Project submitted in partial fulfillment for the Degree of B. Tech in Applied Electronics & Instrumentation Engineering under West Bengal University of Technology

WEARABLE THERMO ELECTRIC ENERGY HARVESTING WATCH

FOR

CHARGING PURPOSES

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MAY 2018

ACKNOWLEDGEMENT

It is a great privilege for us to express our profound gratitude to our respected teacher Mr.Avishek Paul, Assistant .Prof. Department .of Applied Electronics & Instrumentation Engineering, RCC Institute of Information Technology, for his constant guidance, valuable suggestions, supervision and inspiration throughout the course work without which it would have been difficult to complete the work within scheduled time.

We would like to express our gratitude towards Other Faculty Name for his/her kind co-operation and encouragement which helped me in completion of this project.

We are also indebted to the Head of the Department, Applied Electronics & Instrumentation Engineering, RCC Institute of Information Technology for permitting us to pursue the project.

We would like to take this opportunity to thank all the respected teachers of this department for being a perennial source of inspiration and showing the right path at the time of necessity.

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CERTIFICATE OF APPROVAL

The project report titled "**Wearable Thermoelectric Energy Harvesting Watch For Charging Purpose**" prepared by **Debosruti Bhattacharya** Roll No: 11705514014; **Mrinmoyee Bhowmik** Roll No: 11705514021; **Ritika Dey** Roll No:11705514026; is hereby approved and certified as a creditable study in technological subjects performed in a way sufficient for its acceptance for partial fulfilment of the degree for which it is submitted.

It is to be understood that by this approval, the undersigned do not, necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the project only for the purpose for which it is submitted.

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[Supervisor] [Head of the Department]

Applied Electronics & Instrumentation Engineering Applied Electronics & Instrumentation Engineering

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RECOMMENDATION

I hereby recommend that the project report titled "**Wearable Thermoelectric Energy Harvesting Watch For Charging Purpose**" prepared by **Debosruti Bhattacharya** Roll No: 11705514014; **Mrinmoyee Bhowmik** Roll No: 11705514021; **Ritika Dey** Roll No:11705514026 accepted in partial fulfillment of the requirement for the Degree of Bachelor of Technology in Applied Electronics &Instrumentation Engineering, RCC Institute of Information Technology.

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CONTENT

INTRODUCTION

Living subjects (i.e., humans and animals) have abundant sources of energy in chemical, thermal, and mechanical forms. Wearable devices that can be worn by humans in daily life or in special environments have been highlighted with the development of portable electronic devices and IoT (Internet of Things) technologies. These devices are of various types and are available in forms such as smart glasses, smart clothes, biometric sensors, artificial joints, laptops, and mobile phones. They require power ranging from several mill-watts to several tens of watts for operation. The use of wearable devices consuming high amounts of power increases the weight of batteries that are carried together and requires periodic charging. Therefore, energy harvesting devices have been studied as an assistant energy source for batteries or independent energy sources for the permanent use of wearable devices without restrictions associated with power consumption. Human energy can originate from a chemical or a physical energy source. Typical sources of physical energy include the thermal and kinetic energy of the human body. Wearable thermoelectric devices convert heat from the human body into electricity of several μW continuously without affecting the human body. The human body generates kinetic energy in various forms by using muscles, such as foot strike; motions of joints such as ankle, knee, hip, arm, and elbow; and center-of-gravity (COG) motion of the upper body. Among the human body motions, lower limb motions, such as ankle, knee, and hip motions induce For instance, theoretical calculations have demonstrated that body heat, breathing, and arm movements can generate 2.8–4.8W, 0.83W, and 60W, respectively.

TYPES OF ENERGIES:

The report points out that we can harvest energy from several environmental sources:

- Light, using photovoltaic
- Movement of the wearer
- Radio frequency energy (RF)
- Temperature differences using a thermoelectric generator (TEG)

LITERATURE REVIEW

WEARABLE ENERGY HARVESTING: FROM BODY TO BATTERY

Abstract:

In the last decade, EH has matured as a technology and found use in many application scenarios, such as smart grid and wireless sensor networks. Recently, advances have been made in miniaturizing EH devices to supply wearable devices by exploiting ambient energy in the form of motion, thermal gradients, light and electromagnetic radiation. However, harvesting energy from the body for powering wearable devices is more challenging due to strict constraints in terms of size, weight and cost.In this paper, we present a taxonomy of technologies, architectures and design trade-offs for efficient EH systems suitable for wearable devices.We quantify the energy that it is possible to harvest in real application scenarios, which is in the range of 200–700 mJ per day, depending the source, and result in up to 1.5 J per day if coupled.

Authors:

Michele Magno , David Boyle

Imperial College London, United Kingdom

Put this in reference

THERMOELECTRIC ENERGY HARVESTING FOR MOBILE PHONE CHARGING APPLICATION

Abstract:

To address the dramatic increase in energy consumption of personal electronic devices, human body heat is harvested using a thermoelectric generator (TEG). This paper presents harvesting the heat energy also known as thermoelectric energy from human body heat which would be wasted otherwise using a TEG to charge a mobile phone battery. Based on the temperature difference between the heat generated from the heat source and the environment, the TEG is able to convert heat energy to thermoelectric energy. Heat energy is a renewable source that is easily accessible. In this paper body heat is being harvested. A step up DC-DC converter is used to step up the harvested voltage. This voltage can be either stored or used to power up low-power electronics. In this work, a typical Universal Serial Bus (USB) hand phone was charged using the harvested heat energy.

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GENERAL BLOCK DIAGRAM OF THE WEARABLE THERMO ELECTRIC ENERGY HARVESTER

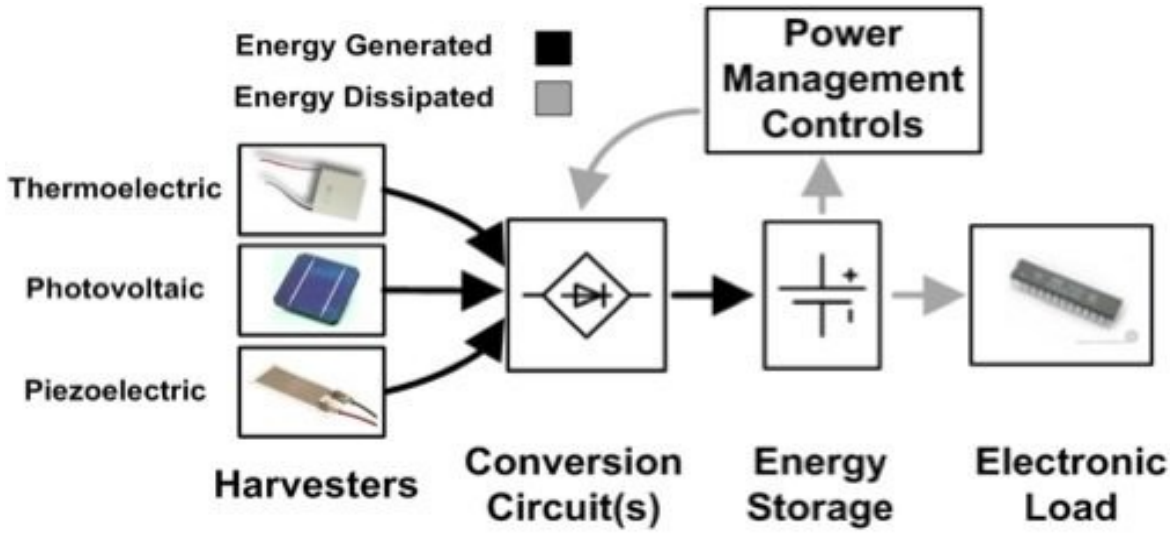

Fig. no.1 Wearable Thermo-Electric Energy Harvester

MOTIVATION

- Modules for Cooling
- Modules for Power Generation
- Different types of non-conventional energy sources
- Thermoelectric Ingots

IMPLEMENTATION

HARDWARE REQUIREMENTS:

- An Active Temperature sensor(10K Thermistor)
- Storage Chip (LM 358)
- IC regulator(LM 7805)
- Commercial Resistors
- MOSFET(IRF-540 OR P556N) Devices
- Electronic Preset
- Diode (1N4007)
- USB port
- Adapter (12 V)

THEORITICAL DESCRIPTION

AN ACTIVE TEMPERATURE SENSOR (10K Thermistor)

FEATURES:-

- With more than 70 years of technology experience in the development, design and manufacture of high quality sensors, Thermo metrics offers one of the most comprehensive ranges of temperature measurement and sensing products in the world today.
- Thermometric' temperature technologies include high accuracy NTC thermostats, PTC heaters, non-contact IR and custom design capabilities globally.
- Thermo metrics provides solutions to a wide range of temperature sensing challenges faced by the healthcare, automotive, industrial and consumer markets.
- Thermistor temperature range -55 °C to 125 °C

Fig. no. 2 Diagram of active sensor (10K Thermistor)

STORAGE CHIP (LM 358)

FEATURES :-

- Available in 8-Bump DSBGA Chip sized packet
- Input Common-Mode Voltage Range Includes Ground power supplies.
- Differential Input Voltage Range Equal to the Power Supply Voltage
- Large Output Voltage Swing

Utilizing the circuit designs perfected for quad op-amps, this dual op-amp features low power drain, a common mode input voltage range extending to ground/VEE, and single supply or split supply operation.

They can operate at supply voltages as low as 3.0 V or as high as 32 V, with quiescent currents about one-fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications.

The output voltage range also includes the negative power supply voltage.

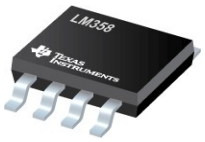

Fig. no.3 Dual OP-AMP (LM 358)

IC REGULATOR (LM 7805)

FEATURES:-

- Input voltage range 7V- 35V
- Current rating $I_c = 1A$
- Output voltage range $V_{Max=5.2V}$, $V_{Min=4.8V}$
- Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs.
- A voltage regulator IC maintains the output voltage at a constant value.
- 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC).
- The xx in 78xx indicates the output voltage it provides.
- 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

Fig. no. 4 IC Regulators (LM 7805)

COMMERCIAL RESISTORS

FEATURES:-

- A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element.
- In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

- High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators.
- Fixed resistors have resistances that only change slightly with temperature, time or operating voltage.
- Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.
- Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment.
- Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.
- The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude.
- The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component.

Fig. no. 5 Commercial Resistors

MOSFET (IRF- 540 OR P556N) DEVICES

FEATURES OF THE MOSFET (IRF - 540 OR P556N) DEVICES:-

- Low Gate Charge Qg results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Effective Costs Specified

Fig. no. 6 MOSFET (IRF 540 OR P556N)

ELECTRONIC PRESET

FEATURES:-

- A preset is a three legged electronic component which can be made to offer varying resistance in a circuit.
- The resistance is varied by adjusting the rotary control over it.
- The adjustment can be done by using a small screw driver or a similar tool.
- The resistance does not vary linearly but rather varies in exponential or logarithmic manner.
- Such variable resistors are commonly used for adjusting sensitivity along with a sensor.
- The variable resistance is obtained across the single terminal at front and one of the two other terminals.
- The two legs at back offer fixed resistance which is divided by the front leg.
- So whenever only the back terminals are used, a preset acts as a fixed resistor.
- Presets are specified by their fixed value resistance.

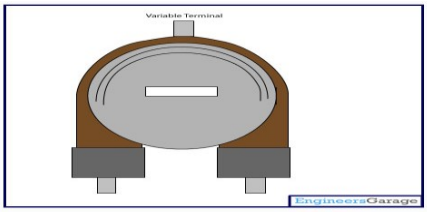

Fig. no. 7 Electronic Presets

DIODE (1N4007)

FEATURES:-

- Average forward current is 1A
- Non-repetitive Peak current is 30A
- Reverse current is 5uA.
- Peak repetitive Reverse voltage is 1000V
- Power dissipation 3W
- Available in DO-41 Package
- A rectifier diode is used as a one-way check valve.
- Since these diodes only allow electrical current to flow in one direction, they are used to convert AC power into DC power.
- When constructing a rectifier, it is important to choose the correct diode for the job; otherwise, the circuit may become damaged.
- Luckily, a 1N4007 diode is electrically compatible with other rectifier diodes, and can be used as a replacement for any diode in the 1N400x family.

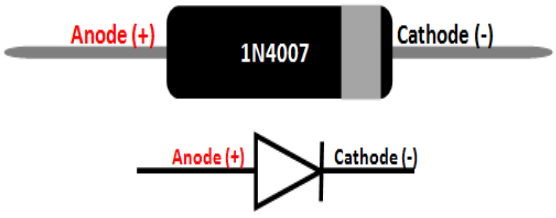

fig. no. 8 Diode(1N4007)

USB PORT

FEATURES:-

- A USB port is a standard cable connection interface for personal computers and consumer electronics devices.
- USB stands for Universal Serial Bus, an industry standard for short-distance digital data communications.
- USB ports allow USB devices to be connected to each other with and transfer digital data over USB cables.
- They can also supply electric power across the cable to devices that need it.
- Both wired and wireless versions of the USB standard exist, although only the wired version involves USB ports and cable.

ADAPTER (12Volt)

FEATURES:-

- Adapters for battery-powered equipment may be described as chargers or rechargers (also battery charger).
- AC adapters are used with electrical devices that require power but do not contain internal components to derive the required voltage and power from mains power.

RESULTS & DISCUSSION

From our Body temperature (skin) the active temperature sensor (10 K) NTC Thermistor sense the temperature and that sensing temperature is fed to the dual op-amp chip (LM 358), which has two inverting and non inverting input points. There is an IC voltage regulator chip (LM 7805), which can regulate the voltage in the total circuit and it maintains the output voltage at a constant value. The Commercial resistors are used to adjust the circuit elements. We are using a MOSFET (IRF-540) device which has three parts- Gate,Drain and Source and through these parts it is working.By blinking the LED the circuit is executed and through USB port any electronic device(mobile) can be charged.

CONCLUSION

The market for thermoelectric energy harvesters will reach over. Even though energy harvested is small and in the order of mill watts, it can provide enough power for wireless sensors, embedded systems, and other low-power applications. Harvesting energy from nonconventional sources in the environment has received increased interest over the past few years as designers look for alternative energy sources for low-power applications. The evolution of body-powered devices during 6 years of their development vindicates that only low-power applications, i.e., those consuming below 1 mW,

it can be powered indoors by using human body heat. On the other hand, it has been shown that most of the wireless health monitoring and medical devices can work at a power of less than 1mW with no loss in the signal quality.

FUTURE SCOPE OF STUDY

The scope of the application of energy harvesting extends to both powering of devices within and on or near the body. In the case of medical monitoring, differing needs will determine where the device is best placed and the energy harvesting solutions will need to be adaptable to this. These kinds of technologies applicable are taken as any that draw upon the human body for the energy to be harvested. Therefore, might harvest energy from other sources(e.g., solar energy, electromagnetic fields)

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