

Timed Traffic Light PCB

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Abstract:

The objective of this project was to design and fabricate a printed circuit board that would emulate a traffic light. Light emitting diodes (LEDs) were used for the green, yellow and red lights of the traffic light. The lighting of the LEDs was timed using a combination of a counter IC and a timing IC. The timing and lighting order was set to emulate a UK traffic light, with timing controllable by a potentiometer.

Project Description:

The goal of this project was to design and build a traffic light. A schematic and description was based on a kit by RSH Electronics. The traffic light emulates a UK traffic light. To time the traffic light, a 555 timer IC was used in its astable mode to generate pulses. When wired as shown in figure 1, the IC puts out rectangle pulses with a given frequency. R2 is connected to another resistor R1 as well as a capacitor. In this arrangement, the capacitor is charged through R1 and R2, but only discharged through R2. The frequency is modified by changing the values of R1, R2, and C. For this project, the resistance of R2 in the figure was changed by using a potentiometer.

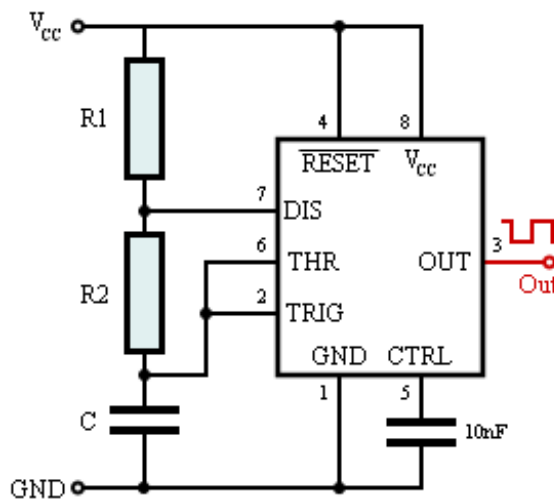


Figure 1: 555 Timer in Astable Mode

The pulses generated by the 555 timer were fed into a decade counter. A 4017 decade counter was used in this case. To time the three LEDs, the outputs in figure 2 were used. For the first five counts (Q0-Q4) the $\div 10$ counter has a high output, then the count cycles through the next five counts (Q5-Q9). The LEDs were connected to the IC as shown in figure 2. For UK traffic lights, both red and yellow lights are illuminated at the same time before transitioning to green. To eliminate this for a US traffic light, the yellow LED connected to Q4 could be eliminated, but I chose not to for this project.

4017 counter outputs high	LEDs ●●● = LED on		
	red	amber	green
Q0 and +10	●		
Q1 and +10	●		
Q2 and +10	●		
Q3 and +10	●		
Q4 and +10	●	●	
Q5			●
Q6			●
Q7			●
Q8			●
Q9		●	

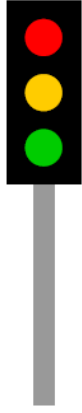


Figure 2: 4017 Counter outputs

The schematic is shown below in figure 3. Power was supplied by a 9V battery, and the device is turned on and off with a switch.

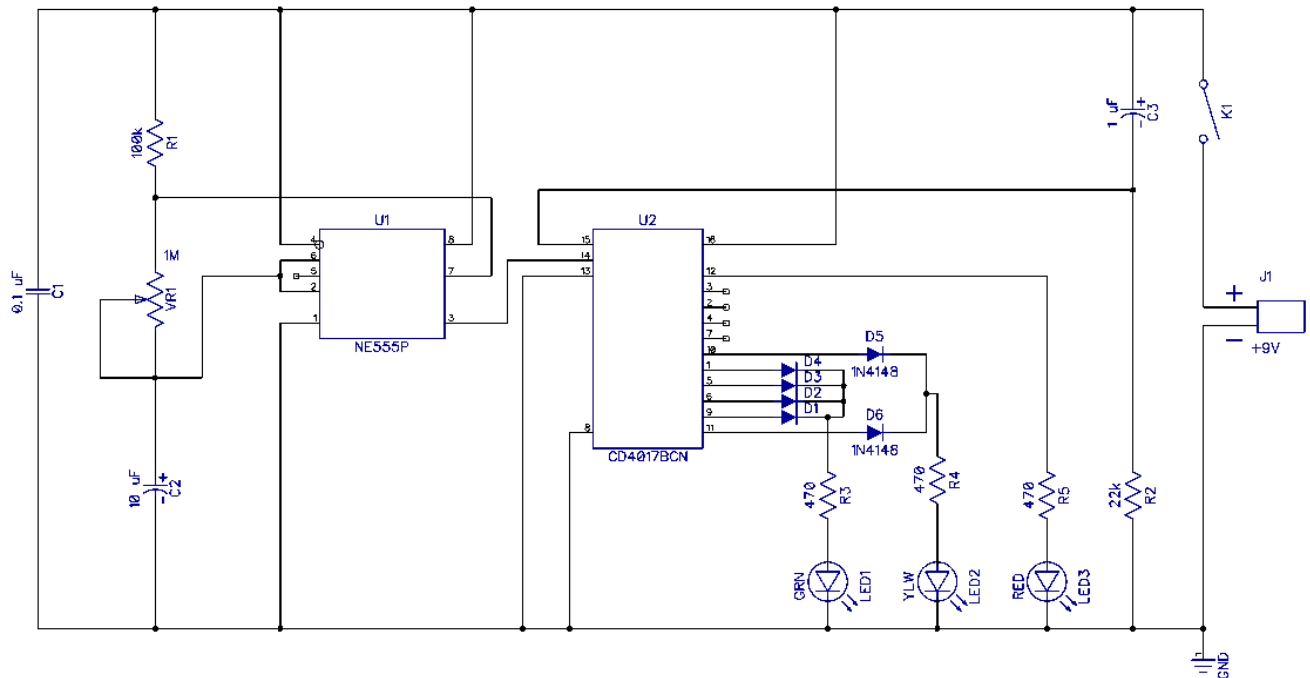


Figure 3: Schematic of Traffic Light

The schematic was turned into a board layout. To simplify assembly and align the LEDs, the traces were put on both sides of the board. The layout is shown in figure 4, with silkscreen in green, top traces in black, and bottom traces in grey. For ease of assembly, only through-hole components were used.

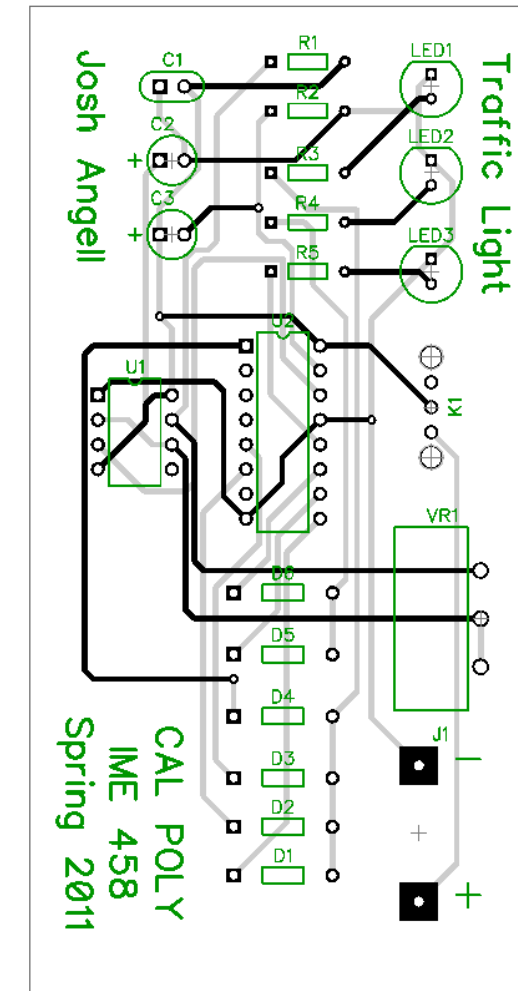


Figure 4: Board Layout

After the layout was sent off to be manufactured, the board was assembled. Upon assembly, I recognized that the vias for the resistors were slightly too small, but I was still able to push the leads through. I also found that the pattern for the switch was dimensioned incorrectly, which necessitated cutting off the unused lead and bending the mounts to fit the board. This did not affect the operation of the board.



Figure 5: Assembled Board

Conclusion:

The project resulted in a functional printed circuit board that emulates a UK traffic light. When the switch is turned on, the lights illuminate in the correct order and have the correct timing. The timing can be adjusted using the potentiometer, from approximately 10 seconds for the full cycle up to approximately one minute.

From this project I learned how to turn a schematic into a functional circuit board, as well as the considerations that must be made along the way to have the board function properly.

If the project were to be done again, I would pay closer attention to dimensioning the components when making patterns. Otherwise, this project was a straightforward approach to emulating a traffic light.

BOM

Item #	Qty	Reference Designator	Type	Value/Part #	Package Type	Manufacturer	Manufacturer/Part #
1	3	R1, R2, R3	Resistor	470 Ω , 1/4W, $\pm 5\%$	Axial	Std	
2	1	R4	Resistor	22k Ω , 1/4W, $\pm 5\%$	Axial	Std	
3	1	R5	Resistor	100k Ω , 1/4W, $\pm 5\%$	Axial	Std	
4	1	C1	Capacitor	0.1 μ F	Through-Hole	Std	
5	1	C2	Polar Capacitor	1 μ F 50V radial	Through-Hole	Std	
6	1	C3	Polar Capacitor	10 μ F 25V radial	Through-Hole	Std	
7	6	D1,D2,D3,D4,D5,D6	Diode	1N4148	Axial	Philips	
8	1	LED1	LED	Green, 3mm	Through-Hole	Std	
9	1	LED2	LED	Yellow, 3mm	Through-Hole	Std	
10	1	LED3	LED	Red, 3mm	Through-Hole	Std	
11	1	VR1	Potentiometer	1M, horizontal	Through-Hole	Alpha	POT1MB
12	1	U1	Timer IC	NE555	DIP-8	Texas Instruments	NE555P
13	1	U2	Counter IC	4017	DIP-16	Texas Instruments	CD4017BE
16	1	K1	Switch	1P2T 0.5A 50VDC	Through-Hole	Wealth Metal	SS12F45G8
17	1	J1	Cable, 9V, Battery Snap			Std	Std
18	1		Plastic Knob, Potentiometer			Std	Std