Creating a Side-Illuminated Modular Display Device

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Abstract

This report details the technical process that was carried out to successfully design and create a side illuminated modular display device. The device was inspired by the current “Lixie Tube” design in which several acrylic sheets containing symbols are illuminated, creating colourful display. The design compromises of laser-cut materials, Printed Circuit Boards and microcontrollers. Results from the prototype model validated the success of the design and allowed the discussion of improvement areas, so that they could be implemented before the final product. The report concludes the project stating the overall successes and impacts of the design.

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List of Acronyms

PCB	Printed Circuit Board
LED	Light emitting diode

1 Introduction

1.1 Background

Side illuminating modular display devices utilize several Light emitting diodes (LEDs) to illuminate acrylic sheets, each etched with a specific design. These devices have been prevalent for decades with most referring to them as a modern-day alternative to the "Nixie Tube". Initially these designs were predominantly used to display stationary information such as a light up sign. However, it was found that if you stack these sheets in an array (Figure.1), it was possible to display a set of changing information. This was considered a perfect tool in the design of numeric displays. These were given the name "Lixie Tubes". [1][2]

1.2 Project Objectives

The primary objectives of this project are to successfully design and assemble a modular display device that generates a desired sequence. This process involves the designing and fabrication of a central Printed circuit board (PCB) that will control the LEDs, integrating both the PCB and laser-cut acrylic sheets to create the illuminating display and finally, to write and implement an Arduino programme that controls the LED sequence.

Figure.1: example Image of a Lixie display [2]

2 Design

The design takes on the primary concepts of a side illuminating modular display (Figure.1). It uses a mixture of red, white and blue LEDs, present on a PCB, to light up a set of acrylic sheets that are stacked up behind one another. Each sheet with have a certain symbol engraved, this will allow the creation of a changing 6 symbol sequence.

2.1 Hardware

The physical setup consists of 6 acrylic sheets, each with a different number or symbol etched on, a medium density fibreboard supportive structure that can house the acrylic sheets in a way that they align to respective LEDs, a custom PCB used to power 6 LEDs and finally, an Arduino used to control these 6 LEDs.

2.2 Software

Arduino IDE is used to control the lighting of LEDs using basic logic. This logic includes pin management and sequencing LED illumination.

3 Results

Initially the first PCB had incorrect placement two surface-mount resistors. This caused both red LEDs to light up at the same time while the blue and white LEDs did not light.

Once a new PCB had been fabricated, the prototype model successfully performed a sequence of acrylic illumination, creating a working numerical display. This means that the PCB design, Arduino Code, soldering and assembly were all successful.

Despite the devices successful test, some insights were gained. For example, when conducting the first test, it was evident that the placement of the LEDs on the PCB was critical in the maximisation of brightness. This meant that some of the acrylic sheets were brighter than others as the LED placement was quite arbitrary on the PCB. Another thing that was evident, was the fact that the thick acrylic sheets were diminishing the light levels.

4 Discussion

Overall, the design was successful as it displayed a working illuminated sequence. Aside from the PCB error at the start of the project, the hardware functioned as it should.

4.1 Hardware

If the hardware was to be made again, the LED placement on the PCB would be made more uniformly. This would allow for a more even distribution of light across the whole display. Also, thinner acrylic sheets would be used, this would allow for a brighter light.

4.2 Software

The Arduino code was successful as it produced no errors when compiled. If the code were to be made again, software-based brightness control would be implemented. This would compensate for the light smothering of the acrylic sheets.

5 Conclusion

In this project a side illuminated modular display device was successfully created. The design integrated the use of both hardware and software to create a working 6 symbol sequence. The project made use of skills in PCB design, PCB assembly, embedded systems design and material manufacturing. The final product was both technically successful and an aesthetically pleasing and desirable product. The design can be implemented in numerous different commercial systems.

6 References

[1] “History of display technology,” *Wikipedia*, Apr. 02, 2020. https://en.wikipedia.org/wiki/History_of_display_technology

[2] “‘Lixie’, an LED alternative to the Nixie Tube,” *Hackaday.io*, 2023. https://hackaday.io/project/18633-lixie-an-led-alternative-to-the-nixie-tube#j-discussions-title (accessed Apr. 25, 2025).