# Statement of Purpose

## Project Title: Ultra-Low Power Analog Temperature Alert System (No Microcontroller)

### Introduction

The motivation behind this project stemmed from a fundamental challenge: designing a functional and reliable temperature alert system without relying on microcontrollers or digital logic, while also meeting strict low-power and minimal component constraints. In an era where embedded systems are often overengineered, I wanted to prove that efficient analog design can still serve practical applications — especially in environments where power consumption, cost, or simplicity is a major concern.

### Objective

The objective of this project was to build an ultra-low power analog circuit, powered by a 3V, 1Ah coin cell, that:

- Detects three critical temperature thresholds: 60°C, 70°C, and 80°C

- Triggers a buzzer at a different frequency for each threshold

- Operates for at least 6 months continuously on a coin cell

- Includes a battery level indicator LED that activates only when the voltage is ≥ 2.5V

- Uses no microcontroller, no comparator IC, and only analog components such as transistors, resistors, capacitors, and a TLC555 timer

### Design and Implementation

The circuit was designed and fully simulated in NI Multisim 14.3, with the following implementation steps:

1. Transistor-Based Temperature Detection:

Potentiometers were used in simulation to emulate temperature-based resistance changes. Transistors (BC547) act as switches, turning ON at predefined voltages corresponding to the three temperature thresholds.

2. Frequency Generation via TLC555 Timer:

A single TLC555 timer IC was used in astable mode. Different transistor-controlled RC circuits allowed the timer to output three distinct square wave frequencies.

3. Battery Indicator Logic:

A resistor divider was used to sense the supply voltage. A PNP transistor (BC557) controlled a green LED, ensuring it lights only when the battery voltage is above 2.5V.

4. Power Optimization:

All resistors and RC components were selected to limit current draw. Final optimization brought the total average current consumption to ~9.731 µA.

### Results and Achievements

- Successfully simulated distinct PWM buzzer alerts for 60°C, 70°C, and 80°C

- Verified correct operation of the battery LED indicator at 2.5V threshold

- Achieved ultra-low power operation without digital circuitry

- Demonstrated reliable analog switching and control using fundamental electronics only

### Skills Gained

- Analog circuit design and simulation

- Transistor biasing and switching logic

- Power budgeting and battery life analysis

- TLC555 timer tuning and RC network design

- Debugging complex analog systems in simulation environments

### Future Scope

- Replace simulation potentiometers with real NTC thermistors in hardware

- Miniaturize PCB design for deployment in wearable or environmental monitoring applications

- Explore temperature-based hysteresis for smoother threshold switching

- Use ultra-low leakage components to reduce current draw further

### Conclusion

This project strengthened my understanding of pure analog systems, something often overlooked in today’s digitally dominated landscape. It challenged me to think critically and optimize at every level, from component selection to circuit topology. I consider this a milestone in my journey as an electronics and computer engineer, merging theory with real-world constraints to create a robust and power-efficient solution.