Modern Railway Crossing Detector Using Multivibrator

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***Abstract*—In the rapidly flourishing country like ours, accident in the unmanned level crossing are increasing day by day. No fruitful steps have been taken so far in these areas. Our project report deals with automatic railway gate operation, implemented in unmanned level crossings at remote areas detection of train approaching the gate can be sensed by means of the reed switch placed on either side of the gate. Train arrival and departure sensing can be achieved by means of magnet properties .When the wheels of the train over, the reed switch which are placed near the track sense and this acts as a signal to the circuit indicating train arrival. Yellow signal appears for the road user, once the train cuts the reed switch placed before the 2 km before the gate. Once yellow light appears after approximately 3 seconds, it automatically blinks the red light that indicates train is crossing. When the train has passed level crossing it operates the cancel reed switch which switch off the light until the next train arrives. This can be implemented in manned level crossing also, as manned errors can be eliminated by automation.**

***Index Terms*—Sensor, railway gate, magnetic contact technique.**

I. INTRODUCTION

AT PRESENT scenario, in level crossing, the railway gate is operated normally by a gate keeper after receiving the information about train's arrival. When a train starts to leave a station, Station master of the particular station delivers the information to the nearby gate. The above said procedures are followed for operating the railway gates.

Semiautomatic railway gate operation is also followed in certain areas. Signal are located in the vicinity of railway gate along with gate master board and a master light. Our paper deals with automatic railway gate control (i.e.) gate operated without gate keeper. It is implemented in unmanned level crossings at remote areas.

The arrival of the train to reach the level crossing is sensed by the switch place on either side of the gate at about 2 KM from the level crossing. So the arrival is sensed by the either side of the sensor and then the sensed signal is send to the circuit and this act as a signal to the circuit indicating train arrival. Yellow signal appears for the road user, once the train cuts the reed switch placed before the 2KM before the gate.

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Once yellow light appears after approximately 3 seconds, it automatically blinks the red light that indicates train is crossing. When the train has passed level crossing it operates the cancel reed switch which switch off the light until the next train arrives. This placed light signal on either side of the gate warning to the load user indicating the arrival of the train.

II. BLOCK DIAGRAM FOR CIRCUIT

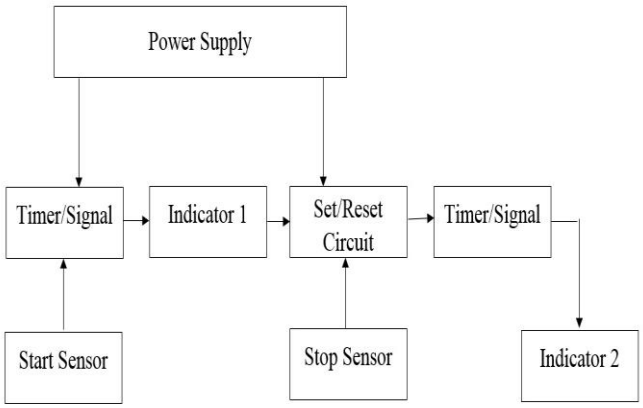

Fig. 1. Block Diagram

A. Start/Stop Sensor

These blocks are used to detect the arrival and the departure of the train. This sensor works on the magnetic field generated by the train. A determined time and hence gives trigger to the Set/Reset Circuit [5], [1].

B. Trigger/Timer

As the signal from start sensor gets to the timer 1 block, it gets operational. Timer 1 block gives the output of glowing indicator 1 for, timer 1 and stop sensor .when the 1st input of this block goes high. This block gives the signal to the gate to rotate anticlockwise and the other input goes high it gives the signal to rotate clockwise hence the controlling of gate is controlled. A determined time and hence gives trigger to the Set/Reset Circuit [5], [1].

C. Set/Reset Circuit

This block is used to supply the Indicator driver Circuit. This Circuit have two States. As the Circuit gets triggered, it changes it's from one to other. As the output of this block goes high, it gives supply to the indicator driver Circuit [5], [1].

D. Indicator Driver Circuit

This is basically a driver Circuit which is used to supply to the indicator 2 for the period of passing of train. This block controls the blinking of the LED's connected at the indicator 2.

E. Gate Driver Circuit

This block is used to control the rotation of the gate i.e. DC motor. The blocks get two inputs i.e. from timer 1 and stop sensor. when the 1st input of this block goes high, this block gives the signal to the gate to rotate anticlockwise and when the other input goes high it gives the signal to rotate clockwise. Hence the controlling of gate is controlled [5], [1].

III. FUNCTIONAL PARTS AND MODES OF 555 TIMER IC AND REED SWITCH

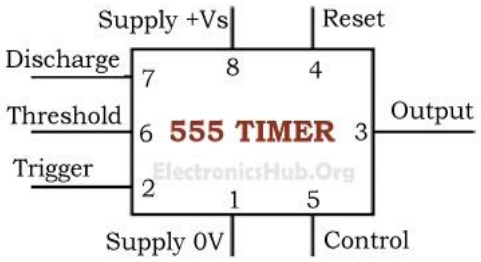

Fig. 2. Internal structure of 555 IC

A. Functional Parts 555 Timer IC

1) *Comparator:* It is used to compare two voltages at the input level which is inverting (-) one and non-inverting (+). If the voltage at non-inverting is higher than other than the output is high. For ideal comparator input resistance infinite [2].
2) *Voltage Divider:* As the input resistance is infinite in the comparator so the voltage among all the resistors is being divided equally. Value across each resistor is vin/3 [2].
3) *Flip/Flop:* Digital electronic devices with memory. If the input is high while low at R then the output at Q is high. It means when S is high Q output is high and if R is high Q output is low [2], [5].

B. Pin Description of 555 Timer IC

Pin 1: **Grounded Terminal:** All the voltages are measured with respect to the Ground terminal [3], [2].

Pin 2: Trigger Terminal: The trigger pin is used to feed the trigger input hen the 555 IC is set up as a monostable multivibrator. This pin is an inverting input of a comparator and is responsible for the transition of flip-flop from set to reset. The output of the timer depends on the amplitude of the external trigger pulse applied to this pin. A negative pulse with a dc level greater than Vcc/3 is applied to this terminal. In the negative edge, as the trigger passes through Vcc/3, the output of the lower comparator becomes high and the complimentary of Q becomes zero. Thus the 555 IC output gets a high voltage, and thus a quasi stable state [3], [2].

Pin 3: Output Terminal: Output of the timer is available at this pin. There are two ways in which a load can be connected to the output terminal. One way is to connect between output pin (pin 3) and ground pin (pin 1) or between pin 3 and supply pin (pin 8). The load connected between output and ground supply pin is called the *normally on load* and that connected between output and ground pin is called the normally off load [3], [2].

Pin 4: Reset Terminal: Whenever the timer IC is to be reset or disabled, a negative pulse is applied to pin 4, and thus is named as reset terminal. The output is reset irrespective of the input condition. When this pin is not to be used for reset purpose, it should be connected to + V_{CC} to avoid any possibility of false triggering [3], [2].

Pin 5: Control Voltage Terminal: The threshold and trigger levels are controlled using this pin. The pulse width of the output waveform is determined by connecting a POT or bringing in an external voltage to this pin. The external voltage applied to this pin can also be used to modulate the output waveform. Thus, the amount of voltage applied in this terminal will decide when the comparator is to be switched, and thus changes the pulse width of the output [3], [2].

Pin 6: **Threshold Terminal:** This is the non-inverting input terminal of comparator 1, which compares the voltage applied to the terminal with a reference voltage of 2/3 V_{CC}. The amplitude of voltage applied to this terminal is responsible for the set state of flip-flop. When the voltage applied in this terminal is greater than 2/3Vcc, the upper comparator switches to +Vsat and the output gets reset [3], [2].

Pin 7: **Discharge Terminal:** This pin is connected internally to the collector of transistor and mostly a capacitor is connected between this terminal and ground. It is called discharge terminal because when transistor saturates, capacitor discharges through the transistor. When the transistor is cut-off, the capacitor charges at a rate determined by the external resistor and capacitor [3], [2].

Pin 8: Supply Terminal: A supply voltage of + 5 V to + 18 V is applied to this terminal with respect to ground (pin 1) [3], [2].

C. Modes Of 555 Timer IC

1) 555 in Astable Mode

IC 555 works in astable mode along with the internal circuit described in the block. There are three resistors named R inside it and all have equal values. These form a voltage divider having reference voltage of 1/3 and 2/3 of vcc (power supply). The logic state of flip flop is controlled by the reference voltage which is given to one of the inputs of both two comparators. Pin 2 of the 555 is the trigger input. If the voltage at pin 2 is <1/3 of vcc, the flip flop switch to a low state of output of the low comparator. The output stage has an inverting action. In other words, output at 555 high when flip flop output low [3].

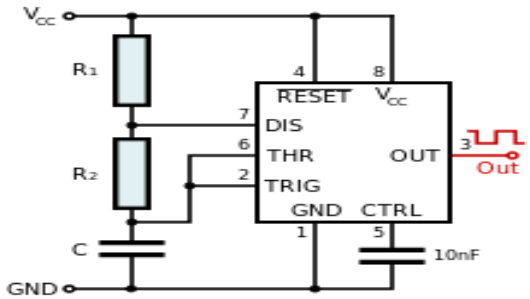

Fig. 3. Astable mode of IC 555

a) $Time\ for\ which\ output\ is\ high = 0.693\ (R_1 + R_2)\ C$

b) $Time\ for\ which\ output\ is\ low = 0.693\ R_1\ C$

c) $Period\ of\ Output\ T = 0.693\ (R_1 + 2\ R_2)\ C$

d) $PRF\ of\ Output = \frac{1.44}{(R_1+R_2)\ C}$

e) $Duty\ Cycle = \frac{R_1+R_2}{R_1+2\ R_2}$

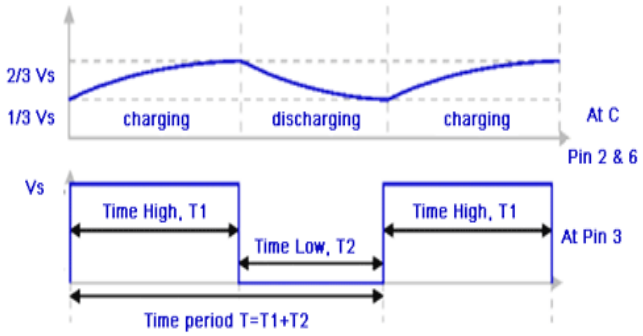

Fig. 4. Waveform for Astable mode

Now imagine if the power supply is first connected to the astable circuit. Timing capacitor is discharged at the starting. The output in 555 is high and voltage is 0V at pin2. With the help of resistor R1 and R2 and capacitor C starts charging. Note that C is also connected to pin6 which is the threshold input of 555.The output of the lower comparator is reached at the next level when voltages across C is more than 1/3 of vcc. The output of flip flop doesn't change and remain at low state. The input at the second comparator is the voltage at pin 6, the threshold input, and 2/3vcc from the internal voltage divider. The output of second comparator reaches at next level when the voltage at C moves more than 2/3 of vcc. Now the flip flop switch from low to high state and output of 555 also switch from high to low [3].

Flip-flop is attached with the NPN transistor internally and pin 7 which is discharge pin of the IC is connected to the collector of the transistor. The transistor gets into on mode when the flip flop is in high state giving a low resistance path to 0V from the discharging pin. The voltage decreases as the capacitor C starts for vacant via a resistor R2.Note capacitor discharges only via R2 while discharging via R1 and R2 both. The lower comparator moves to the next level when the voltage across C<1/3 of vcc, state of flip flop switches and 555 reaches to high [3], [2].

2) 555 in Monostable Mode

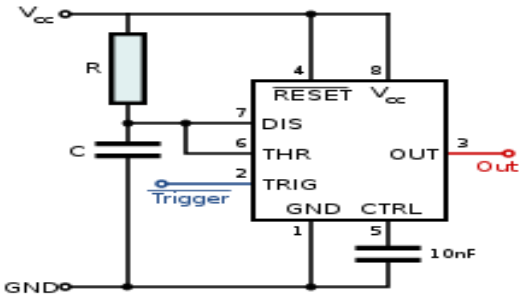

Fig. 5. Monostable Mode of 555 IC

Choosing of R and C:

a) Choose C first (there are relatively few values available).

b) Choose R to give the time period required.

c) R should be in the range of 1K to 1M.

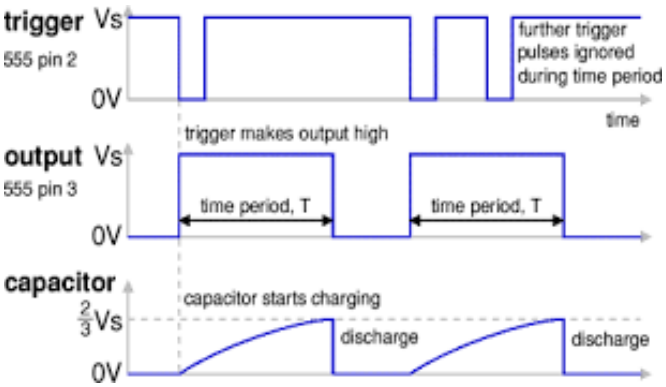

Fig. 6. Waveform for mostable mode

Brief description:

a) Monostable circuit provides a single pulse when triggered.

b) Monostable means one stable that is output low.

c) The 'output high' on triggered is a very temporary state.

d) The duration of the pulse is called the time period (T) and this is determined by resistor R and capacitor C [3], [2].

3) 555 in Bistable Mode

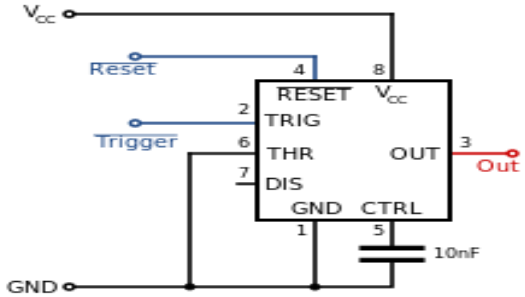

Fig. 7. Bistable mode for 555 IC.

The circuit is called a bistable because it is stable in two states: output high and output low. It is also known as a 'flip-flop' [3], [2].

It has two inputs:

a) Trigger which makes the output high. Trigger is active low, it function when <1/3 vs.

b) Reset which makes the output low. Reset is active low, it resets when <0.7V [3], [2].

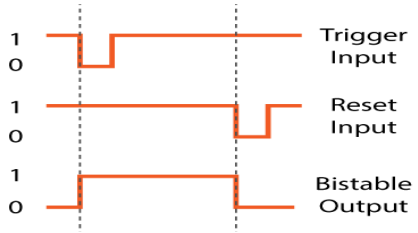

Fig. 8. Waveform for Bistable mode

D. Reed Switch

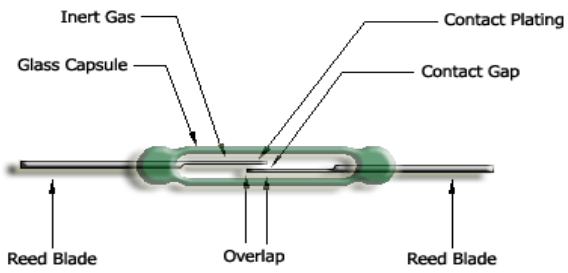

Fig. 9. Internal Structure Reed switch

How does a reed switch work?

Reed switch comes in varieties called normally open (normally switch off) and normally closed (normally switch on). Normally Open [4].

1) Normally Open

Fig. 10. Normally open reed switch

In a reed switch, the two contact are made with the magnetic material and housed inside a thin glass envelop. One of the is magnetic north pole, while the other is south pole. As you bring the magnet up to the switch, it affects contacts in opposite ways, attracting one and repelling the other, so they spring together and a current flows through them. A reed switch like is a normally open (NO) **(**normally off), unless a magnet is positioned next to it, when it switch on. Normally Close [4].

2) Normally Close

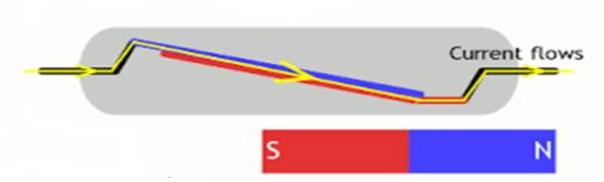

Fig. 11. Switch close when magnet is near

The two contact are snapped together. When you bring the magnet up to the switch, the lower contact is attracted to the magnet, the upper one is repelled, so the contact split apart, opening the switch and breaking the circuit. Reed switches like this are called normally close (NC) (normally on), and they switch off when you bring a magnet up to them [4].

IV. DESIGN OF UNMANNED RAILWAY CROSSING DETECTOR

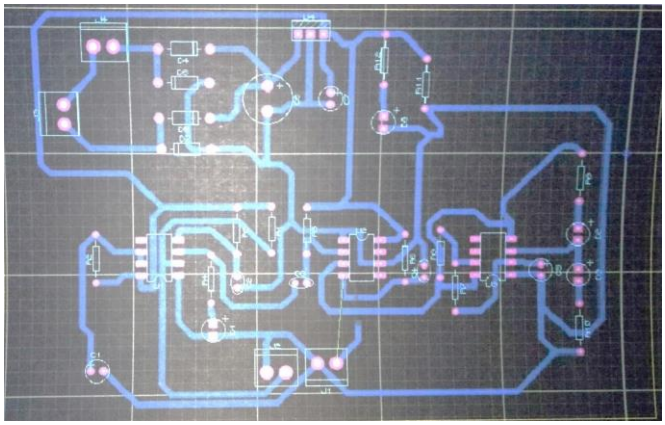

Fig. 12. a. PCB layout

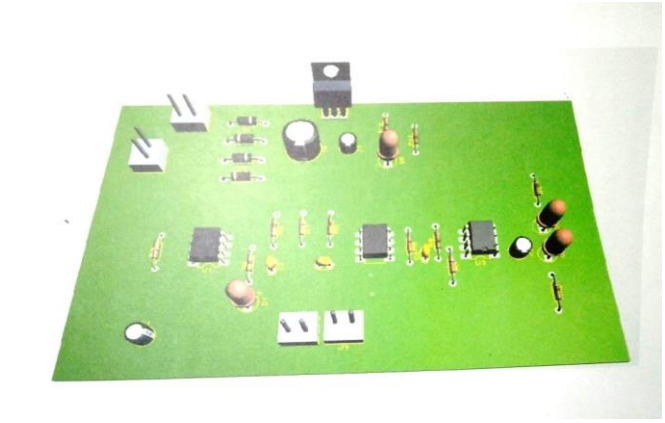

Fig. 12. b. PCB layout

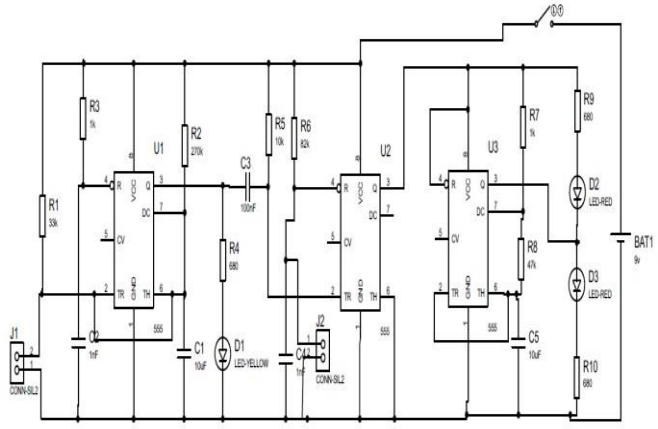

Fig. 13. Cicuit diagram for unmanned railway crossing detector

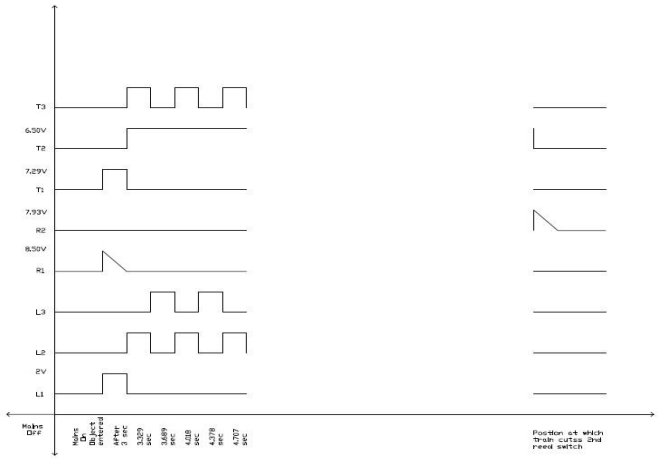

Fig.14. Timing Diagram

Calculations

1) Pin no. 2 of 1st stage = 8.50 V
2) Output of 1st stage = 7.29 V
3) Voltage across C3 capacitor = 8.88 V
4) Pin no. 4 of 2nd stage = 7.93 V
5) Output of 2nd stage = 6.50 V
6) Output of power supply = 9 V
7) Output current of power supply = 0.23 mA

V. RESULT AND DISCUSSION

At present the existing system is manually and human controlled system once the train leaves the station. The station master informs the gatekeeper about the arrival of the train through the telephone. Once the gatekeeper receives the information then he closes the gate depending on the timing at which the train arrives. Hence if the train is late due to certain reasons, then gate remain closed for a long time causing traffic near the gates. There is no centralized system is available presently signals are control by mean of interlocking and wrong signals and signal device which is totally semiautomatic system [1].

The automatic railway gate control at the level crossing. The time for which it is closed is less compared to the manually operated gates and also reduces the human labor. This type of gates can be employed in an unmanned level crossing where the chances of accidents are higher and reliable operation is required. Since the operation is automatic error due to manual operation is prevented [1].

VI. CONCLUSION

1) The idea of railway crossing detector using multivibrator has been undertaken.
2) Again, it can be implemented by adding buzzer in the circuit, so the people who has eye problems or the blind person they can hear the buzzer and save their life.

3) Overall it is very useful project in rural areas. The mechanism works on a simple principal and there is not much of complexity needed in the circuit.

4) It is low cost project, easy to implement and there is no speed limit for triggering.

5) This project is can be specifically used as a Railway crossing light. The main use of this project in the rural area is where one way crossing present and there is no one to control the traffic. It can be implemented in cities also reduce human error and reducing the railway accident.

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