

CONDITIONAL CIRCUIT DESIGN FOR HEART RATE MONITORING USING  
OPTOELECTRONIC SENSOR

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CONDITIONAL CIRCUIT DESIGN FOR HEART RATE MONITORING USING  
OPTOELECTRONIC SENSOR

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

FACULTY OF ELECTRONIC AND COMPUTER ENGINEERING  
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JUNE 2015



UNIVERSITI TEKNIKAL MALAYSIA MELAKA  
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN  
PROJEK SARJANA MUDA II

Tajuk Projek : Conditional Circuit Design for Heart Rate Monitoring  
Using Optoelectronic Sensor

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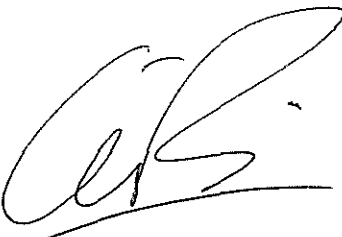
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Special dedicated to my beloved family, siblings, supervisor and friends for their support, inspiration and encouragement along my journey as a student.

## ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful, all praises to Him for the strengths and His blessing, I had completed my final year project and thesis successfully as it is a partial fulfillment of requirements for the Bachelor Degree of Electronic Engineering (Industrial Electronic).

Special appreciation to my supervisor, Dr. Wira Hidayat Bin Mohd Saad for his guidance, advices and supervision along one year of duration for my final year project. His invaluable help of constructive comments and suggestion have contributed to the success of this project. Special thanks to Nurul Akmal, Master student because sharing her knowledge, ideas and advices during completing my project.

Special thanks to all my friends who always give me motivation and moral support to complete this project. Their support, ideas and cooperation help me a lot to accomplish my project. Not to forget, thanks to all the technician for their help during I conducted the testing in the laboratory.

Last but not least, my deepest gratitude goes to my beloved parents and my siblings for their understanding, support and encouragement through this one year. I am also indebted to University Teknikal Malaysia Melaka (UTeM) especially Faculty of Electronic and Computer Engineering (FKEKK) for the facilities provided.

## ABSTRACT

The purpose of this project is to design a conditional circuit to monitor heart rate using optoelectronic sensor. Optoelectronic is an application of electronic device that can detect light. This means that the heart rate is being detected by the light that detect the flow of the blood through the finger. The MULTISIM software is used to test the signal conditioning circuit design while Proteus software is being used to design this circuit for Printed Circuit Board (PCB) fabrication. For this project the optoelectronic sensor used is infrared sensor to monitor heart rate. This project is to create a device with lower cost that can detect and monitor the heart rate using signal conditioning circuit. Then, using data acquisition system which is NI USB 9005 is used to analyze the results obtained and being compared with the oscilloscope reading.



## ABSTRAK

Projek ini bertujuan untuk mereka bentuk litar yang boleh memantau kadar degupan jantung dengan menggunakan pengesan optoelektronik. Pengesan optoelektronik ialah sejenis peranti elektronik yang boleh mengesan cahaya. Ini bermakna bahawa kadar degupan jantung dikesan oleh cahaya yang mengesan aliran darah melalui jari. Perisian MULTISIM digunakan untuk menguji reka bentuk litar manakala perisian Proteus digunakan untuk mereka bentuk litar ini untuk process fabrikasi menggunakan papan litar tercetak (PCB). Pengesan optoelektronik yang digunakan dalam projek ini adalah pengesan inframerah bagi memantau kadar degupan jantung. Projek ini bertujuan untuk mewujudkan peranti dengan kos yang lebih rendah yang boleh mengesan dan memantau kadar degupan jantung dengan menggunakan litar isyarat. Kemudian, dengan menggunakan system perolehan data NI USB 9005, keputusan yang diperolehi dianalisis dan dibandingkan dengan bacaan daripada osiloskop.

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## LIST OF SYMBOL

WHO	World Health Organization
IR	Infrared
DAQ	Data Acquisition System
NI USB	National Instrument Universal Serial Bus
ECG	Electrocardiogram
SAN	Sino-atrial node
AVN	Atrio-ventricular node
LED	Light Emitting Diode
MORES	Micro-Optic Reflective sensor
ADC	Analog Digital Converter
PPG	Photoplethysmography
USD	United States dollar
IC	Integrated Circuit

PCB Printed Circuit Board

BPM Beat per Minute

# CHAPTER I

## INTRODUCTION

### 1.1 Introduction

Cardiovascular disease is the most prevalent diseases in the modern world that lead to death. This disease is mainly cause by the heart and blood vessel that are not functioning properly. According to the World Health Organization (WHO), the numbers of people with cardiovascular disease are estimated 17.5 million in 2012 and this number increases to more than 23 million in 2030 [1]. This disease represents 31% of all global death. These percentage represent 7.4 million number of death cause by coronary heart disease and 6.7 million number of death cause by stroke. These cardiovascular disease are mostly happen in low-income countries and also middle-income countries. Table 1.1 shows the mortality rate of cardiovascular disease in year 2012.

Table 1.1: Mortality rate for Cardiovascular Disease in year 2012 [1]

	<b>Age-standardized mortality rate by cause (per 100 000 population)</b>		
	Cardiovascular Diseases		
<b>Country</b>	Male	Female	Both sexes
<b>Australia</b>	110.6	75.6	92.4
<b>Brunei Darussalam</b>	232.8	189.8	211.1
<b>Cambodia</b>	202.5	170.4	184.7
<b>China</b>	313.8	286.1	300.0
<b>Fiji</b>	494.1	264.0	372.3
<b>Japan</b>	108.0	58.9	81.6
<b>Lao People's Democratic Republic</b>	368.7	326.6	346.2
<b>Malaysia</b>	324.9	268.8	295.8
<b>Mongolia</b>	723.3	483.2	586.7
<b>New Zealand</b>	122.3	86.2	103.8
<b>Papua New Guinea</b>	167.4	131.1	148.5
<b>Philippines</b>	463.6	305.4	376.9
<b>Republic of Korea</b>	112.6	76.2	92.3
<b>Singapore</b>	137.4	82.1	107.7
<b>Solomon Island</b>	314.6	196.6	256.7

Based on Table 1.1, Malaysia is one of the country that have high number of patient with this cardiovascular disease which are 295.8 per 100 000 population that lead to death. Cardiovascular disease also known as a heart disease. It is a heart related disease that could also affect the capillary, artery and vein. This disease will also lead to others cardiovascular related problems which mostly cardiac disease, vascular diseases of the brain and kidney and peripheral arterial disease.

This disease can be reducing if all people have awareness to monitor their glucose level and heart rate daily. This is because by doing close monitoring on heart rate, they can know their condition and consult a doctor for further action. This project is to propose a design of sensor circuit to monitor heart rate in easy way. User can know their health condition as the sensor can detect their heart rate frequency. The frequency will represent their health condition by checking their pulse in beat per minute.

## **1.2 Problem Statement**

Traditional device require cardiologist or medical officer to examine the patient whether their health condition is in good condition or not. The patient also need to go to hospital to check their health condition. The standard Electrocardiogram (ECG) machine can only be used in a big hospital and to use it the patient need the help from specialist to handle the ECG machine. This will burden the patient to monitor their health condition as they have to go to the hospital, thus contribute high cost. This conditional circuit design use Infrared (IR) sensor and photodiode to monitor the pulse of heart rate. The development of this sensor are using low cost and can help user to monitor their heart rate easily at any place by just placing their finger on top of the sensor.

### 1.3 Objective

The aim of this study is to develop a conditional circuit for near infrared optoelectronics sensor for heart rate detection. In order to obtain that, the following objectives need to be achieved:

- 1.3.1 To design a conditional circuit to detect heart rate using optoelectronic sensor.
- 1.3.2 To do a comparative study for the signal conditioning circuit using MULTISIM software and digital oscilloscope.
- 1.3.3 To analyze the consistency collected data of the captured signal.

### 1.4 Scope of Project

This project have a few limitation. Firstly, this project use TCRT1000 sensor that consist of IR sensor with 950 nm wavelength and phototransistor to monitor the heart rate. The IR sensor will capture the reflected signal and send it to phototransistor to transmit into the signal conditioning circuit. Secondly, the designed conditioning circuit consist of high pass filter, active low pass filter and the operational amplifier. The operational amplifier is to amplify the signal so that it can be displayed in the oscilloscope as well as in the MATLAB software. This sensor will be applied at the wrist or finger in order to detect and monitor the heart rate. The complete circuit will be connected to the Data Acquisition (DAQ) from National Instrument NI USB 9005 for the sensor reading and the data will be processed using MATLAB Software.

## 1.5 Thesis Plan

In order to complete this thesis, 5 requirements are needed to be completed, which are Introduction, Literature Review, Methodology, Result and Discussion, and last but not least is Conclusion and Further Development of the project.

**Chapter 1** is about introduction of the project. The basic idea about the project is being explained in this chapter including the objective and scope of this project.

**Chapter 2** is about the literature review on the type of sensor being used for similar project. This section contains the literature review and methodologies that have been collected from different sources for the development of this circuit design.

**Chapter 3** is about the design and methodology of the project.

**Chapter 4** is about the analysis for all the obtained result.

**Chapter 5** is about the conclusion and recommendation of the project.

## **CHAPTER II**

### **RESEARCH BACKGROUND**

#### **2.1 Introduction**

In this chapter, the introduction on heart rate which consist of how human heart work, cardiac cycle, sensor used to detect human heart rate, heart rate pulses and how IR sensor detect the heart rate are being explained. The concept to monitor the heart rate is also explained in this chapter. All of this background study is from gathered from books, articles, journals and internet. In this chapter, the theory and concept that are related to this project and also knowledge of various type of sensor, to monitor heart rate is being discussed.