National Institute of Technology Warangal

LINEAR IC APPLICATIONS PROJECT

PROJECT: FIRE ALARM USING THERMISTOR AND NE555

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ABSTRACT

This project implements a temperature-sensitive alarm system designed to provide audible warnings when ambient temperature exceeds predetermined thresholds. Utilizing fundamental electronic principles of thermal detection and signal processing, the circuit transforms temperature variations into corresponding electrical signals that trigger an alarm response.

The system employs a negative temperature coefficient sensing element to continuously monitor environmental conditions, with signal amplification and conditioning stages that enhance detection accuracy. When temperature parameters move beyond established safety limits, the circuit activates an oscillator that generates an audible warning through an acoustic output device.

The design prioritizes reliability, sensitivity, and power efficiency while maintaining simplicity in construction and operation. This temperature alarm serves diverse practical applications including domestic safety monitoring, equipment protection, laboratory environmental control, and industrial process supervision. Its implementation demonstrates core concepts of electronic sensing, signal processing, and automated response systems in a practical format suitable for educational purposes or real-world deployment.

INTRODUCTION

The Temperature-Activated Alarm System is an electronic monitoring device designed to provide audible warnings when ambient temperature exceeds predetermined thresholds. This project combines fundamental electronic principles with practical application to create a reliable safety system that can be implemented in various environments.

At its core, the circuit utilizes a thermistor-based sensing mechanism coupled with transistor amplification stages and a 555 timer oscillator to produce an audible alarm response. The design prioritizes reliability, sensitivity, and power efficiency while maintaining a relatively simple component structure that can be assembled with commonly available electronic parts.

LIST OF COMPONENTS

Semiconductors

- ❖ IC1 - NE555 Timer IC
- ❖ T1 - BC548 NPN Transistor
- ❖ T2 - BC558 PNP Transistor
- ❖ T3 - SL100B NPN Power Transistor
- ❖ D1 - 1N4001 Diode

Resistors

- ❖ R2 - 33kΩ

- R3 - 470Ω
- R4 - 560Ω
- R5 - 47kΩ
- R6 - 2.2kΩ
- R7 - 470Ω
- R8 - 470Ω
- T1 - Thermistor (NTC type)

Capacitors

- C1 - 10µF, 16V Electrolytic Capacitor
- C2 - 0.04µF Ceramic Capacitor
- C3 - 0.01µF Ceramic Capacitor

Other Components

- S1 - 8Ω, 1W Speaker
- PCB or Breadboard
- Connecting Wires
- 6V Power Supply

<u>555 TIMER IC</u>

Pin	Name	Purpose
1	GND	Ground reference voltage, low level (0 V)
2	TRIG	The OUT pin goes high and a timing interval starts when this input falls below 1/2 of CTRL voltage (hence TRIG is typically 1/3 V_{CC}, CTRL being 2/3 V_{CC} by default, if CTRL is left open).
3	OUT	This output is driven to approximately 1.7 V below $+V_{CC}$ or GND.
4	RESET	A timing interval may be reset by driving this input to GND, but the timing does not begin again until RESET rises above approximately 0.7 volts. Overrides TRIG which overrides THR.
5	CTRL	Provides "control" access to the internal voltage divider (by default, 2/3 V_{CC}).
6	THR	The timing (OUT high) interval ends when the voltage at THR is greater than that at CTRL (2/3 V_{CC} if CTRL is open).
7	DIS	Open collector output which may discharge a capacitor between intervals. In phase with output.
8	V_{CC}	Positive supply voltage, which is usually between 3 and 15 V depending on the variation.

Modes of Operation

Astable Mode: Functions as a free-running oscillator that continuously switches between high and low output states without external triggering. It produces rectangular wave outputs with adjustable frequency and duty cycle determined by external RC components. This mode is used for clock generation, LED flashers, and tone generators.

Monostable Mode: Also called "one-shot" mode, it produces a single output pulse of predetermined duration when triggered by an input signal. Once triggered, the output remains high for a period determined by an RC time constant, regardless of further input changes. Applications include timing delays, pulse generation, and debouncing.

Bistable Mode: Acts as a flip-flop with two stable states. The output changes state based on signals applied to the trigger and reset pins. It remains in either state indefinitely until explicitly commanded to change. This mode is used for latching functions and simple memory applications.

THERMISTOR

Fig : Thermistor

Operating Principles

The thermistor in this circuit serves as the primary temperature sensing element. As an NTC (Negative Temperature Coefficient) thermistor, its resistance decreases predictably as temperature increases, making it ideal for temperature threshold detection.

Implementation in This Circuit

- The thermistor is connected to the positive supply and forms a voltage divider with R8 (470Ω)
- This configuration converts temperature changes into voltage variations
- The changing voltage is processed through the transistor network (BC548)
- When temperature rises above the threshold, the resulting voltage change triggers the alarm

Practical Considerations

- The circuit uses the thermistor's non-linear resistance-temperature relationship to detect specific temperature points
- The diode D1 (1N4001) helps stabilize the reference voltage against supply variations
- Capacitor C1 (10µF) filters any rapid fluctuations, preventing false triggering
- Temperature threshold can be adjusted by modifying the values in the resistor network

Performance Factors

- Response time depends on thermistor size and thermal mass
- Accuracy is determined by thermistor quality and component tolerances

- Environmental factors like air circulation affect sensitivity and response

DESCRIPTION OF THE CIRCUIT

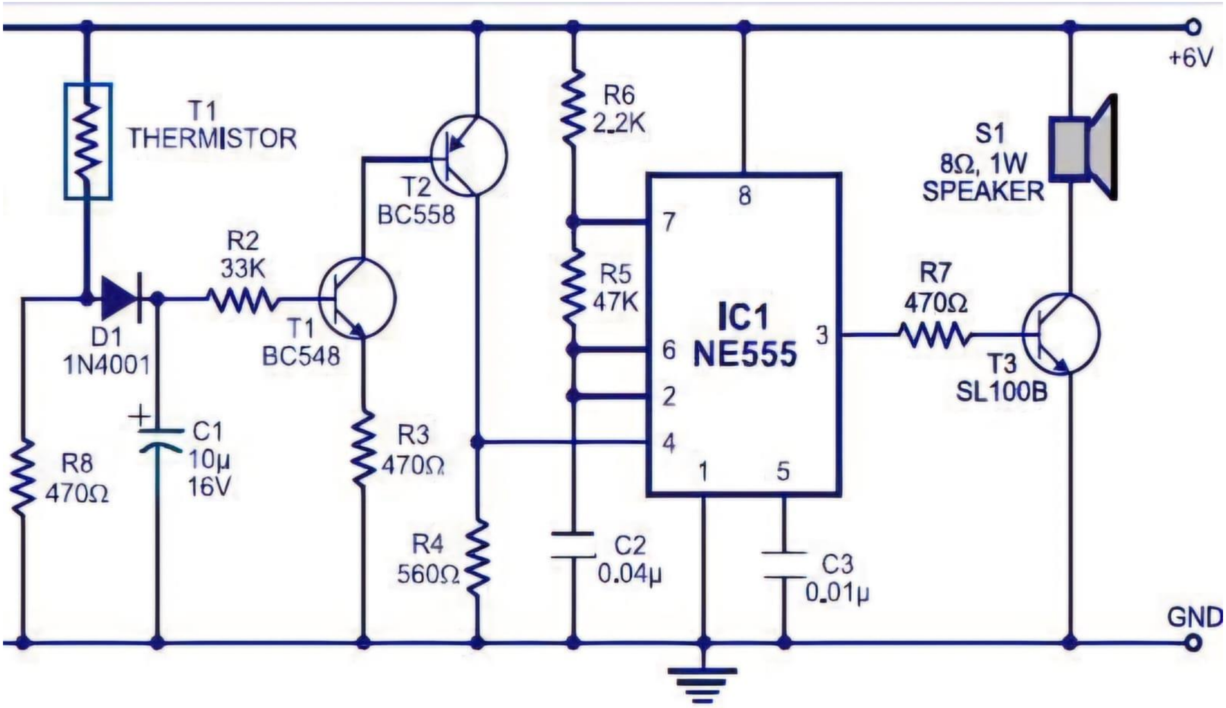


Fig : Circuit diagram of fire alarm using thermistor

The temperature-activated alarm circuit is an integrated electronic system designed to monitor ambient temperature and produce an audible warning signal when temperature thresholds are exceeded. The circuit employs a combination of analog sensing, signal amplification, and oscillation to achieve reliable temperature monitoring capability.

Power Supply

The circuit operates from a +6V DC power supply, providing sufficient voltage for all active components while maintaining power efficiency.

The ground rail serves as the common reference point for all circuit operations.

Sensing Section

At the heart of the sensing section is a thermistor (T1), a temperature-dependent resistor whose resistance decreases as temperature increases. This thermistor forms a voltage divider with resistor R8 (470Ω), creating a temperature-responsive voltage node. Diode D1 (1N4001) provides protection against reverse current flow, while capacitor C1 (10µF) filters out any voltage fluctuations, ensuring stable operation of the sensing stage.

Signal Conditioning

The voltage variations from the thermistor network are fed to a two-stage transistor amplifier:

- The first stage uses T1 (BC548), an NPN transistor biased through R2 (33kΩ), which amplifies the small current changes from the thermistor. R3 (470Ω) serves as the collector load resistor.
- The second stage employs T2 (BC558), a PNP transistor, providing additional amplification and signal inversion. This stage incorporates R4 (560Ω) as an emitter resistor and R6 (2.2kΩ) as a collector resistor, establishing proper operating conditions.

Timer Section

The conditioned signal drives IC1, an NE555 timer configured as an astable multivibrator (oscillator). The timer's operation is determined by:

- R5 (47kΩ) and C2 (0.04µF), which set the oscillation frequency
- C3 (0.01µF), which stabilizes the control voltage at pin 5

- Pin 2 (trigger) receives input from the transistor stages to activate oscillation
- Pin 3 provides the output signal for the alarm

Output Section

The timer's output drives transistor T3 (SL100B), a power transistor capable of handling the current requirements of the speaker. R7 (470Ω) limits the base current to T3, protecting both the timer IC and the transistor. The 8Ω, 1W speaker (S1) converts the electrical oscillations into audible sound, producing the alarm signal.

<u>Operating Principle</u>

When ambient temperature rises, the thermistor's resistance decreases, altering the voltage division ratio in the sensing section. This change is amplified through the transistor stages, eventually triggering the 555 timer when the temperature exceeds the design threshold. Once triggered, the timer generates oscillations that drive the speaker through the output transistor, producing an audible alarm that continues until the temperature returns below the threshold level.

The circuit's design ensures high sensitivity to temperature variations while maintaining immunity to minor fluctuations, preventing false alarms while providing reliable detection of genuine temperature events.

<u>NTC Thermistor Behavior</u>

NTC = Negative Temperature Coefficient

As temperature increases, resistance decreases

Typical thermistors follow: R(T) = R25.eB(1/T – 1/To)

Where:

R(T) = resistance at temperature T (in Kelvin)

R25 = resistance at 25°C (typically 10kΩ)

B = Beta constant of the thermistor (e.g., 3950 K)

T = current temperature in Kelvin

To = reference temp = 298 K (25°C)

Example Calculations

Let's assume:

R25 = 10kΩ

B = 3950

At 25°C (298K):

R25 = **10kΩ**

At 60°C (333K):

R(60°C) = 10k* e^3950(1/333 – 1/298)

= 10k*e^-0.439 ~10k*0.644 = **6.44KΩ**

Vout = Vcc * RNTC/ R1 + RNTC

At 25°C:

Vout = 9* (10k/ 10k+10k) = 9.*(1/ 2) = **4.5V**

At 60°C:

Vout = 9. 6.44k 10k + 6.44k 90.392 = **3.53V**

Sensitivity (AVout / ATemp):

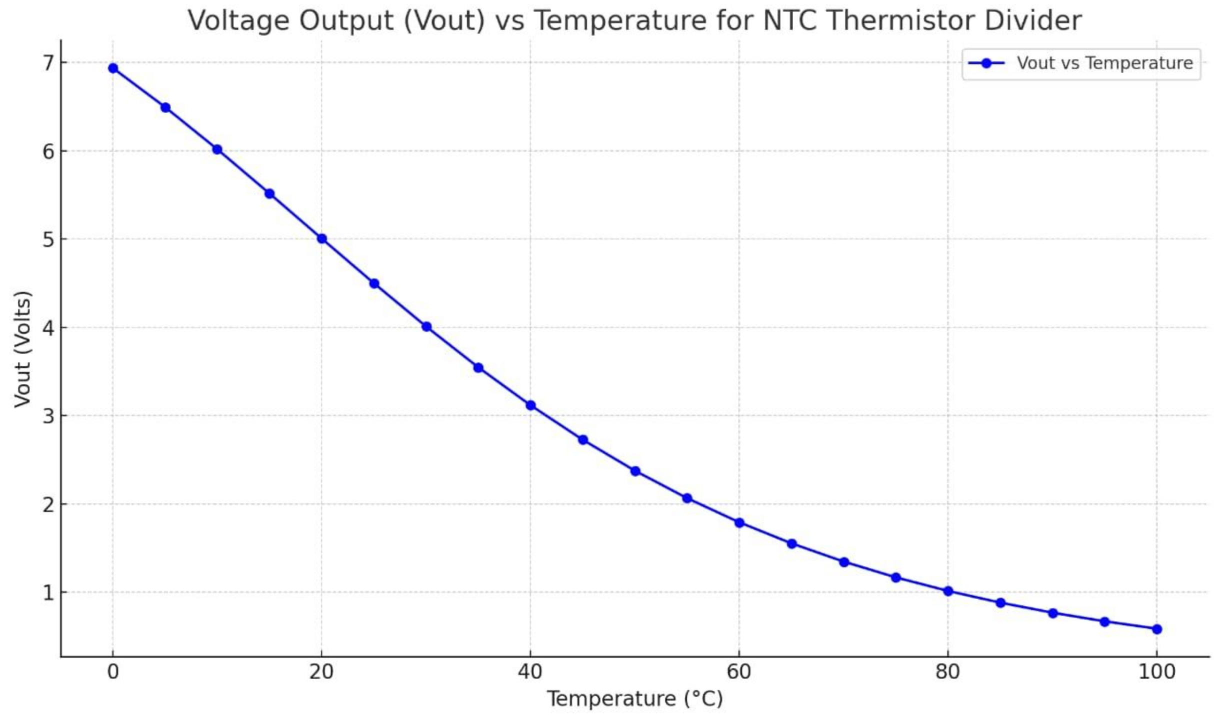
Let's take a range: 25°C to 60°C

AVout = 4.5V - 3.53V = 0.97V

ATemp = 60 - 25 = 35°C

Sensitivity = AV/ AT = 0.97/50 = 0.0194 V/°C

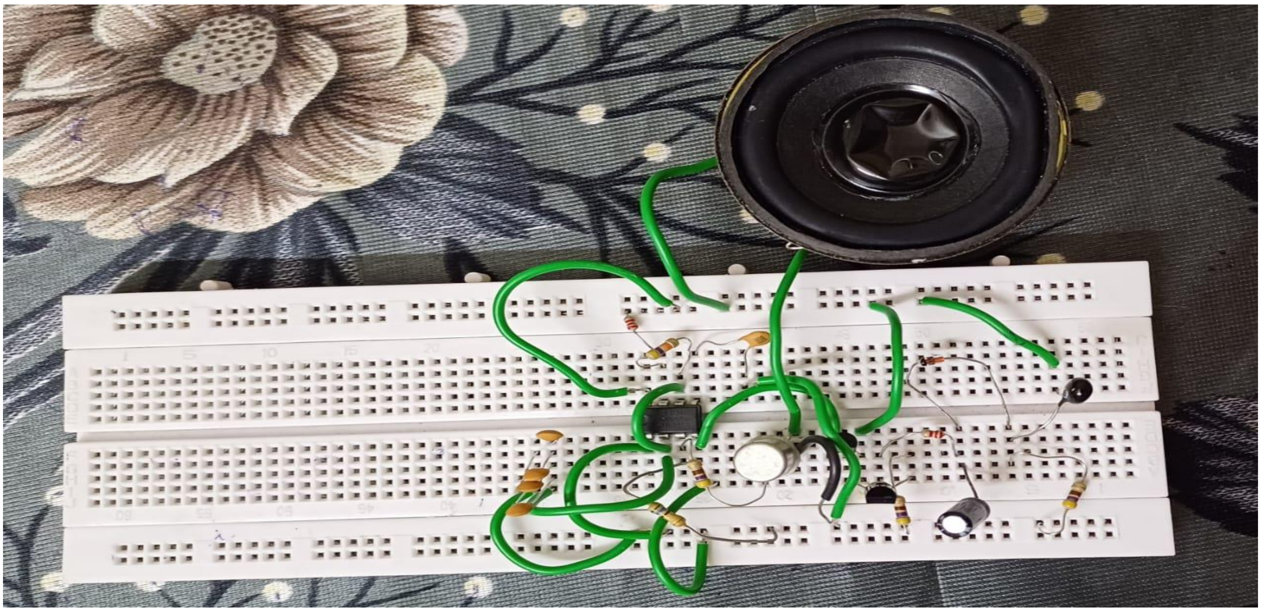
So for each 1°C rise in temperature, the output voltage drops by ~19mV.



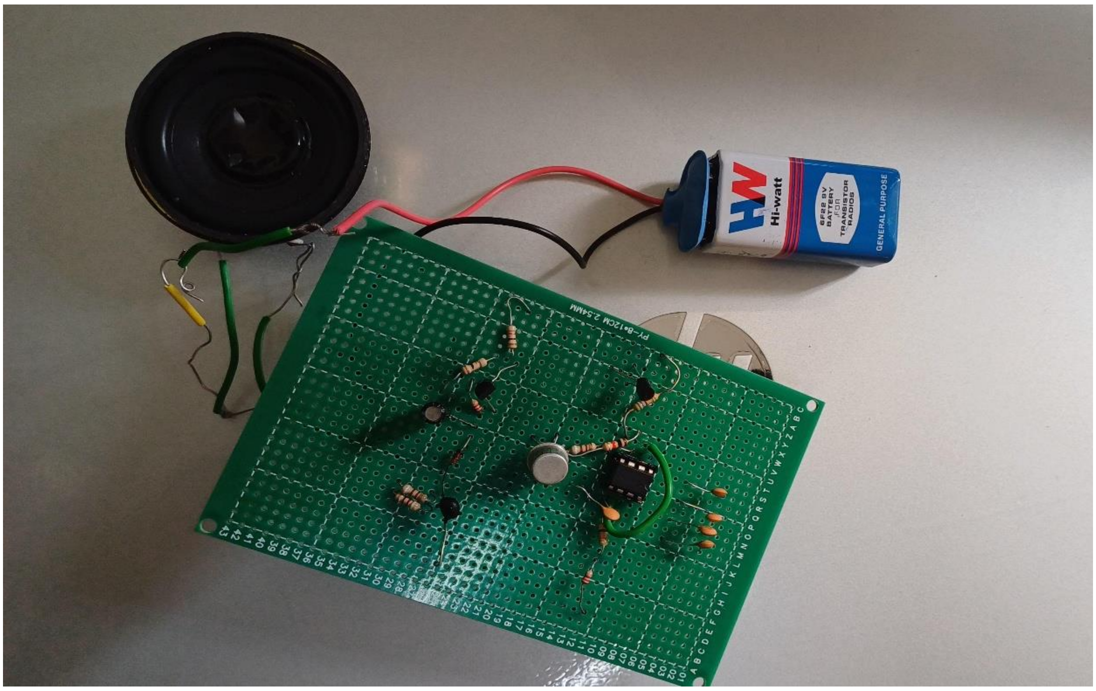
Here vout is the voltage at that voltage divider

EXPERIMENTATION

***ON BREADBOARD*:**



ON PCB :



APPLICATIONS

Temperature-activated alarm systems utilizing thermistors offer versatile applications across numerous environments where reliable heat detection is critical. These systems provide essential monitoring capabilities in various settings:

Residential Applications

- Home fire detection systems, particularly in kitchens and heating equipment areas where smoke detectors may trigger false alarms.
- Attic and basement monitoring to detect overheating electrical equipment.
- Furnace and water heater malfunction detection.

Commercial and Industrial Settings

- Manufacturing facilities where process temperatures must be continuously monitored
- Server rooms and data centers to prevent equipment damage from overheating
- Warehouses storing temperature-sensitive materials or flammable goods
- Electrical distribution panels and transformer stations

Specialized Environments

- Laboratory equipment monitoring where precise temperature control is essential
- Greenhouses and agricultural settings for climate control and frost prevention
- Cold storage facilities and refrigeration systems to detect cooling failures

- ❖ Industrial machinery monitoring to prevent mechanical failures from overheating

Safety-Critical Systems

- ❖ Early warning systems in areas with heightened fire risk
- ❖ Backup detection systems where primary safety measures may be insufficient
- ❖ Confined spaces where traditional smoke detection may be impractical
- ❖ Battery charging stations to prevent thermal runaway conditions

Educational and Development Applications

- ❖ Electronic circuit design demonstrations and training
- ❖ Physics and engineering education on thermal sensing principles
- ❖ Student projects demonstrating practical applications of electronic theory
- ❖ Prototyping platform for more advanced temperature monitoring systems

CONCLUSION

The Temperature-Activated Alarm System presented in this report demonstrates a practical application of electronic principles to create an effective temperature monitoring solution. By combining a thermistor-based sensing mechanism with appropriate signal amplification and timing circuits, the system provides reliable detection of temperature anomalies with an audible warning response.

The circuit design balances sensitivity and stability through careful component selection and configuration. The implementation of a two-stage transistor amplifier followed by a 555 timer oscillator creates a robust system that responds effectively to temperature changes while minimizing false alarms.

This project showcases several important electronic design principles, including temperature sensing, signal conditioning, oscillator operation, and audio output generation. The relatively straightforward component requirements and circuit architecture make this system both cost-effective and accessible for various applications.

The versatility of this temperature alarm system makes it suitable for numerous implementations ranging from simple residential safety devices to more specialized industrial monitoring solutions. Its adaptability also provides opportunities for further enhancements such as adjustable temperature thresholds, visual indicators, or integration with other monitoring systems.

In summary, this Temperature-Activated Alarm System represents a successful integration of electronic components to address a common monitoring need, demonstrating how fundamental circuit design principles can be applied to create practical solutions for real-world applications.

REFERENCES

https://bestengineeringprojects.com/fire-alarm-using-thermistor-and-ne555/