UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE DETERMINATION OF SUITABILITY CONDITION FOR COOLING THE LIGHTNING DETECTION SYSTEM USING PELTIER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electrical Engineering Technology (Industrial Power) (Hons.)

by

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2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **THE DETERMINATION OF SUITABILITY CONDITION FOR COOLING THE LIGHTNING DETECTION SYSTEM USING PELTIER**

SESI PENGAJIAN: **2014/15 Semester 1**

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) (Hons.). The member of the supervisory is as follow:

……

(DR.Zikri Abadi Bin Baharudin)

ABSTRACT

As known widely, most of the Lightning Detection System (LDS) is typically used satellite (networking based) or the combination of electric field and magnetic field measurement that based on the polarity and amplitude. By the polarity and amplitude an equation will be translate in a form of certain algorithm. Based from the previous research and recently, the lightning measuring system that used the old concept which based on electromagnetic field measurement with high resolution recording system was found to be the best method for identification and monitoring. Although this concept is more accurate then Lightning Detection System (LDS) networking based however there are many disadvantages. The disadvantages are regarding on maintenance work such as monitoring, repairing, charging the battery and so on was not automatically operate by the system. Moreover if one intent to automate the operation for LDS based on electromagnetic field measurement with high resolution, this LDS need to be modified in such a way that it can be operate smoothly under the extreme hot weather especially tropic country in Malaysia. This objective of this project is to introduce a new temperature control for LDS as mentioned above by providing conducive temperature in the range of 25^{o}C to 28^{o}C in the box. The scope of this project mainly focused on cooling technique by using peltier for cooling the storage box of LDS which consist of buffer, electronic sensors and all automation tools. The temperature of the storage box is controlled in the range of 25^{o}C to 28^{o}C. Peltier basically use in warming, cooling, and the temperature differential can generate electricity. Peltier is a sample of semiconductor material be connected to two electrodes between a voltages to applying to produce difference temperature. This device is important to keep up the system of temperature contrast regarding required heat evacuation with a specific end goal to keep up the execution of the system. The analysis of this project investigated the suitability of peltier for cooling certain desire volume of storage of the LDS. In order to produce the desire temperature, total number of peltier will be determined. The number of peltier will determined the desired temperature in the range of 25^{o}C to 28^{o}C. For future plan, this project will be upgrade

in terms of the total number of peltier that being used to produce the consistent temperature.

ABSTRAK

Seperti yang diketahui secara meluas, kebanyakan Sistem Pengesanan Kilat biasanya digunakan oleh satelit (rangkaian berdasarkan) atau gabungan medan elektrik dan pengukuran medan magnet yang berdasarkan pola dan amplitud. Pada kutub dan amplitud, persamaan akan diterjemahkan dalam bentuk algoritma tertentu. Berdasarkan kepada hasil kajian sebelumnya dan baru-baru ini, sistem pengukur kilat yang menggunakan konsep lama yang berdasarkan pengukuran medan elektromagnet dengan sistem rakaman resolusi tinggi didapati kaedah terbaik untuk pengenalpastian dan pemantauan. Walaupun konsep ini adalah lebih tepat namun Sistem Pengesanan Kilat berasaskan rangkaian bagaimanapun terdapat banyak kelemahan. Kelemahan adalah mengenai kerja penyelenggaraan seperti pemantauan, membaiki, mengecas bateri dan sebagainya tidak secara automatik beroperasi. Lebih-lebih lagi jika seseorang hendak untuk mengautomasikan operasi untuk LDS berdasarkan pengukuran medan elektromagnet dengan resolusi tinggi, LDS ini perlu diubah suai dalam apa-apa cara yang ia boleh beroperasi dengan lancar di bawah cuaca panas yang melampau terutamanya negara tropika di Malaysia. Objektif projek ini adalah untuk memperkenalkan kawalan suhu untuk LDS yang dinyatakan di atas dengan menyediakan suhu kondusif dalam lingkungan 25^{o}C untuk 28^{o}C di dalam kotak. Skop projek ini terutamanya memberi tumpuan kepada teknik penyejukan dengan menggunakan Peltier untuk menyejukkan kotak penyimpanan LDS yang terdiri daripada buffer, sensor elektronik dan alat automasi. Suhu didalam kotak simpanan dikawal dalam lingkungan 25^{o}C untuk 28^{o}C. Peltier secara ringkas adalah sampel bahan semikonduktor disambungkan kepada dua elektrod antara beza keupayaan untuk menghasilkan suhu yang perbezaan. Peltier adalah contoh bahan semikonduktor dihubungkan dengan dua elektrod antara voltan untuk menghasilkan perbezaan suhu. Peranti ini adalah penting untuk mengekalkan sistem suhu dan memindahkan haba

yang diperlukan dengan matlamat akhir tertentu untuk pelaksanaan sistem. Analisis projek ini disiasat kesesuaian Peltier untuk menyejukkan jumlah tertentu yang diperlukan untuk penyimpanan LDS. Bilangan Peltier juga akan memberi kesan kepada suhu yang dikehendaki dalam lingkungan 25^{o}C untuk 28^{o}C. Bagi perancangan masa depan, projek ini akan meningkatkan dari segi jumlah bilangan Peltier yang digunakan untuk menghasilkan suhu yang konsisten.

DEDICATION

My special thanks and appreciation to my supervisor Dr. Zikri Abadi Bin Baharudin, who had been a lot of help to me in bringing this project. His guidance that has been given has made this project run smoothly. Heartfelt gratitude and my thanks to the friends who have helped also to give ideas and opinions on this project we produce. And do not forget also to all lecturers of Electrical Engineering Technology, which has provided cooperation and assistance to me.

ACKNOWLEDGEMENT

Appreciation directed to my project supervisor Dr. Zikri Abadi Bin Baharudin, he devotes a lot of knowledge to me in carrying out works related to this project we produce.

Here too, I would like to thank the lecturers Department of Electrical Engineering Technology who have helped me in teaching of Electrical Engineering Technology (Power Industrial) and to some extent can help me in preparing the final report of this project. I would also like to thank friends - colleagues who had helped provide materials - a reference to produce this report. Given all that our valued. Thank you for...

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LIST OF SYMBOLS AND ABBREVIATIONS

DT_{max}	-	Higher Temperature Difference
FYP	-	Final Years Project
HVAC	-	Heating Ventilation and Air Conditioning
LDS	-	Lightning Detection System
TEC	-	Thermoelectric Cooling
I_{max}	-	Maximum Current
Q_{max}	-	Maximum Power
V_{max}	-	Maximum Voltage
Tc	-	Temperature Cooling
T_h	-	Temperature Hot
Qc	-	Cooling Load
PIC	-	Programming Integrated Circuit
Cp	-	Specific heat of air
Q	-	Volume flow rate
ρ	-	Density of air
$\Delta\tau$	-	Temperature difference
R	-	Thermal resistance

CHAPTER 1

INTRODUCTION

1.0 Introduction

In the desiccant cooling system, existing air-conditioning system give arise to numerous problems such as pollution to environment (CFC emission). Moreover, the current air-conditioning system is not capable to be used at small space like support to cooling for lightning measurement system. This scenario could be subdued by the introduction of thermoelectric device as an alternating cooling option for cooler box. By using this option it more efficient energy, low cost and spacious. Basically, the thermoelectric device known as Peltier module is a semiconductor based heat pump, where heat is absorbed from one side and dissipated on the opposite side of the module.

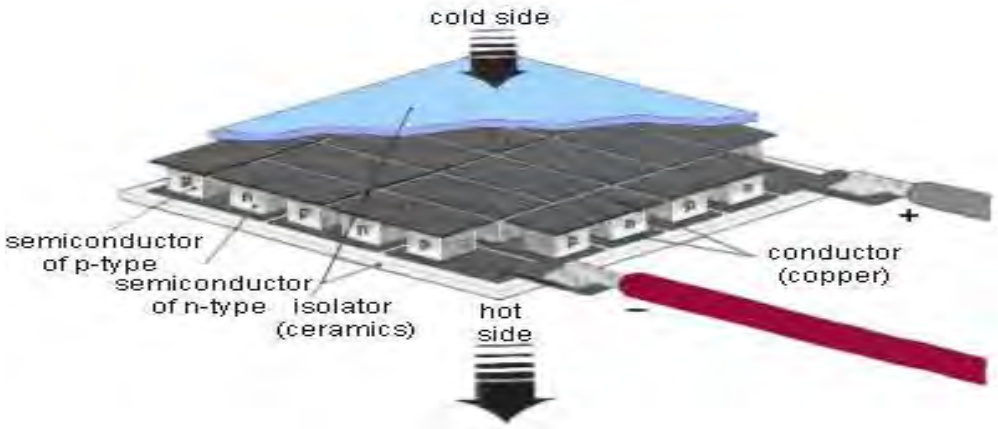

Figure 1.1: The TEC-module

(Source: http://imgarcade.com/1/thermoelectric-cooler-fan/)

1.1 Problem Statement (S)

Generally, Malaysia can be considered as hot country which means that any type of sensitive equipment or electronics item must be operated under conducive environment during hot weather temperature. Therefore the design of Lightning Detection System (LDS) that compose of a lot of sensitive devices which will expose has to be concerned those important aspect as mentioned above.

1.2 Objective

The aim of this project is:

a) To identify the suitability for the application of peltier module cooling system for lightning detection system.
b) To design the hardware of peltier module for controlling the temperature in the lightning detection storage box in the range of 25^{o}C to 28^{o}C.
c) To analyze the changes of temperature for different size of storage box with respect to climate changes.
d) To determine suitable quantity of peltier and the sizing of the storage box for lightning detection system.

1.3 Scope of Project

The project mainly concern on the cooling system in order to control the temperature of lightning detecting instrumentation and devices. The project scope involves the following elements in sizing and designing of the cooling system, as follows:

1. Selection of the type thermoelectric (peltier module). This project use TEC1-12706 model because it suitable for this design and capable of generating electricity when one side is kept cool and heat is applied to the other.
2. Selection of Fans using axial fan and Heat sinks with 0.077mm x 0.06mm x 0.04mm (out) and diameter 0.09mm thickness 0.03mm (in). This dimension for this project

be use because suitable make to be faster for full function the process of cooling at the peltier to heat sink.

3. Prototype Assembly and Fabrication for Cooler box to replace device of lightning detection system. The arrangement for peltier and fan in cooler box is important because it factor to be faster to circulation of the air to produce cold air.
4. Temperature measurements for testing. The temperature consist by maintained between 25ºC to 28ºC during the extreme hot weather. In this temperature range electronic device can function in good condition and suitable when the electronic device is exposed outside the confines of the heat.

CHAPTER 2

LITERITURE REVIEW

2.0 Peltier

As indicated by Brooks Samuel Mann in the year 2006 [Transverse Thermoelectric Effects for Cooling and Heat Flux Sensing], Thomas Johann Seebeck noticed that the study of thermoelectric began when he noticed that two dissimilar metal in the closed loop caused needle of the compass to deflect when the two metals held at different temperature. This is because the electric field was created between the two metals which magnetic fields is inducing to deflect the needle covered by Jean Charles Athanase Peltier [http://www.encyclopedia.com/doc/1G2-2830903338.html]

Figure 2.1: The first idea of thermoelectric device

(Source: http://thermoelectric.com/2005/old/photo-3.htm)

Figure 2.2: The first thermoelectric cooler been made.

(Source: http://thermoelectric.com/2005/old/photo-3.htm)

The single thermocouple schematic outline which comprises of n and one sort p-type. The n and p type semiconductor exist electrons and holes respectively. The electron stream start to finish, consequently the electron stream clockwise or current stream in the circuit counter clockwise. Heat is ingested at the top and discharged as appeared in the figure 2.3. When the polarity is changed, interchange of rejection of hot and cold junction as well as the heat absorption. There are three important thermoelectric effects that have been known since the nineteenth century: (i) Seebeck effect, (ii) Peltier effect and (iii) Thomson effect.

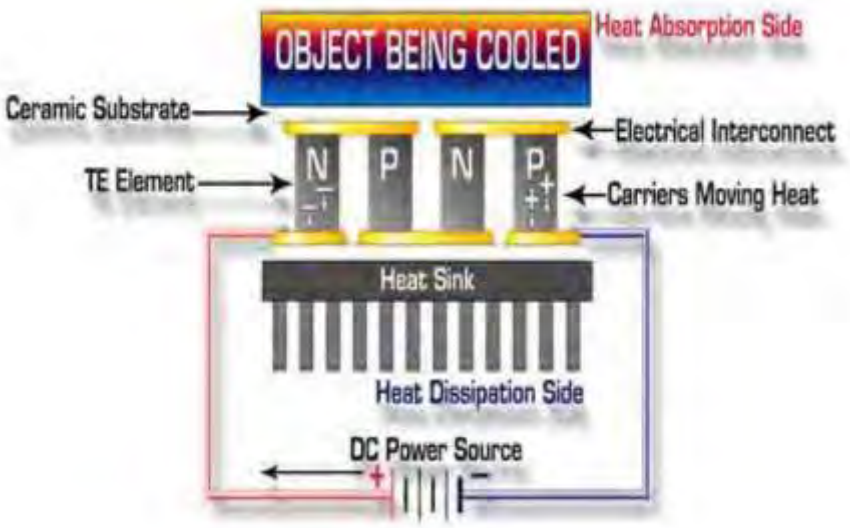

Figure 2.3: Schematic of thermoelectric module operation

(Source: https://www.ferrotec.com/images/technology/temDiagram.jpg)