REDEFINING HOME SAFETY THROUGH PRECISION AND INNOVATION

ECB1204 - ANALOG INTEGRATED CIRCUIT

A PROJECT REPORT

Submitted by

PURUSHOTHAMAN A

RAJKUMAR R S

THOMAS LIVINGSTON G

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

K. RAMAKRISHNAN COLLEGE OF TECHNOLOGY

(An Autonomous Institution, Affiliated to Anna University Chennai and Approved by AICTE, New Delhi)

SAMAYAPURAM, TIRUCHIRAPPALLI – 621 112

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BONAFIDE CERTIFICATE

Certified that this project report titled **“REDEFINING HOME SAFETY THROUGH PRECISION AND INNOVATION”** is the bonafide work of **PURUSHOTHAMAN A (2303811710621081), RAJKUMAR R S (2303811710621085), THOMAS LIVINGSTON G (230381171062115)** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not from part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE	**SIGNATURE**
Dr. S. SYEDAKBAR, M.E., Ph.D.,	Mrs. G. KEERTHANA, M.E.,
HEAD OF THE DEPARTMENT	**SUPERVISOR**
Assistant Professor	Assistant Professor
Department of Electronics and Communication Engineering	Department of Electronics and Communication Engineering
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Samayapuram – 621 112	Samayapuram – 621 112

Submitted for the viva-voce examination held on ………………

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We jointly declare that the project report on **“REDEFINING HOME SAFETY THROUGH PRECISION AND INNOVATION”** is the result of original work done by us and best of our knowledge, similar work has not been submitted to **“ANNA UNIVERSITY CHENNAI”** for the requirement of Degree of **BACHELOR OF ENGINEERING**. This project report is submitted on the partial fulfillment of the requirement of the award of Degree of **BACHELOR OF ENGINEERING**.

SIGNATURE

PURUSHOTHAMAN A

RAJKUMAR R S

THOMAS LIVINGSTON G

Place : Samayapuram

Date :

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CHAPTER 1
PROBLEM STATEMENT

With the rise in security concerns, both residential and commercial properties face an increasing need for effective and affordable security solutions. Traditional security systems, such as CCTV cameras and motion sensors, while effective, can often be expensive, require professional installation, and are not always accessible to small-scale users. As a result, there is a growing demand for simple, low-cost security systems that can be easily implemented and operated by non-technical users.

A redefining home safety through precision and innovation provides a practical and economical solution to these challenges. This system uses a laser beam and a light-dependent resistor (LDR) to create a simple yet effective intrusion detection mechanism. The concept relies on detecting the interruption of the laser beam, which triggers an alarm to alert the user of an intrusion. Despite its simplicity, this system can act as a reliable first line of defense for homes, offices, lockers, or any restricted area.

The proposed system is designed to address specific problems:

The high cost of advanced security systems limits their accessibility for individuals and small businesses. This project uses low-cost components, making it budget-friendly.

Complex installations often deter users from adopting security systems. The laser security system is simple to assemble using readily available components like an LM358 Op-Amp, NE555 Timer IC, and a laser pointer.

Many security systems fail during power outages. This system is battery-operated, ensuring uninterrupted operation.

While cost-effective, the system is designed to provide accurate and consistent detection of intrusions.

However, the laser-based security system also has limitations, such as the need for precise alignment of the laser beam and the inability to detect intrusions that do not cross the beam's path. These limitations make it more suitable for small-scale applications, where simplicity and cost-effectiveness are prioritized over comprehensive coverage.

This project aims to demonstrate the practicality and effectiveness of a laser security system, highlighting its advantages, addressing its limitations, and exploring its potential applications in safeguarding properties and enhancing personal safety.

1.1 BACKGROUND OF THE WORK

Security systems play a vital role in safeguarding properties, assets, and individuals from potential threats. With the rapid advancements in technology, modern security systems have become increasingly sophisticated, yet these solutions often come with high costs and complexities. In contrast, a redefining home safety through precision and innovation offers a simple, affordable, and effective alternative that can be deployed in homes, offices, and other restricted areas.

The fundamental principle of a laser security system lies in detecting the interruption of a laser beam. By employing a laser source and a light-dependent resistor (LDR) as the sensing element, this system is capable of identifying any object or individual crossing the path of the laser. This detection mechanism can trigger an alarm to notify the user of a possible intrusion, providing an additional layer of protection.

Historically, laser technology has been used in various fields, including communication, surveying, and defense systems. Its adoption in security systems leverages the precision and reliability of laser beams. A laser beam is a focused light source that can cover significant distances without significant dispersion, making it ideal for setting up invisible boundaries for security purposes.

The increasing demand for low-cost and user-friendly security solutions has led to the development of projects like this. By using widely available components such as the LM358 operational amplifier, NE555 timer IC, and a basic laser pointer, this project demonstrates the potential to create an efficient and reliable security system. The circuit design and operation are straightforward, making it suitable for DIY enthusiasts, educational purposes, and small-scale security needs.

This project bridges the gap between advanced security systems and cost-effective alternatives, emphasizing the importance of leveraging simple technologies to address real-world challenges. It provides a stepping stone for further advancements, such as integrating wireless communication, camera systems, or remote monitoring capabilities for enhanced functionality.

CHAPTER 2
DESIGN PROCEDURE OF LASER SECURITY

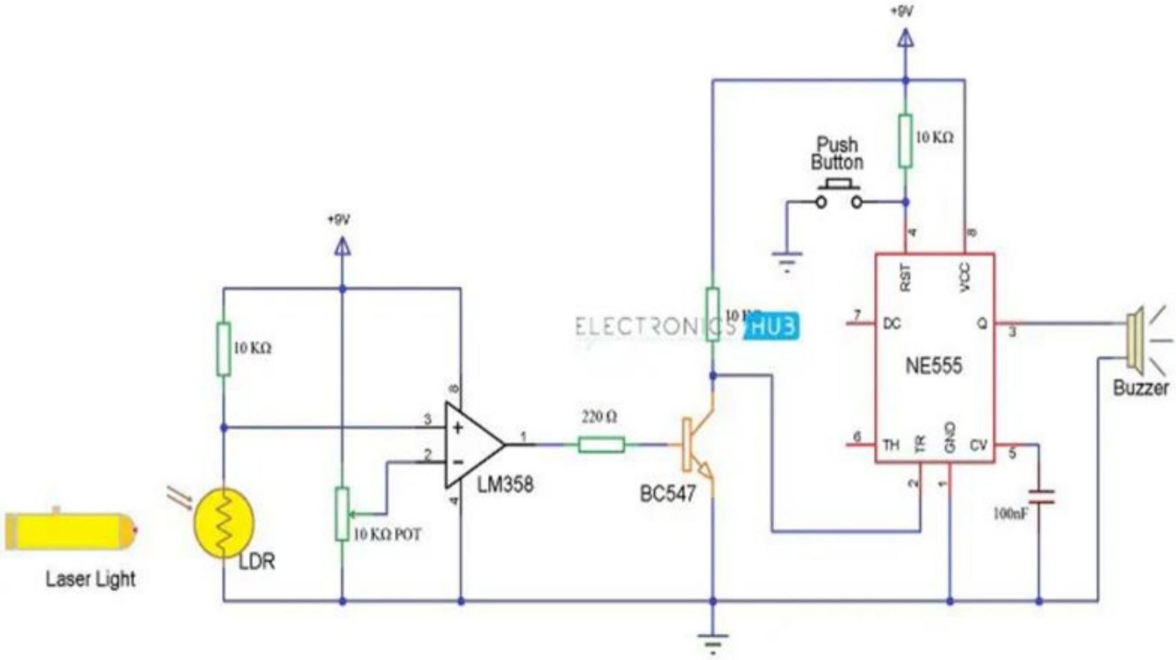

Figure 2.1 Circuit Diagram of Redefining Home Safety Through Precision And Innovation

2.1 CIRCUIT COMPONENTS

2.1.1 LASER POINTER

Laser Pointer acts as the main source of light in this project. We have used a small laser pointer with an output power of less than 1mW. The laser pointer emits red light and the wavelength of the laser output is between 630 nm to 680 nm.

Figure 2.2 Laser Pointer

2.1.2 LDR (LIGHT DEPENDENT RESISTOR)

The LDR acts as a light sensor in this project. As the intensity of the light falling on the LDR increases, the resistance of the LDR decreases and vice – versa. The LDR is used in combination with the laser to form the light sensor and source.

Figure 2.3 LDR

2.1.3 NE555 (IC 555)

IC 555 is a precision timing IC that provides time delays or oscillations. 555 Timer IC has three modes of operation: Astable, Monostable and Bi-stable. In this project, we are going to use the IC 555 in Bi-stable mode.

Figure 2.4 NE555

2.1.4 LM358 (OP – AMP)

LM358 is a dual Operational Amplifier IC and it is capable of operating in all the conventional operational amplifier circuits. In this project, the LM358 is used as a Comparator.

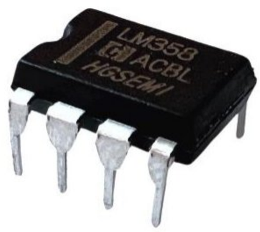

Figure 2.5 LM358

2.1.5 RESISTORS AND CAPACITOR

These resistors are used in various parts of the circuit, including the voltage divider with the LDR, the reference voltage divider with the potentiometer, and as current-limiting resistors for the transistor and other components. The 10 KΩ resistors are critical in controlling the current flow and ensuring that the components operate within their safe limits**.**

Figure 2.6 10 KΩ Resistor

This 220 Ω resistor is used to limit the current going to the base of the transistor (BC547). It ensures that the base current is sufficient to turn the transistor on without overloading it. This resistor plays a crucial role in protecting the transistor from excessive current and ensuring it switches on reliably when the op-amp output is high.

Figure 2.7 220 Ω Resistor

The 100 nF ceramic capacitor is connected to Pin 5 (Control Pin) of the NE555 timer. This capacitor helps stabilize the timer's operation by filtering any noise or fluctuations in the voltage. It ensures that the timer operates correctly and triggers the buzzer without any unwanted interference.

Figure 2.8 100 nF Capacitor

2.1.6 POTENTIOMETER

The 10 KΩ potentiometer is used to provide adjustable control over the reference voltage at the inverting terminal of the LM358. By adjusting the potentiometer, the threshold for detecting the change in light intensity (when the laser is interrupted) can be fine-tuned. This allows for more accurate detection based on ambient light conditions or other environmental factors.

Figure 2.9 Potentiometer

2.1.7 BC547 (NPN TRANSISTOR)

The **BC547** is an **NPN transistor** used as a **switch** in this circuit. It is controlled by the output from the **LM358 op-amp**. When the laser beam is interrupted, the LDR's resistance changes, triggering the op-amp to turn on the transistor. The transistor then activates the **trigger pin (Pin 2)** of the **NE555 timer IC**, causing it to output a high signal and sound the buzzer.

Figure 2.10 BC547

2.1.8 BUZZER

The buzzer is an output device used to signal an alarm when the laser beam is interrupted. When the NE555 Timer IC is triggered by the transistor, it sends a high output to the buzzer, causing it to produce sound. This alerts the user to the intrusion. The buzzer will continue to sound until the reset push button is pressed.

Figure 2.11 Buzzer

2.1.9 PUSH BUTTON

The push button is used to reset the alarm system. After an intrusion is detected, the buzzer will sound continuously. The push button allows the user to reset the system and turn off the alarm by pressing it. This feature ensures that the system can be easily deactivated once the intruder has been detected or after the user has inspected the area.

Figure 2.12 Push Button

2.1.10 9V BATTERY

The 9V battery powers the entire circuit. It supplies the necessary voltage for the LM358, NE555, and other components. The 9V battery makes the system portable and allows it to operate even in environments without a direct power source. This feature is especially useful for mobile or temporary security setups.

Figure 2.13 9V Battery

2.2 WORKING PRINCIPLE OF LASER SECURITY STSTEM

When the laser beam is uninterrupted, the LDR receives continuous light, resulting in a low resistance. The voltage at the non-inverting terminal of the LM358 is less than the reference voltage, and the Op-Amp output remains LOW, keeping the transistor OFF.

If the laser beam is blocked (e.g., by an intruder), the resistance of the LDR increases, causing the voltage at the non-inverting terminal to exceed the reference voltage. The Op-Amp output becomes HIGH, turning ON the transistor.

The transistor sends a LOW pulse to the NE555's trigger pin, activating the buzzer. The alarm stays ON until the reset button is pressed.

2.3 CALCULATION

Capacitor (Ceramic Disc)

The 100 nF capacitor acts as a decoupling or bypass capacitor to filter noise and stabilize the power supply. Its capacitance value can be used to calculate the capacitive reactance (XCX_CXC), which determines how much the capacitor resists AC signals at a given frequency.

Formula

$$X_C = \frac{1}{2\pi f C}$$

Where:

f= Frequency (Hz)

C = Capacitance (Farads)

Example

$C = 100 \text{ nF} = 100 \times 10^{-9} \text{ F}$

Assume $f = 1 \text{ kHz} = 1000 \text{ Hz}$

$$X_C = \frac{1}{2\pi(1000)(100 \times 10^{-9})}$$

$$X_C \approx 1.59 \text{ k}\Omega$$

This means the capacitor offers a reactance of approximately 1.59 k Ω at 1 kHz, filtering high-frequency noise from the power supply.

Resistor (1/4 Watt)

The 10 kΩ resistor is used in several parts of the circuit, such as pull-up resistors or in the voltage divider network with the LDR. To verify its behavior, we calculate the power dissipation using Ohm's Law and the Power Formula.

Power Dissipation Formula:

$$P = I^2 R$$

Or,

$$P = \frac{V^2}{R}$$

Example:

- Assume $V = 5\ \mathrm{V}$ across the resistor and $R = 10\ \mathrm{k\Omega} = 10,000\ \Omega$.

$$P = \frac{5^2}{10,000} = \frac{25}{10,000} = 0.0025\ \mathrm{W} = 2.5\ \mathrm{mW}$$

The 1/4 Watt resistor is suitable because it can handle up to 0.25 W, and the dissipation here is only 2.5 mW, far below the limit.

The **220 Ω resistor** is typically used for current limiting, such as with an LED, ensuring it operates safely without excessive current.

This current is safe for most LEDs but higher than the typical 20 mA. If strict current control is necessary, a higher resistance value, such as 330 Ω, can be used.

Power Dissipation

Current Limiting Formula:

$$R = \frac{V_s - V_f}{I}$$

Where:

- V_s = Source voltage ($9\ \mathrm{V}$)
- V_f = Forward voltage of the LED ($2\ \mathrm{V}$)
- I = Desired current ($20\ \mathrm{mA} = 0.02\ \mathrm{A}$)

$$R = \frac{9-2}{0.02} = \frac{7}{0.02} = 350\ \Omega$$

Since a 220 Ω resistor is used, the current will be slightly higher:

$$I = \frac{V_s - V_f}{R} = \frac{9 - 2}{220} = \frac{7}{220} \approx 0.0318 \text{ A} = 31.8 \text{ mA}$$

This current is safe for most LEDs but higher than the typical 20 mA. If strict current control is necessary, a higher resistance value, such as 330 Ω, can be used.

Power Dissipation

$$P = I^2 R$$

$$P = (0.0318)^2 \times 220 \approx 0.222 \text{ W}$$

The ¼ Watt resistor (0.25 W) can safely handle this power dissipation.

CHAPTER 3

COST OF THE COMPONENTS

Table 3.1 Cost and Quantity of the Components Used

COMPONENT	QUANTITY	COST (APPROX.)
LM358 (Op-Amp IC)	1	25
NE555 (Timer IC)	1	15
LDR	1	15
10 KΩ Resistors (1/4 Watt)	3	3
220 Ω Resistor (1/4 Watt)	1	1
10 KΩ Potentiometer	1	10
BC547 (NPN Transistor)	1	5
Buzzer	1	25
100 nF Capacitor (Ceramic)	1	3
Push Button	1	5
Laser Pointer	1	85
9V Battery	1	25
Connecting Wires	As Required	15
Breadboard	1	80

CHAPTER 4
RESULT AND DISCUSSION

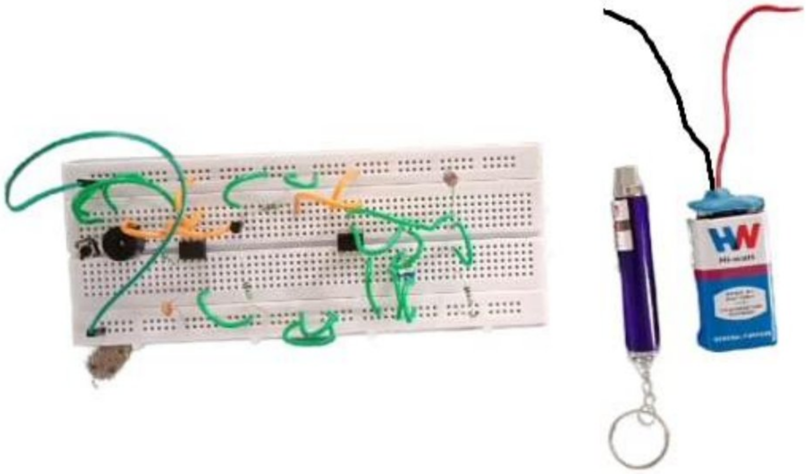

Figure 4.1: Demo of Laser Security System

The laser-based security system was successfully implemented and tested. The key observations and results are as follows:

4.1 ADVANTAGES

The circuit is simple to design and can operate even during power outages using a battery.

It provides an additional layer of security when combined with other systems like electronic locks.

4.2 APPLICATIONS

Can be used to secure rooms, lockers, and entryways. Suitable for monitoring boundaries for pets or children.

The project demonstrates a cost-effective method to enhance security using readily available components. While basic, the system can be expanded and refined to address its limitations.