# LM35-Sensed DC Fan System with Arduino and UA741CP-Based Comparator

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***Abstract*—*The project describes the design and implementation of a temperature-controlled fan and LED indicator circuit using operational amplifiers (op-amps), an LM35 temperature sensor, and an Arduino for display purposes. The primary goal is to control a DC fan based on the temperature readings from the LM35 sensor. The circuit uses comparators to determine when the temperature exceeds or falls below a set reference voltage. A green LED indicates when the temperature is above the reference, turning the fan on, while a red LED lights up when the temperature is below the reference. The Arduino is used to display the current temperature and fan speed on a 16x2 LCD screen. This, provides an effective way to manage temperature control with visual and digital feedback, making it an excellent choice for applications in cooling systems and environmental monitoring.*

***Keywords*—*Op-Amp, Comparator, LED, LM35 Temperature sensor, Reference voltage, DC fan, Arduino, 16x2 LCD display, Temperature control.***

***Nomenclature***

| ***Abbreviation*** | ***Full Form*** |
|---|---|
| *AC* | *Alternating Current* |
| *DC* | *Direct Current* |
| *EV* | *Electric Vehicle* |
| *LED* | *Light Emitting Diode* |
| *LCD* | *Liquid Crystal Display* |
| *POT* | *Potentiometer* |
| *USB* | *Universal Serial Bus* |
| *BJT* | *Bipolar Junction Transistor* |
| *DMM* | *Digital Multimeter* |
| *HVAC* | *Heating, Ventilation, and Air Conditioning* |
| *Op-Amp* | *Operational Amplifier* |
| *LM35-Sensor* | *Precision Centigrade Temperature Sensor* |

## I. Introduction

In the world of electronics, temperature-controlled systems play a significant role in maintaining optimal performance and preventing overheating in various devices such as CPUs, GPUs, and microwave ovens. This project aims to design a temperature-controlled DC fan system with visual indicators, mainly LEDs, using op-amps, an LM35 temperature sensor, and an Arduino microcontroller. The concept is that the system will help monitor the temperature in real-time and activate a DC fan to maintain a desired temperature range [1]. This will ensure that the device operates efficiently and safely. Although we haven't added the fan directly to cool the components, it can be achieved easily. The goal behind this project is to create a simple yet effective temperature control solution that can be easily implemented in various applications, such as cooling computer components, managing temperature in electronic enclosures, and other environmental monitoring tasks. By integrating op-amps as comparators, visual LED indicators, and an Arduino for real-time temperature and fan speed display, this project offers a simple and comprehensive approach to temperature management.

## II. Literature Review

### A. Working Principle

In the circuit, three op-amps were used: one as a buffer and two as comparators. The output of the LM35 is fed directly to the non-inverting input of the buffer op-amp, ensuring a pure signal free from noise or loading effects. The buffer's output is then supplied to the comparators. If the LM35 output is below the reference voltage, the first comparator turns on, lighting a red LED connected through a 100-ohm resistor, indicating that the LM35 output is below the reference voltage. The second comparator activates the DC fan and a green LED when the LM35 output exceeds the reference voltage. At this point, the red LED and the first comparator turn off, indicating that the LM35 output is now higher than the reference voltage.

### B. Related Projects

Temperature-Controlled Water Heater: This project utilizes an LM35 sensor to monitor water temperature. The sensor's output is buffered by an op-amp functioning as a voltage follower. Two comparators then use the buffered signal: one to activate a relay controlling the water heater when the temperature is below the threshold, and the other to deactivate the heater when the temperature exceeds the threshold.

Liquid Level Monitoring System: This project employs liquid level sensors, such as ultrasonic or float sensors. The sensor signals are buffered and connected to comparators. One comparator starts a water pump when the liquid level is low, and the other stops the pump when the level is high.