

# Amplification of the Thermoelectricity using Op-Amp

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## ABSTRACT

Energy crisis is a bottleneck in the supply of energy resources to an economy as there has been an enormous increase in the global demand for energy in recent years. Supply of energy is far less than the actual demand. Now days, studies are being conducted on thermo electric generator (TEG) as it has emerged as a possible solution to the energy crisis in the world. Moreover, it provides low voltage to the components of integrated circuit industry. One of the major limitations with the TEG is that the output of the device is in micro volts. This paper presents a method to increase the output of the thermo generator (Chromel- Alumel) from micro volts to milli volts.

## Keywords

Thermo generators, TEG, Energy Conservation, Chromel-Alumel, Thermo Couple.

## 1. INTRODUCTION

A thermo generator is a device which converts heat into electricity. Thermo generator finds its applications in many domains of daily use. The important application of TEG is in bio-electronic industry.

In this paper chromel-alumel thermo couple has been used and a method to boost the output of this thermo couple using op-amp has been presented. Previous studies [1, 2, 3, 4, 5, 6, and 7] reveal that the output of the Thermo Generators can boost to certain volts by using a MOSFET amplifier with a dc- dc boost converter, Chanditha Janaka Udalagama [1] has worked using the Bismuth Telluride thermo generator.

## 2. CHROMEL- ALUMEL TEG

As compared by Bismuth Telluride, the Chromel- Alumel thermo couple is a K- type thermo couple, its seeback coefficient is positive and its internal resistance is 22 ohms whereas the internal resistance of Bismuth Telluride is 2.8 ohms. The seeback coefficient is given by:-

$$VOC = \alpha \Delta T$$

Where VOC is open circuit voltage,  $\alpha$  is the seeback coefficient,  $\Delta T$  is the difference in temperature. The seeback coefficient of Chromel- Alumel Thermo Couple is  $40 \mu V/^{\circ}K$ . The output produced by the thermo couple is around  $200 \mu V$  which is in the same range as obtained from Bismuth telluride [1]. This voltage is too small to be utilized; hence it has to be amplified. [1,2 ,3 ] These have amplified the Thermo Couple output using MOSFET. In the present work we have tried to

amplify the output of Chromel – Alumel thermo couple, using op-amp as the amplifier [Fig.1]. There is no external source of voltage in the circuit as shown in Fig. 1.

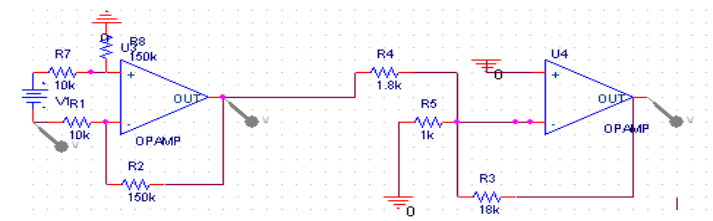


Figure: - 1

This amplifier consists of two op amps connected as inverting amplifiers. The amplification is carried out in two stages. The first op amp amplifies the input with a gain of 15.2 (stage-1) whereas the final amplification is provided by the next op amp with a gain of 10 (stage-2). The feedback resistance ( $R_{f2}$ ) of the second op amp is variable that varies from  $9 \text{ k}\Omega$  to  $18 \text{ k}\Omega$ . The output for the above circuit is tabulated as shown in table-1 by taking minimum ( $9 \text{ k}\Omega$ ) and maximum ( $18 \text{ k}\Omega$ ) value of feedback resistance. The input supply voltage is also varied from  $28 \text{ mV}$  to  $-28 \text{ mV}$ .

## 3. EXPERIMENT

As measured, the dc output of the Chromel Alumel thermo generator is  $200 \mu V$  (in micro volts). It is first fed to a step up transformer whose turn ratio is 1: 140. The input voltage is amplified to  $28 \text{ mV}$ . Then this voltage is fed to the op amp amplifier. The dc output voltage obtained is  $4.28 \text{ V}$ . Another transformer with the turn ratio 1:535 is connected in parallel with the first transformer that will provide a constant supply of  $15 \text{ V}$  to the op amp.

The block diagram of the above circuit is as follows:-

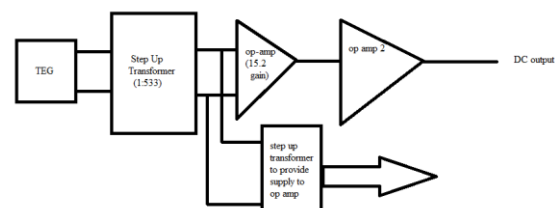


Figure :- 2

## 4. CALCULATIONS

The Table-1 shows the output voltages of both the stages 1 and 2 as the input resistance varies from 9k to 18k and the input supply varies from 28mV to -28mV.

Input Supply (Green)	Feedback Resistance	Output Voltage Stage-1 (Red)	Output Voltage Stage-2 (Blue)
-28mV	9k	0.420	-2.175
-28mV	18k	0.420	-2.974
28mV	9k	-0.427	2.555
28mV	18k	-0.427	4.28

Table :- 1

## 5. SIMULATION RESULTS

The simulation results for all the above cases shown below.

a) Simulation result for the input voltage is -28mV and the Rf2 is 9k is shown in Fig3.

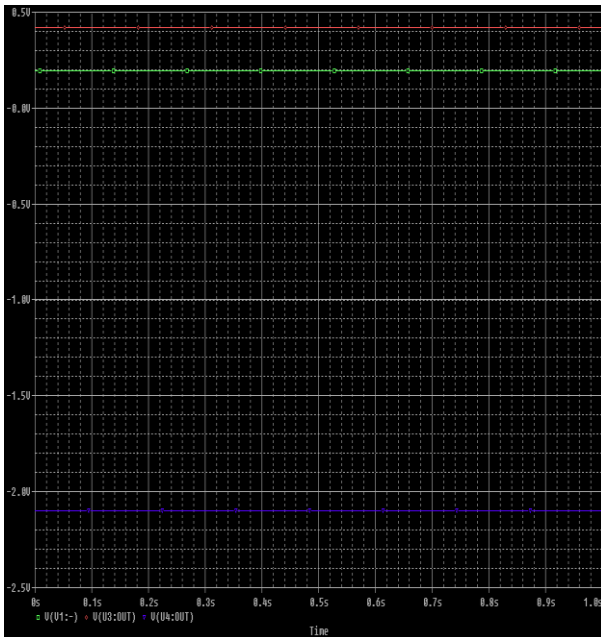


Figure :- 3

The figure shows that the stage 1 amplifier amplifies the input (green) to 0.420 V (red) and the second stage gives output of -2.1754 (blue)

b) Simulation result for the input voltage is -28 mV and the feedback resistance Rf2 is 18 kΩ is shown in Fig4.

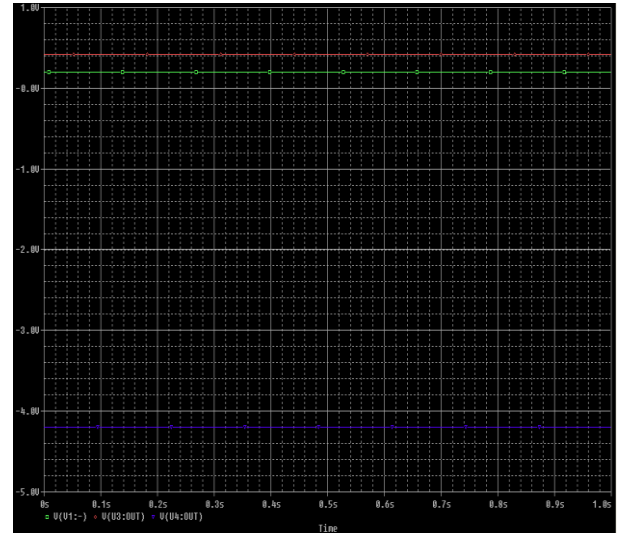


Figure :- 4

The figure shows that the stage 1 amplifier amplifies the input (green) to 0.420 V (red) and the second stage gives output of -2.974 (blue).

c) Simulation result for the input voltage is +28mV and the Rf2 is 9k is shown in Fig.5

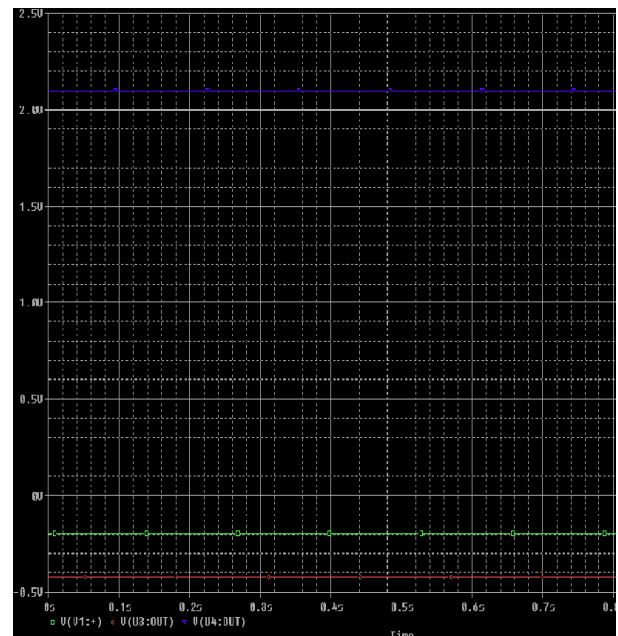


Figure :- 5

The figure shows that the stage 1 amplifier amplifies the input (green) to -0.420 V (red) and the second stage gives output of 2.555 (blue)

d) Simulation result for the input voltage is +28mV and the Rf2 is 18k is shown in Fig.6.

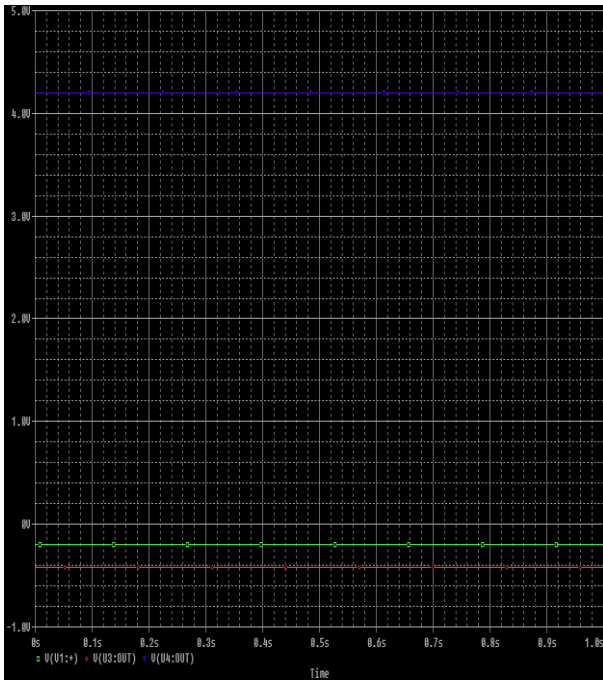


Figure :- 6

1. The figure shows that the stage 1 amplifier amplifies the input (green) to -0.420 V (red) and the second stage gives output of 4.28 V (blue).

## 6. CONCLUSIONS

The output of the thermo generator can be increased to the desired voltage level by using step up transformer and multiple stages of op-amp amplifier. The voltage can be brought up to the range of few volts from micro volts. In the present work voltage level of 200 micro volts was increased to a level of 4.28 volts as shown in the simulation result. This can be further increased by using more op-amp stages. Moreover, new studies can be conducted using different thermo couples that can provide sufficient output as required

## 7. REFERENCES

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