

THERMOELECTRIC COOLER (TEC)

FOR AUTOMOTIVE CABIN

MUHAMMAD KHAIRULHARIZ BIN MD ZAKI

UNIVERSITI MALAYSIA PAHANG

THERMOELECTRIC COOLER (TEC)

FOR AUTOMOTIVE CABIN

MUHAMMAD KHAIRULHARIZ BIN MD ZAKI

This thesis is submitted as partial fulfilment of the requirements for the award of the Bachelor of
Electrical Engineering (Hons.) (Electronics)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

16 DICEMBER 2016

THERMOELECTRIC COOLER (TEC)

FOR AUTOMOTIVE CABIN

MUHAMMAD KHAIRULHARIZ BIN MD ZAKI


This thesis is submitted as partial fulfilment of the requirements for the award of the Bachelor of
Electrical Engineering (Hons.) (Power Systems)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

2016/2017

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of the Bachelor Degree of Electrical Engineering (Hons.) (Electronics).

Signature	:	
Name of Supervisor	:	AMIR IZZANI BIN MOHAMED
Position	:	LECTURER
Date	:	16/12/2016

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : HARIZ
Name : MUHAMMAD KHAIRULHARIZ BIN MD ZAKI
ID Number : EC11094
Date : 16/12/2016

TABLE OF CONTENTS

	PAGE
SUPERVISOR’S DECLARATION	
STUDENT’S DECLARATION	
ACKNOWLEDGEMENT	
ABSTRACT	i
TABLE OF CONTENTS	ii
LIST OF TABLE	iv
LIST OF FIGURE	v
LIST OF SYMBOLS	vi
LIST OF ABBREVIATION	vii
CHAPTER 1 : INTRODUCTION	
1.1 Overview	1
1.2 Problem Statement	3
1.3 Objective	4
1.4 Scope Of The Project	4
1.5 Thesis Outline	5
CHAPTER 2 : LITERATURE REVIEW	
2.1 Introduction	6

2.2	Thermoelectric Cooler	6
2.3	Peltier Effect	8
2.4	Fuzzy Temperature Of A Thermoelectric Cooler	9
2.5	Thermoelectric Generator	10
2.6	The Effect Of Pulse Width Modulation (PWM) Frequency On The Reliability Of Thermoelectric Modules	11
2.7	Buck Converter	13
2.8	Buck Converter process	14
CHAPTER 3 : METHODOLOGY		
3.1	Introduction	15
3.2	Work flow	15
3.3	Hardware	17
3.3.1	Controller Circuit	17
3.3.2	Controller	18
3.3.3	Temperature Sensor	19
3.3.4	Display	20
3.3.5	Driver Circuit	21

3.3.5.1 Power Transistor Driver	21
3.4 Software Involved	22
3.4.1 Arduino	22
3.5 Model Create	23
3.6 Microcontroller	24
CHAPTER 4 : RESULT AND DISCUSSION	
4.1 Introduction	25
4.2 Controller System Board	25
4.3 Liquid Crystal Display	26
4.4 Full System	27
CHAPTER 5 : CONCLUSION AND RECOMMENDATION	
5.1 Conclusion	33
5.2 Recommendation	34
REFERENCE	35
APPENDIX A	36
APPENDIX B	40
APPENDIX C	4

LIST OF TABLES

Table No.	Title	Page
3.1	Arduino UNO Specification	24
4.1	Temperature Value Of The Car In Daylight	28
4.2	Temperature Value Of The Car At Night	29
4.3	Temperature Of Peltier Module	30
4.4	Temperature Value Using Thermoelectric	31

LIST OF FIGURES

Figure No.	Title	Page
1.1	Thermoelectric cooler	1
2.1	Cut Way of Peltier Module	6
2.2	Schematic Of Thermoelectric Module Operation	7
2.3	Peltier Module	9
2.4	Cross Section Of A Typical TEC	9
2.5	PWM Signal And Duty Cycle	11
2.6	PWM Circuit	11
2.7	Buck Converter	13
2.8	switch Q shut on and off	14
3.1	Work Flow	15
3.2	Overall system	17
3.3	Arduino UNO Pin Diagram	18
3.4	LM35DZ Schematic Diagram	19
3.5	16x2 LCD With Arduino	20
3.6	IR2109 Power Transistor Driver	21
3.7	Fan Circuit With Buck Circuit	22
3.8	Arduino Software	22
3.9	Cabin Model	23

4.1	Control System Board	25
4.2	Schematic Diagram LCD	26
4.3	Information Display	26
4.4	System of project	27
4.5	Graph car temperature	28
4.6	Temperature Graph inside car at night	30
4.7	Temperature Graph of Thermoelectric cooler	31
4.8	temperature graph using thermoelectric cooler module	32

LIST OF SYMBOLS

$\%$	Percentage
f	Frequency
Ω	Ohm
\leq	Less Than Or Equal To
\geq	Greater Than Or Equal To
$^{\circ}\text{C}$	Degree Celsius
\times	Multiplication

LIST OF ABBREVIATIONS

DC	Direct Current
AC	Alternating Current
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
PWM	Pulse Width Modulation
BJT	Bipolar Junction Transistor
IGBT	Insulated Gate Bipolar Transistor
GTO	Gate Turn-Off Transistor
TEC	Thermoelectric Cooler
LED	Light Emitting Diode
LCD	Liquid Crystal Display
D	Duty Cycle
V	Volt
A	Ampere
AH	Ampere Hour
V_{in}	Input Voltage
V_o	Output Voltage

MUHAMMAD KHAIRULHARIZ BIN MD ZAKI

This thesis is submitted as partial fulfilment of the requirements for the award of the Bachelor of
Electrical Engineering (Hons.) (Electronics)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

16 DICEMBER 2016

THERMOELECTRIC COOLER (TEC)

FOR AUTOMOTIVE CABIN

ABSTRACT

Nowadays, air conditioning system of automobile arises to such many problems such as CFC emission that cause air pollution, the usage of fuel is increased and engine performance is decreased. Moreover, the current air-conditioning system is not capable to be used during the parked session. This scenario could be subdued by the introduction of thermoelectric device as an alternating cooling option for car interior. Fuel usage decrease by using this pollution option and decreased engine performance can be prevented since the letter option was in the bracket of 'Go Green' region. The project is to make the automotive cabin being cooled by using thermoelectric cooler that can be applied on the car in the hot sunny day. The system should be automatically turned on when the engine of the car is stop depending on the temperature inside and outside of the car. This temperature can be controlled by temperature sensor. The project is using the source of the automobile battery.

CHAPTER 1

INTRODUCTION

1.1 Overview

Recently the automobile has been combined with an airconditioning to make the inside cabin cooling subject. The problems rised when the automobile stop moving on the road and being at rest momentum. This can cause the uncomfortable situation from the temperature inside cabin. This make user sense hot.

The thermoelectric cooler function is the way to make the inside cabin thempture cool at set point of the user. The user will set the temperature required at 25°C and the temperature of the cabin is follow the user set temperature. When the thermoelectric cooler or fan stop running and do not function. This state is the cause of inside the cabin temperature is drop below user setting.

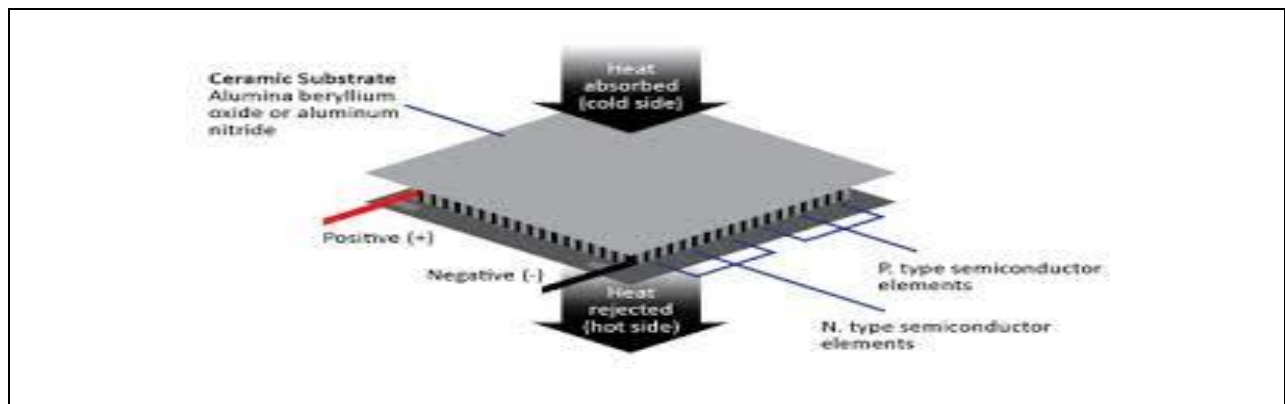


Figure 1. 1 : Thermoelectric Cooler (TEC)

To make the new system, the thermoelectric cooler are used to this system. Thermoelectric cooler in other name is peltier. The peltier with peltier effect is the equipment that support semiconductor. The heat of the peltier is cooling which is absorbing and the other side is heating that realease heat after absorbed [1]. The thermoelectric cooler is as **Figure 1. 1**. The thermoelectric cooler is from this principal that the thermoelectric cooler feeding the cabin room to become cooler as the temperature set while the other surface realease heat as the exhause that placed with cooling plate and fan to realease heat. However there are so much concept and style of transistor that can be used in this system. The thermoelectric cooler need enough current driver circuit for electrical direct current load. The transistor that has the less power loss will make the perfect system of the thermoelectric cooler.

There are many type and style of the transistor that can use in this system. The style are Bipolar Junction Transistor (BJT), Metal Oxide Semiconductor Field Effect Transistor (MOSFET), Insulated Gate Bipolar Electronic Transistor (IBGT) and Gate Turn-Off electronic Transistor (GTO). To make the system running it need a high change frequency that is Buck converter. The fundamental say the change frequency used is square wave wherever it is duty cycle can confirm how long the facility switch can activate.

1.2 Problem Statement

In the day light, there must be an hot temperature. While that happened the air conditioning of automobile these day not function very well. This is the problem that appear from air conditioning system and when temperature is so much hot it can cause the heat stroke. While there also other problem that is the couse of air pollution and cost from the maintainance of air conditioning system.

The thermoelectric cooler (TEC) is the must be the item and system that the people use in the automobile. The system desing is the attachement of the thermoelectric cooler and the heat sink on the both side. The system can make the thermal resistance the lowest. This thermoelectric cooler design attached heat sensor can eleminate the worries of air conditioning disadvantages and the improvement of automobile these day.

REFERENCE

- [1] Harrington, SS 2009, *Thermoelectric air cooling device*, Patent Application Publication, US Patent Number 5623828.
- [2] Huang, BJ., Chin, C.I and Duang, C.L., 2000, "A Design Method of Thermoelectric Cooler", *Int. J of Refrigeration*, vol. 23, pp. 208-218.
- [3] Ioffe, AF., 1957, *Semiconductor Thermoelements and Thermo electric Cooling*, London: Infosearch Limited.
- [4] Trip, N. D., & Dale, S. (2010). Digital Control for Switched Mode DC-DC Buck Converters, 99–102.
- [5] H. H. R. Ensil, "Maximum point tracking : A cost saving necessity in solar sys-tems," *IEEE PESC '90*, Vol. 2, pp. 1073-1077, Nov. 1990
- [6] R. J. Buist *CRC Handbook of thermoelectrics*, 1995 :CRC Press, Inc.
- [7] https://en.wikipedia.org/wiki/Thermoelectric_generator
- [8] M. Vinoth, D. Perma, 2014, "Automated Car Safety Seat Cooling System using Thermoelectric cooler" *Int. Con. On Computation of power, energy, information and communication*.
- [9] Siti Marhainis Othman " Fuzzy Logic Control for Non Linear Car Air Condi-tioning" UTM
- [10] Buist, R. J., *Methodology for Testing Thermoelectric Material and Devices*, *CRC Handbook of thermoelectric*, CRC PTess, Inc., 1995.
- [11] <https://en.wikipedia.org/wiki/Arduino>