PORTABLE DIGITAL BLOOD PRESSURE METER

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours

Faculty of Electronic and Computer Engineering
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Date : 9 MAY 2008

To my loving husband, mum and family. Also, to my fellow friends.

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ABSTRACT

This project is to design a portable digital blood pressure meter. The device controlled by a Programmable System on Chip (PSoC®). The system is able to measure a blood pressure. The objectives of this project are to build a low cost blood pressure meter with quick time – to – market development. The previous similar project used a microcontroller such as Programmable Integrated Circuit (PIC) or microcomputer to running the program. The operation of those processing unit was designed by writing an instruction code. The problem with writing code is time consuming and sometimes need debugging the process. To solve this problem, an embedded visual design tools called PSoC Express will be used. The drag and drop with some algorithm expression design tools can accelerate the product development. Thus time – to – market of a product can be shorten. The measurement will be measured the hand cuff or other type of sensor and the reading value will be displayed on Liquid Crystal Display (LCD).

ABSTRAK

Projek ini adalah untuk mereka and membina Meter Tekanan Darah Digital Mudah Bawa. Alat ini akan dikawal oleh '*Programmable System on Chip (PSoC®)*'. System ini berkebolehan untuk mengukur tekanan darah. Objektif sebenar projek ini adalah untuk membina meter tekanan darah yang murah dengan masa untuk rekaan pembinaan dipasarkan adalah singkat. Projek terdahulu sebelum ini menggunakan mikropemproses seperti *Programmable Integrated Chip (PIC)* atau mikrokomputer untuk menjalankan program. Operasi kedua – dua unit mikropemproses ini direka dengan menulis kod arahan. Masalah dengan kod program program yang ditulis adalah masa yang dihadkan dan kadang kala memerlukan process debug. Untuk menyelesaikan masalah ini, *PSoC Express* akan digunakan. Proses ambil dan letak dengan rekaan perkakasan persamaan algorithm akan mempercepatkan penghasilan produk. Jadi, masa untuk produk dipasarkan adalah singkat. Pengukuran akan diukur the menggunakan *'hand cuff'* atau jenis sensor yang lain dan nilai bacaan akan dipaprkan pada Paparan Cecair Kristal (LCD).

TABLE OF CONTENT

II LITERATURE REVIEW

III METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

MCU	microcontroller unit
PSoC	Programmable System on Chip
PIC	Programmable Integrated Circuit

APPENDIX

CHAPTER I

INTRODUCTION

1.1 Overview

It is undeniable that nowadays people are more aware of the health conditions. One of the most widely used methods to test the health conditions of an individual is to measure their blood pressures. The Portable Digital Blood Pressure Meter is a device that can be used to measure a blood pressure in a real life.

This project is to design and build a portable handheld blood pressure meter. The device controlled by a Programmable System on Chip (PSoC®) chip will be able to measure blood pressure. The measurement will be taken through hand cuff that connected with pressure sensor and display the reading on liquid crystal display (LCD). This project is based on hardware / software design.

1.2 Project Objective

There are three main objectives in this project. The objectives are to build a Portable Digital Blood Pressure Meter that used to measure human arterial blood pressure. The second objective is to introduce a new Microcontroller Programming method called Programmable System on Chip (PSoC®). This tools is a drag and drop process without using a writing code. The third objective is to overcome the debugging process using PSoC Express Tools.

1.3 Problem Statement

Nowadays, Portable Digital Blood Pressure Meter available in market is more bulky, expensive and required high maintenance to design the system. The product is more expensive because of device used to design the system. The PIC or microcomputer is more expensive and required high maintenance to design compared with PSoC Express.

Previous similar projects [1] [2] [3] use microcontroller such as PIC or microcomputer MN157451. The operation of those processing units was designed by writing instruction code. The problem with code writing is the time consuming and sometimes need debugging process. In this project, an embedded visual design tools will be used called PSoC Express™. The drag and drop with some algorithms expression design tools can accelerate the product development. The proven error-free working library overcomes the debugging process. Thus, time-to-market of a product can be shorten.

1.4 Scope of Project

The project is a system on chip (SoC)-based design that will produce a prototype of a blood pressure meter. It is divided into two part; programming and hardware fabrication.

The programming development will use PSoC Express™ programming tools. This code-free design tools can also perform simulation and program download to the PSoC® chip using the same graphical user interface (GUI).

Hardware prototype is a handheld portable device. It consists of PSoC® chip, pressure sensor, liquid crystal display, lump components fabricated on a printed circuit board (PCB). A hand cuff input gadget will be connected to the meter to complete the prototype.

The system will be used to measure the blood pressure range between 0 to 25kPa (0 mmHg to 188mmHg). The system will measure the blood pressure in 4 ranges which is:

- 0 to 4kPa (0 mmHg – 30.1 mmHg)- Very low
- 4 kPa to 12 kPa (30.1 mmHg to 90.2 mmHg) – Low
- 12 kPa to 18 kPa (90.2 mmHg to 135.3 mmHg) – Normal
- 18 kPa to 25 kPa (135.3 mmHg to 188 mmHg) – High

1.5 Methodology

There are seven methodology steps in this project. The first step is literature review. The journal, application notes and books that are related to this project must to search and studies first before proceed to the next step. Next, learn the PSoC Express™ design tools. The tutorials and examples ™ version 2.2 used a reference to study the PSoC Express. After that, the SoC Programming design will be proceed. The circuit that read data from pressure sensor and display the reading on LCD will be developed and simulated. Testing on the Cypress Semiconductor evaluation board will also be performed. It is follows by design the PCB. Proteus software will be used to transfer the functionally correct circuit to the PCB. Fifth, the hardware will be assembled which is the entire component will be soldered and troubleshoot. Then, the Prototype will be test on at least 30 samples of blood pressure to ensure its functionality. Last, writing a report to document all the theories, finding and conclusion.

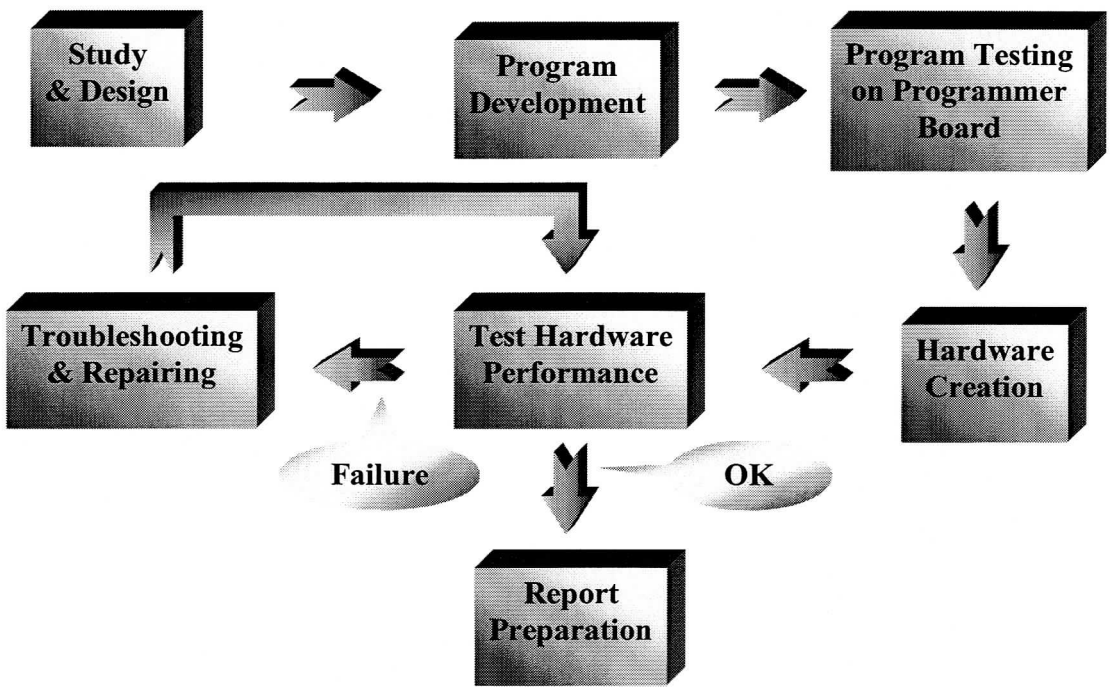

Figure 1.1: Methodology of the project

1.6 Report Structure

This report is divided into five chapters. They are introduction, literature review, project methodology, result and analysis and conclusion. The first chapter is introduction that introduce about the project. The objectives and scopes of the project are included in the introduction too. The second chapter is the literature review. It includes research about the blood pressure range, theory and concept that is relevant to the project.

The third chapter is about the project methodology. In this chapter, the methods and project flow is explained. The fourth chapter is about result and also analysis of the project. In this chapter, the progress of the project is showed. The last chapter is the conclusion for the project. This chapter will discuss about the conclusion and also the suggestion of how to improve this project.

CHAPTER II

LITERATURE REVIEW

2.1 Overview

Literature review is important before the project begin. All references existing PSoC Express are studied to have a fundamental knowledge of this project. This chapter will explain about the theory, concept and method that have been used in the previous project. Three previous projects will be discussed in this chapter. This chapter also presents the fundamental concept of PSoC design tools.

2.2 Literature Review of Blood Pressure Meter

Blood Pressure Meter has been reported in most clinical measurement of arterial blood pressure is made by sphygmomanometer [1].

The doctors usually measures the patient's blood pressure with pump the air into the cuff and use the stethoscope to listen to the sounds of the blood in the artery of the patient's arm [2]. Besides that, the wearable devices and signal processing method for tele-home healthcare is also the way to build the blood pressure meter, in which vital

signs monitoring is essential [3]. The project also shows that a typical set of transducer / disposable catheter consist a pressure transducer, a continuous flow device, stop – cocks, and some manometer tubing are used to measure from the radial artery.

The oscillometric method design by Waradorn Wattanapanitch and Warut Suampun was used to perform a measurement of blood pressure meter [3]. The air will be pumped into the cuff to be around 20 mmHg above average systolic pressure (about 120 mmHg for an average). After that the air will be slowly released from the cuff causing the pressure in the cuff to decrease. As the cuff is slowly deflated, the tiny oscillation will be measured in the air pressure of the arm cuff. The systolic pressure will be the pressure at which the pulsation starts to occur. The MCU will be used to detect the point at which this oscillation happens and then the pressure was record in the cuff. Then the pressure in the cuff will decrease further. The diastolic pressure will be taken at the point in which the oscillation starts to disappear.

The Wearable Medical Devices for Tele-Home Healthcare design by K.Hung, Y.T. Zhang and B. Tai is based on the biosignals such as biopotential and body motion signals that acquired by wireless sensors attached to a patient's body, and send to a nearby intermediate terminal for processing and / or relaying to a remote control [1]. The development of system are based on miniature and wearable biosensors for continuous acquisition of multiple biosignals, short – range, wireless communication between sensors and a home – based intermediate terminal, mobile phone communication for remote data access and multisensor data fusion methods to provide pre – diagnosis.

Others project, used the oscillometric method and a microcomputer [2]. The systems divide into 3 parts which hardware, software and specification of developed digital pressure meter (SE-100). The hardware was built by using microcomputer MN157451 (CMOS, 4 Bit), Pressure / Frequency Converter, LCD Display, Motor & Valve as shown in Figure 2.1. By using the microcomputer MN157451, the software that controls the hardware and processor the input signal was developed. The functions

of this software are auto zeroing, auto power off, removal of artifacts and display of the max and min value of blood pressure and heart rate.

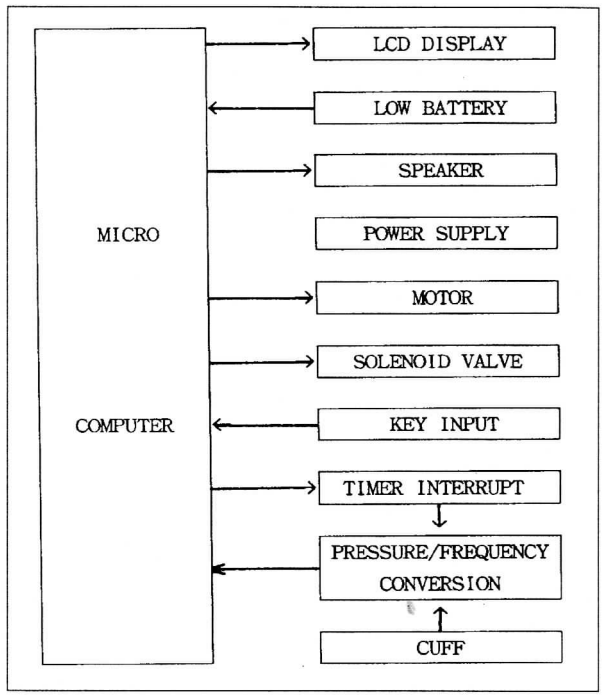

Figure 2.1: Hardware Block Diagram of Equipment

2.3 The Blood Pressure Range

Blood pressure refers to the force exerted by circulating blood on the walls of blood vessels, and constitutes one of the principal vital signs. The pressure of the circulating blood decreases as blood moves through arteries, arterioles, capillaries, and veins; the term blood pressure generally refers to arterial blood pressure, i.e., the pressure in the larger arteries, arteries being the blood vessels which take blood away from the heart. Blood pressure is most commonly measured via a sphygmomanometer, which uses the height of a column of mercury to reflect the circulating pressure. Although many modern blood pressure devices no longer use mercury, blood pressure values are still universally reported in millimeters of mercury (mmHg).