Thermoelectric Powered Heart Rate Monitor

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Figure 18. Prototype of Thermoelectric Generator

INTRODUCTION

Thermoelectric generating technology is being pioneered today as a future method of generating electric energy by harvesting waste heat of various means. Some examples of waste heat will be body heat, engine exhaust or essentially any heat that is produced by machines. This project focuses on harnessing this waste heat in order to produce enough electric energy to power a heart rate monitor. It operates on the principle that a difference in temperature induced on two sides of a thermoelectric generator will result in a small voltage and current flowing through the circuit. The voltage is small and is boosted using a DC-DC converter in order to create a large enough charge sustained over a long period of time in order to charge three AAA Ni-MH batteries. Currently all these heart rate monitors are battery powered, but these batteries have to be frequently replaced. Even if rechargeable batteries are used, these batteries will often have to be charged using an electric wall charger. A technological and societal emphasis is being placed on renewable energy for the continued preservation of our environment. This design eliminates the need to ever charge batteries using a wall charger, and is wearable.

SUMMARY OF IMPACT

The three R's of reducing the carbon footprint have always been stressed as being Reduce, Reuse, Recycle. The key elements of the thermoelectric powered heart rate monitor are to tackle these key points. It does not require an extra power supply. It utilizes a rechargeable battery in order to store the charge produced by the thermoelectric generators. It is reusable for up to 3 to 5 years equivalent to hundreds of recharge cycles. The design of this device is small and very light so it is easy to wear on the wrist without looking cumbersome or feeling uncomfortable. It will provide a lot of convenience to the user. The impact of the widespread use of this concept is phenomenal, which will be able to power not just a heart rate monitor but many small household devices.

TECHNICAL DESCRIPTION

The thermoelectric generator is a small, one inch square device consisting of 127 Bismuth Telluride thermocouples encased in a ceramic shell. With the 5 degree Celsius difference in temperature between the hot and cold sides of the TEG, it produces 40mV. Four of these thermoelectric generators are connected in series to boost the voltage up to 160mV. This voltage is fed into a DC-DC converter which needs a minimum of 80mV to power it and in turn boosts the voltage up to 10V. The thermoelectric generators are housed on an aluminum plate which acts as both a place holder and a heat sink. Additional pin fin aluminum heat sinks are placed on top of the thermoelectric generators in order to aid in cooling, ensuring a maximum ΔT is maintained. Everything is held in place using thermally conductive epoxy to ensure that maximal heat is transferred from the body to the hot side of the thermoelectric generators.

Three AAA Ni-MH batteries with a voltage capacity of 1.2V and 850mAh are used to store the charge produced by the thermoelectric generators. A diode is placed in series before the batteries to ensure that the voltage flows only one way to the batteries and not from the batteries to the thermoelectric generators. The batteries are in turn connected to the heart rate sensor through two wires which are connected to the positive and negative leads of the sensor circuit. It takes about 50 minutes to charge the batteries to approximately 2.88V at which time the sensor can be activated for a period of 3 minutes of constant monitoring. This discharge time could be increased if the sensor duty cycle was decreased. The sensor takes approximately 10 seconds to give a heart rate reading.

The cost of the parts and supplies for this project was about $300.

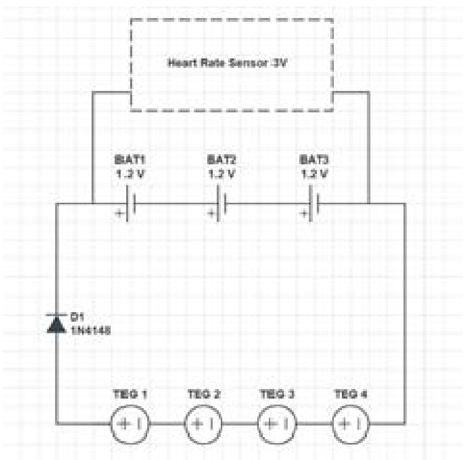

Figure 19. Charging Circuit Diagram