EE313-Analog Electronics Laboratory

Final Project Report - Micro Air Conditioner

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***Abstract*—The purpose of this paper is to demonstrate my micro air-conditioner design for EE313 Analog Electronics Laboratory term project of Middle East Technical University.**

Index Terms— set, control, operation, display

I. Introduction

The micro air-conditioner is composed of five subsystems, namely, the set unit, sensing unit, control unit, operation unit and display unit. The system measures ambient temperature by the sensing unit and compares it with the set temperature provided by set unit. If the difference is bigger than 1 degree, the operation unit gets activated through the control unit. Thus, the sensor is kept at a set temperature autonomously. Moreover, the display unit shows ambient or set temperature as a light spectrum.

II. Subsystems

A. Set Unit

The Set unit consists of a potentiometer, resistors, and a buffer (Fig.1). Output voltages between 2.4 and 4 Volts are obtained by a simple voltage divider circuit. This output is transferred to other subunits by a buffer.

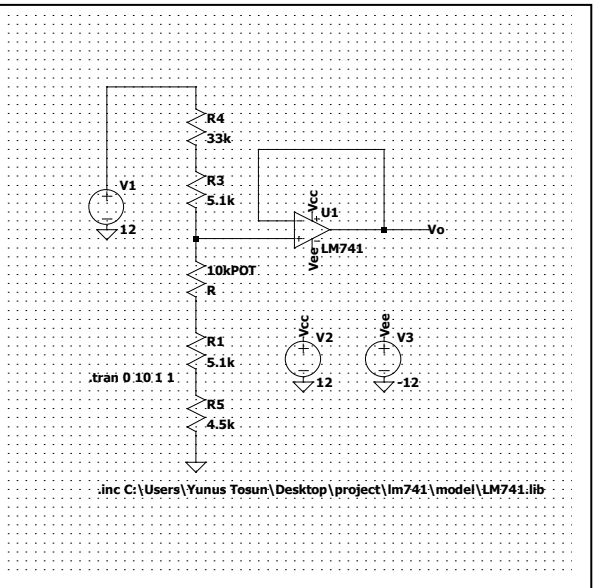

Figure 1: Set Unit

B. Sensing Unit

The sensing unit consists of a temperature sensor and a noninverting amplifier. As the temperature sensor LM35 is used. The output voltage of the temperature sensor is amplified ten times by a noninverting amplifier. Thus 0.1 volt corresponds to 1 degree for both sensing unit and the set unit.

C. Control Unit

The control unit takes inputs from the sensing unit and the set unit and controls the operation unit. This subsystem compares the ambient and the set temperature, and if the difference is more than 1 degree, activates the operation unit. This is done by a difference amplifier (Fig.2). Set voltage is the non-inverting input, sensing unit output is the inverting amplifier of the amplifier. When the difference between inputs is more than 0.1 volts, the amplifier goes to either positive or negative saturation (Fig.3). If the set voltage is higher by more than 1 degree, it goes positive saturation and activates heater. Similarly, if the sensing voltage is higher by more than 1 degree, it goes negative saturation and activates cooler. A buffer is added to the output in order to isolate the difference amplifier from the load.

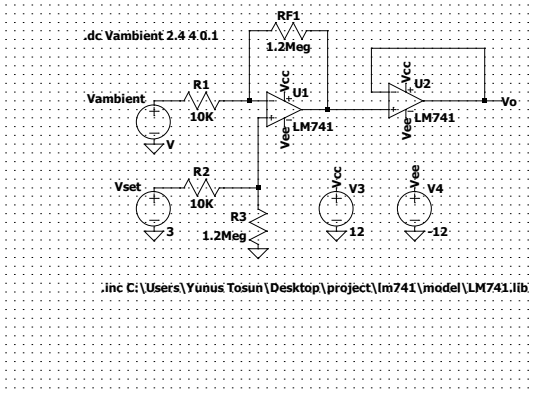

Figure 2: Control Unit

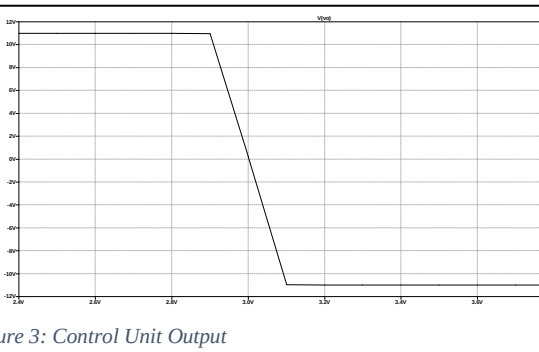

Figure 3: Control Unit Output

D. Operation Unit

The operation unit consists of heating and cooling parts. 5V fan as cooler and 4.7-ohm stone resistor as heater is used. The fan and the stone resistor are both connected to 6V supply by a relay. These relays are controlled by the control unit. One forward and one backward diode is connected to the output of the buffer at the control unit. Since the output current of the op-amp is not enough to activate the relays, relay driver circuits are added between the control unit and the relay coils (Fig.4).

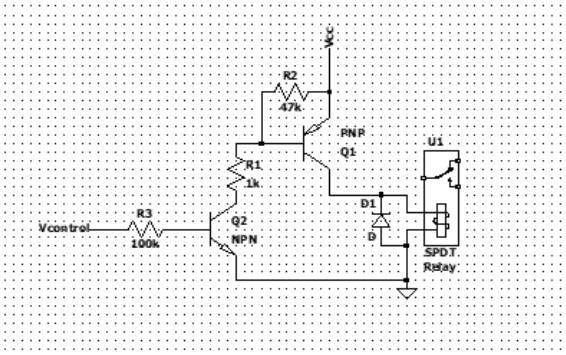

Figure 4: Relay Driver Circuit

The control unit and the operation unit can be seen together in *Figure 5: Control and Operation.*

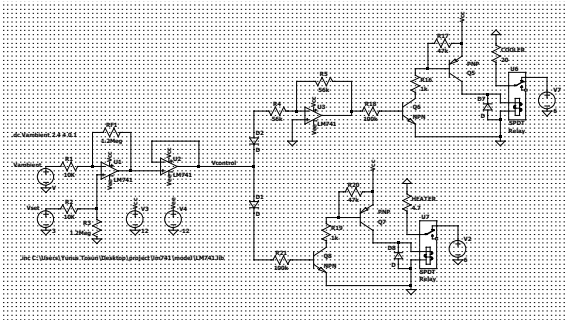

Figure 5: Control and Operation

The operation unit works as desired which can be seen from the simulation result at *Figure 6* (For this simulation the set temperature is 30 degrees.)

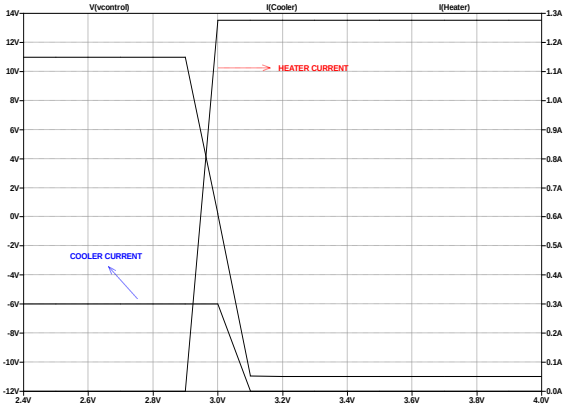

Figure 6: Heater and Cooler Currents vs Temperature

E. Display Unit

The display unit shows the ambient or the set temperature in analog manner. It was needed to acquire the visible light spectrum with respect to temperature at Fig.7.

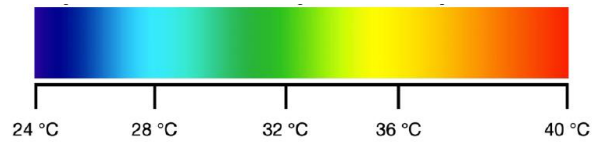

Figure 7

In order to obtain such a spectrum, the power of the LEDs with respect to temperature should be similar to Fig.8.

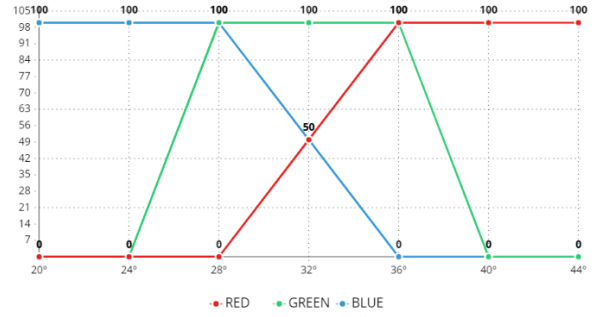

Figure 8

To obtain such a graph, red, green and blue LEDs are controlled separately.

1) Blue LED control: In order to control blue led, an inverting amplifier, shown in Fig.9 , is used. It takes input from the set unit or the sensing unit and inverts it if input voltage is between 2.8 Volts ad 3.6 Volts. It goes to positive saturation if the input is less than 2.8 volts, and it goes to negative saturation if the input is greater than 3.6 volts. Thus, we obtain the output shown at Fig.10 at the blue led.

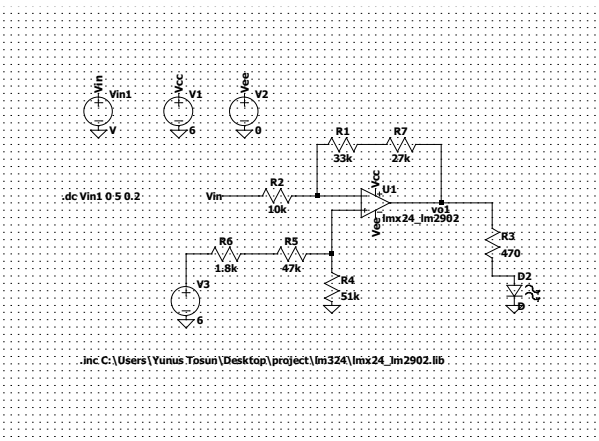

Figure 9: Blue LED Circuit

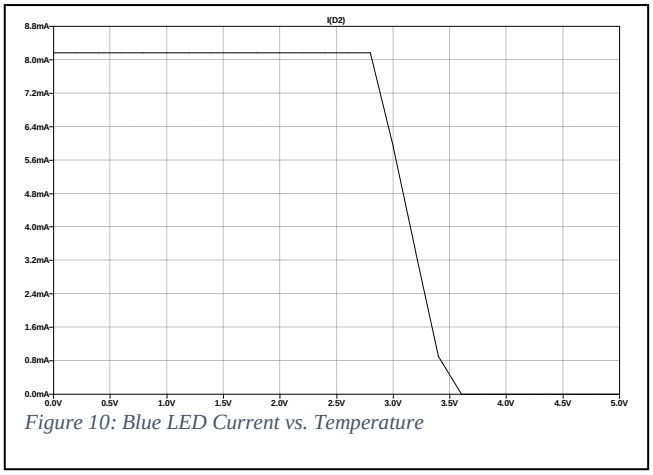

Figure 10: Blue LED Current vs. Temperature

2) Red LED control: In order to control red led, a non-inverting amplifier, shown in Fig.11, is used. To supply desired voltage to the inverting amplifier, a voltage divider circuit is used with a buffer in between. It takes input from the set unit or the sensing unit. If input voltage is between 2.8 Volts ad 3.6 Volts, it transfers the input to the led. It goes to negative saturation if the input is less than 2.8 volts, and it goes to positive saturation if the input is greater than 3.6 volts. Thus, we obtain the output shown at Fig.12 at the red led.

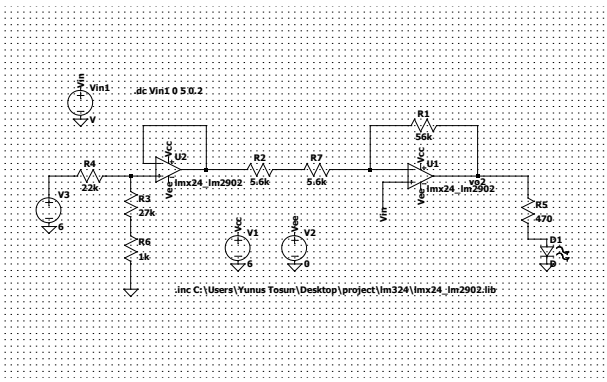

Figure 11: Red LED Circuit

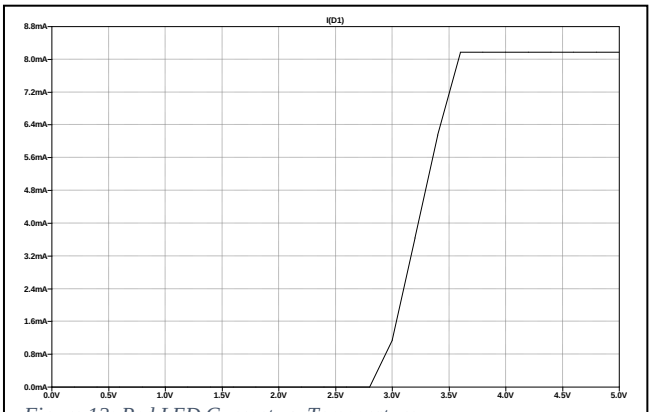

Figure 12: Red LED Current vs. Temperature

3) Red LED control: In order to obtain green light graph, shifted version of the red light and shifted version of the blue light is used. By taking a minimum of those two graphs, green light graph is obtained. Shifted red and shifted blue are constructed using the same circuits at red light and blue light by supplying different inverting or non-inverting voltage. Then, the minimum of the outputs of these two circuit is taken by a minimum amplifier circuit (figure..). Thus, the graph shown in figure.. is obtained.

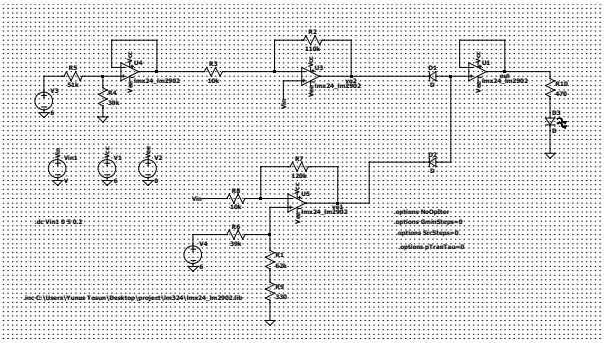

Figure 13: Green LED Circuit

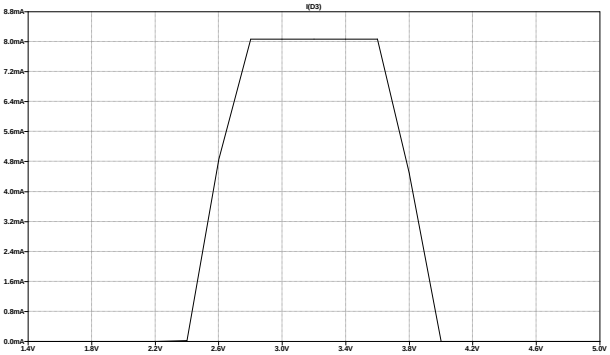

Figure 14: Green LED Current vs. Temperature

III. Experimental vs Theoretical Results

Theoretical results are obtained by LTSpice. Since mostly exact same components are simulated, there was no significant difference between theoretical and experimental results. However, there were some small deviations such as small voltage drops due to the environmental errors.

IV. Conclusion and Comments

I have designed and implemented a micro air-conditioner. Along the process, I encountered some problems and sought a solution from an engineering perspective. During this problem-solving process, I have learnt to approach problems from an engineering point of view. Also, I have gained lots of technical experience. Since I used analog devices to build this project, I comprehend how analog devices work very well.

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REFERENCES