ELEKTRONICA-ICT

Project Ontwerpen

Designing a soldering station

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Content

1 Introduction

This assignment aims to learn how to design a product with a focus on the PCB design and the overall end product. To work with a wider range of components and improve the learning curve, I decided to design a soldering station that I can use in future projects. I started with an electric schematic published by Elektor [1], a specialized magazine in electronics. The variety of components in this device makes it a perfect item in the scope of this task and objective.

The prototype has the additional feature of a solder fumes exhaust through a movable fan and integrated LED illumination for better sight of the workpiece while soldering.

This application note will discuss the difficulties I have encountered in the development and execution of this project and the characteristics of the final prototype.

2 Material and methods

The power source for the soldering station is a toroidal transformer with an input of 230V with 60VA and an output of 2 x 12V with 2,5A of current. The exhaust fan with LEDs will be powered by a separate power supply from an old device that delivers 12V and 1,5A.

The output power of the transformer will be processed in the first section of the main PCB by two D6KB6U bridge rectifiers and a RECOM R-78 series DC/DC converter. This results in a 5V circuit for the electronics and a 12V or 24V circuit for the soldering iron, depending on the selected iron. A Schrack/TE connectivity relay will manage this switching.

In the amplifying section, the Op-Amps amplify the voltage on the temperature sensor, respectively 361x for C-type soldering irons (Hako) and 181x for K-type soldering irons (Weller and JBC). The regulator is built with two BC547, one BC557 transistor, and an IRF9Z34NPBF MOSFET. This setup results in a flexible and solid iron control.

All the settings and configurations are handled by the Atmega4809 IC. This chip is programmed in C++ through an Arduino IDE and the UPDI [2].

The display PCB is built with four separate seven-segment digits and an encoder to operate the system.

For extra comfort, while soldering a workpiece, the station is equipped with additional light. Therefore I chose 6 SMD Power LEDs that consume 180mA per LED and deliver a total of 300 Lumen, directly on the workpiece. These lights are mounted on de external fan that exhausts the solder fumes. The LEDs and fan are powered by a secondary power supply of 12V and 2A.

All the PCBs are designed in Altium and produced by JLCPCB. They are double-layered and, although Elektor prescribes only true hole components that are easier to handle, but would make de design bigger, I used a combination of true hole and SMD components to keep everything as compact as possible. This way the end product is more compliant with the current SDGs and has a neater aesthetic design. The THT components are soldered by hand after baking the SMD components in a reflow oven.

For the enclosure, I used 1,5mm thick aluminium that is cut by a waterjet en bend with a bending machine.

COMPONENT		#Qty	PRICE	COST	TOTAL	SUPPLIER
ITEM	TYPE					
7 segment-digit	WL-T7DS	4	€ 0,89	€ 0,00	€ 0,00	Wurth
Bridge rectifier	KBJ608G	2	€ 1,66	€ 1,66	€ 3,32	Mouser
Ceramic capacitor	C0805C103K1HACAUTO	3	€ 2,98	€ 2,98	€ 8,94	Mouser
Ceramic capacitor	C0805C104K8RACAUTO	6	€ 0,44	€ 0,44	€ 2,64	Mouser
Ceramic capacitor	WCAP-CSGP 0,01µF	4	€ 0,09	€ 0,00	€ 0,00	Wurth
Choke	CM2545X171B-10	1	€ 1,52	€ 1,52	€ 1,52	Mouser
Choke	WE-SD 10 µH	1	€ 1,67	€ 0,00	€ 0,00	Wurth
Connector	AC voeding KS202	1	€ 0,69	€ 0,69	€ 0,69	TME
Connector	Term. Blok 2p 1729128	4	€ 1,10	€ 1,10	€ 4,40	Mouser
Connector	WR-PHD 2 pin	1	€ 0,32	€ 0,00	€ 0,00	Wurth
Connector	WR-PHD 4 pin	1	€ 0,90	€ 0,00	€ 0,00	Wurth
Connector	WR-PHD 5 pin	1	€ 1,10		€ 0,00	Wurth
Connector	WR-PHD dual 10 pin	1	€ 0,98	€ 0,00	€ 0,00	Wurth
Connector	WR-PHD dual 6 pin	1	€ 0,51	€ 0,00	€ 0,00	Wurth
Connector	WR-TBL 3 pin	3	€ 1,07	€ 0,00	€ 0,00	Wurth
Diode	1N4007-B	1	€ 0,23	€ 0,23	€ 0,23	Mouser
Diode	1N4148	1	€ 0,09	€ 0,09	€ 0,09	Mouser
Electrolytic capacitor	WCAP-AT1H 10µF	3	€ 0,15	€ 0,00	€ 0,00	Wurth
Electrolytic capacitor	WCAP-AT1H 100µF	2	€ 3,69	€ 0,00	€ 0,00	Wurth
Electrolytic capacitor	WCAP-ATG8 4700µF	1	€ 5,71	€ 0,00	€ 0,00	Wurth
Encoder	WS-ENTV 15 pulse 360	1	€ 3,93	€ 0,00	€ 0,00	Wurth
Fuse holder	WR-FSH	1	€ 2,17	€ 0,00	€ 0,00	Wurth
Enclosure	Aluminium + quartz (18€)	5	€ 2,79	€ 2,79	€ 31,95	PXL MS
Integrated circuit	ATMEGA4809-PF	1	€ 2,67	€ 2,67	€ 2,67	TME
Integrated circuit	R-78B3.3-1.0L	1	€ 9,68	€ 9,68	€ 9,68	Mouser
Integrated circuit	TM1637	1	€ 0,23	€ 0,23	€ 0,23	AliExpress
Light-emitting diode	WL-SWTP SMD LEDS	6	€ 0,46	€ 0,00	€ 0,00	Wurth
Operational amplifier	MCP6002-I/P	1	€ 0,41	€ 0,41	€ 0,41	Mouser
PCB	Display PCB + stencil	1	€ 11,00	€ 11,00	€ 11,00	JLCPCB
PCB	LED PCB	1	€ 2,00	€ 2,00	€ 2,00	JLCPCB
PCB	Main PCB + stencil	1	€ 11,00	€ 11,00	€ 11,00	JLCPCB
Relay	RT424005	1	€ 4,03	€ 4,03	€ 4,03	Mouser
Resistor	10 Ohm THT	2	€ 0,02	€ 0,02	€ 0,04	AliExpress
Resistor	100 Ohm 0508	3	€ 0,13	€ 0,13	€ 0,39	Mouser
Resistor	10k Ohm SMD 0805	6	€ 0,09	€ 0,09	€ 0,53	Mouser
Resistor	10M Ohm 1206	1	€ 0,17	€ 0,17	€ 0,17	Mouser
Resistor	18k Ohm SMD 0805	3	€ 0,09	€ 0,09	€ 0,26	Mouser
Resistor	1M Ohm SMD 1206	1	€ 0,81	€ 0,81	€ 0,81	Mouser
Resistor	4,7k Ohm 0805	6	€ 0,09	€ 0,09	€ 0,53	Mouser
Resistor	5,6k Ohm SMD 0805	4	€ 0,11	€ 0,11	€ 0,46	Mouser
Resistor	68k Ohm SMD 0805	1	€ 0,32	€ 0,32	€ 0,32	Mouser
Screw	M3 PCB	10	€ 0,05	€ 0,05	€ 0,50	AliExpress
Screw	M3 x 30mm inbus	1	€ 0,13	€ 0,13	€ 0,13	Conrad
Switch	WS-RSTV	2	€ 4,26	€ 0,00	€ 0,00	Wurth
Tool	Copper wire	1	€ 4,68	€ 4,68	€ 4,68	AliExpress
Tool	Soldering iron	1	€ 20,47	€ 20,47	€20,47	AliExpress
Tool	Sponge	1	€ 0,28	€ 0,28	€ 0,28	AliExpress
Transformer	TST60W 2x12V	1	€ 18,40	€ 18,40	€ 18,40	TME
Transistor	BC547CTFR NPN	3	€ 0,32	€ 0,32	€ 0,95	Mouser
Transistor	BC557ATA PNP	1	€ 0,35	€ 0,35	€ 0,35	Mouser
Transistor	MOSFET IRF9Z34NPBF	1	€ 0,88	€ 0,88	€ 0,88	Mouser
Zener diode	1N5231B	1	€ 2,28	€ 2,28	€ 2,28	Mouser
TOTAL COST					**€ 157,22**	

3 Results

3.1 Electronics

3.1.1 Main PCB

In the PCB design, I forgot one connection from the incoming power terminal block to a rectifier. To solve this problem, an external cable was soldered underneath the PCB. I didn't implement polygons on my PCB because I ordered my PCB before the lesson about polygons was given, luckily this application isn't that sensitive to EMI interference. The only drawback for this application is the sustainability due to the loss of copper and the print will be less heat conductive.

All the components work like they should despite my ICs being soldered directly on the print without sockets.

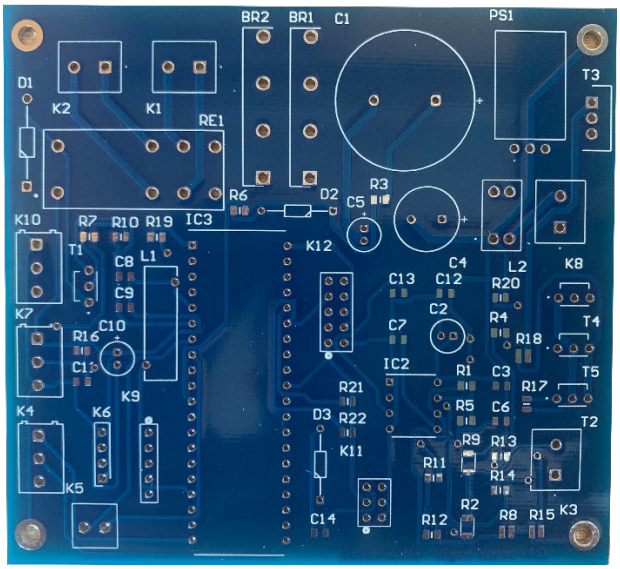

Figure 1: main PCB

3.1.2 Display and LED PCB

On the LED PCB the footprint of the LEDs got reversed when the footprint was manipulated. By ignoring the silk text and mounting the LEDs in the correct position, this issue was solved.

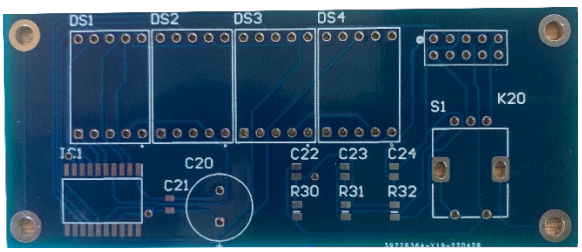

Figure 2: display PCB

3.1.3 Power unit

The power for this design comes from the toroïdal transformer and a recovered 12V power adaptor. For the transformer, I had to have special attention to not cross the phases and burn the system.

3.2 Hardware

3.2.1 Solder iron

The soldering iron is a JBC T245 replica, made in China. It fits, looks and works like the original for a quarter of the price. Though the solder tips are more fragile and tend to oxide faster when in use.

3.2.2 Enclosure

The aluminium enclosure is compact and has a holder for the soldering iron and -sponge. System setup is done with a single rotary encoder that is placed next to the display.

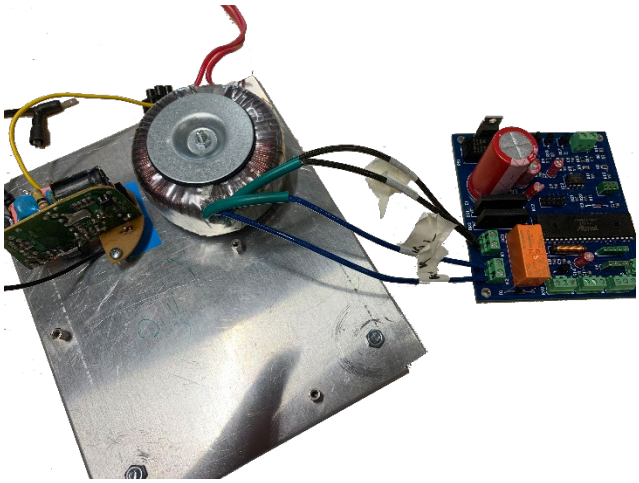

Figure 3: Inside; transformer, 12V unit and main PCB

Figure 4: external exhaust fan

Figure 6: front view

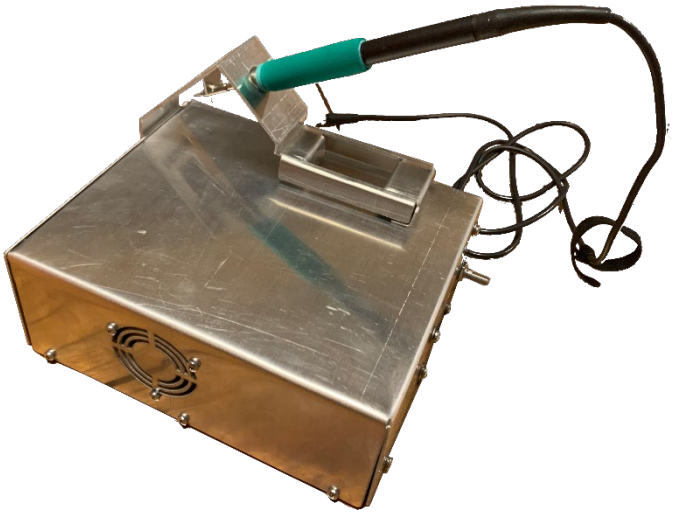

Figure 5: station with iron

4 Discussion

This project had some difficulties, specifically in the endproces. Besides the connection that I forgot on the main PCB, there are some problems with the display print. I'm still troubleshooting the print at this moment. If the problem remains, I will replace the display print with one out of the shelf.

The point of attention for the enclosure is that the production quality of the machines in the Makerspace is not professional enough. There were problems with the waterjet that caused an ugly finish when cutting out the aluminium. Especially in the fine details, there is a lack of precision and there was a displacement of the aluminium sheet, caused by the machine itself.

The problems in the early phase were mainly the shortage in the electronic component market. But this was a known problem that had already been going on since the COVID pandemic. So I was prepared to cover this by starting in an early stage gathering everything I needed for this project.

If I would do this project again, I would take more time and consideration on the process. Do some extra controls before producing parts, like the PCB and the enclosure.

The speed control of the external fan is not implemented at this time, therefore I'm manipulating the C++ code and this will be implemented as soon as the system works in the standard setup.

I like to acknowledge *Wurth Elektronics Belgium [4]* for the sponsorship of components. They provided me with a considerable amount of the needed parts and granted a great service when I had questions or remarks.

Also special thanks to the lectors who supported my project(s), even outside the official hours whenever I had questions about my hardware and/or code. Thanks to Patrick Hilven, Frederik Vreys, Ward Martens, Koen Gilissen and Dieter Vanrykel.

5 Reference list

[1] L. Lemmens, M. Claussen. " Soldeerstation 2021: makkelijk om te bouwen!," Elektor magazine, vol. mei/juni, pp 30-36, 2021.

[2] kakushinAU. "Atmega4808", Github.com/kakushinAU, 9 juni 2021. https://github.com/kakushinAU/Atmega4808 [geraadpleegd op 30 april 2022].

[3] onbekend, "Altium", cursus PXL, PXL-digital, PXL Hogeschool, Hasselt, 2022.

[4] Wurth Elektronics. multiple datasheets, https://www.we-online.com/catalog/en [geraadpleegd tussen februari en mei 2022]