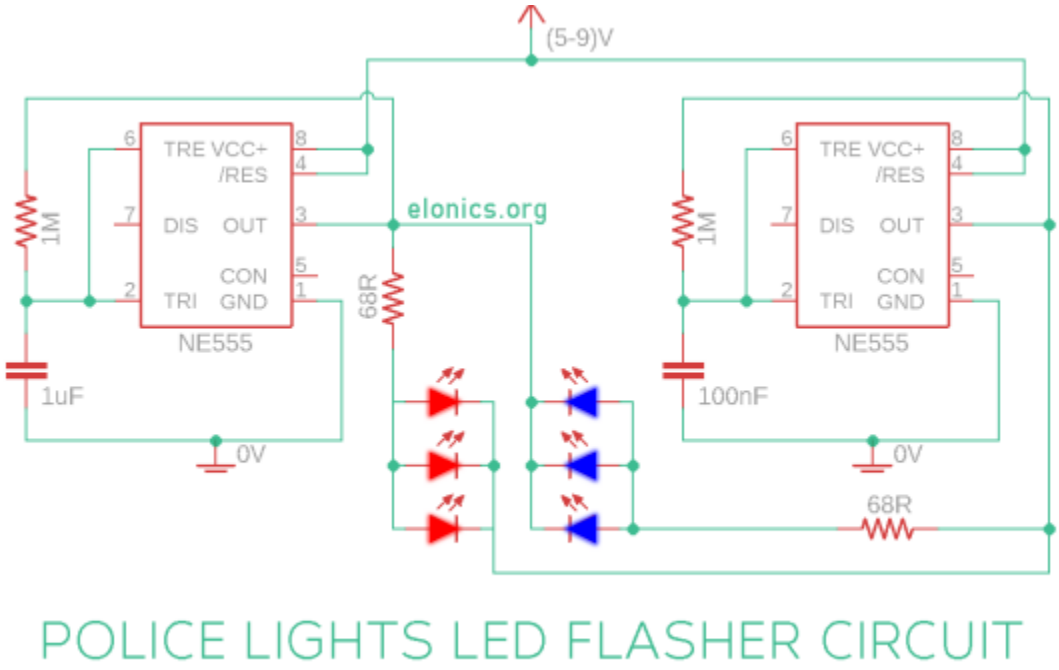
Design Project 1: 555 Timer Project Final Report

Design Overview:

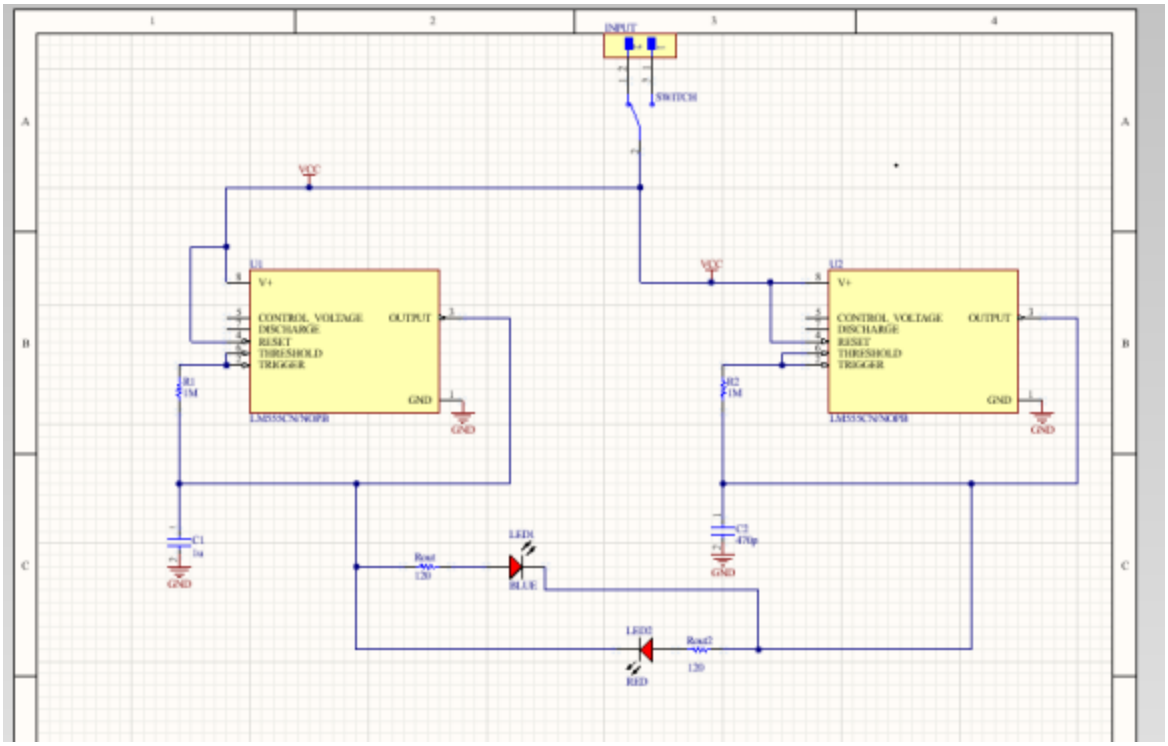
Police Flashing Lights LED Circuit with 555 Timer We all have seen a police car with their lights flashing, zooming through traffic, trying to warn of their presence, and to alert other road users that they are approaching at speed while attempting to stop crime or provide assistance to emergencies. Those flashing blue and red lights can be easily recreated using two NE555 Timer ICs, resistors, capacitors, power supply and a couple LEDs. The NE555 Timer ICs set in astable multivibrator mode can provide a free-running oscillation, in which the output can alternate from high to low in a particular frequency. All done without the need of an external trigger.

Police Flashing Lights LED Schematic

Below is the schematic of the original design that I referenced for this project. Some modifications were made and specified below in the modification section.



Modification: I added a switch in this circuit to control the power supply such that the circuit can be turned on and off conveniently without having to keep connecting the power supply repeatedly. I would also use a 9v battery as the power supply to produce a bright LED. I ended up using only two LEDs (one blue and one red) instead of three each. Below is my final schematic with the modifications implemented.

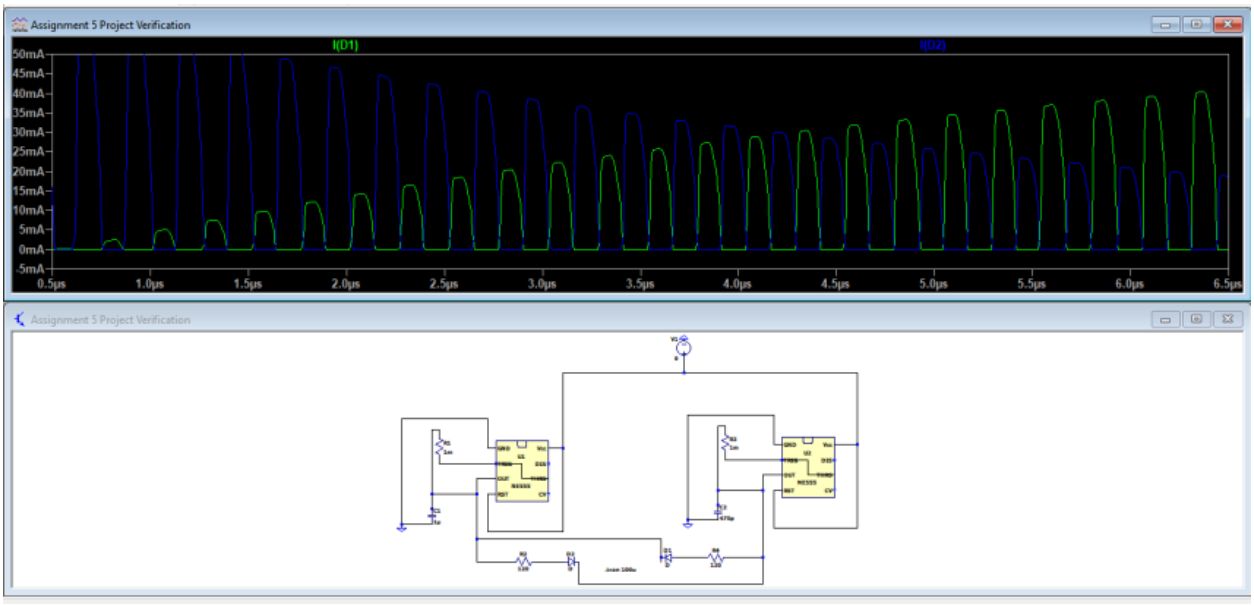


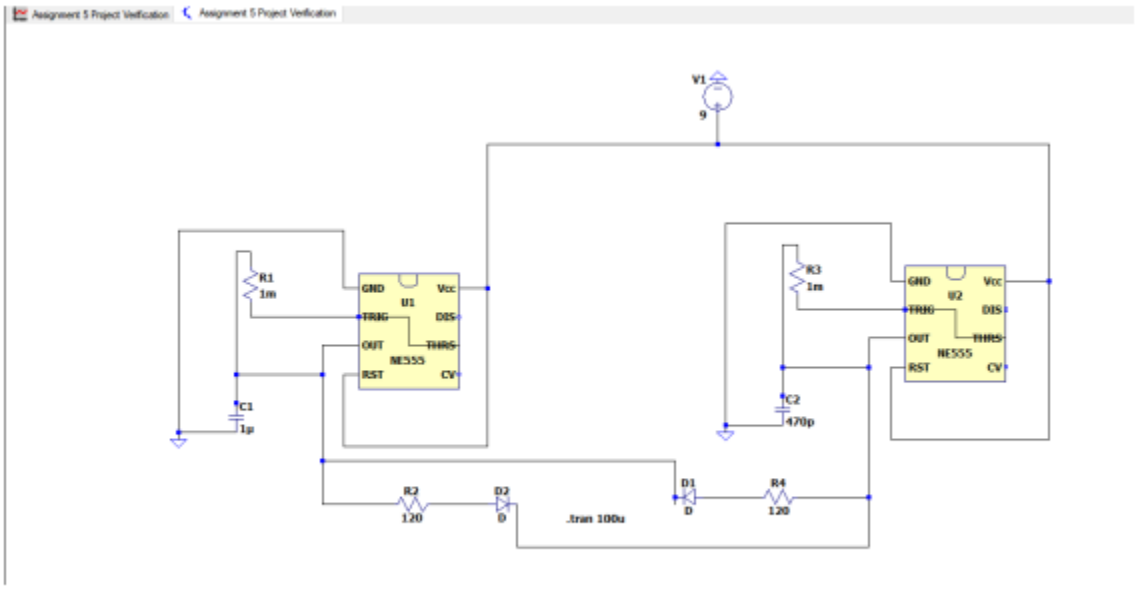
Operation: The 9v battery supplies a direct current power to the circuit. The slide switch is responsible for turning on and off the 9v supplied to the circuit. Two 1M Ohm resistors for pulling down the output voltage for it to charge and discharge the two capacitors and the 120 Ohm resistors are to limit the current going through the LEDs. The LEDs are arranged such that the Red LED turns ON when the output of the first NE555 IC is ON and the output of the second NE555 is OFF at the same time. Similarly, the Blue LED turn ON only if the output of the first NE555 timer is OFF and the output of the second NE555 timer is ON at the same time. When the output of the first NE555 timer is ON, only the Red LED can be turned on and will blink at the speed at which the second NE555 timer toggles the output. That blinking speed is determined by the size of capacitance used. The higher capacitance, the more time it takes the output to toggle and hence a slower blinking speed, and vice versa. Similarly, when the first NE555 timer is OFF, the Blue LED blink at the speed at which the second NE555 timer toggles the output. The repetition of this cycle creates a very similar effect to the flashing lights used in police cars.

Design Verification:

LTSpice Verification: I simulated the current passing through two diodes to represent the turning on and off of the LEDs in astable mode. I was able to represent my other components with the respective parts and value for adequate verification. I simulated the use of a 9V DC power supply to represent my battery. I ran my simulation with a transient analysis and period of 100 microseconds to see how the circuit responds to changes in driving voltage from the outputs of the two 555 Timers. As you see in the image below, when the blue current signal (current passing through diode D2) goes to 0mA, the green current signal (current passing through diode D2) goes on and vice versa. This operation is consistent

with the intended operation of this project. The results of the simulation and the schematic are shown in the images below.





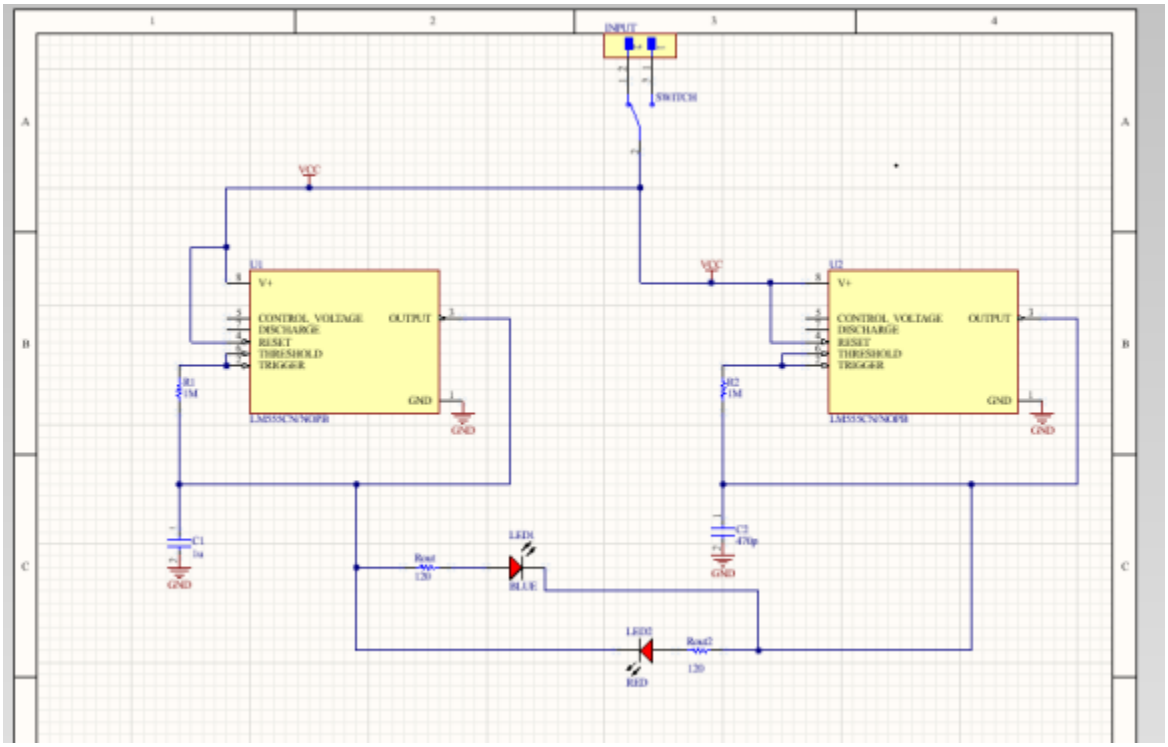
I set up my simulation almost identical to the actual schematic and operation, so I was confident with this one simulation/test to move on the design implementation.

Breadboard Prototype: I was able to build and verify the whole design on my breadboard. I supplied the 9V battery to the circuit and the LEDs were blinking alternatively as expected. I used a higher capacitance than what is in my actual schematic so that I could see the LED flashing and a slower rate to observe the operation. A link to the video recording of the working circuit is attached (https://www.youtube.com/shorts/u3q9cirp-LE) The alternated flashing of the LEDs was enough evaluation to prove my design works as expected.

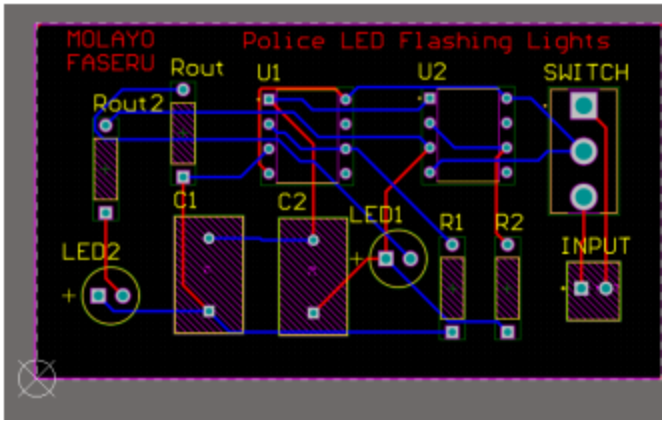
Design Implementation:

Below is my PCB Schematic: I used all through-hole components for consistency and ease of soldering.

Used a two pin header to be able to supply power to the circuit. A three pin switch to toggle between power and ground to control the powering on/off of the circuit.



PCB Layout: Below is an image of my PCB layout. I arranged it such that it can fit in a smaller PCB and have minimal wasted space to minimize manufacturing costs. One best practice design I used was avoiding ground loops. I made sure to connect each ground to individual ground sources instead of connecting components together and using one ground source. This makes less ground connections with individual PCB traces, reduces elective noise/crosstalk and ensures ground is consistent. This best practice was a challenge during the troubleshooting as I needed to ground one of the ground source manually for the circuit to work (should have added a ground source to pin one of the two pin header in the pcb schematic). Design verification of this layout was smooth, I did not get any errors with my layout as the connections/components were well spaced-out during routing. I did not make any changes while laying out the board as well.



My Design Verification Report

Designed

Design Rule Verification Report

Date:	9/19/2022		
Time:	8:17:39 PM	**Warnings:**	0
Elapsed Time:	00:00:01	**Rule Violations:**	0
Filename:	C:\Users\Public\Documents\Altium\Projects\PCB_555Project-Ass#6\PCB_555Project-Ass#6.PcbDoc		

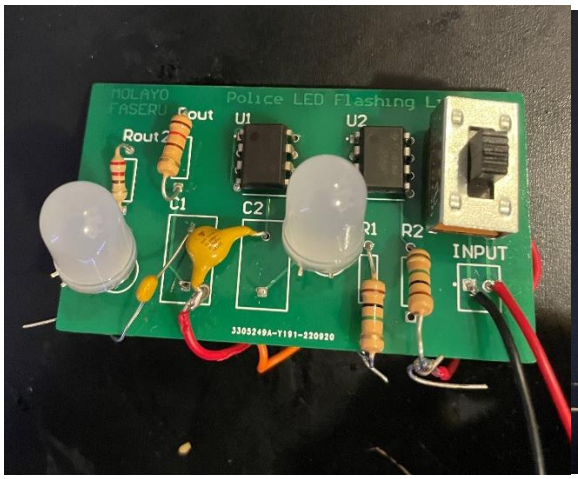
Summary

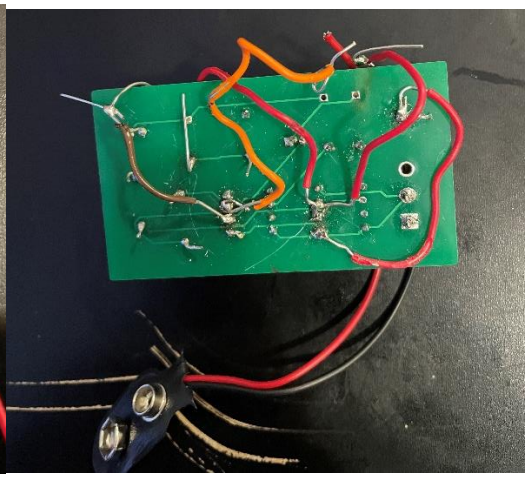
Design Manufacturing and Assembly:

I put all the components through the hole and suspended my board with a board holder and soldered the components one-by one. I had to remove and replace multiple components during the testing process, and I made use of the desolder tool to aid the process.

Design Testing:

My test plan was to build the circuit and measure the voltages and currents on the different components to make sure everything was connected and getting power. At first when I built the circuit, it wasn't functioning, and the LEDs did not light up at all but was I was measuring 8v voltage across it. Which is when I realized the LEDs were assembled in the opposite polarities. So, I took them out and flipped them, and I also realized that I had to connect the ground from the power source ground to one of the individual ground sources to ground the circuit. After that, the LEDs were lit up but were not flashing as supposed. I looked again at my schematic and noticed that the capacitors (C1and C2) and resistors (R1 and R2) were connected directly to the Rout and the cathode of the LEDs directly instead of the pin 2 and output pin 3 of the 555 Timers respectively. So, I took out one end of the capacitors and resistors and connected them to the respective 555 Timers with jumper cables. After all that debugging, my design was finally functioning as the LEDs were flashing appropriately. Here are images of my final design with all the necessary jumpers connected.





Here is a link to a demonstration of my working design.

https://youtu.be/VYti94OA27Q

SOURCES

[1] https://elonics.org/police-lights-themed-flashing-led-circuit-using-555-ic/