Project Report on

An Implementation of Traffic Light System in a 4-way intersection with a Major and a Minor Street

Group No. **4**

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Introduction

Traffic Lights are used for controlling vehicular traffic and pedestrian traffic. Nowadays, as there are different types of vehicles and the number of vehicles is increasing. Thus, for avoiding traffic jams and accidents traffic lights are mandatory. There are mainly three vehicular lights in the traffic signal, each having a different message for the drivers. The red light asks the driver to yield at the intersection, green light gives the driver a free license to drive through the intersection whereas the yellow light or amber light alerts the driver to wait if the next light is red or get ready to go. However, there are also green and red lights for pedestrians which helps them to cross the road safely. Traffic lights have proved to be an amazing way to stop vehicular collisions and control traffic jams in today's modern era where everyone owns different types of vehicles. For our project, we are assigned a project to design a circuit for controlling a traffic light system. Thereby, we have made a system with the help of 555 timer and 4017 counter.

Objectives

- To investigate the 555 Timer and how to implement its various conformations.
- To observe how the IC-4017 counter works.
- To understand how traffic lights switch from one to another.
- To get familiar with how a relay works and implement an Optocoupler-NPN relay.
- To investigate a clock signal generator and implement a custom pulse generator from simple clock signals.

Proposed Model

This project will demonstrate a Traffic Light Control System for a 4-way road intersection with a major and a minor street. The proposed system consists of mainly two parts. They are “Pulse Generator and Phase Cycler” and “Phase Controllers”. Pulse Generator will create a pulse wave of desired frequency and interval through which we can control the Phase Cycler. The phase controller uses the output of the phase cycler to output the designated traffic lights. The traffic light works in six different phases with a particular sequence to reduce the traffic load and help the pedestrian move through the intersection.

Experimental Setup

Components and Equipment

1. 2N1711 NPN Transistor
2. 555 Timer
3. 4017 Counter
4. AND Gate
5. Capacitor
6. Clock Generator
7. Diode
8. Red LED
9. Yellow LED
10. Green LED
11. Logicstate
12. NOT Gate
13. Optocoupler-NPN Transistor
14. OR Gate

15. Resistor

16. 12V Voltage Source

Circuit Diagram

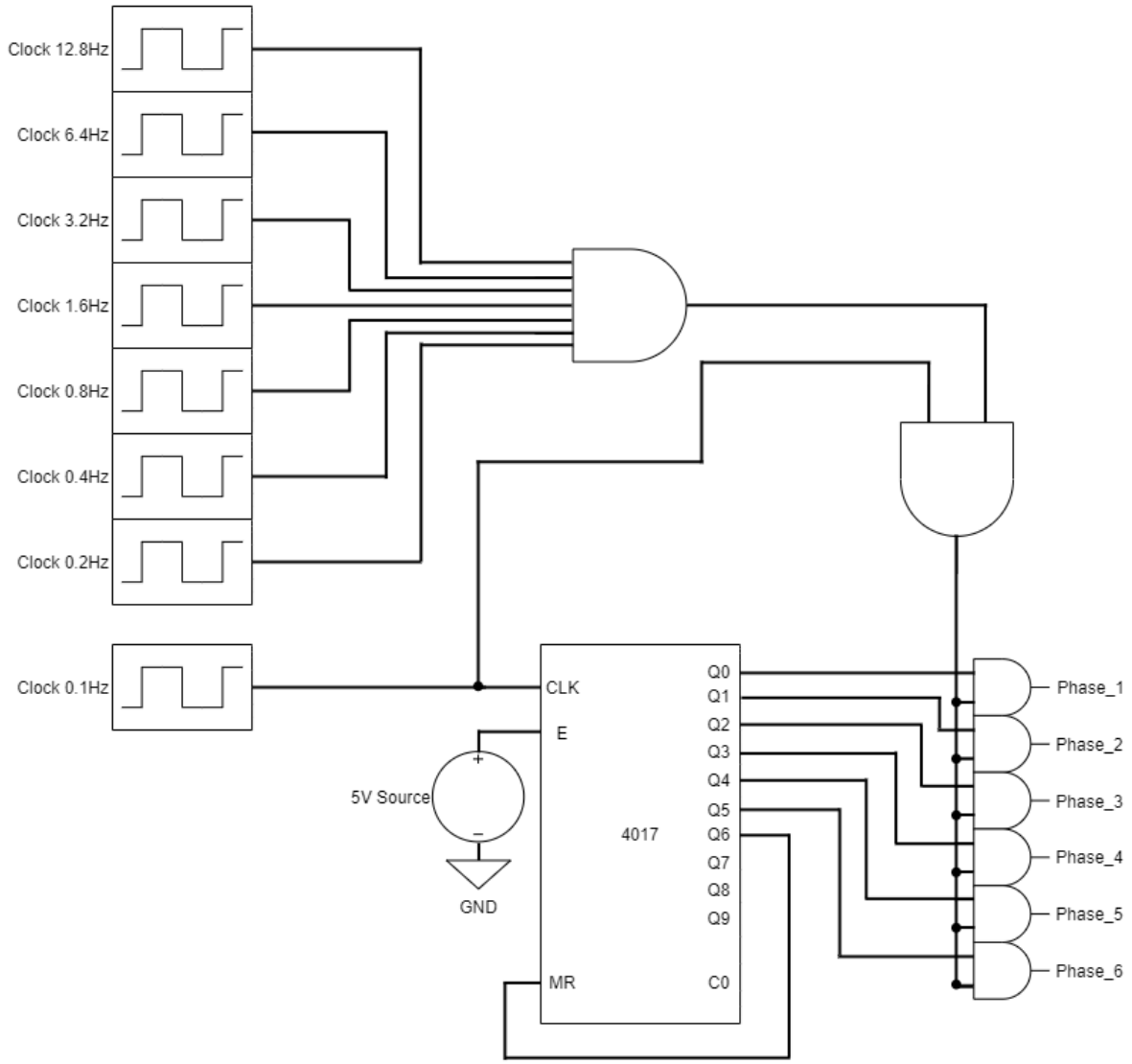

Fig-2.1: Pulse Generator and Phase Cycler

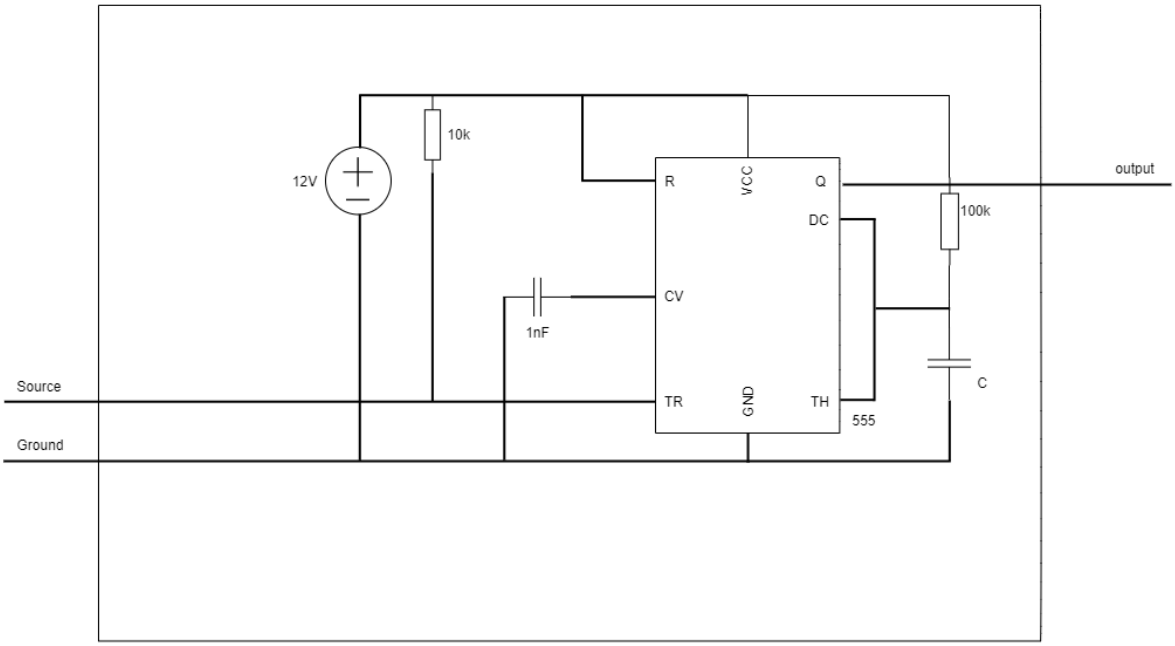

Fig-2.2: Timer Block

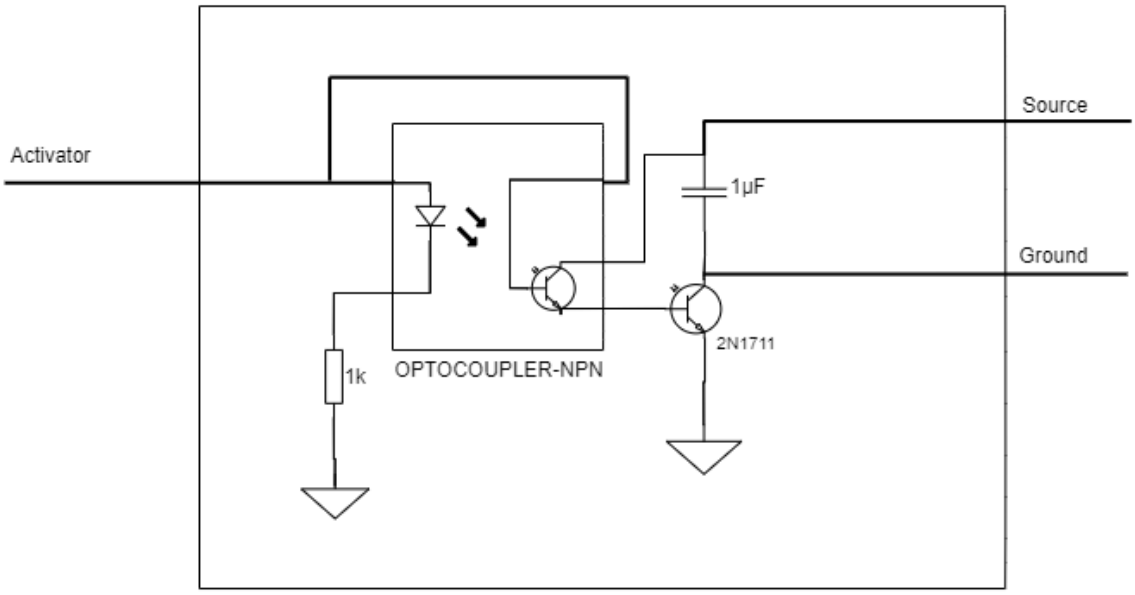

Fig-2.3: n_phase_switch

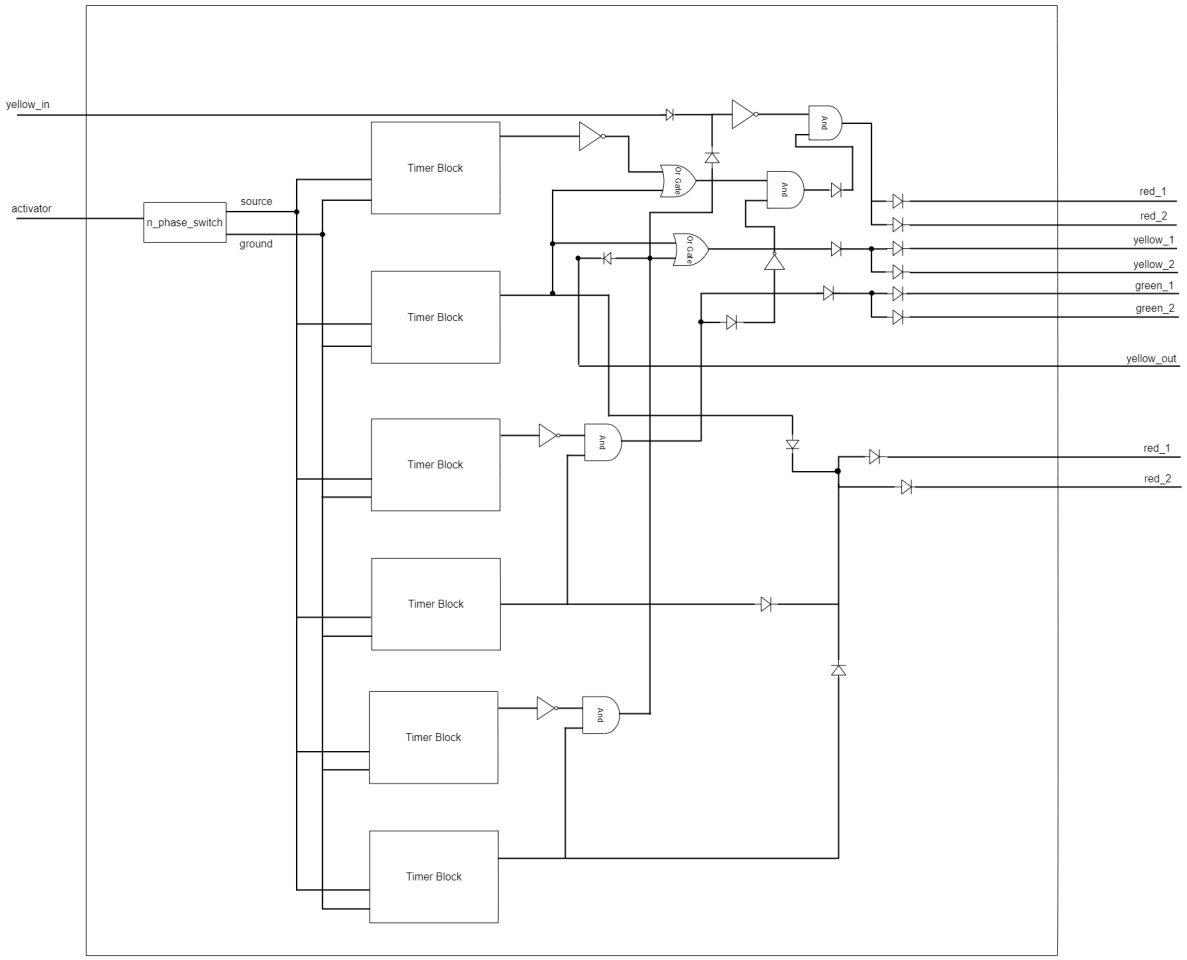

Fig-2.4: n_phase_controller

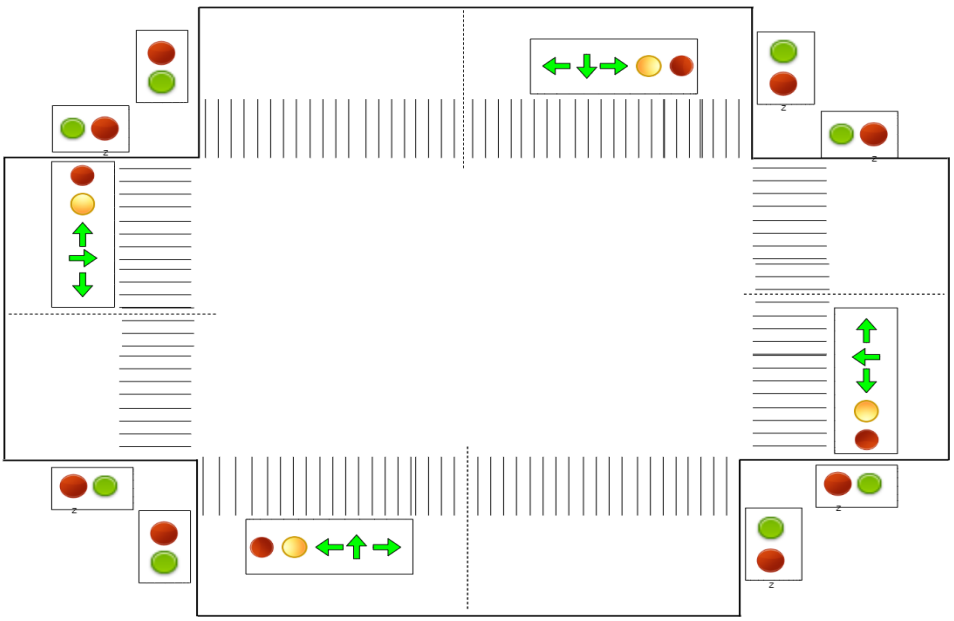

Fig-2.5: 4-way Intersection with a Major and a Minor Road

Explanation

Pulse Generator and Phase Cycler

1. **Pulse Generator:** In this system, we need each traffic light to glow for a specific amount of time. That's why we need timers. But the timer works only when we give a pulse to the timer. This pulse time needs to be very small compared to the time interval between two pulses. Again, we need to give contentious pulses with a certain time interval. To achieve this, we had made a Pulse Generator which generates a small pulse with a large time interval. We had used clocks of various frequencies and added them by AND gate to get the desired pulse.

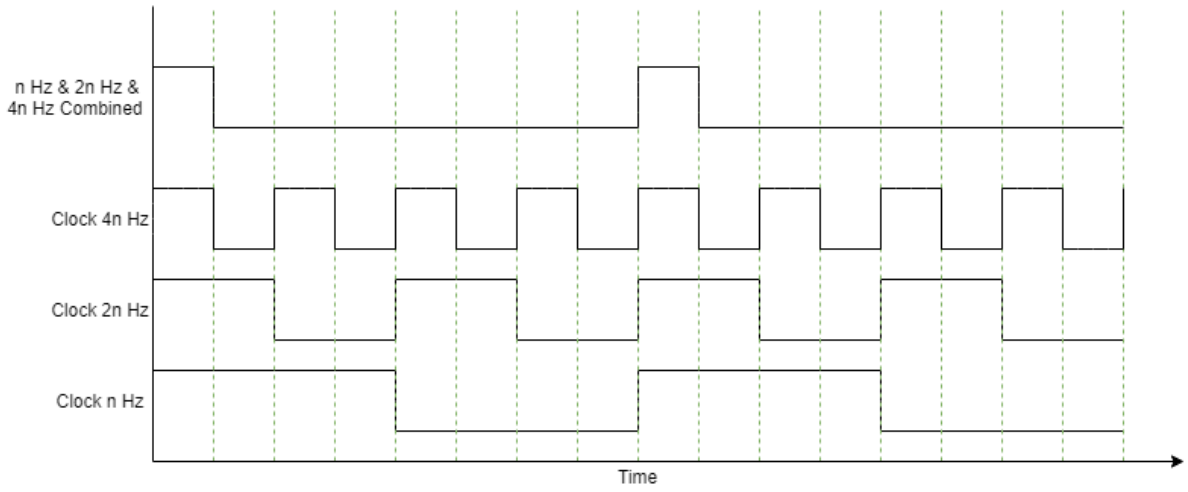

Fig-2.6: Pulse Generator

From the above fig-2.1, we see 3 clocks of twice the frequency of the previous clock have been combined to produce a n Hz pulse with an interval of 7n Hz. By this theory, we had made the following equation:

$$Number\ of\ Clocks, n$$

$$Frequency\ of\ Initial\ Clock, f_a$$

$$Time\ Period\ of\ Pulse, T_p$$

$$Time\ Period\ of\ Interval, T_i$$

$$T_p = \frac{1}{2^n f_a}$$

$$T_i = \frac{1}{f_a}(1 - \frac{1}{2^n})$$

In our system, we had used 8 clocks and the initial frequency was 0.1 Hz. From the equation, we get, Time Period of Pulse, T_p= 3.91ms and Time Period of Interval, T_i = 9.96s.

2. **Phase Cycler:** Our system shows traffic lights sequence in a 4-way road intersection. Since we also have a pedestrian zebra crossing light in the head of every road. We need to have a sequence to clear out the traffic and also make way for pedestrians. For this reason, our design uses 6-phases. In each phase, there will be a sequence of how the traffic can move and which zebra crossing will be open. These are given below:

    a. **Phase_1 (For Major Street Left Turn)**

    b. **Phase_2 (For Major Street Vehicle and Pedestrian through Movement)**

    c. **Phase_3 (For Major Street Right Turn)**

    d. **Phase_1 (For Minor Street Left Turn)**

    e. **Phase_2 (For Minor Street Vehicle and Pedestrian through Movement)**

    f. **Phase_3 (For Minor Street Right Turn)**

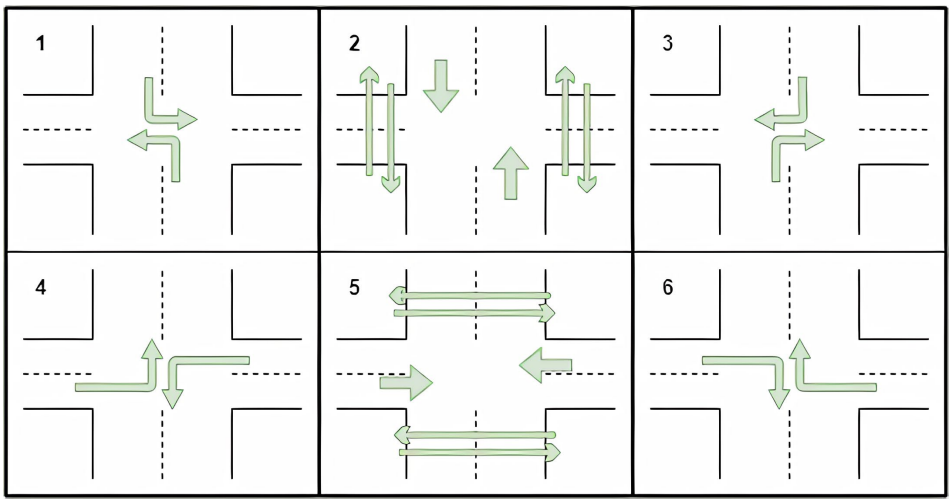

Fig-2.7: 6-Phases Traffic Sequences

Each phase has its timers for the traffic lights and pedestrian lights. And each phase is controlled by one 4017 counter. This 4017 counter repeats every 6 phases and its clock is connected to the initial clock of the pulse generator. So, the phase shifts every 10s. Since the counter outputs HIGH while the counter is in a phase, we used AND gate with every output of the counter with the pulse generator. And, the output of the AND gate is connected to the phase switches. This creates a small pulse every time the counter shifts and turns off.

Phase Controllers

Phase Controller Block: A Phase Controller Block is a circuit that has 2 inputs and 5 outputs for controlling 2 red traffic lights, 4 yellow traffic lights, 2 green arrow traffic lights, 2 green pedestrian lights.

a. **Inputs:** There are two inputs. One is for activating the whole phase and all the timers and another is for controlling the corresponding left and right yellow lights.
b. **Outputs:** There are 5 outputs. Their uses are:
    i. Two opposite red traffic lights.
    ii. Two opposite yellow traffic lights.
    iii. Two opposite green arrow traffic lights/Two opposite green pedestrian lights
    iv. Two opposite red traffic lights while both yellow and red traffic lights are on.
    v. Two corresponding left and right yellow lights while both yellow and red traffic lights are on.

A Phase Controller Block has 2 types of blocks for controlling the sequence of lights. They are:

a. **Relay block:** A relay contains one input and two outputs. When the input HIGH through the input the two output shorts and they get connected. The relay block uses a npn-optocoupler, a npn transistor and a capacitor to form a relay. When the input

receives a signal the npn transistor shorts by connecting the second output with the ground and two output shorts.

b. **Timer Block:** A timer block contains two inputs and one output. When we short two inputs together the output turns HIGH for a certain amount of time. This timer function is done by using a 555 timer in a Monostable configuration. We can adjust the time by using the appropriate capacitor in the monostable configuration. There are 6 timers for controlling the red, yellow and green lights.

Each phase turns on the lights in a sequence of 4 parts. They are,

a. Yellow and Red Traffic Light (0s-2s)
b. Green Arrow Traffic Light (2s-8s)
c. Yellow Traffic Light (8s-10s)

When the relay receives an input and all 6 timers activate at the same time. The function of each timer is:

a. **1st Timer:** The first timer is used to turn off the red traffic light while the whole phase runs. So, the timer keeps running for 10s.
b. **2nd Timer:** The second timer is used to turn on yellow and red traffic lights for 2 seconds.
c. **3rd and 4th Timer:** The third and fourth timers are used to control green arrow traffic lights. The third timer runs for 2s and the fourth timer runs for 8s. The inverse output of the third timer output and output of the fourth timer is imputed through an AND gate and the output of the AND gate turns on the green arrow traffic lights. For this configuration, these two timers turn on green arrow traffic lights for 2s to 8s.
d. **5th and 6th Timer:** The fifth and sixth timers are used to control yellow traffic lights. The fifth timer runs for 8s and the sixth timer runs for 10s. The inverse output of the fifth timer output and output of the sixth timer is imputed through an AND gate and the

output of the AND gate turns on the yellow traffic lights. For this configuration, these two timers turn on yellow traffic lights for 8s to 10s.

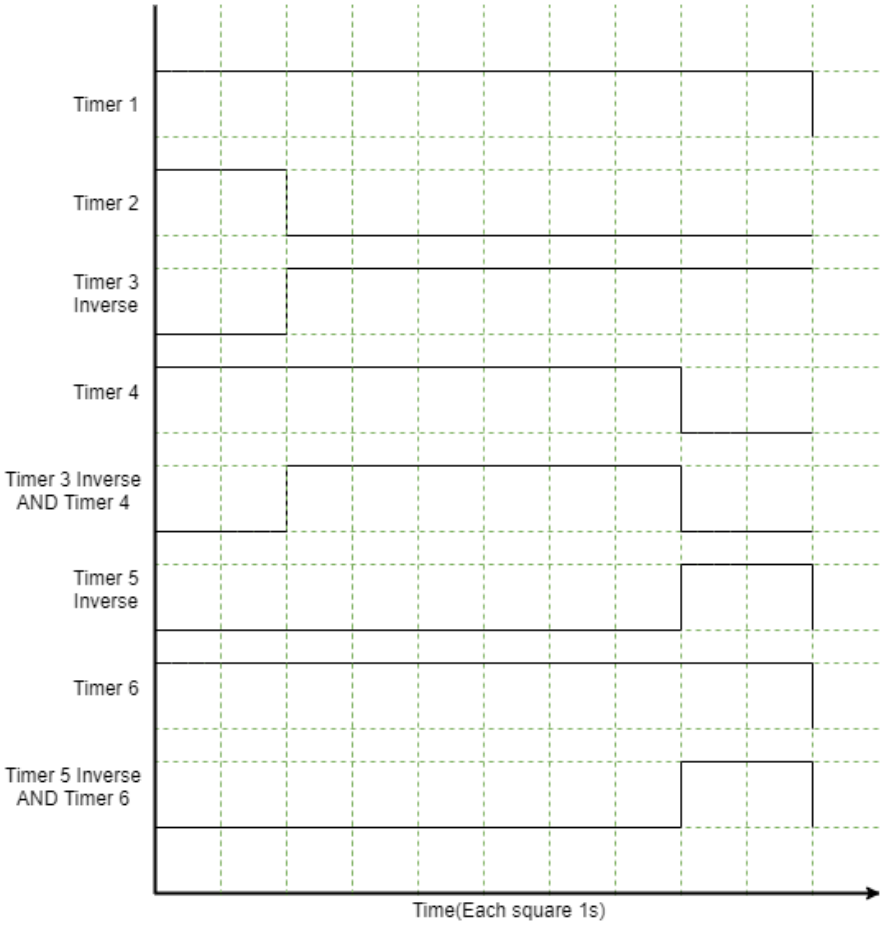

Fig-2.8: 6 Timers outputs

Results and Analysis

The system successfully ran and showed the desired traffic light sequences. The clocks all together formed a pulse which helped the 555 timer to start successfully and cycle between each phase. The whole phase cycle repeated itself after completing 6 phases. The ratio between red: yellow: green traffic light has been 1:1:3.

Conclusion

The above-demonstrated system has some limitations such as, it cannot detect vehicle presence which can lead to long delays for pedestrians if there are no cars. On the other hand, there is no button for pedestrians which may lead to delay in clearing vehicles if there are no pedestrians. Finally, there is no weight attached to the timers of each phase so it would not be suitable for all types of road intersections. Nevertheless, in our project, we proved that it's possible to implement in reality. Moreover, in this project, we didn't use any kind of microprocessors, rather we used two major things such as the 555 timer and the IC-4017 counter in this whole project to implement our traffic light system project. This traffic light system is not only for transportation but also for how pedestrians cross the road. So, we thought not only about vehicles but also about pedestrians how to cross the roads safely. In this project, we were inspired by creating designs that are used in developed countries. To conclude, we can implement this traffic light system design in our country's both major and minor streets, which will be helpful for both our transportations and pedestrian's movement in a perfect rule.

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