DESIGN & DEVELOPMENT OF ELECTRONIC LETTER BOX USING LDR

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ABSTRACT

This paper reports a design and development of electronic letter box which indicates the presence and absence of letter designed using timer IC 555 and LDR. The setup also consists of LED’S, when the letter is put inside, LED glows which indicate the presence of letter.

KEYWORDS: Electronic Box, Comparator, Flip-Flop, LDR

Here we are introducing electronic letter box, which is designed using Timer IC 555 and LDR basically indicate the presence of letter. IC 555 timer is a one of the most widely used IC in electronics and is used in various electronic circuits. The IC555 timer is called so, the timer got its name from the three 5 kilo ohm resistor in series employed in the internal circuit of the IC. As shown in fig 1 and 2, the 555 timer comes as 8 pin DIP (Dual In-line Package) device. There is also a 556 dual version of 555 timer which consists of two complete 555 timers in 14 DIP and a 558 quadruple timer which is consisting of four 555 timer in one IC and is available as a 16 pin DIP in the market.

Figure 1: IC 555 Pin Diagram

Figure 2: Internal Configuration of IC 555

As shown in figure 2, IC555 includes two comparators, one RS flip-flop and other few discrete components like transistors, resistors etc. the biasing voltage (Vcc) is divided in three parts through voltage divider using same value of resistors R. From these, 1/3Vcc is given to non-inverting terminal of trigger comparator and 2/3 Vcc is given to inverting terminal of threshold comparator. The outputs of both comparators are given to R and S inputs of flip-flop. The Q’ output is actual output of IC and Q output drives discharging transistor that provides discharging path to external capacitor whenever it is high. When negative trigger <1/3 Vcc is applied at trigger input pin, the trigger comparator gives high output that resets the flip flop and Q’ output that is the output of chip goes high. When positive trigger >2/3 Vcc is applied at threshold input pin, the threshold comparator gives high output that sets the flip flop. The Q output will become high and the output of chip goes low. At that time discharging transistor that provides discharging path to external capacitor. The high reset input keeps flip-flop enable. If it is low, flip-flop disables and output will be low. No any effect of threshold and trigger comparator outputs [Available at 1 and 3].

MATERIALS AND METHODS

Comparator

The Comparator is the basic electronic component which compares the two input voltages i.e. between the inverting (-) and the non-inverting (+) input and if the non-inverting input is more than the inverting input then the output of the comparator is high. Also the input resistance of an ideal comparator is infinite.

Voltage Divider

As we know that the input resistance of the comparators is infinite hence the input voltage is divided equally between the three resistors. The value being Vin/3 across each resistor.
**Flip/Flop**

Flip/Flop is a memory element of Digital-electronics. The output (Q) of the flip/flop is ‘high’ if the input at ‘S’ terminal is ‘high’ and ‘R’ is at ‘Low’ and the output (Q) is ‘low’ when the input at ‘S’ is ‘low’ and at ‘R’ is high.

**FUNCTION OF DIFFERENT PINS**

a. **Ground:** This pin is used to provide a zero voltage rail to the Integrated circuit to divide the supply potential between the three resistors shown in the fig.2.
b. **Trigger:** The voltage at the non-inverting end of the comparator is \( V_{in}/3 \), so if the trigger input is used to set the output of the F/F to ‘high’ state by applying a voltage equal to or less than \( V_{in}/3 \) or any negative pulse, as the voltage at the non-inverting end of the comparator is \( V_{in}/3 \).
c. **Output:** It is the output pin f the IC, connected to the Q’ (Q-bar) of the F/F with an inverter in between as show in the figure 2.
d. **Reset:** This pin is used to reset the output of the F/F regardless of the initial condition of the F/F and also it is an active low Pin so it connected to ‘high’ state to avoid any noise interference, unless a reset operation is required. So most of the time it is connected to the Supply voltage as shown in the figure 2.
e. **Control Voltage:** As we can see that the pin 5 is connected to the inverting input having a voltage level of \( (2/3) \ V_{in} \). It is used to override the inverting voltage to change the width of the output signal irrespective of the RC timing network.
f. **Threshold:** The pin is connected to the non-inverting input of the first comparator. The output of the comparator will be high when the threshold voltage will be more than \( (2/3) \ V_{in} \) thus resetting the output (Q) of the F/F from ‘high’ to ‘low’.
g. **Discharge:** This pin is used to discharge the timing capacitors (capacitors involved in the external circuit to make the IC behave as a square wave generator) to ground when the output of Pin 3 is switched to ‘low’.h. **Supply:** This pin is used to provide the IC with the supply voltage for the functioning and carrying of the different operations to be fulfilled with the 555 timer.

**The IC 555 can be used as following 3 types**

a. **Astablemultivibrator** – it has no stable state. It has two quasi stable states that automatically changes from one to another and back. So actually it changes from high to low state and low to high state without any trigger input after pre determine time.
b. **Monostablemultivibrator** – it has one stable state and one quasi stable state. It jumps into quasi stable state from stable state when trigger input is applied. It comes into stable state from quasi stable state after pre determine time automatically.
c. **Bistablemultivibrator** – it has both stable states. Two different trigger inputs are applied to change the state from high to low and low to high.

**APPLICATIONS**

The IC 555 timer is used in many circuits, for example One-shot pulse generator in Monostable mode as an Oscillator in Astable mode or in Bistable mode to produce a flip/flop type action. It is also used in many types of other circuit for achievement of various purposes for instance Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) etc.

**LDR**

A LDR as shown in figure 3 (light dependent resistor) is a light controlled variable resistor made of a high resistance semiconductor. An LDR is also called as photoresistor or photocell. In the dark, a photoresistor can have a resistance as high as several mega ohms (MD), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. An LDR can be applied in light and dark activated switching circuits. LDR used in some dynamic compressors together with a small incandescent or neon lamp, or light-emitting diode to control gain reduction. A common usage of this application can be found in many guitar amplifiers that incorporate an onboard tremolo effect, as the oscillating light patterns control the level of signal running through the amp circuit [Available at 3 and 5].
RESULTS AND DISCUSSION

This circuit as shown in figure 4 uses a timer IC which is 555. IC 555 is connected as comparator with pin 6 connected with positive supply, the output goes high-1 when the trigger pin 2 is at lower than 1/3 level of the supply voltage. Conversely the output goes low-0, when it is above 1/3 level. So small change in the voltage of pin 2 is enough to change the output of pin 3 from 1 to 0 and 0 to 1. The output has only two states high and low and cannot remain in any intermediate stage. It is power by 9V battery for portable use. The circuit is economic in power consumption. Pin 4, 6 & 8 is connected to the positive supply and pin 1 is grounded.

![Figure 4: Electronic Letter Box Circuit Diagram](image)

To detect the present of letter we have used LDR and a source of light. LDR is a special type of resistance whose value depends on the brightness of the light which is falling on it. It has a resistance of about 1 mega ohms when in total darkness, but a resistance of only about 2-5 k ohms when brightly illuminated. It responds to a large number of light spectrums. The source of light and LDR is so adjusted in the letter box that light will directly fall on the LDR but when letter is kept inside then it will block the beam of light and LDR will be under darkness. We have made a potential divider circuit with LDR and 100k variable resistance connected in series. Voltage is directly proportional to conductance so more voltage we will get by this divider when LDR is getting light and low voltage in darkness. Divided voltage is given to pin 2nd of IC 555. As soon as LDR gets dark the voltage of the pin 2 drops 1/3 of the supply voltage and pin 3 gets high and LED glows. We can also use two LED at output pin 3, for present LED 1 and for absent LED 2. For this method one LED is connected as forward bias and other is connected as reverse bias to indicate both high and low conditions. To limit the current of LED resistance is used in series. For source light, use Red or White LED. For LED 2 and 3 you can use any other color- green, red, yellow or blue[1,6].

As in fig. 5 & 6 when there is no letter present red light will glow, red is the indication that no letter is present. As letter is put inside the letter box, shown in fig 7 and fig 8, there is no light falling on the LDR then its resistance increases which results in decrease of the voltage at pin 2 of the IC 555. IC 555 has got comparator inbuilt, which compares between the input voltage from pin 2 and 1/3rd of the power supply voltage. When input falls below 1/3rd then output is set high otherwise it is set low. So when letter is put inside it, the result will be decrease in input voltage then output set to high, which indicates the presents of letter by glowing LED1. If there is no letter inside, then LED2 will be on{Available at 2 and 7}.

![Figure 5: Absence of Letter](image)

The corresponding observations of the electronics letter box as follows: If the letter box is empty i.e, there is no letter inside the box which turns ON the LED2.

![Figure 6: Absence of Letter](image)

Figure 7: After Inserting Letter inside the Box

![Figure 7: After Inserting Letter inside the Box](image)
If there is a letter inside the box, the LED1 will glow which indicates the presence of letter.

**Figure 8: After Inserting Letter inside the Box**

**CONCLUSIONS**

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the feature in which thing we may occupy every place. The presentation of “ELECTRONICS LETTER BOX “is used to indicate the presence of letter in a letterbox. In our daily life it is much useful because there is no need of checking empty letter box .Here by using this setup; it will make LED to glow which indicate presence of letter. Hence we conclude that the principle of the development of science is that “nothing is impossible”. So we shall look to a growth of science in bright world.

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