LEDITRON

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Content

1. Introduction

For this project I build 'leditron'. This is a clock with 4 separate 7segment displays.
The clock is build using led filaments from modern light bulbs. I chose for a warm white color to get a more characterful appearance in the project. I build this project because I think it would be a good addition to my room setup. Also it would have the possibility to be transformed into an alarm clock.
In this Application note I will be talking about the designing process, sourcing of the components and building the physical aspects of this project.

2. Material and methods

The Leditron uses a 12V 2A power supply that's connected to the boosterboard. The boosterboard contains a variety of components for getting the voltage up to about 80 volts. This is depending on the desired brightness. On the pcb that contains the boosterboard, there's also a timer chip which controls what leds light up at a specific moment. This chip derives the 80 volts to the desired filament.
Because I have multiple LED segment displays, there is also a splitter board. The splitter board does exactly what the name implies, it splits te signals into 2 separates for controlling 2 displays at a time.

To take control of the time im going to use a Arduino nano connected to a real time clock module. This module has an onboard battery so it keeps the clock ticking even when the power is disconnected.

The enclosure will be entirely 3D printed. Initially my idea was to print the base with an FDM printer and the segment displays using a resin printer. Unfortunately I was having a lot of issues with all of my printers. But was able to get one to work properly. This way could use an FDM printer for fabricating all the parts.

For material I used PLA+, this is pretty tough material which is easy to print. Using this material I can keep printing costs pretty low. The enclosure was printed in 0.25mm layer height for a faster print. The total of the base fitted in 2parts, both where 10h prints.

The led segment displays eventually will be printed with the same PLA+, at the same layer height to keep printing time at a minimum. They will be about 2h prints.

The Estimated total printing time would be 28hours.

Bill of material:

Component	Amount	Price/piece	Supplier
Power Inductor (SMD), 47 µH, 600 mA	2	4,74	Farnell
SMD Chip Resistor, 390 kohm, ± 5%, 500 mW, 1206	10	0,04	Farnell
Bipolar (BJT) Single Transistor, NPN, 300 V, 500 mA, 625 mW, TO-92	10	0,16	Farnell
Bipolar (BJT) Single Transistor, PNP, 300 V, 500 mA, 625 mW, TO-92,	5	0,20	Farnell
Trimpot, Single Turn, Cermet, Top Adjust, 5 kohm,	2	0,98	Farnell
Fast / Ultrafast Diode, 600 V, 1.35 A, Single, 1.35 V,	5	0,14	Farnell
Bipolar (BJT) Single Transistor, PNP, 80 V, 1 A, 800 mW, TO-92,	5	0,26	Farnell

Component	Amount	Price/piece	Supplier
Timer, Oscillator & Pulse Generator IC ,CMOS RC Timer, 1 MHz	3	0,77	Farnell
SMD Chip Resistor, 2.2 kohm, ± 1%, 500 mW,	10	0,07	Farnell
SMD Chip Resistor, 3.3 kohm, ± 5%, 500 mW,	10	0,05	Farnell
SMD Chip Resistor, 4.64 kohm, ± 1%, 660 mW, 1206	20	0,11	Farnell
SMD Chip Resistor, 220 ohm, ± 1%, 500 mW, 1206	10	0,04	Farnell
Fuse, Surface Mount, 2 A, Fast Acting, 32 VDC,	5	0,37	Farnell
MD Chip Resistor, 10 ohm, ± 1%, 500 mW, 1206	10	0,10	Farnell
MD Chip Resistor, 10 ohm, ± 1%, 500 mW, 1206	10	0,04	Farnell
SMD Chip Resistor, 1 kohm, ± 1%, 500 mW, 1206	20	0,07	Farnell
Bipolar (BJT) Single Transistor, NPN, 45 V, 100 mA, 625 mW, TO-92	5	0,11	Farnell
SMD Multilayer Ceramic Capacitor, 300 pF, 50 V, 1206	10	0,24	Farnell
Power MOSFET, N Channel, 500 V, 20 A, 0.23 ohm, TO-220	2	2,89	Farnell
SMD Multilayer Ceramic Capacitor, 4.7 µF, 100 V, 1210	2	1,53	Farnell
SMD Chip Resistor, 100 kohm, ± 5%, 250 mW, 1206	40	0,01	Farnell
PCB Booster+splitter	5	23,50 (total)	JLPCB

3. Results

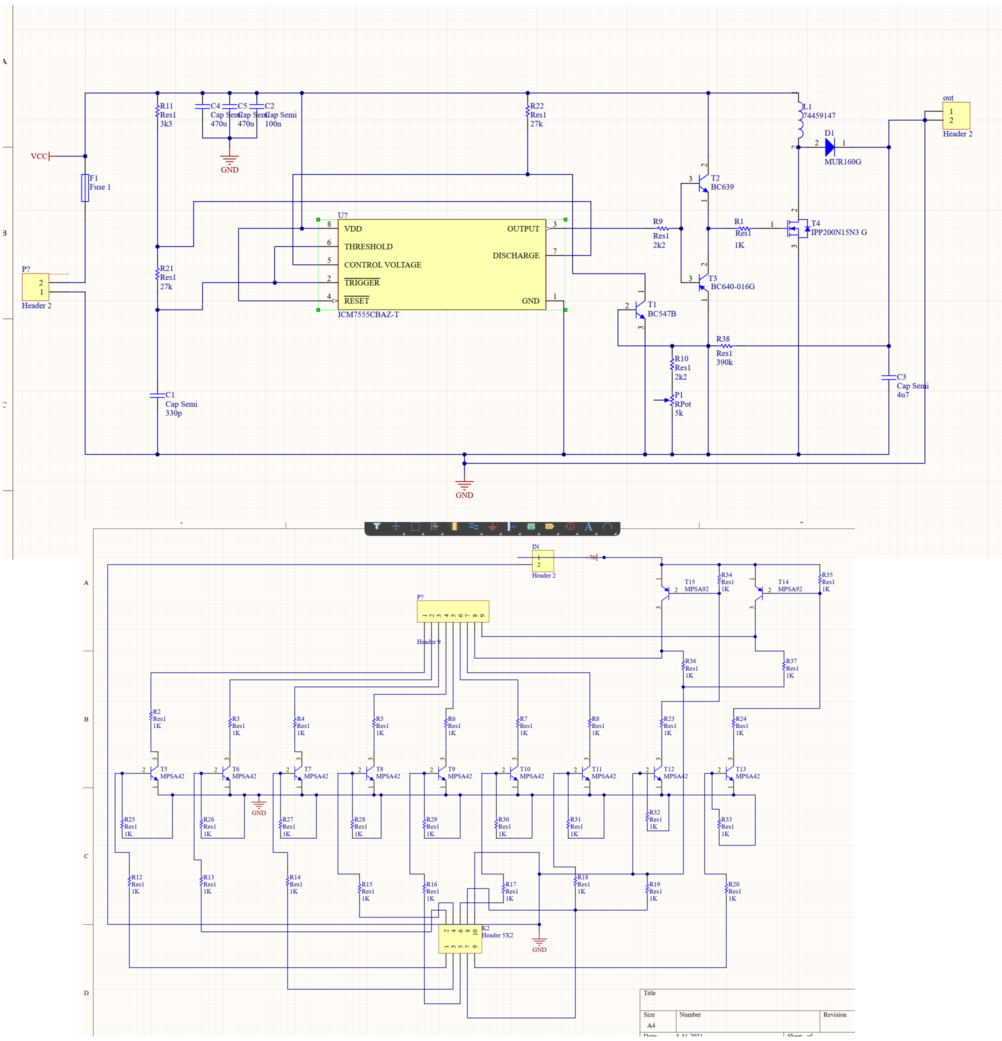
Each filament in the system will consume about 0.5watts at 80 volts. This means at full brightness, with all leds powered up, 88:88, these will take up 14watts of power. This state will obviously never occur.

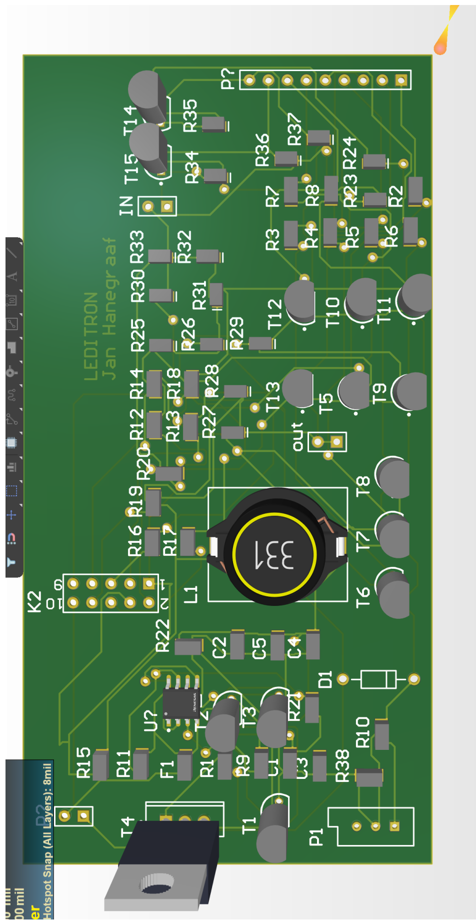
For design I've taken inspiration from digital alarm clocks, but with a different look. The design is pretty big, but this comes in real handy for use on a shelf. The big appearance helps with the readability of the numbers.

3.1. Parts

3.1.1. Boosterboard

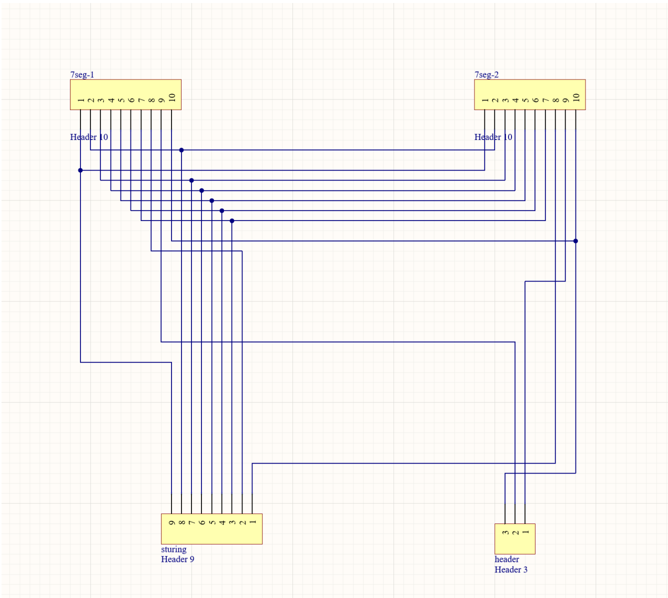
The leditron has a total of 4 independent functions. First off the 12 volts from the power supply will be converted to 80 volts on the boosterboard. This 80 volts will be used to drive the led fillaments that form the clock. The second part of the project is the driving part, which is created on the same board as the boosterboard. This takes care of delivering the 80v to the correct filament at the requested time.

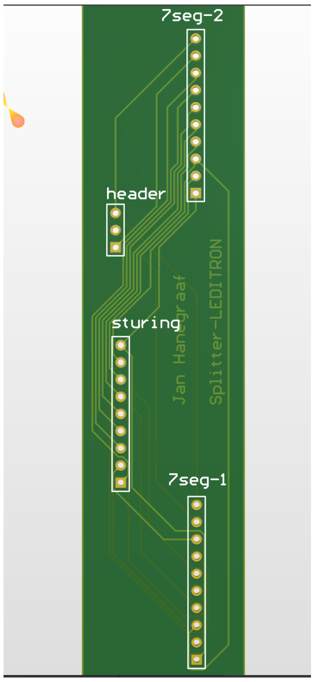




3.1.2.Splitter-board

For the third part there is a splitter board. This is used for multiple segments to be controlled from 1 board. This splits the output into multiple lines, which will be controlled by the Arduino.





3.2. Arduino

The Arduino is the last part of this project. This will take care of the time calculations and functions. The Arduino gets the time from the RTC module that contains a CR2032 battery so it won't lose it's settings. To get the clock starting all you need to do Is plug it in, flip the switch and you're off. The Arduino will get its power directly from the 12V supply so it won't need any extra external cables.

3.2.1.RTC module

The RTC module Is powered by the 3.3v rail on the Arduino and takes about 50uA. This board is able to send the time and date using serial communication. The baudrate will be set at 9600, with a refresh delay of 1second. This takes away a significant amount of stress from the controller, which will result in a better power consumption and more stable system.

4. Discussion

During the design process I experienced a few issues about how I could place the components on the pcb to keep it as compact as possible but able to solder everything with ease. To fix this issues I took my time to figure out how to get everything the way I wanted. And getting things nice and tidy.

While designing the casing I had the issue that the program took to much material off in the sides so it was unstable and very flimsy. This was solved by creating a almost duplicate shape which was just a few mm smaller. This object I place inside the main one en had them subtracted from each other. This resulted in a sturdy design.

The next issue that I encountered was a warped bed on my printer. That's why a few of my prints became warped as well. This was fixed later on by swapping out the parts for some new. But unfortunately I did not have enough time to get all the warped parts printed again.

My final issue lays by my supplier of parts. The mosfet I have to use for this application seemed to be in stock when ordered. After ordering i received an email stating it was delayed by a week. After a week I got

an email to tell me it was delayed until February 2022.
This was a big setback and had the complete project fail. For aesthetics I replaced the missing mosfet with one identical to the eye, not in function.

If I were to do this project again, I would change it up a bit. I would go for a different style of casing to make it a bit more compact. Also would integrate the different boards into one. Maybe solder on a header for the Arduino to tidy everything up.