

DEVELOPMENT OF SELF-POWERED THERMOELECTRIC BASED COOLING
SYSTEM FOR LCD PANEL

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This Report Is Submitted In Partial Fulfillment of Requirements for the Bachelor
Degree of Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elecktronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

June 2016



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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Thank for my beloved family. Thank for my supervisor and all lecturers who guiding me, and to all my friends for giving me mentally and moral support during process of finish final year project.

ACKNOWLEDGEMENT

First of all, I would like to express my deepest appreciation to all those who supporting and helping me to complete this report. Thank to my family for encourage and provide me resources to complete my project with any concern.

Besides, a special gratitude I give to my supervisor, Prof. Madya Dr. Kok Swee Leong who contributes in suggestion in term of knowledge and experience, helped me along my final year project. PM Dr.Kok always gave good motivation and suggestion to complete this project.

Furthermore, I would like to acknowledge with much appreciation of the Engineer assistance from Research Lab2, Puan Hafizah Binti Adnan, who gave the help for arrange all required equipment and material to complete my final year project.

Thank to anyone for sharing the ideas and knowledge for the circuit design and provide guide to finish the project in time. They had given me a lot of encouragement and tips to improve my project.

ABSTRACT

Nowadays, electronic systems or devices have become part of our life. All of the electronic systems or devices will dissipate heat while heat dissipated affecting the functionality and lifetime of the system or devices. However, the heat dissipated can be converted from one form to another and thus turning the waste energy into useful energy. Thermoelectric generator (TEG) is a generator which converts heat energy to electrical energy. In this project, TEG will be used to minimize the heat that generated from the electric system. Firstly, heat dissipated is characterized from 85" inch Thin-film-transistor liquid-crystal display (TFT LCD) from Quantum Electro Opto System Sdn. Bhd. Heat dissipated from power board of LCD panel is collected and compared with thermal analysis from different size of LCD panel. After that, hotplate is used to simulate the heat dissipated for LCD panel. TEG is placed between hot plate and heat sink to generate voltage output. After that, power conditioning circuit is designed to boost up the voltage generated from the TEG. In this project, power conditioning circuit is a combination of Multivibrator and Charge Pump circuit. Output voltage from the power conditioning circuit is used to power up wireless electronic devices for the application of triggering cooling system. This mechanism is referred to as self-powering whereby the RF transmitter is powered by the heat itself without necessary to use battery. After RF transmitter turned on, RF signal will send to RF receiver to trigger on the cooling fan on receiver station.

ABSTRAK

Pada masa kini, sistem atau peranti elektronik adalah sebahagian daripada hidup kita. Semua sistem atau peranti elektronik akan menghilangkan haba manakala haba yang dilesapkan daripadanya akan menjejaskan fungsi and jangka hayatnya. Walau bagaimanapun, haba yang dilesapkan adalah sesuatu tenaga iaitu tenaga haba. Oleh itu, tenaga tersebut boleh ditukar dari satu bentuk kepada bentuk lain. Ia boleh mengelakkan tenaga haba menjadi tenaga buangan. Thermoelectric (TEG) adalah penjana yang menukarkan tenaga haba kepada tenaga elektrik. Dalam projek ini, TEG akan digunakan untuk mengurangkan haba yang dijana dari sistem elektrik. Pertama, pengukuran haba yang dilepas pada permukaan 85" inci Thin-Film-Transistor Liquid-Crystal-Display (TFT LCD) dari Quantum Electro Sistem Opto Sdn. Bhd. Heat hilang dari LCD panel dikumpul, and dibandingkan dengan LCD panel yang saiz berbeza. Selepas itu, hot plate digunakan untuk simulasi haba yang dilesapkan daripada panel LCD. TEG diletakkan di antara hot plate dan heat sink untuk menjalan voltan keluaran. Selepas itu, litar-itar adalah "Multivibrator" dan "Charge Pump" direka untuk meninggikan voltan yang dihasilkan daripada TEG. Voltge dari litar tersebut digunakan untuk memberi kuasa kepada peranti elektronik yang tanpa wayar untuk sistem penyejukan. Mekanisme ini dirujuk sebagai menjanakan kerana tenaga elektrik untuk RF transmitter adalah dari haba TEG tanpa menggunakan bateri. Selepas RF transmitter dihidupkan, isyarat RF akan menghantar kepada RF receiver untuk menhidupkan kipas penyejuk di stesen RF receiver.

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CHAPTER 1

INTRODUCTION

In this chapter introduction of project will be discussed as a guideline for the research. Introduction includes the project background, objectives, problem statement, scope of the project, summary of methodology and project overview.

1.1 Project Background

Excessive heat energy dissipates from electronic system may cause malfunction and lower efficiency of the operating system, therefore it needs to be eliminated. In this project, thermoelectric generator (TEG) will be used to minimize the heat generated from the electric system by transforming into useful electrical power for powering other electronic devices.

TEG is a device that operates according to thermoelectric effect, whereby the effect is a phenomenon of transforming heat into electrical energy and vice versa. The TEG is used to work as a self-powered cooling system which generates electrical energy to power up cooling fan and RF transmitter and receiver circuit.

In this project, the heat source is from an LCD display. Characterization on the heat source is carried out on real life TFT LCD panel (Thin-film-transistor liquid-crystal display) from Quantum Electro Opto System Sdn. Bhd. The temperature obtained from the back-light LED and power board of the LCD panel. After that, hot plate is used to carry out the experiment in the lab, the output voltage of TEG is converted up by using power conditioning circuit. After voltage is converted up, it will be used to power the RF transmitter so one trigger signal will send from transmitter to receiver.

Project design of self-powered cooling system will focus on green technology

and environmentally friendly for sustainable development. Once the heat energy turned into electric energy, lifetime of electronic device or system can be protected. Meanwhile, it can reduce the heat energy on the electronic device or system. Besides, the cooling fan in this cooling system can be switched ON when necessary. Therefore, it is more power effective and cost effective. On the other hand, the self-powered cooling system can improve the overall efficiency of energy conversion system. Meanwhile, this project can be embedded to any display or electronic system such as refrigerator, car engine, industry machine, and so on. Thus, it will be more flexible compare to other cooling system existed in the market and it have high potential of commercialization.

1.2 Problem Statement

Every electronic device dissipates heat and it affects functionality and lifetime of the devices. Engineers designed heat sink to dissipate the heat efficiently, but heat energy will become waste. According conservation of energy, the energy can be neither created nor be destroyed, but it transforms from one form to another. Thus, heat energy can be transforms to another useful energy and can avoid it become waste. Thermoelectric will be used to transforms heat energy to electric energy.

Peltier module is a kind of thermoelectric, usually is used as thermoelectric cooler. In this project, it will be used as thermoelectric generator (TEG), to generator electric energy from heat energy. The problem of TEG is high temperature gradient needed to generate high output power. Besides, the power conditioning circuit needs to be designed by using passive component. On the other hand, low voltage generated needs converted up by using power conditioning circuit.

1.3 Project Objectives

There are three objectives that need to achieve in this project, which are:

- i. To characterize heat dissipation in 85' inch LCD panel.
- ii. To design a power conditioning circuit based on output of TEG.

- iii. To develop a cooling system depends on the output of power conditioning circuit.

1.4 Scope of Work

The scope of work of this project is to develop a cooling system using the output of TEG. The heat source for the experiment is from a real 85" inch LCD panel, and different size of thermal analysis LCD panel is study to estimate the trends of the heat dissipation for LCD panel. In this project, existing TEG is used to generate voltage. In order to simulate the real heat dissipation from the LCD panel, experiment is being carried out in laboratory using hot plate and heat sink is used to release heat and increase the temperature gradient hence increase the voltage output. There are two parts of circuit design, which are RF transmitter station and RF receiver station. Energy harvested is used to power up RF transmitter station, and external DC power source is used to powered RF receiver station. Material and equipment included TEG, RF module, RX-2B (RF encoder), TX-2B (RF-decoder), Multisim, Multimeter with thermocouple, and hotplate are used to complete this project.

1.5 Report Overview

This thesis consists the introduction project, concept applied, method used, problem solving, analysis and conclusion of self-powered cooling system. In this report, there are 5 chapters which are introduction, literature review, methodology, discussion and result, and conclusion.

In chapter 1, main idea of self-powered cooling system is delivered via project background, objectives, problem statement, scope of work and summary of methodology.

In chapter 2, study background related to the project will be done. Overall results of the literature will produce a framework that shows the link between research projects with theories and concepts.

In chapter 3, method used in this project is discussed and undergo step by step. The purpose of this chapter is to explain the method used and testing the system carried out by using this method.

In chapter 4, the result obtain from the project should present clearly and neatly. The results of the present invention will be described and compared to the past research.

In chapter 5, report concludes with the overall summary of the studies based on the objectives and achievement. Besides, recommend any changes and improvement approach concerned with the topic.

CHAPTER 2

LITERATURE REVIEW

In this chapter, background and theory that related to this project will be discussed. Besides, the application done by other researchers relate to the theories is analyzed. Lastly, the improvement on other application will be discussed also.

2.1 Thermoelectric effect

Thermoelectric effect is any phenomenon that involves an interchange between the heat and electrical energy and this phenomenon is irreversible. The reversible phenomena of the thermoelectric effect can more specifically implied at dissimilar conductors of junction. In addition, limited temperature gradients are present throughout area of conductors [1].

Seebeck effect was discovered in 1821 by T.J. Seebeck noticing different types of energy is produce in a complete junction when the junction is connected by two types of conductors detect to two different temperature from upper and lower surface or terminal. After 13 years later, Peltier effect was being mentioned by Jean Peltier. This effect mention about the cold and hot temperature produces from the current flow within the doubled material circuit [2].

After that, an attach had been made between Seebeck and Peltier effect to become Thomson effect. This effect discovers about the reversible between and heat and electrical energy. As thermoelectric power generation is being studied across decades, these three effects play an important role in determining thermoelectric power generation performances [2].

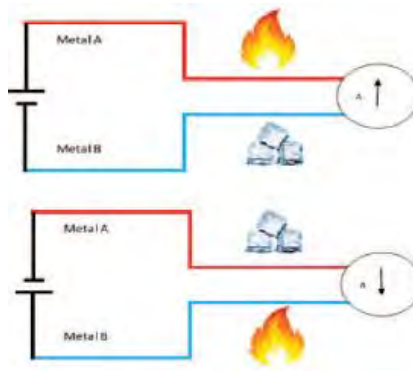


Figure 2.1: Illustration of Peltier effect[2]

Peltier effect is the phenomenon of product two different temperature terminals between two dissimilar conductors from the flows of electric charge. The rate dQ/dt of heat absorbed at a junction between two dissimilar conductors (A and B) is:

$$\frac{dQ}{dt} = (\Pi_A - \Pi_B)I \quad (2.1)$$

Where, I is the electric current and Π_A , Π_B are Peltier's coefficients of the conductors.

The Seebeck effect is the production of the current flow, between two dissimilar conductors. Two conductors connected in series and parallel junctions are held at two different temperatures T_H and T_C and an V appears between their free contacts:

$$V = -S(T_H - T_C) \quad (2.2)$$

Where, S is Seebeck's coefficient.

The Thomson effect is the production or absorption of heat along a conductor with temperature gradient ΔT when electric charge flows through it. The heat dq/dt produced or absorbed along a conductor segment is:

$$\frac{dq}{dt} = -KJ\Delta T \quad (2.3)$$

Where, J is the current density, and K is Thomson's coefficient.

The three coefficients are related by Thomson relations (Kelvin relations).