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TEMPERATURE SENSING AND CONTROL OF A THERMO-ELECTRIC COOLER

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***Abstract*— In this paper, we have proposed a cost efficient and environmental friendly way of controlling the temperature of the surroundings by using a Thermo- electric cooler. The Peltier module working on the thermo-electric effect is a solid state module doesn't use any vapors or effluents thus causing no harm to the environment. The controller is a simple proportional controller which fixes the temperature of the cooler according to the reference voltage. With the change in voltage, the desired temperature can be achieved.**

***Keywords*— Temperature control, Controller, Environment-friendly, Thermo-Electric cooler.**

1.INTRODUCTION

This paper aims to make use of a controller for temperature regulation. A square wave inverter will be used for switching of a Peltier module. A Peltier uses no vapors or liquids and thus produces no effluents that harm the environment. Peltier module works on the principle of Thermo-Electric effect. It is a solid-state active heat pump. The lack of moving parts or circulating fluids makes it easier to handle.

When a DC current is passed through the Peltier module, it pumps heat from one side to the other. Thus, one face heats up while the other face cools down. The heating or cooling of the desired face can be achieved by changing the polarity of the module. The desired set point temperature will be changed used a potentiometer. It will make use to 2 switches which will provide a opposite polarities of current to the module resulting in heating and cooling of the desired face with respect to the set point.

Such a control mechanism can be used for thermal cycling of components for research purposes. It can also be used for refrigeration purposes to attain a desired temperature.

We plan to implement the temperature control using a proportional controller which will bring down the error to zero during switching of the circuit thus preventing the temperature sensitive components from damage. In this project, The dual in-line rail to rail op-Amp LT1632 was used for controller module, A Peltier module for temperature control, A CPU fan & a Heat Sink for quick dissipation of heat energy of the Peltier modul and A temperature sensor – LM35.

2.PROPOSED MODEL

The circuit makes use of a Thermoelectric Cooler which works on the principle of the Thermo-Electric effect for the control of the temperature. An Op- Amp is used which acts as a comparator to switch the MOSFET on and off. This MOSFET in turn controls the TEC. The temperature of the TEC is measured using an LM35, the output of which is amplified with a gain

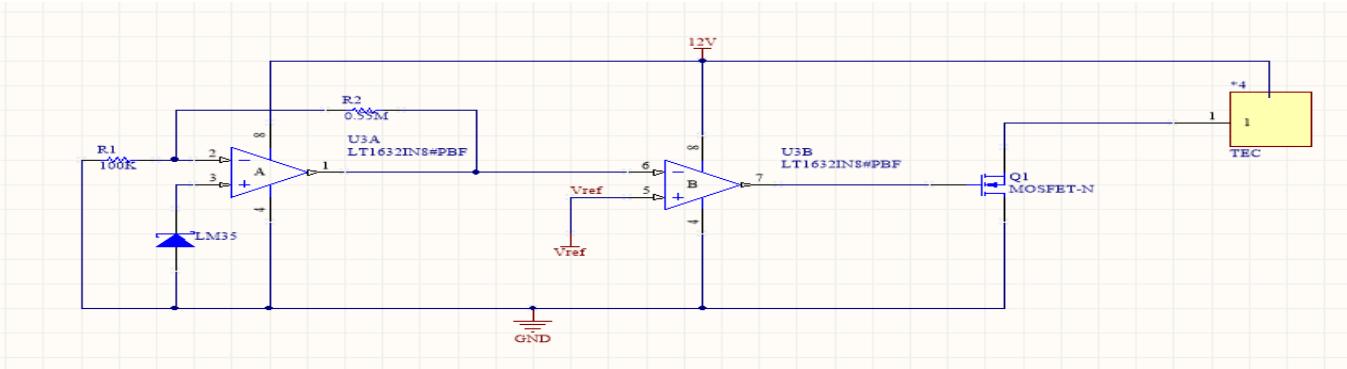

Figure 1. Proposed model

of 6.5. The output is fed into the comparator whose other terminal is at a reference voltage. This reference voltage decides the switching of the MOSFET.

The circuit consists of a dual inLine rail to rail OP-Amp-LT1632. This IC has two OP-Amps with a voltage rating of -30 to 30V. [1] The negative terminals of the OP- Amp are grounded to restrict the full swing of the Op-Amp in the negative direction. This was done for switching off of the circuit is the negative terminals becomes higher than the positive terminal. The reason for this will become apparent in a moment as the explanation of the circuit proceeds. LM35, a temperature sensor, gives a voltage of 250 mV at 25º C. Its voltage increases at a rate of 1 mV per degree Celsius. Thus, a gain of 6.5 was provided using a non-inverting amplifier with resister values of 100kΩ & 0.55 MΩ respectively. This is now fed into the comparator. [2]

This comparator is set at a desired reference voltage corresponding to the desired temperature. This voltage can be changed to increase or decrease the temperature. The output of theLM35 after being amplified is fed into the negative terminal. This is compared with the Vref at the positive terminal. As long as the required temperature is higher, i.e. Vref is higher, the module gets heated up. As soon as the temperature of the module reaches the required temperature, LM35 gives the output and the voltage at the negative terminal becomes higher. Thus, the output of the comparator drops down to zero therefore switching the mosfet off which in turns switches off the TEC module. The proposed model circuit is as shown in figure 1.

3.RESULTS & DISCUSSIONS

An analysis of the above circuit was done. In analysis, the supposition was taken that the circuit is operated through a PID controller instead of just a proportional controller to bring the potential down to zero. The results of the analysis are shown in figure 2.

However, during practical implementation, it was observed that the error in a simple proportional circuit comes down to zero and hence, to save resources and software complexity, only a linear proportional circuit was implemented.

4.APPLICAIONS

Avionics: A trend of growing power demand on both civilian and military aircrafts, owing to increasingly powerful electrical systems such as avionics, in-flight entertainment, and radar, has led to considerable challenges in thermal management. Thermoelectric Coolers (TECs) surface as a possible method, given that they are lightweight and compact in size, with a high mean time between failures (MTBF) and ability to change from cooling to heating with a simple voltage polarity reversal [3].

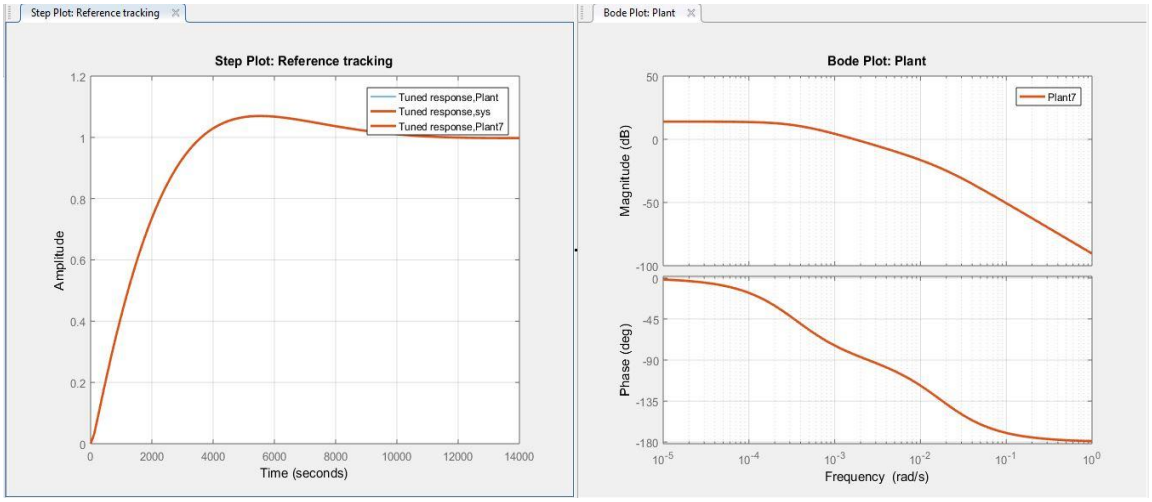

Figure 2. Fequency response of a TEC using a PID controller

Calorimeters: A calorimeter for use in measuring a sample is provided. The calorimeter may include a sample chamber for housing the sample therein. A separate reference chamber may not be present in the calorimeter. The calorimeter may also have a sample thermoelectric cooler in which heat from the sample chamber is transferred to the sample thermoelectric cooler.

Wine Cabinets: They are used in wine cabinets because they have less moving parts and require much less power to operate, thermoelectric cooled wine refrigerators use

much less energy than compressor cooled units. This feature not only benefits the customer, but the environment as well. Microtome Stage Coolers: Thermoelectric cooling units have been used to replace CO 2 gas and solid CO2 for microtome stage and Knife cooling. The stage temperature may be lowered to –36 C in 40–60 sec and at the optimum cutting temperature, five μ serial sections of fixed frozen tissue are obtainable [4].

Reason for the thermoelectric cooler is better than a refrigerator:
Compressor cooled wine refrigerators have a much more powerful cooling capacity than refrigerators, which is why most built-In units use a compressor. This is also the reason you will see more large-capacity units with compressor cooling functions.

5.CONCLUSIONS

The system can be used in several places such as in homes and hostels without creating any environmental issues. The circuit was just an initial circuit and much more advancement can be done in the same.

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