Abstract

The project consists of designing and building a sequential taillight system for an automobile. The device uses two sets of 5 LEDs for the right and the left taillights. 3 push buttons are used to operate the device. When the Left button is pressed, the LEDs of the left taillight flash at approximately 1/8 second intervals. When the Right button is pressed, the same procedure goes for the right taillight. The turn complete button turns off all the LEDs. The circuit operating the device is built using sequential logic.

Components:

(10) LEDs
(8) DM7474 Dual Positive-Edge-Triggered D Flip-Flops
(1) TC4584B Hex Schmitt Trigger
(2) DM7404 Hex Inverting Gates
(2) DM7406 Hex Inverting Buffers with High Voltage Open-Collector Outputs
(2) CD4012C Dual 4-Input NAND Gate
(1) DM7408 Quad 2-Input AND Gates
(3) Push buttons
(1) On/Off switch
(10) 300Ω Resistor
(1) 1MΩ Resistor
(1) 0.1 μF Capacitor
(3) 10kΩ Resistor

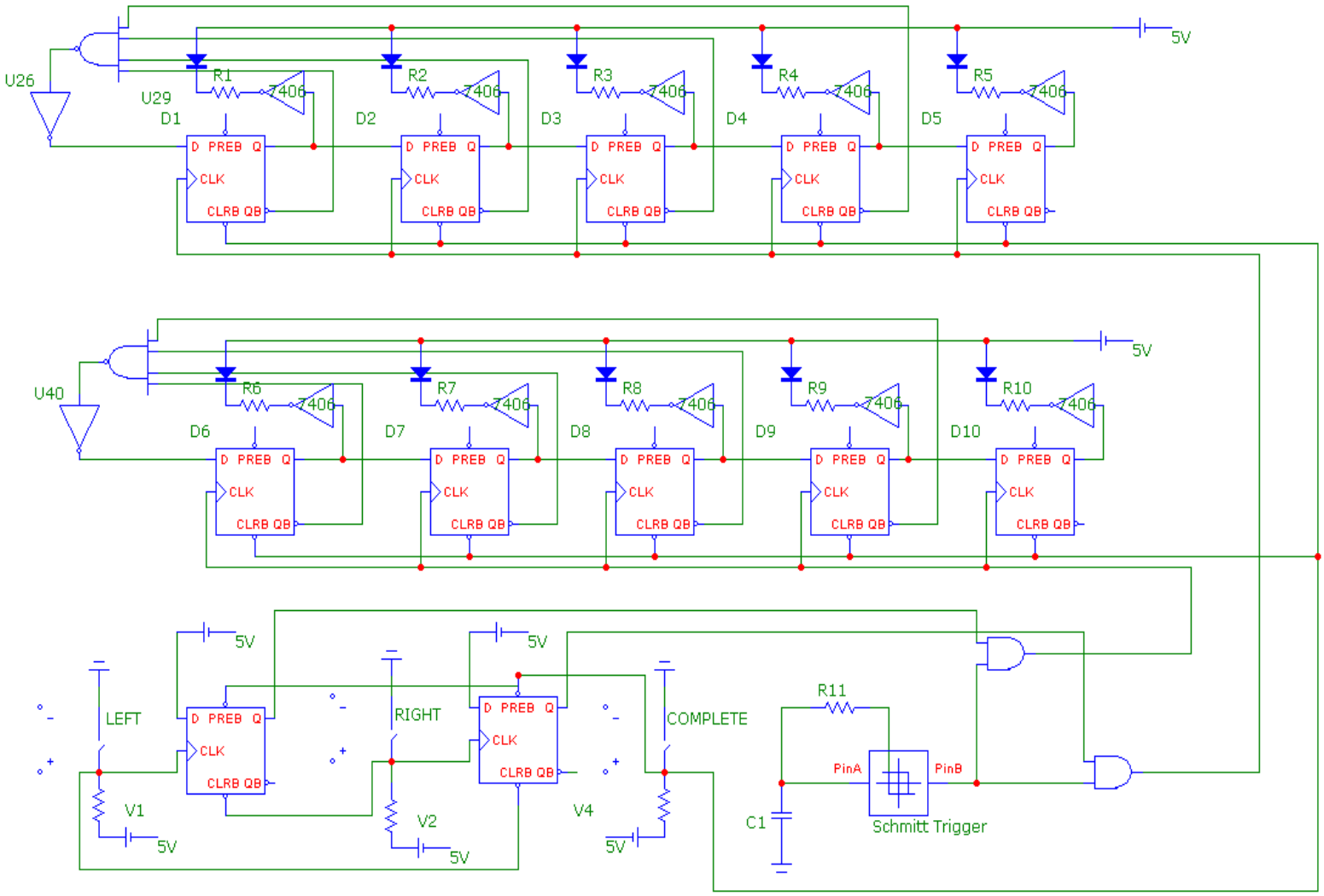


Figure 1: Circuit Diagram

The idea in designing this device is to use sequential logic and state machines to operate the taillights. The circuit has two main parts. The first part (at the top of the circuit), handles the sequential flashing of the LEDs and the second part (at the bottom of the circuit) controls the 3 buttons.

How does the device work internally?

The system has:

- 3 inputs: Left (L), Complete (C), and Right (R)
  These 3 inputs represent the button pressed by the user.

- 10 outputs: $L_A\ L_B\ L_C\ L_D\ L_E$ / $R_A\ R_B\ R_C\ R_D\ R_E$
  These 10 outputs determine how the LEDs will flash sequentially on the left or the right side.

If the input is R, the left control flip flop is cleared and the Schmitt Trigger only runs the right set of 5 flip flops at 8Hz.
If the input is L, the right control flip flop is cleared and the Schmitt Trigger only runs the left set of 5 flip flops at 8Hz.
If the input is C, all the 10 flip flops are cleared and the flashing stops.

Setup of the TC4584B Hex Schmitt Trigger as a clock

In order to meet the requirements of the project, the LEDs should flash at approximately 1/8 second. This is achieved by connecting a single resistor-capacitor network to an inverting Schmitt trigger. The capacitor connects between the input and ground and the resistor connects between the output and the input. The output is a continuous square wave whose frequency depends on the values of R and C, and the threshold points of the Schmitt trigger.

The flashing frequency of the LEDs should be approximately 8 Hz.

From the characteristics of the TC4584B Hex Schmitt Trigger:

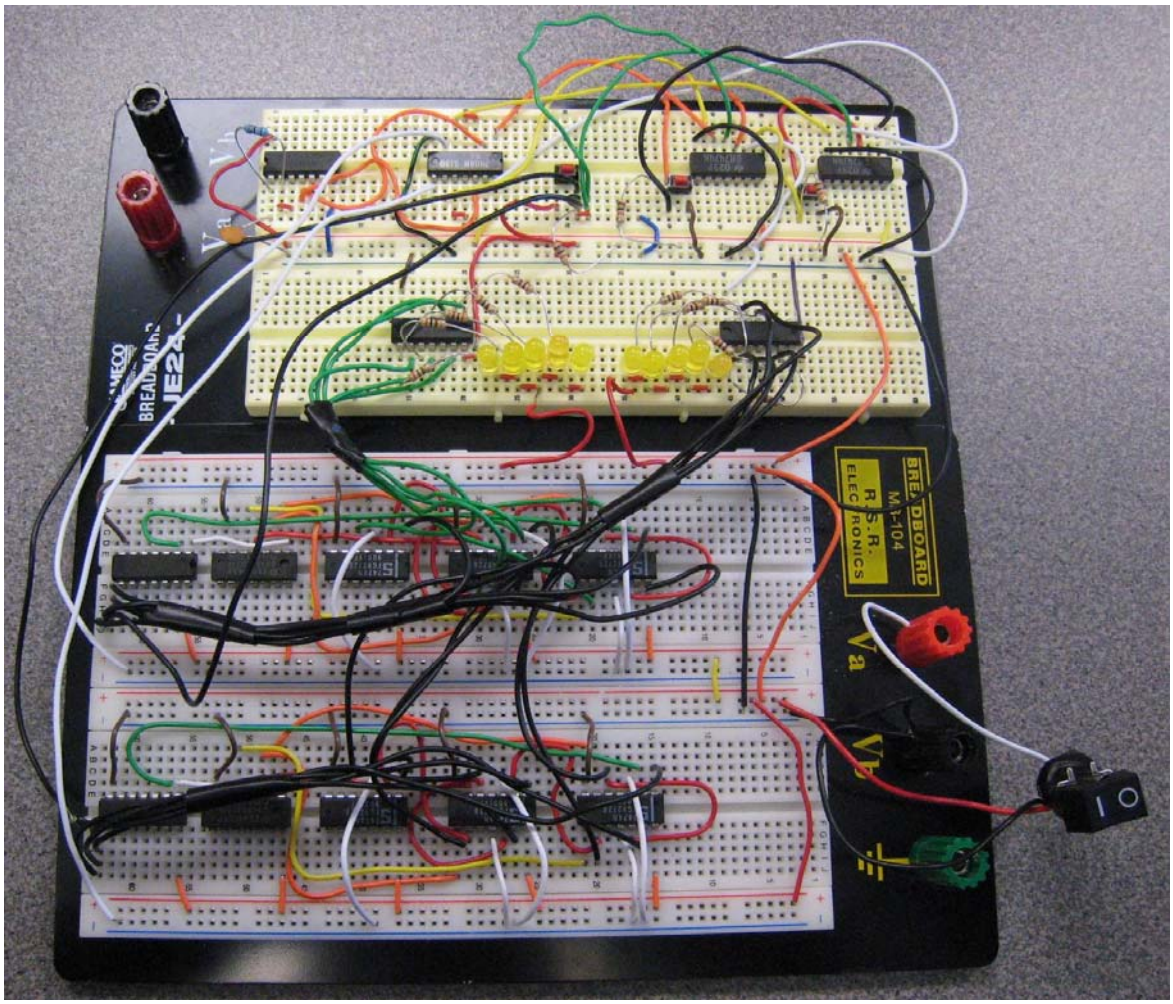
$$\rightarrow \frac{1.2}{R.C} = 8\ Hz$$

For R = 1MΩ, C = 0.15 μF

Physical value of the capacitor: C = 0.10 μF

Extra features

- The device is portable, using a pack of 4 x 1.5V AA batteries.
- An On/Off switch is added to easily power the device on and off.



Final Board Picture

Conclusion

The main problem encountered with this project was to implement the logic to activate the taillights without holding the buttons pushed. This was done using a sequential state machine that continuously remembered the previous input. Finally, the device had been tested and works successfully.

I first decided to use a microprocessor to implement the device but I changed my mind. The reason is that the circuit is not complex enough to require a microprocessor and can work easily on flip flops. However, in terms of massive production and commercialization, I would recommend the use of microprocessors since they are getting more accessible and cheaper.