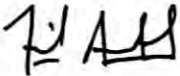


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PPG TRANSIMPEDANCE AMPLIFIER CIRCUIT

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This Report Is Submitted In Partial Fulfillment of Requirement for the Bachelor Degree
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MAY 2006

DECLARATION

“I, hereby declare that this thesis entitle, PPG Transimpedance Amplifier Circuit is a result of my own research idea except for works that have been sited clearly in the references”

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Special dedication to my loving parents, Mr Abdul Samat bin Osman and Mrs Noor Hasanah binti Haji Haltami, all my siblings, my kind hearted supervisor Mr Farid Arafat Azidin and special thank to my dearest friends.

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ABSTRACT

A photoplethysmograph (PPG) is a method of detecting human pulse with principal of correlation analysis. A PPG is described that performs a frequency analysis of the peripheral volume pulse wave. A Trans-impedance amplifier is used to convert current received from the photodiode to voltage for future processing. The pulse detector receives information in terms of an analogue signal. Pulse carrier is low-frequency signal with upper informative frequency. Therefore to raise the method performance we apply low-pass filter, 100Hz. A low-pass filter passes relatively low frequency components in the signal but stops the high frequency components. The so-called cutoff frequency divides the pass band and the stop band. In other words, the frequency components higher than the cutoff frequency will be stopped by a low-pass filter.

This project also develops a low noise Pulse Sensor through Correlation Analysis (Lock-In). The lock-In acts like an Amplitude Modulation used Multiplication of reference signal and measured signal. Through correlation analysis or lock-in, noises that exist in measured signal can be rejected. Lock-In is capable to improve the Signal-to-Noise ratio significantly: The band-pass filter cuts simply out a more or less broad part of the noise power spectrum in the vicinity of the input signal, hereby reducing the average relative noise power at the output, or the relative rms noise voltage, respectively.

The purpose of this project is to detect human pulse through their finger. It provides variety of information such as their healthy information.

ABSTRAK

Photoplethysmograph (PPG) adalah satu kaedah untuk mengesan denyut nadi manusia melalui prinsip analisis 'correlation'. PPG akan menunjukkan analisa frekuensi bagi isipadu gelombang denyut nadi. Pengesan denyut nadi akan menerima maklumat/data dalam bentuk isyarat analog.. Penguat Transimpedance (Transimpedance amplifier) digunakan bagi menukarkan arus yang diterima daripada photodiode kepada voltan untuk proses- proses yang seterusnya. Isyarat pembawa merupakan isyarat yang mempunyai frekuensi yang rendah. Bagi meningkatkan isyarat ini, low-pass filter 100Hz digunakan. Low-pass filter akan membenarkan isyarat yang mempunyai frekuensi yang rendah dan akan menghentikan isyarat yang mempunyai frekuensi yang tinggi iaitu yang melebihi 100Hz.

Projek ini akan membangunkan pengesan denyut nadi yang mempunyai hingar yang sangat kecil melalui analisis 'correlation' atau 'lock-in'. Lock- in ini bertindak seperti modulasi amplitud yang menggunakan hasil darap antara isyarat rujukan dan isyarat yang diukur. Melalui kaedah ini, hingar yang wujud dalam isyarat yang diukur dapat dikurangkan. Lock- in juga berupaya meningkatkan nisbah antara isyarat kepada hingar dengan berkesan.

Objektif utama projek ini dijalankan ialah untuk mengesan denyut nadi manusia melalui jari. Kaedah ini akan memberikan pelbagai maklumat seperti maklumat kesihatan seseorang itu.

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LIST OF ABBREVIATIONS

PPG	-	Photoplethysmograph
AM	-	Amplitude modulation
DC	-	Direct Current
IC	-	Integrated Circuit
BJT	-	Bipolar Junction Transistor
FET	-	Field-Effect Transistor
LED	-	Light Emitting Diode
IR	-	Infrared
SMT	-	Surface Mount Technology
PCB	-	Printed Circuit Board

CHAPTER I

INTRODUCTION

1.1 OVERVIEW

These chapters will overview the whole project of PPG Transimpedance Amplifier Circuit such as project background, objective and scope of project, problem statement, methodology, and thesis summary. Beside, this chapter also will explain briefly about the project workflow from beginning to the final.

1.2 PROJECT BACKGROUND

The title of this project is “PPG Transimpedance Amplifier Circuit”. It is a project that develops a Pulse Sensor through Correlation Analysis. For this, an electronic switch is necessary and possible to use a normal switch, DG419

In this project, 555 timers were used. It is an oscillator that can generate the frequency and for this circuit, frequency 1 KHz is needed to generate without using a function generator. So, this project has advantages where the using of internal equipment can reduce.

The scope of this project is to detect human pulse through finger. This signal is very small and has much noise and distortion. Correlation Analysis was applied to repair this signal and reduce the noise.

1.3 OBJECTIVE AND SCOPE OF PROJECT

1.3.1 Objective of project

The main aim of this project is to develop hardware to interface data and make a low cost amplification of PPG circuit. This circuit will amplify the small signal from human body and reduce the noise. It carried out on the following objectives:

1. To design and develop the circuit for detecting human pulse through finger.
2. To generate frequency 1 kHz from 555 timer.

3. To produce the whole system functioning correctly.
4. To study basic knowledge of electronic circuit and understand the function of the PPG Transimpedance Amplifier circuit.
5. To learn the principle of correlation analysis and how to reduce noise signal from human body.
6. To understand Transimpedance Amplifier and Low Pass filter.
7. To display and manipulate pulse signal in an oscilloscope.

1.3.2 Scope of project

The scope of this project included:

1. It is almost concentrated and specific in hardware design only.
2. To study and understanding the operations, and the functions each part on the circuit.
3. Selecting and designing the best type of filter circuit to reduce the noise signal especially in recognizing which is the acquire signal from human body.

1.4 PROBLEM STATEMENT

By doing this project, we have a problem to get human pulse signal around 0.5 – 1s and 20uV. Usually, it also difficult to get the same signal between measured signal and reference signal. Beside, the signal is affected by noise. We will

detect very small noisy signals from a resonant absorption process. The photoplethysmograph provide a poor measure of changes in volume and it is very sensitive to motion artifact.

1.5 METHODOLOGY

Achieving the objective of this project and answering the problematic as mentioned in the previous chapter, the following methodology are going to be carried out in this project:

1. Process of studies (literature study)
2. Process of analysis
3. Process of evaluation (adjustment)

Literature studies are done for the purpose of learning about the operation, characteristics and also the functions each part of the circuit. In the literature study, determination will be done by understanding the problem statement based on the project objectives.

1.6 WORK SCHEDULES

Work Schedules														
	2005							2006						
Project Activities	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Title Selection														
Analyses Objectives														
Gather Information														
Further Reading														
Calculation														
Circuit design using P-Spice/ Multisim														
Simulations														
Writing Report														

Table 1.1: Work schedule for PSM 1

Work Schedules														
	2005						2006							
Project Activities	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Designing Hardware														
Testing														
Writing Thesis														
Final Presentation and Submission														

Table 1.2: Work schedule for PSM 2

1.7 THESIS SUMMARY

This thesis include of five chapters that will explain in detail about the project or system. The first chapter is introduction to overview the project such as project background, objective, scope and methodology and also problem statement for this project.

Second chapter will discuss about the information relate to the project. The facts and info from the different references material will discuss to decide the best technique or procedure to execute the project.

Third chapter is about methodology to execute the procedure in second chapter in detail. The method for this project is to develop hardware.

Fourth chapter is analysis and result. All of analysis result such as graph, signal waveform, calculation and etc will discuss in this chapter. Analysis process for the equipment will be implemented.

Last chapter in this thesis are conclusion and suggestions. In this chapter, conclusion is based on achievement while implement this project from the beginning until the end. Beside, the suggestions will state to improve the project operation to make it better in the future.

CHAPTER II

LITERATURE REVIEW

2.1 OVERVIEW

This chapter will detail explain about the theory and concept of the project. The main objective is to explain the perspective and method that used in the research. Beside, this chapter also shows the theory and concept that use to settle the project problem. Understand the theory is important that will use as a guideline in doing a research. The research outcome can compared with the theory for better understanding.

2.2 INTRODUCTION

There are many kinds of products that have functions to detect a signal from human body and then monitor it through oscilloscope or any software such as LABVIEW. Nowadays, there are many ways to measure this signal and usually a different device was used to detect the signal at different part of body. For detect the pulse signal at the finger, PPG (Photoplethysmograph) circuit was applying. This device usually used as medical equipment and very high-cost to develop because it is required many systems which is combined to make one complete system. However, the circuits that will develop in this project have a more low-cost compare to this device at the market now. Even though, it still has same advantages.

2.3 BENEFIT

Using this project, we didn't need any function generator to generate the frequency of the circuit. We can get 1kHz direct from the circuit of 555 timers. This timer can oscillate what frequency we need refer to the design that we develop. The advantage of this method is less internal devices will used such as function generator to make this circuit function.

2.4 PPG (PHOTOPLETHYSMOGRAPH)

The photoplethysmograph (PPG) is a device for detecting blood volume changes in living tissue based on the determination of the optical properties of a selected skin area [1]. For this purpose non-visible infrared light is emitted into the skin. More or less light is absorbed, depending on the blood volume in the skin. Consequently, the backscattered light corresponds with the variation of the blood volume. Blood volume changes can then be determined by measuring the reflected light and using the optical properties of tissue and blood. The skin with less blood looks white, while skin with more blood looks darker. The photoplethysmograph does nearly the same thing but with much higher sensitivity and resolution. The reflection of light (wavelength 650nm) is detected with a photodiode and transimpedance amplifier. The device consists of a light source, photo detector, and ac amplifier and can be used to detect flow variations in the periphery during the cardiac cycle. They concluded that scattering, reflection, absorption, and movement of the vessel wall all play a role in producing the signal. The photoplethysmograph has been widely used for a variety of applications including monitoring of digital arterial pressure and compliance in man and detecting anxiety.

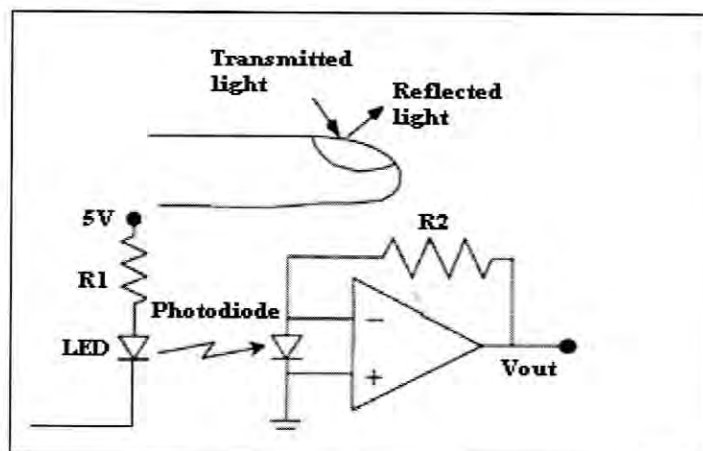


Figure 2.1 PPG Infrared Optical Sensor [1]