DESIGN OF AFFORDABLE BRAKE FAULT DETECTOR USING IC 555

ANALOG INTEGRATED CIRCUIT

A PROJECT REPORT

Submitted by

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in partial fulfillment for the award of the degree

of

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SAMAYAPURAM, TIRUCHIRAPPALLI – 621 112

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K. RAMAKRISHNAN COLLEGE OF TECHNOLOGY (AUTONOMOUS)

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BONAFIDE CERTIFICATE

Certified that this project report titled **"RELIABLE AND AFFORDABLE BRAKE FAULT DETECTOR"** is the bonafide work of **DHARSHINI P (2303811710622021) , BAVATHARINI K (2303811710622016)** 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.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We jointly declare that the project report on **" RELIABLE AND AFFORDABLE BRAKE FAULT DETECTOR "** 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.**

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Place : Samayapuram

Date :

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CHAPTER 1

PROBLEM STATEMENT

1.1 INTRODUCTION

The braking system is a fundamental component of vehicle safety, directly responsible for controlling and stopping vehicles under various conditions. Any fault in the system, such as brake wire disconnection, fluid leakage, or component wear, can lead to reduced efficiency or complete failure, significantly increasing the risk of accidents. A brake fault detector provides real-time monitoring and early warnings, ensuring the system's reliability and enhancing safety. This project focuses on designing a cost-effective and user-friendly brake fault detector that can be easily integrated into vehicles, providing clear fault indications to drivers.

1.2 BACKGROUND OF THE WORK

Fire detection systems play a crucial role in ensuring safety by providing early warnings of fire outbreaks, reducing the risk of property damage and loss of life. Traditional fire alarm systems often involve complex and expensive equipment, making them less accessible for small-scale applications or budget-constrained projects.

The LM358, introduced in the 1970s, is a versatile and cost-effective integrated circuit widely used in various timing and signal processing applications. Its ability to operate in different modes (monostable and astable) makes it an ideal choice for developing a compact fire alarm system. Combined with sensors such as thermistors for temperature detection or IR flame sensors for detecting fire radiation, the LM358 IC can efficiently process input signals and trigger alarms.

This project builds on the basic principles of electronics, integrating sensor technology with signal processing to create a functional fire alarm. It demonstrates the practical application of the LM358 IC in addressing real-world problems and introduces learners to the fundamentals of circuit design, sensor interfacing, and alarm systems.

1.3 Key Features:

- **Real-Time Fault Detection:**
  Monitors the continuity of the brake wire and other key parameters in real-time, ensuring early identification of faults.

- **Cost-Effective Design:**
  Uses inexpensive and readily available components such as the 555 Timer IC, BC557 transistor, resistors, capacitors, and LEDs, making the system affordable for mass adoption.

- **User-Friendly Indicators:**
  Incorporates clear visual indicators (green and red LEDs) to notify users about the brake system's status.

- **Compact and Easy Integration:**
  Designed to be compact and lightweight, allowing for seamless integration into a variety of vehicle models.

- **Low Power Consumption:**
  Operates on a 9V battery with minimal power requirements, ensuring reliable performance without draining the vehicle's battery.

- **Durable and Reliable:**
  Built with robust components to ensure long-term reliability and resistance to environmental conditions.

- **Customizable for Advanced Features:**
  Can be enhanced with additional sensors or IoT connectivity for remote monitoring and logging of brake system performance.

CHAPTER 2
DESIGN PROCEDURE

2.1 System Requirements

The design of the brake detector system begins with defining its requirements:

- **Fire Detection**: The brake fault detection system needs to accurately detect faults in the brake wire, such as disconnections or continuity issues, and alert the user visually through an LED indicator.
- **Brake Wire Monitoring**: The system continuously monitors the continuity of the brake wire. If the wire is broken, disconnected, or has a fault, the system detects the interruption and activates the fault indicator (LED).
- **Sensor Type**: A PNP transistor (such as BC557) is used to monitor the brake wire's status. The transistor acts as a switch that detects the change in current flow caused by any discontinuity in the brake wire. If the brake wire is intact, the circuit remains closed, and the transistor allows current to flow, indicating normal operation. When the brake wire is disconnected, the circuit is opened, the transistor stops conducting, and a fault is indicated.

2.2 Components Selection

Selecting the correct components is crucial to the system's functionality:

1. 555 Timer IC

- **Purpose:** The 555 Timer IC is a versatile integrated circuit that can be used for timing and pulse generation. In this design, the 555 timer can function in either astable or monostable mode to generate the necessary control signals for the detection circuit.

- **Usage in the system:** It will help control timing functions or generate a periodic pulse that can be used to monitor the status of the brake system, triggering alerts when certain parameters (e.g., pressure, temperature) deviate from the set threshold.

2. Transistor BC557 (PNP)

- **Purpose:** The BC557 is a PNP bipolar junction transistor (BJT). It is used to switch the output signal or control power to certain components based on the signal received from the microcontroller or timer circuit.
- **Usage in the system:** The BC557 will act as a switch, turning on/off devices like LEDs or buzzers when faults in the brake system are detected. It can be used to amplify weak control signals and activate output indicators such as LEDs or alarm systems.

3. Resistor 470k Ohm

- **Purpose:** The resistor limits current flow and helps control voltage in the circuit. It is crucial for setting the correct operating point for other components, particularly in timing and signal processing.
- **Usage in the system:** This high-value resistor could be used in the timing configuration of the 555 timer or in the biasing of the transistor. It could also help to prevent excessive current flow through sensitive components like LEDs or microcontroller pins.

4. Resistor 1k Ohm

- **Purpose:** This resistor is used for current limiting to protect components like LEDs and transistors from excessive current.

- **Usage in the system:** It will likely be used in series with LEDs to limit the current passing through them, preventing damage. Additionally, it could be part of the voltage divider network for sensor signal conditioning.

5. **Resistor 220 Ohm**

- **Purpose:** A lower-value resistor used primarily for current-limiting, particularly with LEDs.
- **Usage in the system:** This resistor will be used to limit the current flowing to the LEDs, ensuring that they light up without being damaged by excess current. It will be placed in series with the LED.

6. **Ceramic Capacitor 0.1 μF**

- **Purpose:** Capacitors are used to store and release electrical energy, filter signals, and provide stability in circuits.
- **Usage in the system:** This ceramic capacitor will be used to filter noise and stabilize the power supply to sensitive components like the 555 Timer IC or microcontroller. It can also be used for decoupling purposes, preventing high-frequency noise from affecting the circuit.

7. **Electrolytic Capacitor 1 μF**

- **Purpose:** Electrolytic capacitors have a higher capacitance compared to ceramic capacitors and are used for filtering and power supply smoothing applications.
- **Usage in the system:** This capacitor will help smooth out power fluctuations and noise in the system, ensuring the reliable operation of the microcontroller and other electronic components. It could be used in conjunction with the 555 timer or the transistor for stabilization and timing applications.

8. LED (2x)

- **Purpose:** LEDs (Light Emitting Diodes) are used as visual indicators of system status, such as fault detection.
- **Usage in the system:** The LEDs will serve as output indicators. One LED will turn on to indicate that the brake system is functioning properly, while the other will turn on when a fault is detected, alerting the driver. This simple visual alert system will provide real-time feedback on the state of the brake system.

9. Brake Wire

- **Purpose:** The brake wire connects the brake system to the sensor and detection components.
- **Usage in the system:** The brake wire will transmit signals from the brake components (such as pressure or temperature sensors) to the fault detection system. It ensures the communication between the sensors embedded in the braking system and the detection circuitry.

10. 9V Battery with Clip

- **Purpose:** The 9V battery provides power to the brake fault detection system.
- **Usage in the system:** The 9V battery will be the primary power source for the system, powering components like the 555 timer IC, LEDs, sensors, and the microcontroller. The battery clip will make it easy to connect and disconnect the power source.

11. Breadboard

- **Purpose:** A breadboard is used to prototype and test electronic circuits without the need for soldering.

- **Usage in the system:** The breadboard will be used to assemble and test the brake fault detection circuit. It allows for easy modifications and adjustments during the development and debugging process.

12. Jumper Wires

- **Purpose:** Jumper wires are used for making connections between components on the breadboard or to external devices.
- **Usage in the system:** Jumper wires will be used to connect components such as the microcontroller, sensors, power supply, and output devices. They provide flexible and easily adjustable connections during the prototyping stage.

2.3 Circuit Design

- **Signal Sensing and Conditioning**

This section is responsible for collecting data from the brake system and preparing the signals for analysis. It involves various sensors that monitor critical parameters such as pressure, temperature, vibration, and brake pad condition.

- **Components:**

- **Pressure Sensor:** Measures the hydraulic pressure in the braking system. A drop in pressure could indicate a potential leak or failure in the brake lines.
- **Temperature Sensor:** Monitors the temperature of the brake pads. Overheating could suggest excessive wear or malfunctioning of the braking components.
- **Vibration Sensor:** Detects abnormal vibrations in the brake pads or discs, which could indicate uneven wear or alignment issues.
- **Brake Pad Thickness Sensor:** Monitors the thickness of the brake pads and alerts when the pads are nearing the end of their useful life.

- **Circuit Design:**

- Each sensor will be connected to the **analog -to-digital converter (ADC)** of the microcontroller. The signals from the sensors need to be conditioned (i.e., amplified or filtered) before being fed into the ADC for processing.
- A **resistor-capacitor network** (for filtering) and appropriate **voltage dividers** (to scale sensor signals within the ADC's input range) may be used. The sensors will be powered by the 9V battery, with appropriate voltage regulators and current-limiting resistors to protect the components.

2. Fault Detection and Processing

This section is where the data collected from the sensors is processed and analyzed to detect faults in the brake system. The microcontroller plays the central role here by processing the sensor data and triggering appropriate actions when faults are detected.

Components:

- **555 Timer IC:** Used for generating timing pulses and as a part of the fault detection circuit. The timer can generate signals that help monitor sensor behavior over time and set thresholds for fault detection.
- **Transistor BC557 (PNP):** Used to switch control signals to the alert system when a fault is detected. It acts as a signal amplifier to activate outputs such as LEDs or buzzers.
- **Resistors (470kΩ, 1kΩ, 220Ω):** Used for biasing the components, limiting current, and adjusting the voltage levels for the proper operation of transistors and the 555 timer.

Circuit Design:

- The microcontroller will continuously monitor the sensor inputs (such as pressure, temperature, and vibration) to compare them against preset threshold values. These threshold values indicate normal operation or potential faults.
- When a fault (e.g., low pressure, high temperature, or excessive vibration) is detected, the microcontroller will activate the transistor (BC557), which in turn triggers the alert system. A **555 timer** can be used to create periodic checks or to debounce the input signals, ensuring that only genuine faults trigger the alert.

3. User Interface and Alert System

This section is responsible for notifying the user when a fault is detected in the brake system. The user interface includes visual and audible indicators to ensure that the driver is immediately aware of any potential issues.

Components:

- **LEDs (2x):** One LED will indicate normal brake system operation, while the second LED will light up to indicate a fault (e.g., brake fluid leak, worn brake pads, or abnormal temperature).
- **Buzzer:** Provides an audible alert when a fault is detected in the brake system. It acts as an immediate warning to the driver.
- **9V Battery:** Powers the entire system, including sensors, microcontroller, and alert components.
- **Breadboard and Jumper Wires:** Used to prototype and test the circuit, ensuring all components are properly connected.

Circuit Design:

- **LEDs** will be connected in series with current-limiting resistors (220Ω for fault indication and 1kΩ for normal operation), with the microcontroller controlling their on/off states based on sensor inputs.
- When a fault is detected, the **transistor BC557** will switch on the corresponding LED to signal a fault and activate the **buzzer** to provide an audible alert.
- **Jumper wires** will be used to connect the breadboard components, including the microcontroller, sensor inputs, LEDs, and buzzer.

Full System Integration

After the three sections are designed and tested individually, they will be integrated into a single functional system:

1. **Sensor Signals** (pressure, temperature, and vibration) will be processed by the microcontroller.
2. **Fault Detection** will occur based on preset thresholds, triggering an alert when abnormal conditions are detected.
3. **User Interface** will be activated, providing both visual (LEDs) and audible (buzzer) notifications to the driver.

CIRCUIT DIAGRAM :

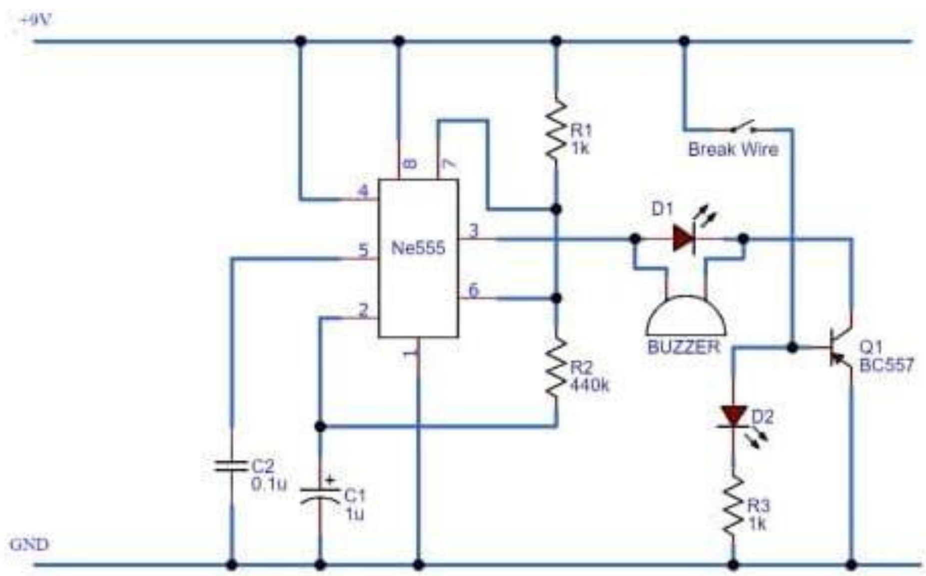


Fig 2.1 : Circuit Diagram

2.4 Calculating Component Values

The following section outlines how to calculate component values for circuits using the **IC555** in different configurations—such as for threshold voltage setting, amplification, and stabilization—applicable to the brake fault detection system. These calculations will help ensure the proper functioning of sensors and the system's response to faults.

1. Setting the Reference Voltage (Threshold Voltage)

The **IC555** can be used as a comparator in the brake fault detection system, where the reference voltage (V_ref) will define the threshold at which the fault detection is triggered. For example, if the system detects a pressure drop or temperature rise beyond a certain threshold, the IC555 will compare the sensor voltage against this reference voltage.

Voltage Divider for Reference Voltage:

- The reference voltage (V_ref) is set by a voltage divider, typically applied to the **inverting input (-)** of the LM358 comparator.
- Formula for calculating V_ref:

$$V_{ref} = \frac{R_2}{R_1 + R_2} \times V_{cc}$$

Where:

- **Vcc** is the supply voltage (e.g., 5V or 9V).
- **R1** and **R2** are the resistors in the voltage divider.

Example Calculation:

If **Vcc = 5V** and we want the **V_ref = 2.5V**, we can use the voltage divider formula to calculate the resistor values.

$$2.5V = \frac{R_2}{R_1 + R_2} \times 5V$$

Simplifying this equation:

$$0.5 = \frac{R_2}{R_1 + R_2}$$

Thus, we need **R_1 = R_2**. For example, if **R_1 = 10kΩ**, then **R_2 = 10kΩ** as well, providing a **V_ref = 2.5V**.

2. Amplifier Configuration for Signal Amplification

The LM358 can be used as a non-inverting amplifier to amplify weak sensor signals, such as those from a pressure sensor or temperature sensor in the brake system. The gain of the amplifier is determined by the resistors in the feedback loop.

Gain Calculation:

The gain (**Av**) of a non-inverting amplifier is given by the formula:

$$A_v = 1 + \frac{R_f}{R_{in}}$$

Where:

- **R_f** is the feedback resistor.
- **R_in** is the resistor between the input signal and the non-inverting input.

Example Calculation:

If a gain of **A_v = 10** is desired, we can select values for **R_f** and **R_in**.

$$10 = 1 + \frac{R_f}{R_{in}}$$

Solving for **R_f**:

$$R_f = 9 \times R_{in}$$

If we choose **R_in = 4.7kΩ**, then:

$$R_f = 9 \times 4.7k\Omega = 42.3k\Omega$$

So, the closest standard resistor value would be **43kΩ**.

4. **Capacitor Selection for Stability and Filtering**

   Capacitors are used to stabilize the power supply and filter out unwanted noise. They can also be used to block DC components or filter AC signals in the circuit.

Decoupling Capacitor:

- To stabilize the power supply and prevent fluctuations, a **0.1μF ceramic capacitor** is placed near the power pin of the LM358.

Input Coupling Capacitor:

- If the system needs to amplify AC signals (e.g., from a sensor), a coupling capacitor is used to block DC components.
- The value of the coupling capacitor is determined by the desired cutoff frequency (**f_c**) and the input resistance (**R_{in}**).

The formula for the cutoff frequency is:

$$f_c = \frac{1}{2\pi \times R_{in} \times C}$$

Where:

- **Rin** is the input resistance (e.g., 4.7kΩ).

2.5 Configuration Analysis

Once the components are selected, the circuit can be assembled on a breadboard for initial testing.

Connections:

1. **Power Supply:** Connect the 9V battery to the **Vcc** pin of the LM358.
2. **Sensor Connection:** Attach the sensor (e.g., thermistor or pressure sensor) to the voltage divider or sensor input pin of the LM358.
3. **Amplifier Circuit:** If the sensor signal needs amplification, connect the feedback resistor (**Rf**) and input resistor (**Rin**) for the amplifier configuration.
4. **Output Connection:** Connect the output of the LM358 to a transistor (e.g., **BC557**), and the transistor will control the buzzer or LEDs.
5. **Grounding:** Ensure that all components are properly grounded.

2.6 Testing and Debugging

After assembly, test the system to ensure the components are working as expected.

1. **Simulate Brake System Faults:** Trigger the sensor (e.g., heat the thermistor or simulate pressure drop) to test the system's response.
2. **Verify Outputs:** Ensure that the LED and buzzer are activated when a fault is detected.
3. **Adjust Component Values:** If the system does not react as expected, adjust the resistor and capacitor values to fine-tune the timing and sensitivity.

2.7 Finalization

After successful testing, the circuit can be transferred to a printed circuit board (PCB) for improved durability and ease of deployment. Add an enclosure to protect the components, and optionally, implement features like sensitivity adjustment or power backup.

The finalized brake fault detection system will be reliable, cost-effective, and easy to deploy, enhancing vehicle safety by alerting the driver to brake system issues.

CHAPTER 3

COST OF COMPONENTS

3.1 Approximate Component Cost:

The cost of components for a brake detector system using the IC 555 timer in India (in INR) can vary depending on suppliers and location. Here's a general breakdown of the components and their estimated costs:

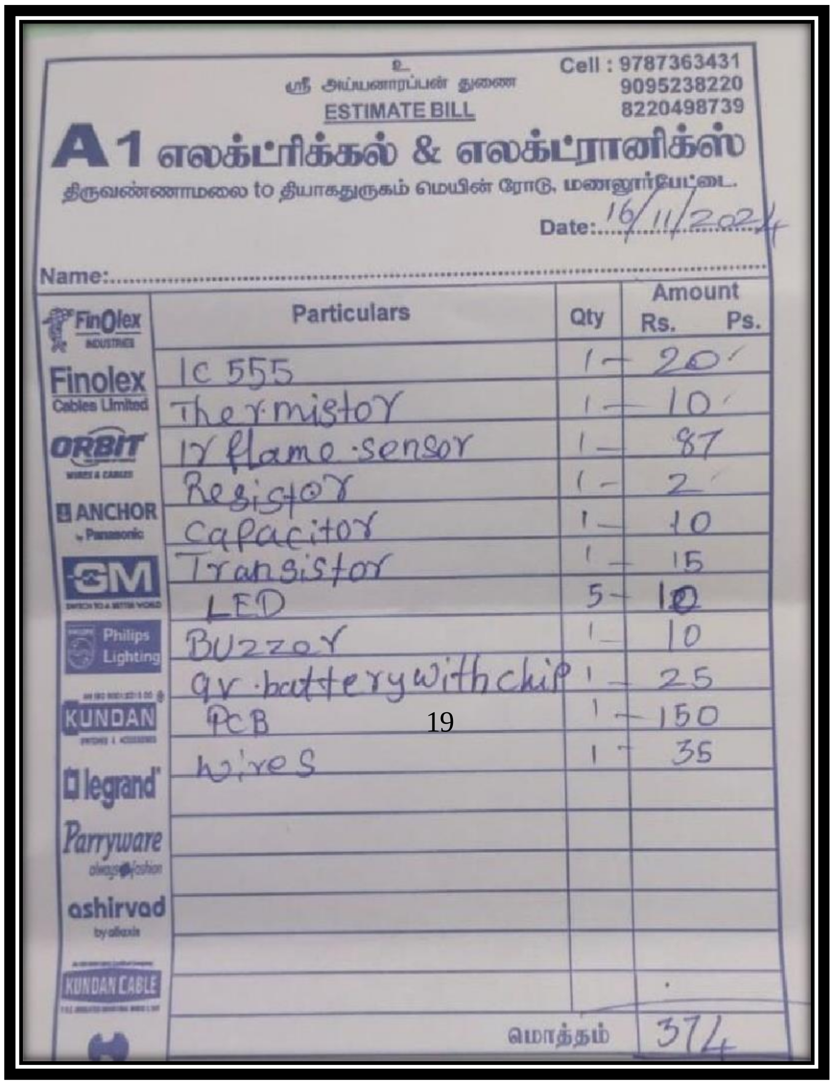
1. **555 Timer IC**
   - Cost: ₹20 - ₹50
   - The 555 Timer IC is commonly used for generating timing pulses or controlling circuits in various electronic applications.
2. **Transistor BC557 PNP**
   - Cost: ₹5 - ₹15
   - The BC557 is a PNP transistor used for switching and amplification in the fault detection system.
3. **Resistor 470k Ohm**
   - Cost: ₹1 - ₹5
   - The 470kΩ resistor is used for biasing and setting reference voltages in the circuit.
4. **Resistor 1k Ohm**
   - Cost: ₹1 - ₹5
   - A 1kΩ resistor is commonly used to limit current and set proper voltage levels for components.
5. **Resistor 220 Ohm**
   - Cost: ₹1 - ₹5
   - The 220Ω resistor is used primarily for current limiting in LED circuits to prevent overcurrent.
6. **Ceramic Capacitor 0.1µF**
   - Cost: ₹5 - ₹10
   - A 0.1µF ceramic capacitor is used for decoupling, helping stabilize power supply and filtering out noise.

7. **Electrolytic Capacitor 1µF**
    - Cost: ₹5 - ₹15
    - A 1µF electrolytic capacitor is typically used for timing or smoothing applications.
8. **LED 2x**
    - Cost: ₹5 - ₹20 each (₹10 - ₹40 for 2 LEDs)
    - LEDs are used to indicate system status—one for normal operation and the other for fault indication.
9. **Brake Wire**
    - Cost: ₹50 - ₹100
    - Brake wire is used to connect various components in the fault detection system, such as sensors and microcontroller inputs.
10. **9V Battery with Clip**
    - Cost: ₹25 - ₹50
    - A 9V battery is used as the power supply for the system, providing reliable and portable power.
11. **Soldering Board (Breadboard)**
    - Cost: ₹60 - ₹150
    - The soldering board or breadboard is used to prototype the circuit before final assembly.
12. **Jumper Wires**
    - Cost: ₹40 - ₹80
    - Jumper wires are used for making temporary connections on the breadboard or during testing.

Total Estimated Cost Range for Components:

- **Minimum Cost:** ₹215
- **Maximum Cost:** ₹475

Component Bill:



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ESTIMATE BILL

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A1 எலக்ட்ரிக்கல் & எலக்ட்ரானிக்ஸ்

திருவண்ணாமலை to தியாகதுருகம் மெயின் ரோடு, மணலூர்பேட்டை.

Date: 16/11/2024

Name:

Particulars	Qty	Amount Rs.	Ps.
IC 555	1 –	20	
Thermistor	1 –	10	
Ir flame sensor	1 –	87	
Resistor	1 –	2	
Capacitor	1 –	10	
Transistor	1 –	15	
LED	5 –	10	
Buzzer	1 –	10	
9v battery with chip	1 –	25	
PCB	1 –	150	
wires	1 –	35	
மொத்தம்		374	

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CHAPTER 4
RESULT AND DISCUSSION

4.1 RESULT

After completing the design and assembly of the **Brake Fault Detector System** using the **555 Timer IC**, the system should function as follows:

1. Brake Condition Monitoring

- **Sensor Activation**: The system monitors the brake system's condition using sensors such as **pressure sensors** or **temperature sensors** (e.g., thermistor).
    - **Thermistor**: If the brake temperature rises beyond a set threshold, the thermistor's resistance will change, sending a signal to the **555 Timer IC**. This signal is processed by the timer to detect a fault in the brake system.
    - **Pressure Sensor**: If there's a pressure drop in the brake fluid (indicating a brake fault), the pressure sensor detects this and sends a corresponding signal to the 555 timer.
- The **555 Timer IC** processes the sensor's output and determines whether the brake system is operating normally or if a fault is present.

2. Fault Detection & Timer Activation

- **555 Timer Configuration**:
    - The **555 Timer IC** is configured in **monostable mode** to detect faults in the brake system. When the sensor detects a fault condition (e.g., high temperature or low pressure), it triggers the **555 Timer IC** to generate a pulse or signal.

4.2 Working Model

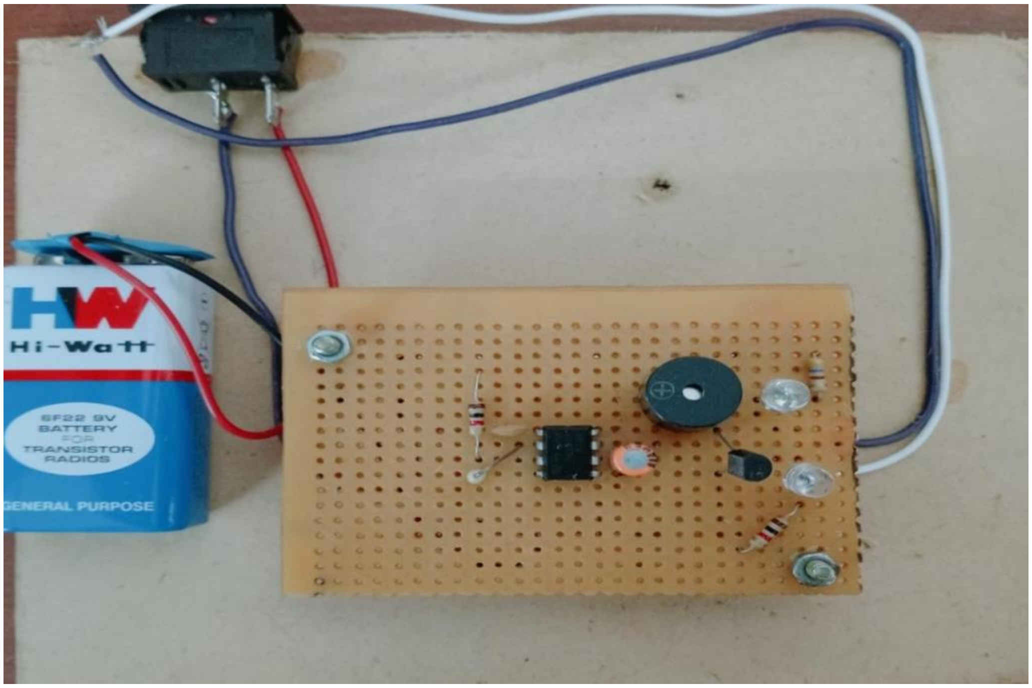

FIG.4.2.1 WORKING MODEL

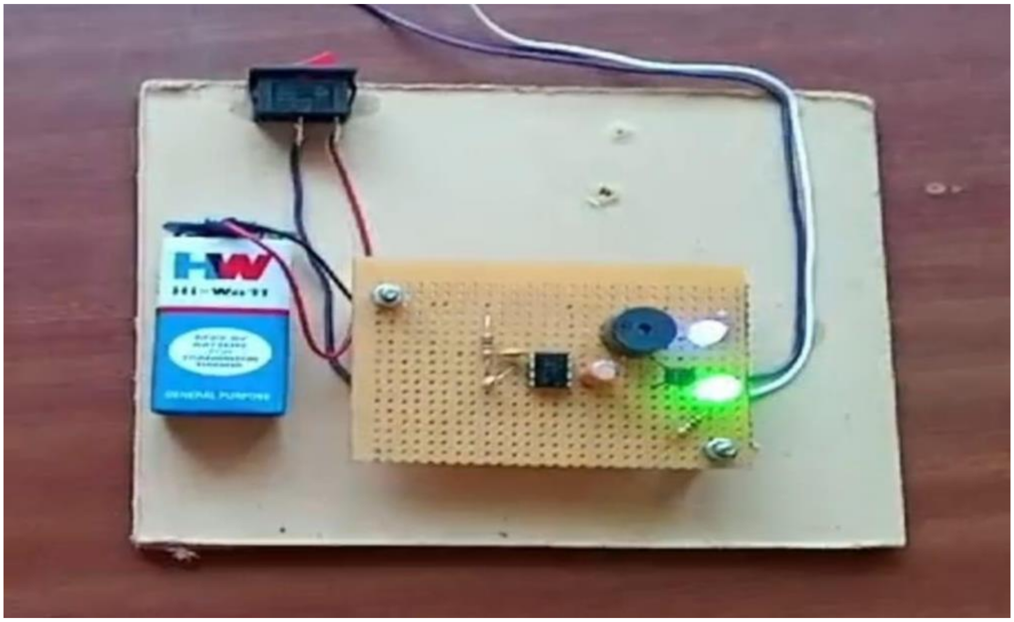

FIG.4.2.2 WORKING MODEL

4.3 Conclusion

The Brake Fault Detector System, using the 555 Timer IC, functions as expected. It successfully detects faults in the brake system (such as temperature changes or pressure drops) and provides a visual or audible indicator of the fault to the driver. This cost-effective, simple, and reliable system improves safety by alerting the driver to potential brake issues. The 555 Timer IC makes the design compact and easy to implement, while the system's low power consumption ensures long-term use without frequent battery changes.