I. Introduction

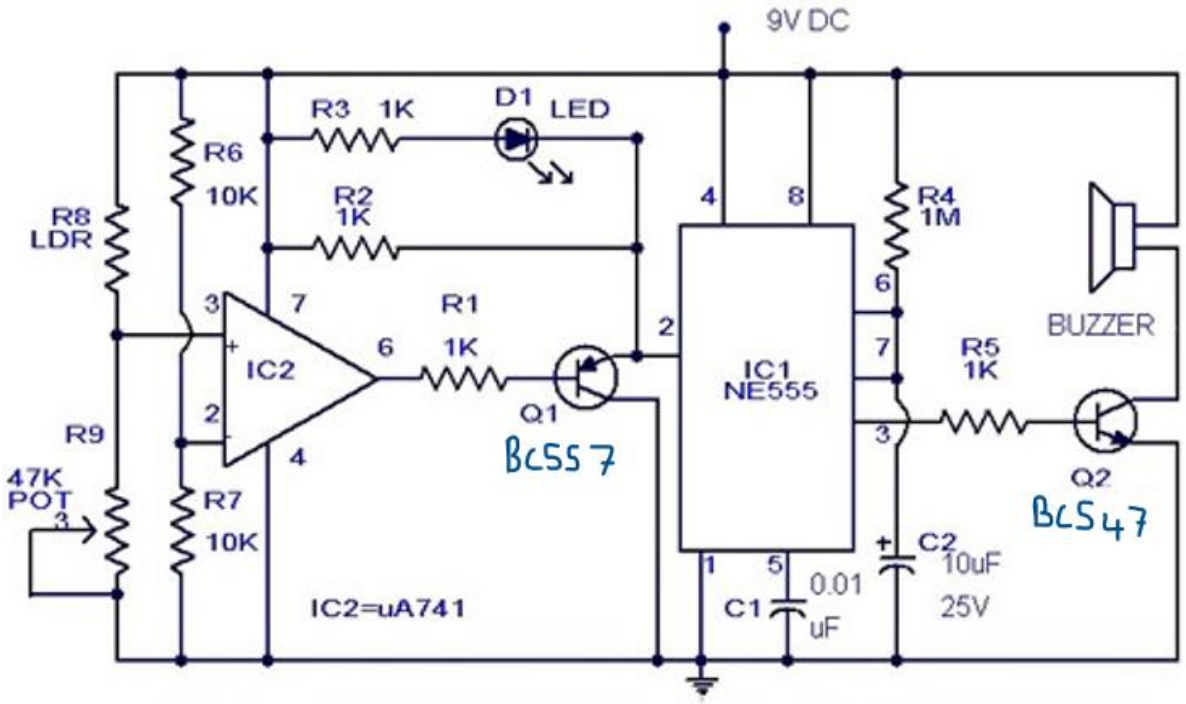
In modern times, the concern for the security of residences and electronic devices has become an area of equal importance. Security alarm systems play a very important role in securing the area from any kind of unwarranted entry or access. The security alarm system circuit provides effective means for detecting the breach and warning the users about the security lapse. The circuit works on the principle of activating an alarm signal by a specific condition – which here is blocking the light – making it very useful for securing the restricted area and for the protection of our property. This circuit is designed to be cost effective, easy to build, and very efficient, making it very useful for use in an electronics project or assignment for increased security and reduced unwanted access or entry.

II. Objective & Description

The primary objectives of the project are:

1. Design a working security alarm circuit using Ne555 timer.
2. Testing and confirming the circuit design using Proteus.
3. Implementing the circuit using hardware components.
4. Documenting our observations and results.

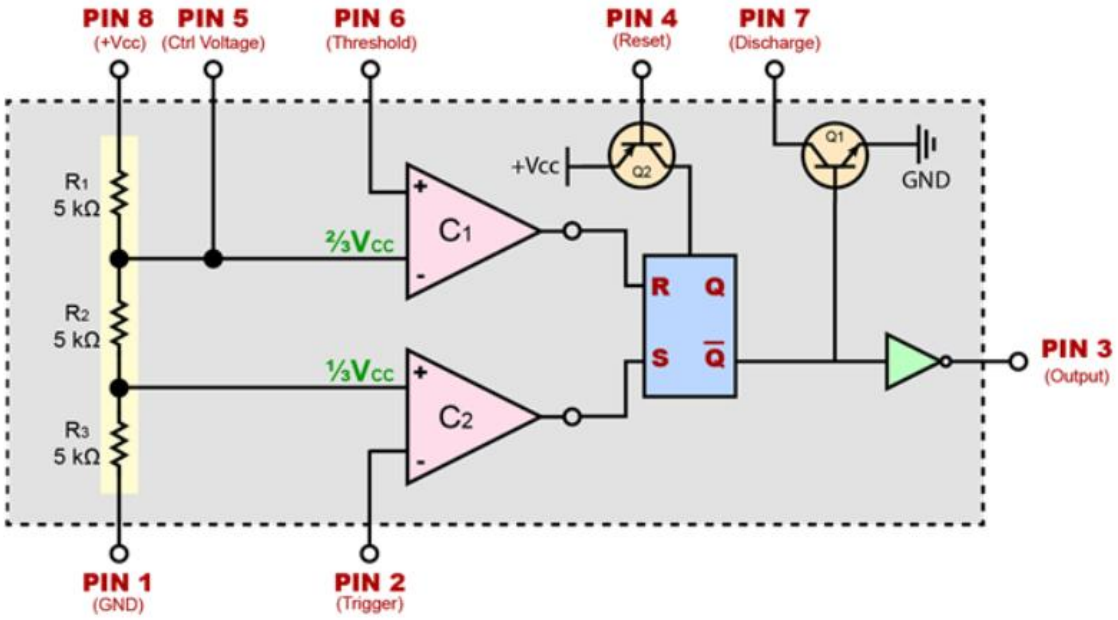
Schematics and Components:



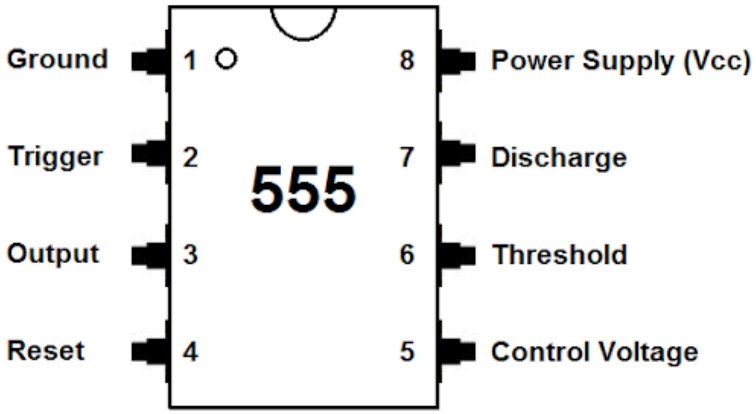
- NE555 Timer (IC1).
- UA741 Operational Amplifier (IC2).
- Potentiometer (Variable resistor).
- Light emitting diode (LED).
- Light dependent resistor (LDR Sensor).
- Transistors: **Q1 – BC557** (PNP Transistor), **Q2 – BC547** (NPN Transistor).
- Resistors: **1kΩ** (4 units), **10kΩ** (2 units)**, 1MΩ.**
- Capacitors: Polarized Capacitor **10µF,** Ceramic Capacitor **0.01µF**.
- Buzzer
- Power supply (DC): **9V**
- Breadboard and Wires

NE555 Timer (IC1):

- **Overview:** The NE555 timer is a widely used and versatile integrated circuit designed for timing, pulse generation, and oscillation applications. It contains 23 transistors, 2 diodes, and 16 resistors, internally configured to operate in monostable, astable, and bistable modes.



- **Datasheet and Pin Descriptions:**



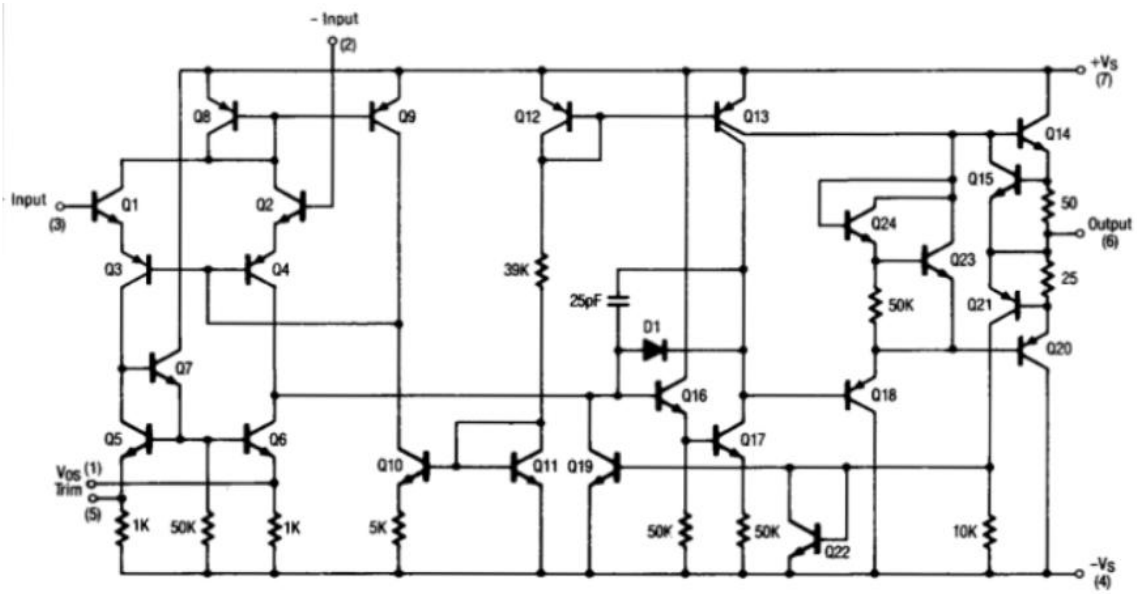
Pin Descriptions		
Pin Name	**Pin Number**	**Description**
GND	1	Ground
TRIG	2	Trigger set ⅓ Vcc
OUT	3	Timer output
RESET	4	Reset active low
CONT	5	External adjustment of internal threshold and trigger voltages
THR	6	Threshold set to ⅔ Vcc
DIS	7	Low impedance discharge path
Vcc	8	Chip supply voltage

- **Use in our circuit:**

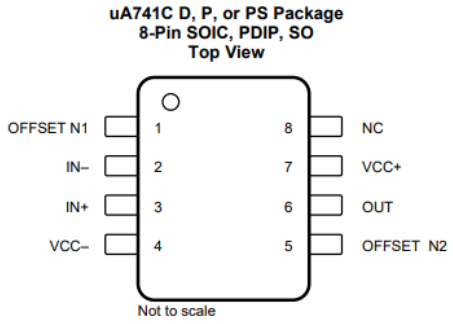
  The 555 timer generates the pulsing signal that drives the alarm sound. In this circuit, once triggered by Q1, it oscillates and produces a repeating output signal rather than a constant voltage, which makes the buzzer beep instead of staying continuously on.

UA741 Operational Amplifier (IC2):

- **Overview:** The UA741 operational amplifier is a widely used general purpose analog integrated circuit. It consists of multiple bipolar transistors, resistors, and capacitors arranged to provide high voltage gain, high input impedance, and low output impedance, making it suitable for signal amplification and analog processing applications.



- **Datasheet and Pin Descriptions:**



NC- no internal connection

Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
IN+	3	I	Noninverting input
IN–	2	I	Inverting input
NC	8	—	No internal connection
OFFSET N1	1	I	External input offset voltage adjustment
OFFSET N2	5	I	External input offset voltage adjustment
OUT	6	O	Output
VCC+	7	—	Positive supply
VCC–	4	—	Negative supply

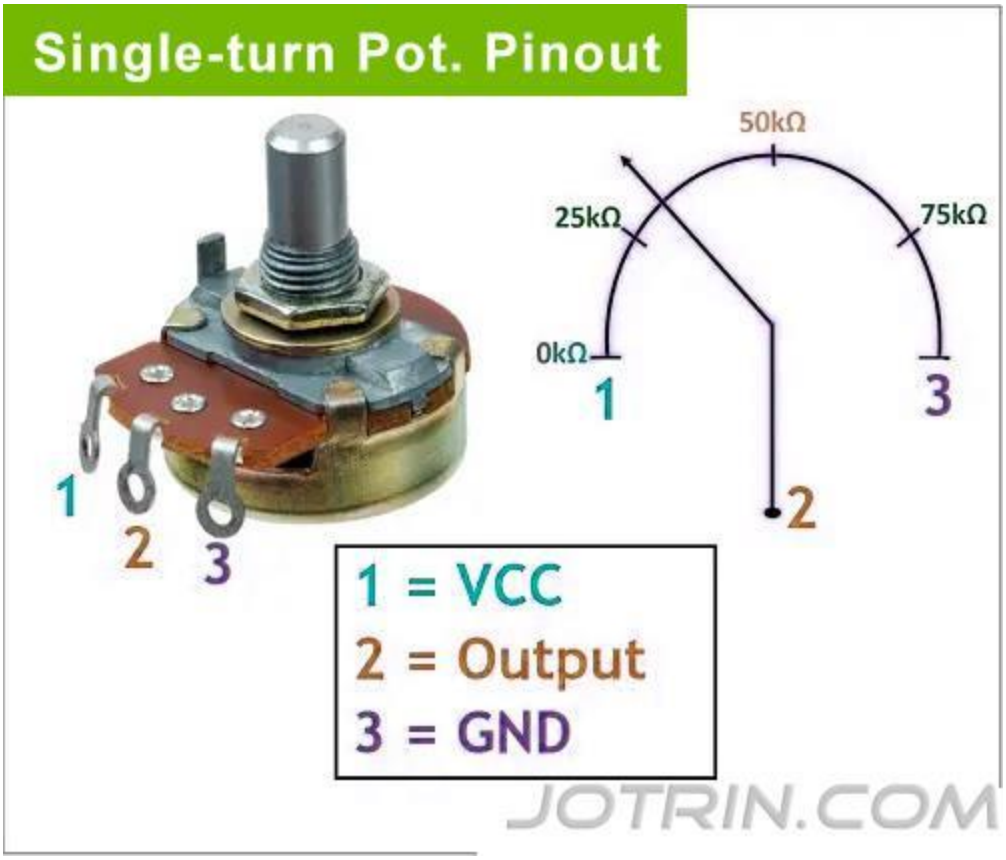
- **Use in our circuit:**

  The op-amp is used as a comparator in this circuit. It compares the voltage produced by the LDR and sensitivity control with the reference voltage, and when the light level crosses the preset threshold, the op-amp output switches state to indicate that an intrusion has occurred.

Potentiometer (Variable resistor):

- **Overview:** The potentiometer is a component that works like a variable resistor and voltage divider. The potentiometer has three terminals, and a resistive track, with a moving contact point that is referred to as a wiper. The voltage or resistance, which is determined by the resistive track, can be controlled through rotation or translation of the control that is connected to the wiper.

- **Datasheet and Pin Description:**

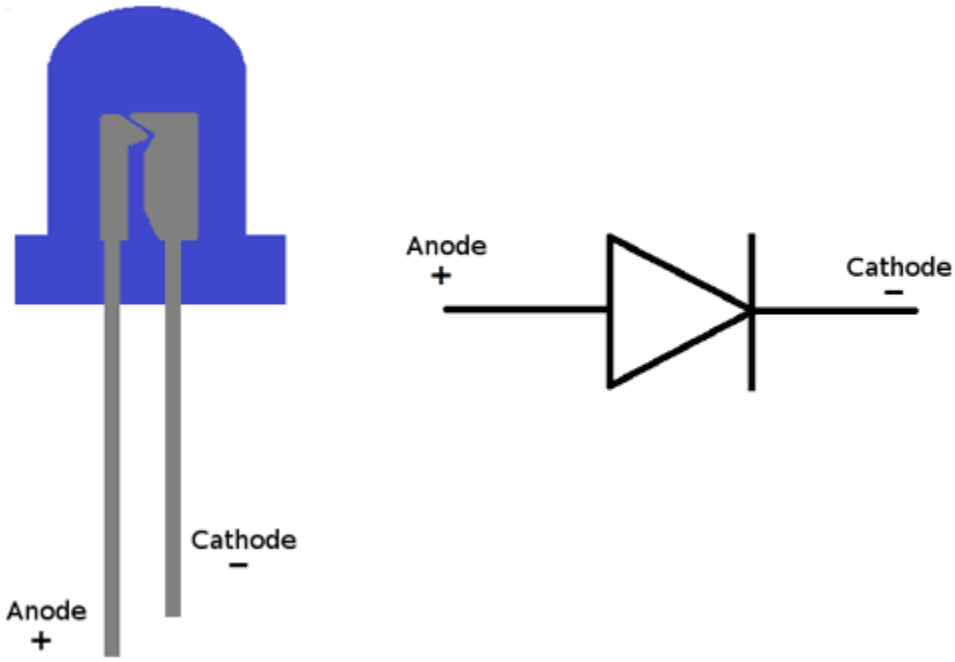


- **Use in our circuit:**
  The potentiometer adjusts the sensitivity of the alarm system. In this circuit, it sets the reference level against which the LDR voltage is compared, allowing the user to decide how much light change is required to trigger the alarm.

Light emitting diode (LED):

- **Overview:** A light-emitting diode (LED) is a common electronic component that produces light when electricity flows through it. It is made from special semiconductor materials. It has two different behaviors.
  1. Forward bias: When the positive voltage is applied to the LED's anode and negative to the cathode, current flows and the LED lights up.
  2. Reverse bias: When the voltage is applied in the opposite direction, very little or no current flows, and the LED does not light.

- **Datasheet:**

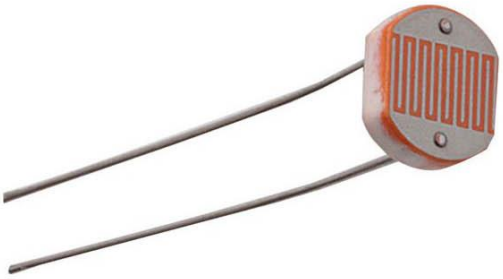


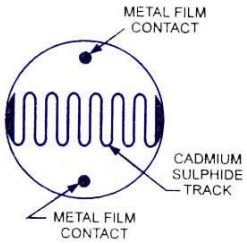
- **Use in our circuit:**
  The LED serves as a visual alarm indicator. In this circuit, it turns on when the comparator detects an intrusion, showing that the alarm condition is active even before or while the buzzer sounds.

Light dependent resistor (LDR Sensor):

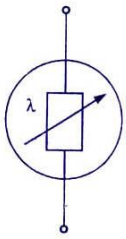
- **Overview:** A light-dependent resistor (LDR), also known as a photoresistor, is an electronic component whose resistance changes based on the amount of light falling on it. It is made from a semiconductor material that becomes more conductive as light intensity increases. And its sensitivity is determined by the potentiometer.

- **Datasheet:**





(a) Basic Structure



(b) Symbol

LDR

- **Use in our circuit:**

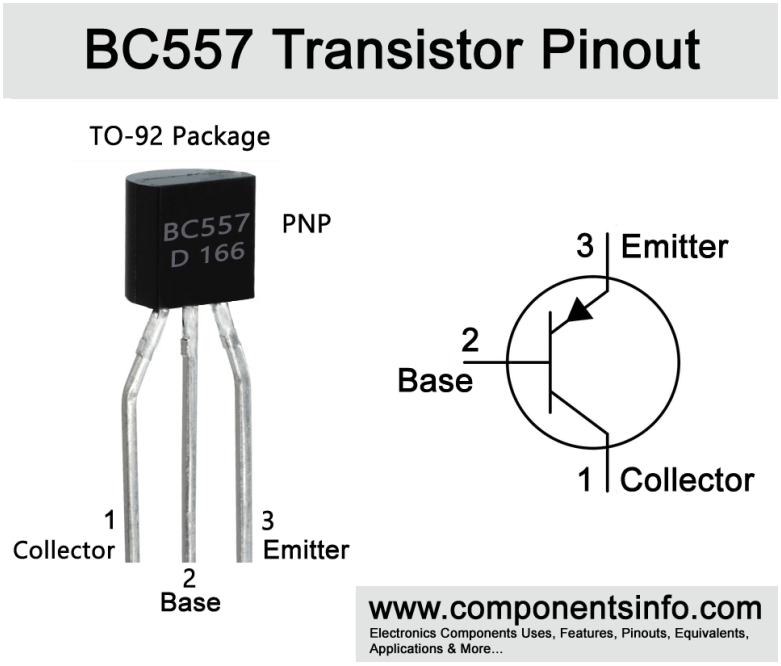
  The LDR is the sensing element of the alarm. In this circuit, its resistance changes when light falls on it, causing a change in voltage at the op-amp input. This voltage change is what allows the circuit to detect when light suddenly appears or disappears, such as when a door or window is opened.

Transistors:

Q1-BC557 (PNP Transistor):

- **Overview:** The BC557 is a widely used general purpose PNP (Positive-Negative-Positive) transistor. This transistor has three regions of the semiconductor material: the emitter region, the base region, and the collector region. In a PNP transistor, the current flows from the emitter to the collector when the base is made more negative with respect to the emitter.

- **Datasheet and Pin Description:**



- **Use in our circuit:**
  Q1 (PNP BC557) acts as a switching interface between the op-amp and the 555 timer. When the op-amp detects a light change, Q1 turns on or off accordingly, allowing it to trigger the 555 timer cleanly without loading the op-amp output.

Q2-BC547 (NPN Transistor):

- **Overview:** The BC547 is a commonly used general purpose NPN (Negative-Positive-Negative) transistor. It has three terminals: collector, base, and emitter, and makes current flow from the collector to the emitter with the base positive with respect to the emitter. In a NPN transistor, the current flows when the base is positive to the emitter.

- **Datasheet and Pin Description:**

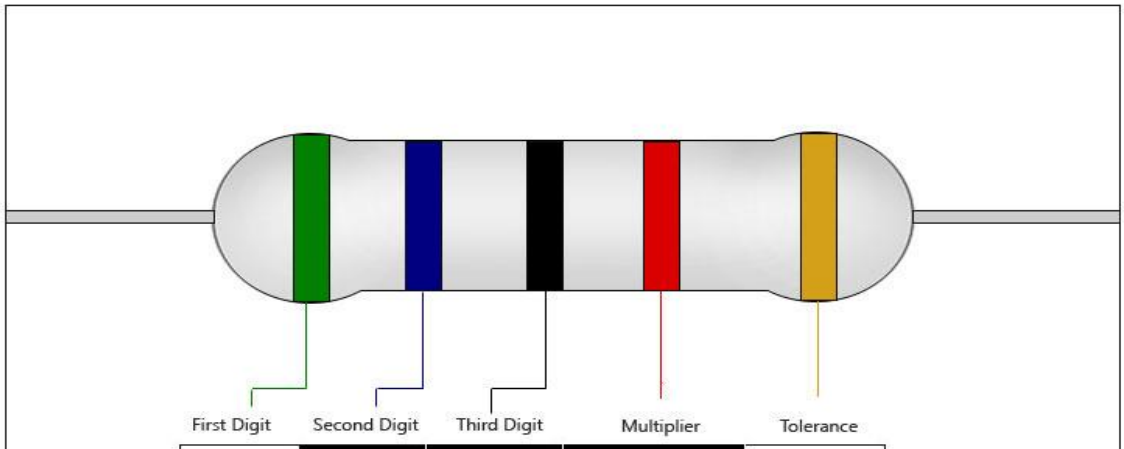
- **Use in our circuit:**
  Q2 (NPN BC547) acts as the power driver for the buzzer. In this circuit, it allows the low-current output from the 555 timer to control the higher current required by the buzzer without damaging the timer.

Resistors:

- **Overview:** A resistor is a two terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, and to divide voltages.

- **Datasheet:**

5 Band Resistor



	First Digit	Second Digit	Third Digit	Multiplier	Tolerance
Black	Nil	0	0	1	Nil
Brown	1	1	1	10	±1%
Red	2	2	2	100	±2%
Orange	3	3	3	1000	±3%
Yellow	4	4	4	10000	±4%
Green	5	5	5	100000	±0.5%
Blue	6	6	6	1M	±0.25%
Violet	7	7	7	10M	±0.10%
Grey	8	8	8	100M	±0.05%
White	9	9	9	1G	Nil
Gold	Nil	Nil	Nil	÷10	±5%
Silver	Nil	Nil	Nil	÷100	±10%

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- **Use in our circuit:**

  R1 (**1kΩ)** limits the current flowing from the op-amp output into the base of transistor Q1. In this circuit, it protects the op-amp while ensuring that Q1 is driven correctly when the comparator output changes.

  R2 (**1kΩ**) helps control the voltage at the junction between the op-amp output, Q1, and the 555 trigger input. In this circuit, it ensures proper biasing so that the trigger signal to the 555 is stable and well defined.

  R3 (**1kΩ**) limits the current flowing through the LED. In this circuit, it allows the LED to safely light up when the alarm condition is detected, giving a visual indication that the system has been triggered.

  R4 (**1MΩ**) sets the timing characteristics of the 555 timer. In this circuit, it controls how fast the buzzer pulses, affecting the tone and repetition rate of the alarm sound.

  R5 (**1kΩ**) limits the base current going into transistor Q2. In this circuit, it protects the 555 output while ensuring Q2 switches fully when the alarm signal is present.

  R6 (**10kΩ**) helps form a stable voltage divider for the op-amp input. In this circuit, it ensures that the voltage coming from the LDR network stays within a usable range for reliable comparison.

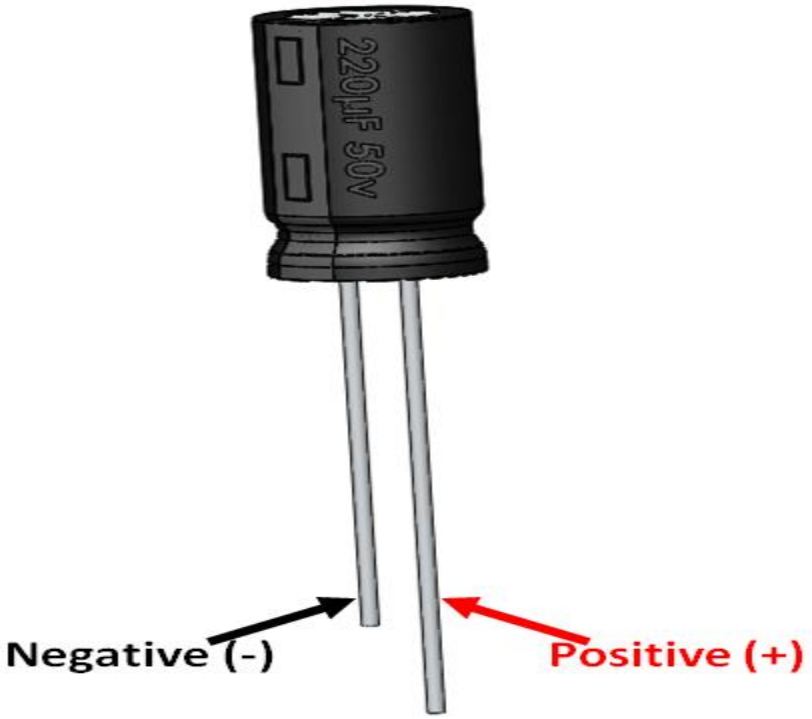
  R7 (**10kΩ**) works with R6 to provide a steady reference voltage to the op-amp. Its role is to stabilize the comparator operation and reduce false triggering caused by small voltage shifts.

Capacitors:

Polarized Capacitor:

- **Overview:** A polarized capacitor is a type of capacitor that has a definite positive (anode) and negative (cathode) terminal and must be connected correctly in a circuit. It is commonly made as an electrolytic capacitor, which allows it to store relatively large amounts of electrical charge in a compact size. Connecting it backward can damage the capacitor or the circuit.

- **Datasheet:**

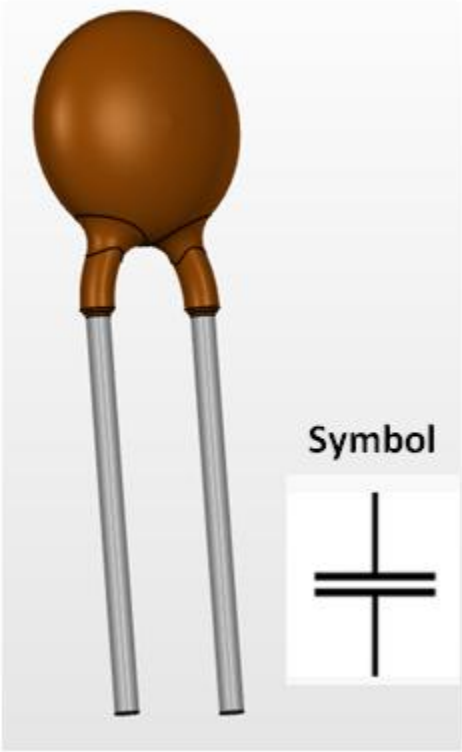


- **Use in our circuit:**
  C2 (**10µF**) works together with R4 to define the oscillation period of the 555 timer. In this circuit, it determines how long each buzzer pulse lasts and helps shape the audible alarm pattern.

Ceramic Capacitor:

- **Overview:** A ceramic capacitor is a type of non-polarized capacitor made from ceramic materials as the dielectric. It can be connected in any direction in a circuit, making it simple and flexible to use. Can be used in AC or DC circuits without worrying about polarity.

- **Datasheet:**

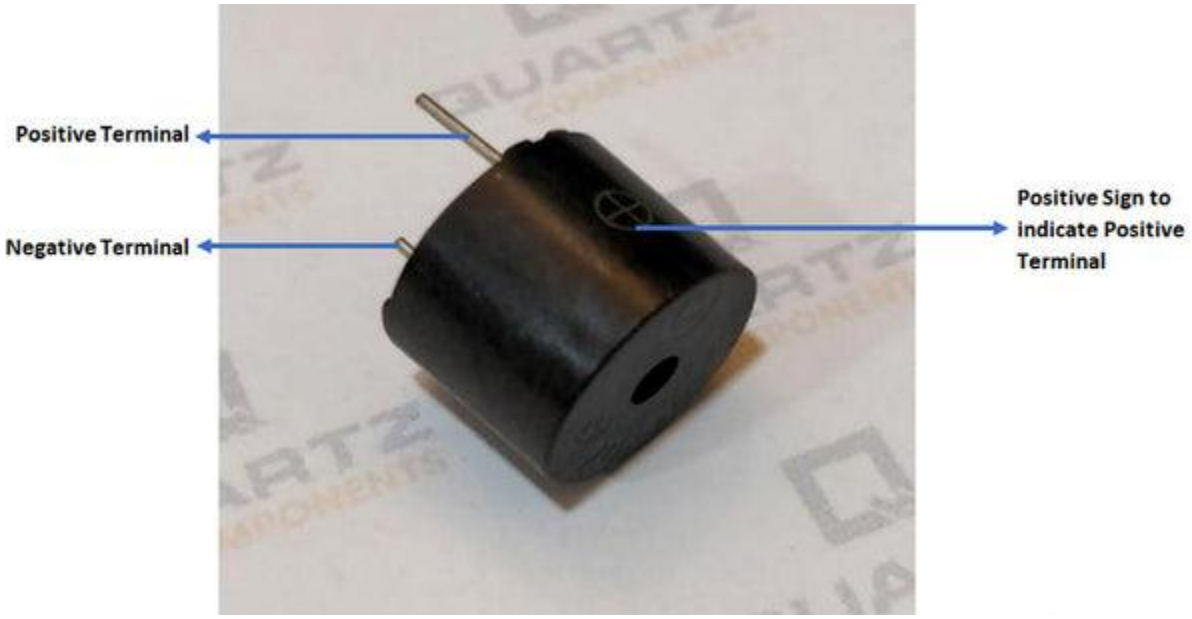


- **Use in our circuit:**
  C1 (**0.01µF**) is connected to the control pin of the 555 timer to suppress noise. In this circuit, it improves stability and prevents unwanted triggering of the alarm due to electrical interference.

Buzzer:

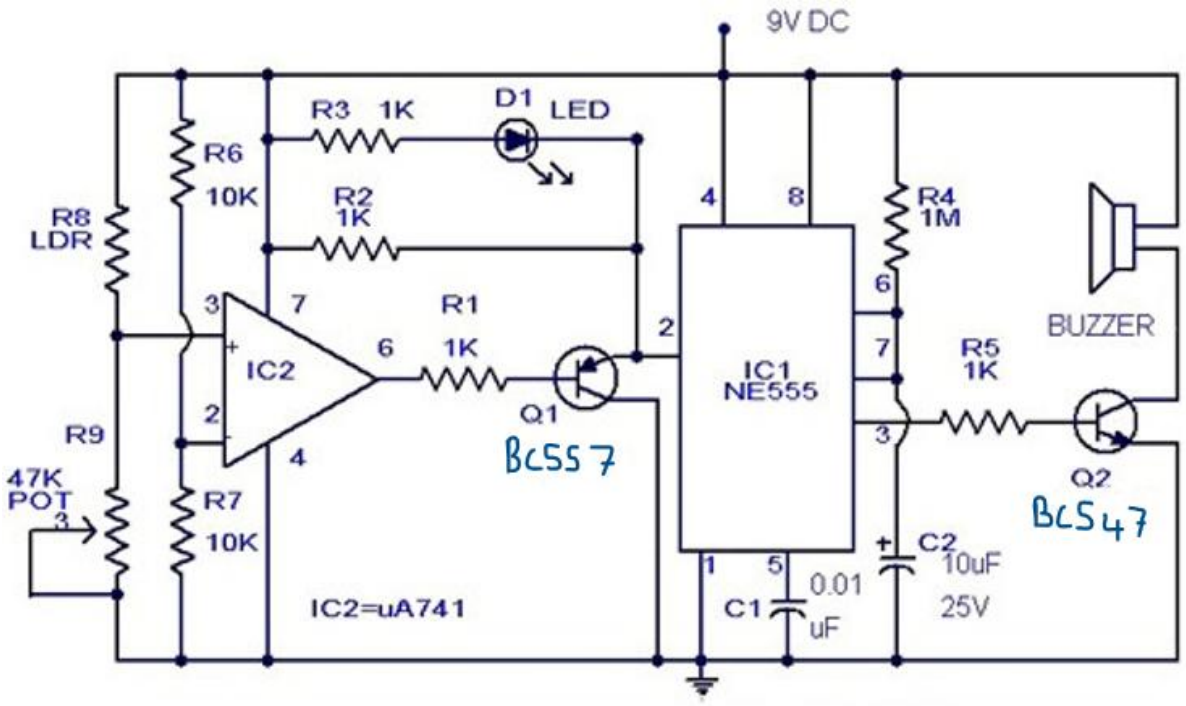
- **Overview:** A buzzer is an electronic device that produces sound when electrical voltage is applied. It converts electrical energy into audible sound, usually in the form of a beep, tone, or alarm.

- **Datasheet:**



- **Use in our circuit:**
  The buzzer is the final alarm output device. In this circuit, it converts the pulsing electrical signal from the 555 timer into an audible sound that alerts others when a light intrusion is detected.

III. Circuit Diagram



IV. Theoretical Analysis

This is a security timer alarm system designed to detect break ins and produce a warning signal. The Light Dependent Resistor (LDR) acts as the light sensor to detect the variation in the level of light. The normal condition is that the level of the incident light keeps the LDR at a steady resistance and voltage level. As soon as the path of the incident light is interrupted, the variation in resistance is sensed by the operational amplifier (UA741), which acts as a comparator to produce a signalling output.

The output of the comparator powers a transistor that turns on the NE555 timer IC. The NE555 IC is set up in a manner that it generates an output pulse after a certain time period to keep the alarm activated for a predetermined period despite any temporary disturbance in the signal. The output pulse activates another transistor acting as a switch to activate the buzzer alarm.

When the light gets interrupted by any object, the timing circuit gets activated for a preset time interval, therefore enabling the buzzer circuit, which has been implemented using the second stage of the NE555 IC. The preset time interval or delay for the buzzer happens because of the resistor **1 MΩ** and the capacitor **10µF** that create a time constant together (R x C = t) and in this case the delay is long (10 seconds) because the values of both the resistor and capacitor are big. The delay can be shorter by decreasing the value of the capacitor or the resistor. We can also increase the delay by increasing their values. The ceramic capacitor **0.01µF** works with resistors to set how fast the timer oscillates. The polarized capacitor **10µF** helps stabilize and smooth the

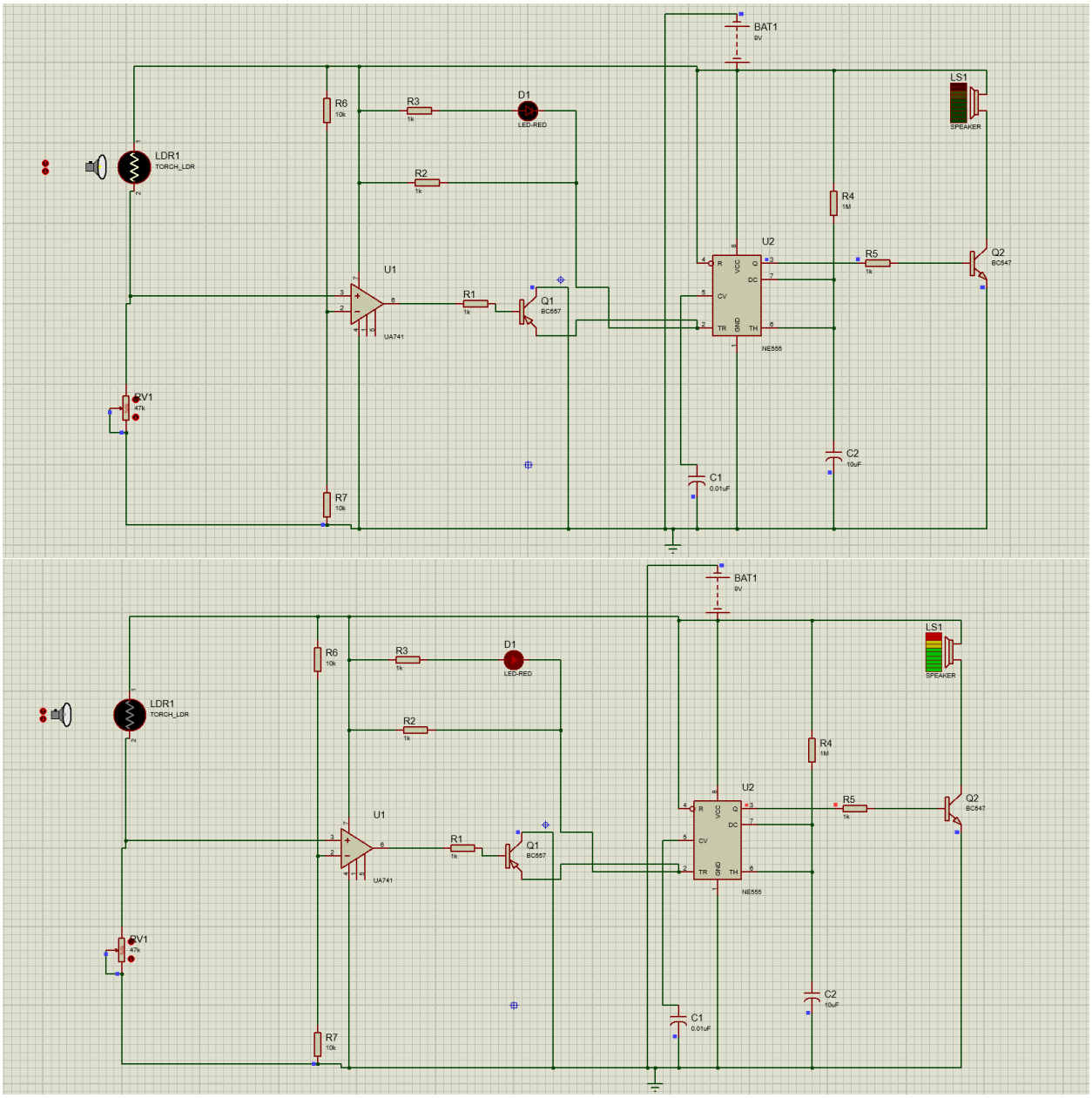
voltage, also helps control how long the timer keeps oscillating once triggered. The circuit uses a **9V** DC power supply.

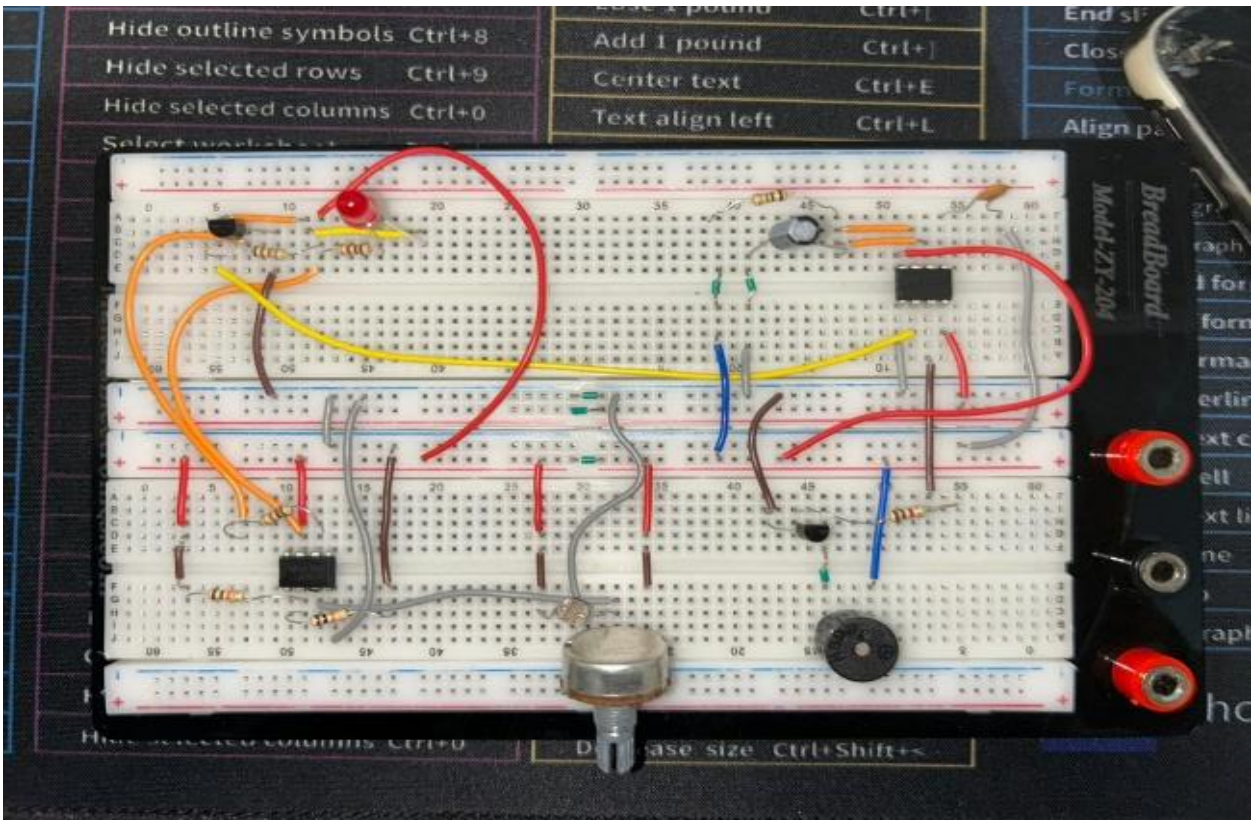
Under normal working conditions, the light is always focused on the light dependent resistor (LDR), keeping the circuit always in an inactive state. On the other hand, when the light is blocked, there is an instantaneous transition in the resistance of the LDR, which in return switches on the comparator circuit. This immediately activates the timer IC. This circuit design ensures that the buzzer is always ON for the configured time duration, even if the blockage is temporary. Using the 555 timer ensures smooth timing functionality. This makes the circuit ideal for security purposes like entry protection, monitoring, or alerting others for restricted areas.

V. Simulation results

When the light is far from the LDR the diode lights up and the buzzer starts making sound. When the light gets close to the LDR the diode lights off and the buzzer has a delay before turning off which is determined and can be changed by the **10µF** or the **1MΩ**. In this case the delay for the buzzer is about 10 seconds.

VI. Simulation & Circuit Screenshots

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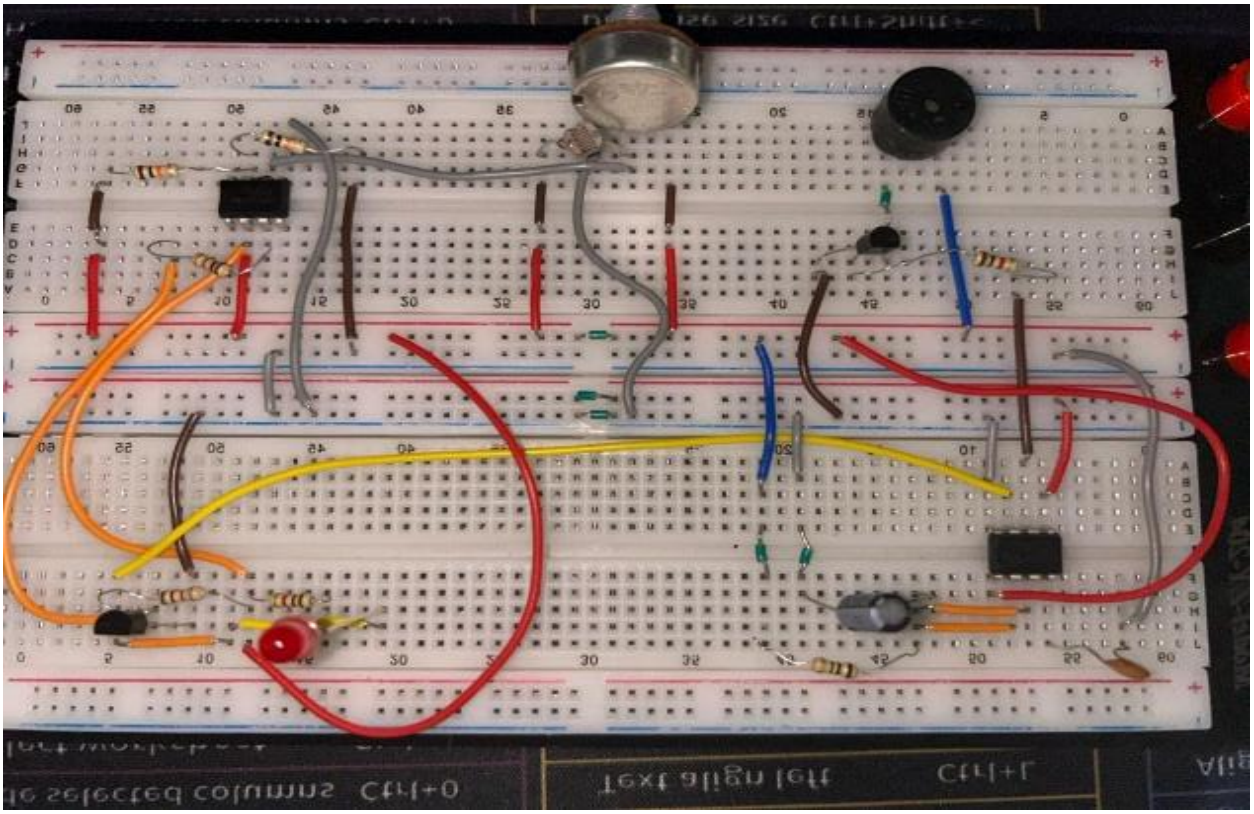

The use of a speaker in the simulation was approved by the doctor because there was no active buzzer on Proteus.

VII. Conclusion

The security alarm circuit is an essential part of modern security systems and is commonly used in areas requiring higher levels of surveillance, such as homes and areas that need constant monitoring. This type of circuit is designed to detect the movement of objects or individuals through the tracking of the interruption of light, which then produces an indicator sound to warn the user of the possibility of an intrusion.

The essential characteristics of the security alarm system include reliability, cost effectiveness, and ease of installation. The use of the security alarm system is applicable to different settings; however, the efficiency of the system may be affected by environmental factors such as dust, fog, or improper alignment of light. To improve the accuracy of the results and prevent false alarms, the security system is often combined with other security devices such as cameras.

This study presents the design of a simple security timer alarm using an LDR, comparator, and NE555 timer IC. During the design process, there were initial difficulties, the transistors needed weren't on Proteus, so they had to be changed with similar ones with the approval of the doctor. In addition to that, it wasn't known that there was a delay on the buzzer, after the delay was known, it wasn't understood why there was a delay, but after research and careful analyzation, it was clear, fully understood, and implemented. This design presents an ideal

security system that can be applied in learning institutions as well as practical environments.

VIII. References

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6. https://www.jotrin.com/
7. https://circuitstoday.com/