

raf

TJ223.P76 .T56 2008.



0000063003

Handheld environment meter / Tian Fung Yapp.

63003

# **HANDHELD ENVIRONMENT METER**

**TIAN FUNG YAPP**

This report is submitted in partial fulfillment of requirements for the award of  
Bachelor of Electronic Engineering (Computer Engineering) with Honors

Faculty of Electronic Engineering & Computer Engineering  
Universiti Teknikal Malaysia Melaka

30 April 2008



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**  
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

**BORANG PENGESAHAN STATUS LAPORAN  
PROJEK SARJANA MUDA II**

**Tajuk Projek** : Handheld Environment Meter

**Sesi Pengajian** : Sesi 2007/2008

Saya TIAN FUNG YAPP mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (  ) :

**SULIT\***

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

**TERHAD\***

(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

**TIDAK TERHAD**

Disahkan oleh:

(TANDATANGAN PENULIS)

Alamat Tetap: P. O. Box 36,

Pejabat Pos Mini Batu Niah,

98000 Miri, Sarawak.

(COP DAN TANDATANGAN PENYELIA)

**ZAMRE BIN ABD GHANI**

*Pensyarah*

Fakulti Kej Elektronik dan Kej Komputer (FKEKK),

Universiti Teknikal Malaysia Melaka (UTeM),


Karung Berkunci 1200, Hang Tuah Jaya

Ayer Keroh, 75450 Melaka.

Tarikh: 30 April 2008

Tarikh: 30 April 2008


“I hereby declare that this report is the result of my work except for quotes as cited in the references.”

Signature :  .....

Author : TIAN FOOK YAPP .....

Date : 30/4/2008 .....

“I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering (Computer Engineering) with Honors.”

Signature : .....  .....

Supervisor's Name : ..... ZAMRE BIN ABD GHANI .....

Date : ..... 30 APRIL 2008 .....

This book is dedicated to my parents, family members and friends.

Last but not least, to my supervisor and all the UTeM lecturers.

## **ACKNOWLEDGEMENT**

This project would not have been possible without the support of many people. Many thanks to my supervisor, Mr. Zamre Bin Abd Ghani, who read my numerous revisions and helped make some sense of the confusion. He always provides the excellent guidance, concern and informative discussions regarding to my project. I would like to express my most sincere gratitude and appreciation to him and everyone who give help to me during the process to accomplish this project. And finally, thanks to my beloved family members for their unconditional love, support and patience and at last to numerous friends.

## ABSTRACT

Handheld Environment Meter which measure and display the result value on a LCD. This project is a microcontroller based system which is uses a PSoC (Programmable System-On-Chip) microcontroller to control the whole. It is called Handheld Environment Meter. This Handheld Environment Meter able to measure environment temperature, pressure and humidity. Selectable switches are used to switch between every function of measurement. This project was developed with the main objective to introduce the PSoC Express which uses a program for allowing user to design and program the microcontroller without writing the source codes. PSoC Express is using the graphical diagram on program development and the successful simulated design will use to generate Hex code and program into PSoC microcontroller using PSoC Programmer. This Handheld Environment Meter has been overcome the problem of the product in current market which is limitation on measurement features. It was a combination of some measurement features. It can be said that this project was a low cost development but is very effective in real time.



## ABSTRAK

Projek ini bertujuan untuk merekacipta sebuah alat pengukur untuk mengambil bacaan suhu, tekanan dan kelembapan keadaan alam sekeliling. Alat pengukur ini direkacipta berdasarkan konsep kawalan mikro dan pengaturcaraan terus diprogramkan ke dalam chip. Ia berkemampuan untuk mengesan keadaan sekeliling dan memaparkan bacaan pada paparan LCD. Dua suis digunakan untuk memilih jenis pengukuran samada bacaan suhu, tekanan atau kelembapan. Projek ini dilaksanakan dengan tujuan utama untuk memperkenalkan program PSoC Express kepada orang ramai. Ini kerana program ini membenarkan pereka untuk mereka sesuatu sistem kawalan mikro tanpa menulis bahasa pengaturcaraan seperti Bahasa C atau Bahasa Pemasangan. Pereka boleh menggunakan gambarajah blok sebagai pengaturcaraan untuk menjayakan rekaannya. Program yang telah disiapkan boleh disimulasi untuk memperolehi litar dan seterusnya diterjemah kepada Hex code untuk diprogramkan ke dalam chip. Alat pengukur keadaan sekeliling ini telah mengatasi masalah-malalah yang terdapat pada produk yang sedia ada di maket. Pengukuran tekanan alam sekeliling adalah fungsi yang jarang dijumpai pada maket sekarang. Selain itu, projek ini hanya melibatkan kos yang murah untuk menghasilkan fungsi yang standing malah melebihi produk yang berharga tinggi.

## CONTENTS

CHAPTER	ITEM	PAGE
	<b>PROJECT TITLE</b>	<b>i</b>
	<b>REPORT COPYRIGHTS</b>	<b>ii</b>
	<b>DECLARATION</b>	<b>iii</b>
	<b>SUPERVISOR APPROVAL</b>	<b>iv</b>
	<b>DEDICATION</b>	<b>v</b>
	<b>ACKNOWLEDGMENT</b>	<b>vi</b>
	<b>ABSTRACT</b>	<b>vii</b>
	<b>CONTENTS</b>	<b>ix</b>
	<b>LIST OF TABLES</b>	<b>xiii</b>
	<b>LIST OF FIGURES</b>	<b>xiv</b>
	<b>LIST OF ABBREVIATIONS</b>	<b>xvii</b>
	<b>LIST OF APPENDICES</b>	<b>xix</b>
<b>I</b>	<b>INTRODUCTION</b>	
	1.1 Background of Project	2
	1.2 Project Objective	2
	1.3 Problem Statement	3
	1.4 Scope of Work	3
	1.5 Short Brief on Methodology	4

## II LITERATURE REVIEW

2.1	Research and Study	6
2.2	PSoC	6
2.3	PSoC Programming Tools	7
2.3.1	PSoC Designer	7
2.3.2	PSoC Express	8
2.3.3	PSoC Programmer	9
2.4	Environment Meter	10
2.4.1	5-in-1 Multifunction Environment Meter	11
2.4.2	4-in-1 Environment Meter	12
2.5	Temperature Detection	13
2.6	Pressure Detection	14
2.7	Humidity Detection	16
2.8	LCD	19
2.9	PSoC Microcontroller	20
2.10	PSoC Programmer Board	24
2.11	Advantages & Disadvantages of PSoC	25
2.12	Proteus	26

## III METHODOLOGY

3.1	Process Flowchart	28
3.2	Environment Meter	29
3.2.1	Sensors Connection	29
3.3	Program Development by Using PSoC Express	30
3.4	Program Downloading into PSoC Microcontroller	42
3.5	Testing Program on PSoC Programmer Board	43
3.6	Power Supply Circuit	46
3.7	Create PCB Layout Using Proteus	46

3.8	Hardware Creation	50
3.8.1	PCB Preparation	51
3.8.2	Components Installation	51
3.8.3	Testing	52
3.8.4	Finalize	52
3.8.5	Product Operation	53

#### **IV RESULT AND DISCUSSION**

4.1	Result of Simulation	55
4.1.1	Temperature Measurement Function	55
4.1.2	Pressure Measurement Function	56
4.1.3	Humidity Measurement Function	56
4.1.4	Combination of Three Functions	57
4.2	Schematic	57
4.3	Hardware Overview	62
4.3.1	Temperature Measurement	63
4.3.2	Pressure Measurement	63
4.3.3	Humidity Measurement	64
4.3.4	Product Overview	64
4.4	Product Testing	65
4.4.1	Temperature	65
4.4.2	Pressure	66
4.4.3	Humidity	66
4.5	Discussion	67
4.4.1	Temperature	67
4.4.2	Pressure	68
4.4.3	Humidity	69
4.6	Product Specifications	69

<b>V</b>	<b>CONCLUSION AND SUGGESTION</b>	
5.1	Conclusion	70
5.2	Suggestion	70
	<b>REFERENCES</b>	71
	<b>APPENDICES</b>	72

## LIST OF TABLES

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Pin descriptions	15
2.2	Relationship between heights to the pressure	16
2.3	PSoC architecture pin description	23
3.1	Switches configuration for measurements selection	46
4.1	Measurements selection for switches	62
4.2	Specifications of temperature measurement	67
4.3	Relation between height and pressure	68
4.4	Specifications of pressure measurement	68
4.5	Specifications of humidity measurement	69
4.6	Product operating time	69

## LIST OF FIGURES

No.	TITLE	PAGE
2.1	PSoC Designer 4.4 GUI	7
2.2	PSoC Express 3.0 GUI	8
2.3	PSoC Programmer 2.30 GUI	9
2.4	PSoC Programmer Board (PSoCEVAL1 Rev D)	10
2.5	5-in-1 Multifunction Environment Meter	11
2.6	4-in-1 Environment Meter	12
2.7	DS1621 digital temperature sensor	13
2.8	MPXV7025G pressure sensor	14
2.9	Humidity sensor (HIH-4000)	17
2.10	Relative Humidity conversion chart	18
2.11	Hitachi LCD (HD44780U)	19
2.12	PSoC Microcontroller outlook	20
2.13	Internal structure of PSoC Microcontroller	21
2.14	PSoC Microcontroller architecture	22
2.15	PSOCEVAL1 Rev D evaluation programmer board	24
3.1	Process flowchart for whole project development	28
3.2	Concept of combination function for Handheld Environment Meter	29
3.3	PSoC Express main program interface	30
3.4	PSoC Express main program interface	30
3.5	Adding the temperature sensor	31
3.6	Temperature sensor was added	31
3.7	Adding the valuator	32
3.8	Adding the set point value	32



3.9	Valuator was added on the project	33
3.10	Adding and setting the display features for LCD	33
3.11	LCD was added in the project	34
3.12	New arrangement for the I/O devices	34
3.13	Insert the Transfer Function	35
3.14	Select Priority Encoder as Transfer Function	35
3.15	Simple expression need to be filled up	36
3.16	Completed design of temperature measurement function	36
3.17	Run simulation on design	37
3.18	Select “ <i>Build</i> ” function for generate the BOM list and hex code	37
3.19	The PSoC microcontroller pin out connection	38
3.20	The build function in the progress to generate Hex code	38
3.21	Build function result	39
3.22	Result of BOM list	39
3.23	Schematic for the PSoC microcontroller	40
3.24	Connection configuration for the LCD and Temperature sensor	40
3.25	Complete design in PSoC Express	41
3.26	Simulation on complete design	41
3.27	Open the PSoC Programmer program	42
3.28	PSoC Programmer load with Hex file for current project	42
3.29	PSoC Programmer Board with USB connection	43
3.30	PSoC Programmer load with Hex file for current project	43
3.31	Temperature detection on PSoC Programmer Board	44
3.32	Pressure detection on PSoC Programmer Board	44
3.33	Humidity detection on PSoC Programmer Board	45
3.34	5V DC power regulator circuit	47
3.35	Proteus Professional 6.9 SP5 GUI	47
3.36	Full schematic for environment meter	48
3.37	PCB design in ARES Professional (Proteus 6.9 SP5)	49
3.38	PCB layout (Down side)	49
3.39	PCB design (Top side)	50
3.40	PCB after go through soldering process	52
3.41	An Environment Meter was built	53
3.42	Product testing for few hours	53



4.1	Temperature measurement on simulation	55
4.2	Pressure measurement on simulation	56
4.3	Humidity measurement on simulation	56
4.4	Three type measurements on simulation	57
4.5	BOM list for environment meter design	58
4.6	Connection pin on PCoC microcontroller	58
4.7	Recommended support components for PSoC microcontroller	59
4.8	Driver schematic for LCD	59
4.9	Driver schematic for digital temperature sensor	60
4.10	Supportive components for temperature sensor	60
4.11	Driver schematic for pressure sensor	61
4.12	Driver schematic for humidity sensor	61
4.13	Schematic of PB1 and PB2	62
4.14	Temperature measurement testing on PSoC Programmer Board	63
4.15	Pressure measurement testing on PSoC Programmer Board	63
4.16	Humidity measurement testing on PSoC Programmer Board	64
4.17	Handheld Environment Meter overview	64
4.18	Product test run for temperature measurement	65
4.19	Product test run for pressure measurement	66
4.20	Product test run for humidity measurement	66

## LIST OF ABBREVIATIONS

- ADC – Analog-to-Digital Converter  
atm – Atmosphere  
BOM – Bill of Material  
CCS C Compiler – Customer Computer Service C Compiler  
CMPLP – Computer Managed Personalized Learning Process  
CPU – Central Processing Unit  
CRC – Cyclical Redundancy Checking  
CSA – CapSense Successive Approximation  
CSD – CapSense Sigma Delta  
CSR – CapSense Relaxation Oscillator  
DAC – Digital-to-Analog Converter  
DC – Direct Current  
DIP – Dual Out-line Package  
DTMF – Dual-tone multi-frequency  
GUI – Graphic User Interface  
HB LED – Hybrid Light Emitter Diode  
Hex – Hexadecimal  
Hg – Hydrargyrum  
IC – Integrated Chip  
I/O – Input and Output  
IDE – Integrated Development Environment  
ISO – International Standard Organization  
IUPAC – International Union of Pure and Applied Chemistry  
ISIS – Integrated Scientific Information System  
kPa – Kilo Pascal

LCD – Liquid Crystal Display  
LSI – Large-scale Integration  
MAC – Multiply-Accumulate  
MCU – Microcontroller Unit  
MSB – Most Significant Bit  
OEM – Original Equipment Manufacturer  
PB – Push Button  
PC – Personal Computer  
PCB – Printed Circuit Board  
PIC – Programmable Interrupt Controller  
PSM – Projek Sarjana Muda  
psi – Pounds per Square Inch  
PSoC – Programmable System-on-Chip  
PVC – Polyvinyl Chloride  
PWM – Pulse Width Modulation  
RAM – Random Access Memory  
RH – Relative Humidity  
ROM – Read Only Memory  
SCL – Serial Clock  
SDA – Serial Data  
SIP – Single In-line Package  
SMP – Symmetric Multiprocessing  
SP – Service Pack  
SPICE – Simulation Program with Integrated Circuit Emphasis  
SRAM – Static Random Access Memory  
SW – Switch  
USB – Universal Serial Bus  
UV – Ultra Violet  
V – Volt

## LIST OF APPENDICES

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
A	Environment Meter	72
B	PSoC	74
C	Input / Output Devices	76

## CHAPTER I

### INTRODUCTION

The Handheld Environment Meter has been designed to combine the functions of temperature meter, pressure meter and humidity meter. It is an ideal multi-function meter with scores of practical applications for professional and home use. The temperature function can be used to measure temperature in factories, schools, offices, hospitals or at home for checking and monitoring the environment temperature in term of providing a best condition for the particular situation. A digital temperature sensor is applied for this purpose to get more accurate real time value. The pressure function is used to measure atmosphere pressure in the field. Commonly, it can be used to determine the pressure in factories and biomedical field. However, some modifications are needed before being introduced to the biomedical field due to the calibration specification of different sector. The humidity sensitive component used in the meter is a very stable, laser trimmed, thermoset polymer capacitive sensing element with on-chip integrated signal conditioning. Applications of this function includes manufacturing factories field, store or logistic. Since the Handheld Environment Meter is a portable instrument tool, it allows user to bring along and basic tools for an engineer to troubleshooting some particular problem regarding the environment condition.

## **1.1 Background of Project**

This project will develop a Handheld Environment Meter by using PSoC Express. The Handheld Environment Meter consists of three measurement functions which are temperature, pressure and humidity detection. The detection value will be displayed on a LCD. This project is able to overcome some of the limitations that other handheld environment meter available in market.

In this project, the development process focuses on the PSoC Express because it is a new software in microcontroller programming based. PSoC Express is a graphical modeling system that allows developers to create applications without resorting to text-based programming tools. On the other hand, developers no need to spend so much time on writing the source code and debugging the errors.

## **1.2 Project Objective**

The main objective of this project is to introducing a new method of microcontroller program. In this project, the PSoC microcontroller which is manufactured by Cypress Semiconductor will be used. PSoC Express will be emphasized on this project including the advantages and the programming procedures. Compare to the existing method known as source code development to program the microcontroller, PSoC Express is a totally new and easier to handle during the development process.

Beside that, this project also focuses on the combination of functions of an environment meter available in current market. Common product in current market has a limitation of measurement function especially pressure detection. By encountering this problem, Handheld Environment Meter will be developed based on three basic measurement functions which is temperature, pressure and humidity.



### 1.3 Problem Statement

The major problem faced by designer is that when the situation requires a microcontroller to control the system, too much time is spend on the program development process. Based on the common microcontroller used in the market such as PIC from Microchip, a completed and successful compiled source code is necessary in order to operate the PIC. Normally, most of the development time is more on the writing of the source code.

Another problem often faced by programmer is that, many errors occurred during compiling the source code. Although the compiler program is able to debug and provide a reference for the user to make corrections, sometime it because too complicated and it is a wasting of time to make correction for all the errors.

By using PSoC Express program, designer is unnecessary to writing the command or deal with any complicated source codes. Dragging and dropping icons were simplified the designing processes and minimize the errors.

### 1.4 Scope of Work

This final project basically is a system-on-chip based which is divided into two categories i.e embedded design and hardware fabrication. This project produces a prototype model. A PSoC microcontroller (CY8C29466-24PXI) is used as the main component in this project. Design and simulation are performed using PSoC Express 3.0 visual embedded development tools. The successful simulated program is downloaded to the PSoC microcontroller using PSoC Programmer 2.30.0.16. Testing on PSOCEVAL1 evaluation board (PSoC Programmer Board) also was carried out.

Then the design is transferred to PCB as a prototyping by using Proteus 6.9 SP5. Then proceed with PCB fabrication which is the etching and soldering process. Testing and troubleshooting on the prototype model was repeated to ensure the all functionality of the prototype.

Based on research and study result, the existing environment meter in the market has limited capability on measurement functions especially is the pressure detection function. That's why it is very hard to find an environment meter with the pressure measurement function. Of course it exists but the price is expensive.

## **1.5 Short Brief on Methodology**

To develop the project during PSM-I, PSoC Express has been used to design the program. By using this software, the program can be develop in shorten time compare with other microcontroller program compilers.

The successful simulated design was converted to the Hex code through PSoC Express. PSoC Programmer downloads the program in Hex code form into PSoC microcontroller via USB/Serial PSoC programmer board.

To verify the functionality of program, the I/O devices were connected to PSoC programmer board based on the schematic provided by PSoC Express. The completed connections of I/O devices were tested on different environment condition such as indoor and outdoor to test the temperature detection.

In PSM-II, the schematic generated by PSoC Express was converted into PCB design by using Proteus. This PCB layout was printed negative and mask on the PCB using UV Light. PCB with the circuit layout was put into automatic etching machine for dissolving the undesired copper.

Successful etching PCB has been drilled for insert the component. All the components were soldered step by step on the PCB. Completed soldered circuit was go through functionality testing process before assemble with the casing.

Lastly, the successful product was tested run for few hours to get the product specification such as sensitivity and operating time.