do the project again, I would choose a different thing to make so I can exactly control the difficulty, size and price.