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Traffic Light Control System in Multisim

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Abstract - *The fundamental idea behind this project is to manage the traffic and avoid traffic jams. It also serves the purpose of avoiding vehicular collisions. This project is just a one-way traffic controller, although it can be further modified as well.[12] The project will be designed to work in a way, it provides instruction to the drivers to drive through the intersection or halt at the intersection. This project is made in Multisim using basic components along with a decade counter and a Timer in astable mode.*

Key Words: Traffic Light, Analog Electronics, Traffic control, Multisim, Traffic Management

1.INTRODUCTION

A traffic light system is used to control vehicular traffic. In recent times, as the population is increasing, parallelly, everyone owns different types of vehicles, most of them own more than the required number of vehicles, resulting in a rise in the numbers of vehicles. That's makes traffic lights are a necessity to avoid traffic jams and accidents. The system consists of three lights, having a different message for the drivers. The upper one is red light indicating the driver to halt at the intersection, the last light is green giving the driver permission to drive through the intersection whereas the middle one, yellow in color, alerts the driver to wait when the next light in order is red or to start the engine and get ready to go if the green light is next. A traffic light system is a proven methodology to stop the collisions of vehicles and to control the traffic jams in today's time where everyone owns the different types of vehicles.[1]

1.1 Components Required

This is a simple project making use of easily available and cheap components. The key components of this circuitry are IC-555 Virtual Timer and 4017BP_10V[CMOS_10V_IC] decade counter. The time of operation of each light is controlled by these two components.[2]

For this project IC-555, virtual timer is used in the astable mode of operation. Pin2 (Trigger)-turn on output when supplied voltage is less than 1/3(VCC). Pin 6(Threshold)-turns off when the supplied voltage is more than2/3(VCC). Pin 7 (Discharge)- for low output voltage capacitor C1=0.01µF is discharged to the ground. The threshold pin and trigger pin are short-circuited to the capacitor, which means that they are at the same voltage. At the beginning of the cycle, the threshold pin is low and the discharge pin is off. So current flows through resistors R1 and R2 and charges capacitor C1. When it charges to 2/3(VCC), the output is switched off by the threshold pin, and the discharge pin switches on to discharge capacitor C1. When it reaches 1/3 VCC, the discharge pin is turned on and C1 starts charging again.[3][4]

CMOS decade counter counts from 0-10 and the output is decoded. Pin 1-7 and 9-11 are the 10 output pins. Pin 8 is connected to the ground of the circuit. Pin 12(carry out) is used as carrying while counting. Pin 14 is connected to the 555 timer. Pin 15 is used to reset the count to 1. Pin 16 is VDD or VCC. Pin 13(clock enable) is an input that holds the count when high.[7]

1.2 Schematic

For a real-world application, this circuit is designed to work on an AC power supply of 220V 50Hz. Step down transformer, voltage regulator, full-wave rectifier, and capacitors are used to scale down the voltage to a D.C. voltage of 11V. Input is provided to the timer which consequently helps to control the operation of the decade counter. The output pins of the decade counter are connected to respective coloured lights (red, yellow, green) after passing through the diode that stops the short-circuiting.[11]

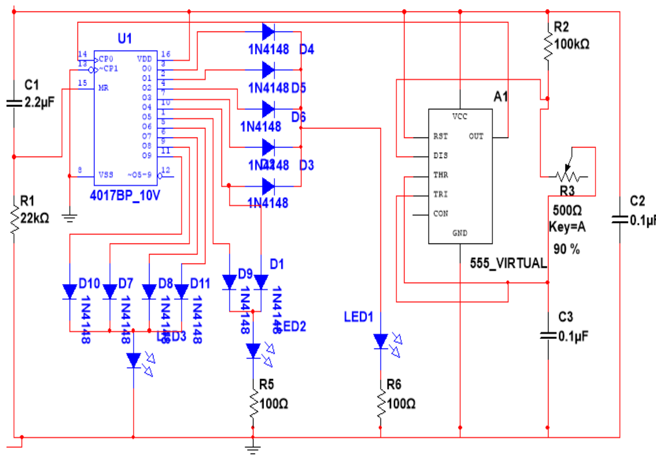

Fig -1: General schematic

2. WORKING

The general AC supply of 220V 50Hz is brought down to 11V ac supply using a step-down three-pin transformer having a turn ratio of 20. Even though the final output required is 9 V we step it down to 11 V only considering the voltage drop in diodes used in further circuitry and the supply voltage fluctuation. If the voltage goes below 9V the circuit stops functioning hence a value higher than the required output is taken from the transformer. The output is then passed through a full-wave rectifier in a bridge configuration to get the output only in the positive part. The output is still in A.C. hence to convert it to DC we use a capacitor. The capacitor clips off the waveform providing a dc wave. The output obtained is still not regulated hence it is passed through a voltage regulator LM2940S-9.0. This regulator is a three-pin component that allows only the output equal to 9 V to pass through[5].

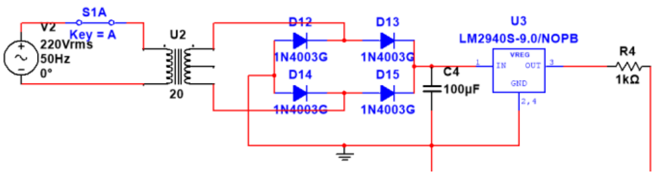

Fig -2: AC to DC conversion

Power is provided to the IC 555 VIRTUAL TIMER, working in astable mode. The timer is used in an astable mode to make sure we can control the inner circuitry of the timer (basically capacitors) to change the time period. To control the time period of the wave generated we use a potentiometer connected to the discharge pin of the timer on one end and another end to the threshold and trigger pin shorted together. On increasing the value of resistance, the time period of the pulse increases and vice versa. By doing the calculations we can hence find the perfect value of resistance, for the required time period. [6]

Frequency=1/(ln(2).(C_3).((R_2)+2.(R_3)))

High time= ln(2).(R_1+R_2).C_3

Low time= ln (2).R_2.C_3

For this circuit, the value for resistance is used so that the high time of each pulse is 41ms and the low time is 35 ms, and a duty cycle of 53.95%. This result is verified by using an oscilloscope.

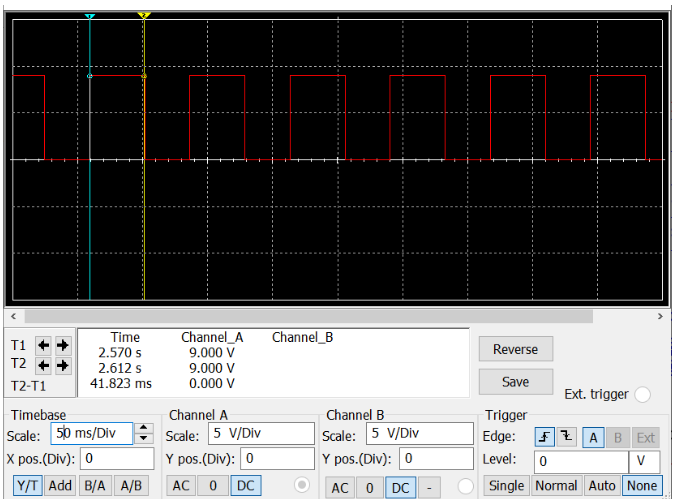

Fig -3: High time produced by the timer as connected in Fig-1

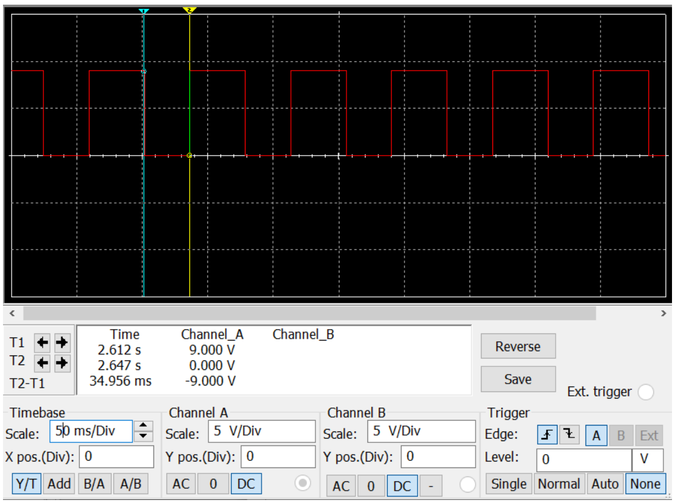

Fig -4: Low time produced by the timer as connected in Fig-1

The output of the timer is given to the decade counter by connecting the output pin of the timer to pin 14 of the decade counter. The decade counter has 10 output pins o0-o9 which give output for one pulse each. We also have pin 12 which is used to cascade 2-decade counters to increase the count to 20 pulses, however, cascading more than 2 counters results in reducing the efficiency of the circuit. Pin o0-o3 are attached to 1N4017 diode each and then they are shorted, making it an OR gate and finally connected to red led. Pin o4-o5 and passed through diodes, shorted and connected to yellow led. In the same fashion pins, o6-o9 are connected to green led.

For the first 4 pulses, one of the inputs from o0-03 is active sequentially hence red led glows. For the next two pulses, the yellow led glows and then the green led for the next4 pulses. The diodes are attached to prevent the circuit from shortening as it blocks the output for the pins when it is not active. Each led is connected to a resistor before being grounded to provide a sink and prevent the circuit from burning.[8][9][10]

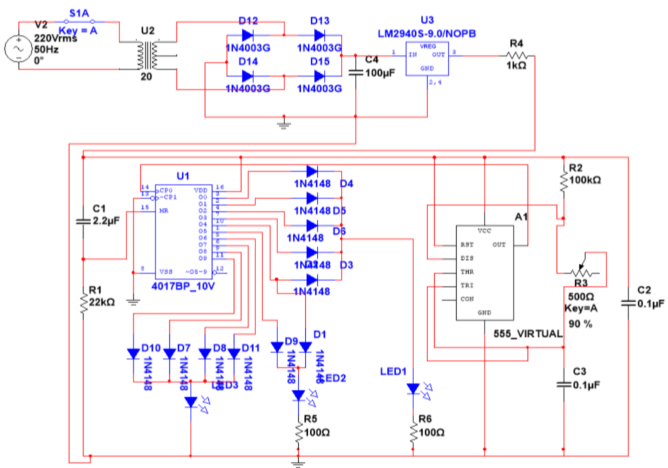

Fig -5: Final circuit for one-way traffic light control system

3. CONCLUSIONS

A simple traffic light control system is used to display the 3 color LEDs – red, yellow, and green. This system can be improved by adding a potentiometer that can control the display time for each LED according to need and also by adding a transformer for conversion from AC to DC voltage that allows this circuit to work in real-life applications. It can be further improved by using a density-based traffic control system with the help of a microcontroller.

The amount of time the LEDs glow for depends on the pulse generated by the 555 timer. The current circuit allows us no control over the timing of each signal, which is very essential in real-world applications. A potentiometer can be used to control this timing.

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