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Body Heat Powered Flashlight Using LTC3108

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Abstract
The Abstract deals with the proper usage of unused energy generated by humans in the form of heat by making it in glowing a Flashlight. Thereby the Flashlight runs solely on the heat of human palm without using any batteries.
Index Terms:- Heat Sink, Linear IC, Peltier Tiles, Stepup Transformer.

I. INTRODUCTION

The average human consumes approximately 2000 Calories per day. This means that the average person expends ~8.37×10^6 joules of energy per day, since most of us are in some sort of equilibrium with our surroundings. Assuming most of this energy leaves us in the form of heat, on average we radiate ~350,000 J of energy per hour. Since Watt is just Joules per second, this is roughly equal to energy given off by a 100 Watt light bulb!
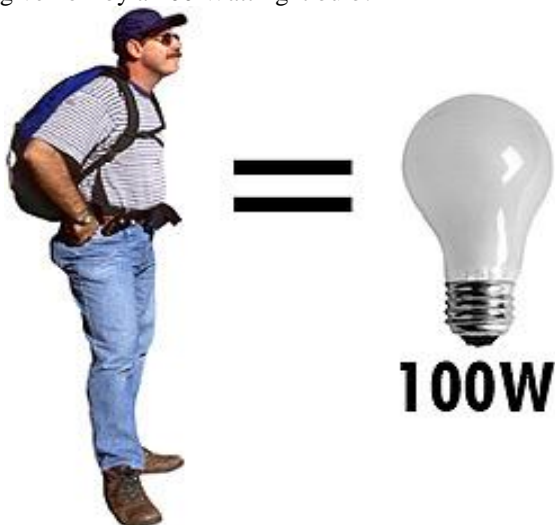
Figure(i) : Energy Radiated by Humans per Hour

This assumption, that most of our expended energy leaves us in the form of heat, is actually a decent one. Speaking as a relatively normal college student (in all relevant respects), the amount of energy I expend doing non-thermal work on my surroundings every day seems pretty trivial. Aside from playing tennis , probably the most energetic thing I do is walk up 5 flights of stairs to my dorm room. This increase in gravitational potential energy, however, is only ~12,000 J, or on the order of 0.1% of my total energy expenditure.

II. DESIGN OF BODY HEAT POWERED LIGHT

The average surface area of the human skin[3] is 1.7 m^2 or 17,000 cm^2, As human dissipates around 350,000 Joules per hour, or 97 watts so the heat so heat dissipation equals to **5.7mW/cm^2**. A useful area of the palm is about 10 cm^2. This implies that 57 mW could be available but only 0.5 mW is needed to generate a bright light at the LED.

The design of body heat powered light includes

* Peltier Tiles
* Oscillator Circuit
* Step-up Transformer
* Heat Sink

III. PELTIER TILES

A Peltier cell also known as a thermoelectric cooler is made up of a large number of series-connected P-N junctions, sandwiched between two parallel ceramic plates. Although Peltier cells are often used as coolers by applying a DC voltage to their inputs, they will also generate a DC output voltage, using the Seebeck effect, when the two plates are at different temperatures. The polarity of the output voltage will depend on the polarity of the temperature differential between the plates.

The magnitude of the output voltage is proportional to the magnitude of the temperature differential between the Plates. When used this manner, a Peltier cell is referred to as a thermoelectric Generator. The output from the Peltier Device is Direct Current. Direct Current cannot be multiplied, but if the DC is changed to AC, the voltage can be stepped up with a transformer. The upper surface of the the peltier is made up of dielectric substrate and internally consists of P-type and N-type. they have a lot of P-N contacts connected in series. They are also heavily doped, meaning that they have special additives that will increase the excess or lack of electrons.
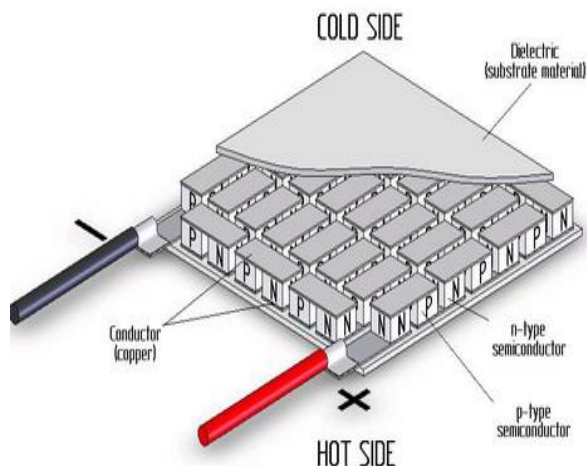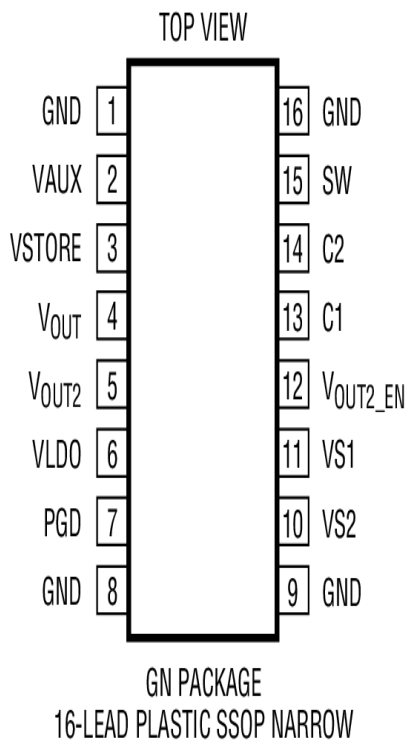
Figure(ii) : Peltier Tile

IV. OSCILLATOR CIRCUIT

Oscillators convert Direct current to Alternating Current. The output from the the Peltier is such a low voltage that need to be busted for which Linear IC LTC3108 is used.

The LTC®3108 is a highly integrated AC/DC converter ideal for harvesting and managing surplus energy from extremely low input voltage sources. The pin configuration of LTC 3108 us shown below

Figure(iii) : Top view of LTC 3108

The LTC3108 utilizes a MOSFET switch to form a resonant step-up oscillator using an external step-up transformer and a small coupling capacitor. This allows it to boost input voltages as low as 20mV high enough to provide multiple regulated output voltages for powering other circuits

In application, a storage capacitor typically a few hundred microfarads is connected to VOUT in. As soon as VAUX exceeds 2.5V, the VOUT capacitor will be allowed to charge up to its regulated voltage. The current available to charge the capacitor will depend on the input voltage and transformer turns ratio, but is limited to about 4.5mA.

VOUT2 is an output that can be turned on and off by the host, using the VOUT2_EN pin. When enabled, VOUT2 is connected to VOUT through a 1.3Ω P-channel MOSFET switch. This output, controlled by a host processor, can be used to power external circuits such as sensors and amplifiers that do not have a low power sleep or shut down capability. VOUT2 can be used to power these circuits only when they are needed.

A power good comparator monitors the VOUT voltage. The PGD pin is an open-drain output with a weak pull-up(1MΩ) to the LDO voltage. Once VOUT has charged to within 7.5% of its regulated voltage, the PGD output will go high. If VOUT drops more than 9% from its regulated voltage, PGD will go low. The PGD output is designed to drive a microprocessor or other chip I/O and is not intended to drive a higher current load such as an LED. Pulling PGD up externally to a voltage greater than VLDO will cause a small current to be sourced into VLDO. PGD can be pulled low in a wire-OR configuration with other circuitry.

The VOUT2 enable input has a typical threshold of 1V with 100mV of hysteresis, making it logic-compatible. If VOUT2_EN (which has an internal pull-down resistor) is slow, VOUT2 will be off. Driving VOUT2_EN high will turn on the VOUT2 output.

The VSTORE output can be used to charge a large storage capacitor or rechargeable battery after VOUT has reached regulation. Once VOUT has reached regulation, the VSTORE output will be allowed to charge up to the VAUX voltage. The storage element on VSTORE can be used to power the system in the event that the input source is lost, or is unable to provide the current demanded by the VOUT, VOUT2 and LDO outputs. If VAUX drops below VSTORE, the LTC3108 will automatically draw current from the storage element.

The frequency of oscillation is determined by the inductance of the transformer secondary winding and is typically in the range of 10kHz to 100kHz. For input voltages as low as 20mV, a primary-secondary turns ratio of about 1:100 is good.

The timing diagram showing the typical charging and voltage sequencing of the outputs is shown below
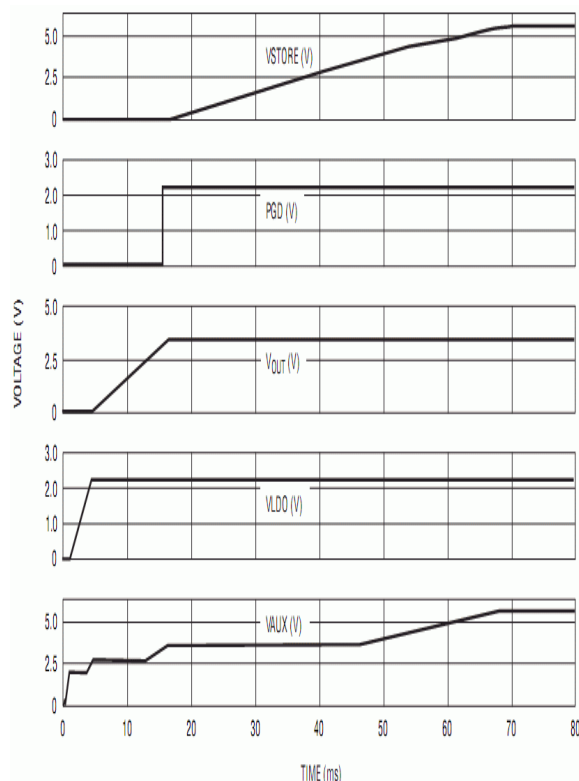

Figure(iv) : Output Voltage Sequencing with VOUT Programmed for 3.3V

V. STEPUP TRANSFORMER

The step-up transformer turns ratio will determine how low the input voltage can be for the converter to start. On a step-up transformer there are more turns on the secondary coil than the primary coil. The induced voltage across the secondary coil is greater than the applied voltage across the primary coil or in other words the voltage has been "stepped-up". Using a 1:100 ratio can yield start-up voltages as low as20mV. Other factors that affect performance are the DC resistance of the transformer windings and the inductance of the windings. Higher DC resistance will result in lower efficiency. The secondary winding inductance will determine the resonant frequency of the oscillator, according to the following formula.

$$\text{Frequency} = \frac{1}{2\pi\sqrt{L \times C}} \text{ Hz}$$

Where L is the inductance of the transformer secondary winding and C is the load capacitance on the secondary winding. This is comprised of the input capacitance at pinC2, typically 30pF, in parallel with the transformer secondary winding's shunt capacitance. Here Two Peltiers are used which are connected to Linear IC one side of peltier is heated by the human palm and the other is cooled.
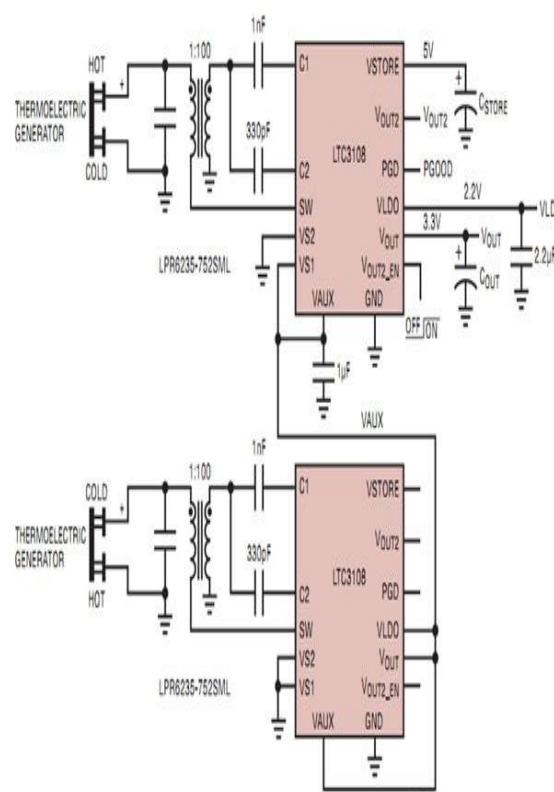
Figure(v) : Peltiers connected to Linear IC

The above figure shows the two peltiers connection to the Linear IC using the step-up transformer of the turns ratio 1:100. The output of the circuit is taken and is tabulated. For the send time the 1:100 turns transformer is replaced by 1:20 turns, the output is found out and tabulated. The Efficiency of the two transformers is compared is is plotted graphically.
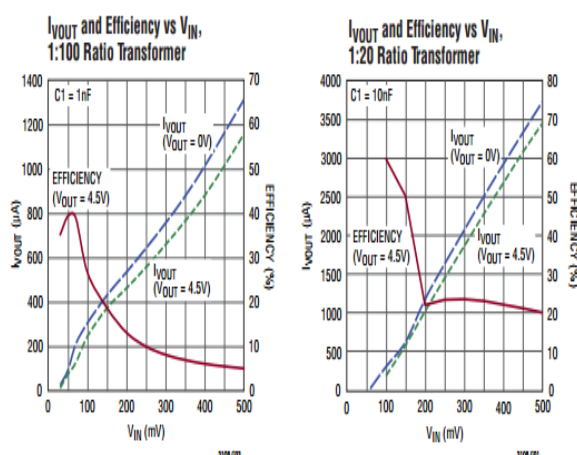

Figure(vi) : Voutvs Vin of 1:100 & 1:20 tansformers

the Vout obtained for the 1;100 ratio transformer is 4.5v and the capacitor used here is C1=1nF while in case of 1:20 ratio, the capacitor used is C1=10nF and efficency is calculated

VI. HEAT SINK

Heat sinks are used where the heat dissipation ability of the basic device is insufficient to moderate its temperature. Here Heat sink is used to cool the peltier tiles. Generally aluminum is used as heat sink due to the cheaper in cost and greater in the performance.
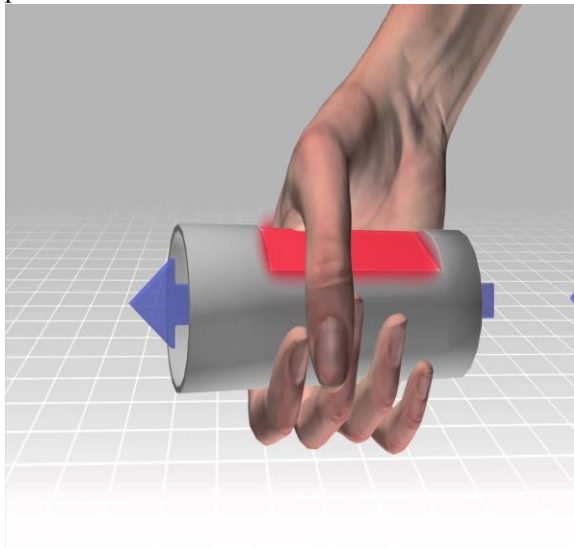
Figure(Vii) : Air flowing through Aluminum tube

Peltier Tiles were mounted on the aluminum tube and placed inside a PVC pipe with a cut for the peltiers.The Hollow space inside the tube allows to pass the air currents freely. So the Flashlight can be divided as the two medium the outer area and the inner area of the tube. The area also referred as Hot side due to the contact of peltier with the with the Human Hand. The inner area also referred as cold side due to the passage of air currents.

VII. CONCLUSION

Even with all the thermal and voltage conversion losses, there was still enough power in the palm to provide usable light. The results proved that some of the unused energy that have been wasted in the form of heat is utilized in glowing a Flashlight using thermo-electric conversion by peltier Tiles.

VIII. ACKNOWLEDGEMENT

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BIOGRAPHY

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