BATTERY CHARGER WITH ALPHANUMERIC LCD MODULE MONITORING

MOHD HAPIZ BIN ARBAIN

This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor of Electrical Engineering

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

NOVEMBER, 2008

"All the trademark and copyrights use herein are property of their respective owner. References of information from other sources are quoted accordingly; otherwise the information presented in this report is solely work of the author."

Signature : ______________________________

Author : MOHD HAPIZ BIN ARBAIN

Date : 12 NOVEMBER 2008

Specially dedicated to

My beloved family and those people who have guided and inspired me throughout my journey of education

ACKNOWLEDGEMENT

In The Name of God, The Most Beneficent The Most Gracious.

As this is my first project, this project would not have been possible without considerable guidance and support. I would acknowledge those who have support and helping me to complete this project successfully.

To Mr. Ruhaizad bin Ishak, my project supervisor, I am deeply indebt. I have learned a great deal from him in moral and academic matters, in improving my written documentation skill and in a wide variety of area through his consistent mentoring as my project adviser.

Most of all, I would like to thank my entire group members, for their strong support. My grateful appreciation also goes to all individuals involved in this project.

Finally to my family, thank you for continuously giving me the support and for making this project possible. My parent always encouraged us to ask questions, to curious about how things work. Thanks for encouraging me to be an independent thinker, and having confidence in my abilities to go after new things that inspired me.

ABSTRACT

The objective of this project is to create a battery charger with alphanumerical LCD module monitoring, display the values of voltage during charging, and can charge most common rechargeable battery types. The design is separated into three basic parts, charging circuit, controller circuit and LCD monitoring screen. This charger is able to charge up to 8 batteries of AAA size at one time, able to protect the battery from overcharge and can present the voltage value. Using PIC16F876A as a brain of the system, all the processes are managed by the controller including the data that display on the LCD screen. User gives instruction to the controller by just pushing the push button near the controller, and view the LCD screen for menu option. Even with limited projected words that can be display on the LCD, this charger still has an interesting output that can be represented to user. Some of it are time counter and automatically stop the charging process before battery is overcharge.

ABSTRAK

Projek ini bertujuan untuk menghasilkan satu alat pengecas bateri yang mempunyai paparan menggunakan LCD serta mampu untuk memaparkan nilai voltan semasa proses mengecas dijalankan. Alat pengecas ini juga mampu mengecas pelbagai jenis bateri. Projek ini dibahagikan kepada tiga bahagian, litar pengecas, Litar pengawal dan litar paparan LCD. Alat pengesas bateri yang dibina juga mampu mengecas bateri AAA sehinga 8 biji secara serentak dan pada masa yang sama dapat mengawal dari berlakunya pengecasan berlebihan serta memaparkan nilai voltan semasa mengecas. PIC16F876A digunakan sebagai otak sistem yang mengatur serta mengawal keseluruhan proses termasuk apa yang dipaparkan di paparan LCD. Pengguna hanya perlu menekan butang suis yang berada berhampiran litar pengawal dengan berpandukan arahan pada paparan LCD untuk menggunakan alat pengecas ini. Walaupun jumlah perkataan yang dipaparkan adalah terhad, alat pengecas ini mampu menarik perhatian melalui mesej yang dipaparkan di skrin paparan LCD.

TABLE OF CONTENTS

CHAPTER		PAGE
TITLES		i
STATEMENT		ii
DEDICATION		iii
ACKNOWLEDGEMENT		iv
ABSTRACT		v
ABSTRAK		vi
TABLE OF CONTENTS		vii
LIST OF TABLES		x
LIST OF FIGURES		xi
LIST OF SYMBOL		xii
LIST OF APPENDICES		xiii

CHAPTER	TITLE	PAGE
1	**INTRODUCTION**	
	1.1 Overview	1
	1.2 Objective	2
	1.3 Scope of Project	2
	1.4 Problem Statement	2
	1.5 Thesis Organization	3

2 LITERATURE REVIEW

2.1 Introduction 4
2.2 General Definitions of charger circuit 4
2.2.1 Types of Charger 5
2.2.2 Timer base 5
2.2.3 Intelligent 5
2.2.4 Fast 6
2.2.5 Inductive 6
2.2.6 Battery Specification 7
2.2.7 Nickel Cadmium (NiCd) Specification 8
2.3 PIC Controller Circuit 8
2.3.1 Origins 9
2.3.2 PIC Memory organization 10
2.3.3 PIC development support 10
2.3.4 PIC Simulator IDE 11
2.3.5 PIC Simulator IDE main features 11
2.4 Monitoring Circuit 12
2.4.1 LCD modules 13
2.4.2 16 x 2 Alphanumeric LCD Module Features 13
2.5 Voltage Regulator LM317 & LM7805 13
2.6 MOSFET 14
2.7 PIC USB programmer 14
2.8 Summary 15

3 METHODOLOGY

3.1 Introduction 16
3.2 Hardware Implementation 17
3.3 Regulated Voltage 18

	3.4	Charging circuit	18
	3.5	PIC16F876A Microcontroller	21
	3.6	16 x 2 Characters LCD	23
	3.7	Software implementation	24
	3.8	Main Program flow chart	25
		3.8.1 Programming of Intro program	26
		3.8.2 Program Coding for Charging Process	27
	3.9	Burning file Into PIC using PIC USB programmer	29
	3.10	Summary	30
4	**RESULT AND DISCUSSION**		
	4.1	Introduction	32
	4.2	Result of Experiment	33
	4.3	Charging Graph	34
	4.4	Discharging Process	36
	4.5	Problem and solution	38
5	**CONCLUSION AND RECOMMENDATION**		
	5.1	Conclusion	41
	5.2	Recommendation	42
	5.3	Commercialization	43
REFERENCES			44
APPENDIXES			46

LIST OF TABLE

TABLE NO.	TITLE	PAGE
2.2.7	Nickel Cadmium (NiCd) Battery Specification.	8
3.5	Pin connection of PIC16F876A for Battery harger developed	22
4.1	MOSFET Operation.	33
4.3.1	Battery Testing.	35
4.4.1	Battery Testing.	37

LIST OF FIGURE

FIGURE NO.	TITLE	PAGE
2.2.6	NiCd Rechargeable Battery	7
2.3	Microcontroller.	8
2.3.4	PIC Simulator IDE Software Window.	11
2.4.1	16 x 2 Alphanumeric LCD Module Features	12
2.5	LM317 Electronic Component	13
2.6	Mosfet	14
2.7	PIC USB programmer device.	14
3.1.1	Block diagram of develop battery charger.	16
3.1.2	The picture of Battery Charge with Alphanumeric LCD Monitoring.	17
3.3.1	Schematic circuit of 5V dc voltage regulator	18
3.4.1	Schematic of charging circuit	19
3.4.2	Hardware simulation using Orcad Pspice software.	20
3.5.1	Schematic for PIC16F876A	21
3.6	Schematic Of LCD screen	23
3.7	Writing the PIC program using PIC simulator IDE.	24
3.8	Main Program flow chart	25
3.9	Program burned using USB PIC burner connects to WinPic800 software.	30
3.10	Picture of battery charger circuit.	31
4.3.1	Analysis of Battery during Charging Process	34
4.4.1	Analysis of Battery during Discharging Process	36
4.4.2	Analysis of Used Battery during Discharging Process	37

LIST OF SYMBOL

DC	-	Direct Current
MOSFET	-	Metal Oxide semiconductor field effect transistor
PIC	-	Peripheral interface controller
IC	-	Integrated circuit
LCD	-	Liquid Crystal Display
NiCd	-	Nickel-cadmium
NiMH	-	Nikel Metal Hydride

LIST OF APPENDIX

APPENDIX NO.	TITLE	PAGE
A	PIC Programming	46
B	The schematic circuit of battery charger.	52
C	Datasheet PIC 16F876A	54
D	Datasheet Mosfet IRF570	60
E	Datasheet 16 x 2 Character LCD	62
F	Cost of project	64
G	Picture of Battery charger with alphanumeric LCD display	66

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **BATTERY CHARGER WITH ALPHANUMERIC LCD MODULE MONITORING**

SESI PENGAJIAN: **2005/2009**

Saya **MOHD HAPIZ BIN ARBAIN (860130-01-5367)**
(HURUF BESAR)

mengaku membenarkan tesis (Sarjana Muda/~~Sarjana~~ /~~Doktor Falsafah~~)* ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis 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) (TANDATANGAN PENYELIA)

Alamat Tetap:

PLB29 KG PARIT LAPIS BANGAS
SERI MEDAN

RUHAIZAD B ISHAK
(Nama Penyelia)

Tarikh: **12 NOVEMBER 2008**

Tarikh: : **12 NOVEMBER 2008**

CATATAN:
- * Potong yang tidak berkenaan.
- ** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai atau TERHAD.
- ♦ Tesis dimaksudkan sebagai tesis bagi Ijazah doktor Falsafah dan Sarjana secara Penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Power System)"

Signature : ______________________________

Name : RUHAIZAD BIN ISHAK

Date : 12 NOVEMBER 2008

CHAPTER 1

INTRODUCTION

1.1 Overview

As the obliteration of fossil fuels and controlling emissions become growing concerns, batteries have taken placed of one the main energy sources available in developing countries. As the number of portable and mobile devices that use batteries increases, all small gadget like phones, digital assistants, laptops, MP3 players, digital cameras, and GPS units is need to be charged using different adaptors specific to each device. In future, the system could be used to charge any of these just by sitting devices with a small built-in pickup onto the charger.

Nowadays, many chargers have been created for restoring power to electrical battery and the new charger is developed to deflect any weaknesses before. With adding more features, this charger has ability to control the process occur and display the output using LCD screen. Furthermore, this charger circuit consists of three basic parts, charging and discharging circuit, controller circuit and monitoring screen. With ability to charge AAA battery (1.2V), this charger able to charge 8 batteries at once time. The charger is also automatically control by a PIC16F876A that act as a brain of the system and work continuously too analysis data for display it on the LCD screen.

1.2 Objective

The main objective for this project is

i. To develop battery charging circuit for charging battery.
ii. To determine the battery voltage during the charging process.
iii. Understand the concept of Charging and discharging process.

The important part of this project is to develop charger circuit control by PIC. As a brain of the system PIC need to be program then connect to the LCD monitor as the output.

1.3 Scope of Project

The scope of the project is developing battery charger that displays battery voltage during process of charging using the LCD monitoring. The charger also used PIC 16F876A as controller that control the whole operation of the circuit.

1.4 Problem Statement

The commercial battery chargers do not display the battery voltage during the charging process, and result overcharge, shorten life time of battery and unknown value of voltage charged into the battery cell. Hopefully, this battery charger will overcome the problem by display the voltage, time done and automatically stop before battery is overcharge.

1.5 Thesis Organization

Including this chapter, it consists of 5 chapters altogether. Chapter 1 is contained full description of the project, chapter 2 is article review, chapter 3 consists of the project methodology, mostly about the project flow and how it's organized. Chapter 4 presents the expected result, while the conclusions are presented in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This thesis involved the design and research regarding on battery charger with alphanumeric LCD module monitoring. In this chapter, the researcher reviews article and past research about the component and device used to make this project a reality. The circuit such as charging, controller and display circuit had being identified to support in the design of generating set for study.

2.2 General definitions of charger circuit

A battery charger is a device used to put energy into a secondary cell or (rechargeable) battery by forcing an electric current through it. The charge current depends upon the technology and capacity of the battery being charged. Charger works by connecting a constant DC power source to the battery being charged. The simple charger does not alter its output based on time or the charge on the battery. Typically, a simple charger takes longer to charge a battery to prevent severe over-charging. Even so, a battery left in a simple charger for too long will be weakened or destroyed due to over-charging. These chargers can supply either a constant voltage or a constant current to the battery.[1]

2.2.1 Types of Charger

2.2.2 Timer base

The output of a timer charger is terminated after a pre-determined time. Often a timer charger and set of batteries could be bought as a bundle and the charger time was set to suit those batteries. If batteries of lower capacity were charged then they would be overcharged, and if batteries of higher capacity were charged they would be only partly charged. With the trend for battery technology to increase capacity year on year, an old timer charger would only partly charge the newer batteries. Timer based chargers also had the drawback that charging batteries that were not fully discharged, even if those batteries were of the correct capacity for the particular timed charger, would result in over-charging.[2]

2.2.3 Intelligent

Output current depends upon the battery's state. An intelligent charger may monitor the battery's voltage, temperature or time under charge to determine the optimum charge current at that instant. Charging is terminated when a combination of the voltage, temperature and/or time indicates that the battery is fully charged. A typical intelligent charger fast-charges a battery up to about 85% of its maximum capacity in less than an hour, then switches to trickle charging, which takes several hours to top off the battery to its full capacity.[2]

2.2.4 Fast

Fast chargers make use of control circuitry in the batteries being charged to rapidly charge the batteries without damaging the cells' elements. Most such chargers have a cooling fan to help keep the temperature of the cells under control. Most are also capable of acting as a standard overnight charger if used with standard NiMH cells that do not have the special control circuitry. Some fast chargers, such as those made by Energizer, can fast-charge any NiMH battery even if it does not have the control circuit. [2]

2.2.5 Inductive

Inductive battery chargers use electromagnetic induction to charge batteries. A charging station sends electromagnetic energy through inductive coupling to an electrical device, which stores the energy in the batteries. This is achieved without the need for metal contacts between the charger and the battery. It is commonly used in electric toothbrushes and other devices used in bathrooms. Because there are no open electrical contacts, there is no risk of electrocution. [2]

2.2.6 Battery Specification

Figure 2.2.6: NiCd Rechargeable Battery.

The nickel-cadmium battery is a type of rechargeable battery using nickel oxide hydroxide and metallic cadmium as electrodes. The abbreviation *NiCad* is a registered trademark of SAFT Corporation and should not be used to refer generically to nickel-cadmium batteries, although this brand-name is commonly used to describe all nickel-cadmium batteries. On the other hand, the abbreviation *NiCd* is derived from the chemical symbols of nickel (Ni) and cadmium (Cd), though it is not to be confused with a chemical formula. There are two types of NiCd batteries: sealed and vented.

Sealed NiCd cells may be used individually, or assembled into battery packs containing two or more cells. Small NiCd dry cells are used for portable electronics and toys, often using cells manufactured in the same sizes as primary cells. When NiCds are substituted for primary cells, the lower terminal voltage and smaller amperehour capacity may reduce performance as compared to primary cells. With a relatively low internal resistance, a NiCd battery can supply high surge currents.

One of the Nickel-Cadmium's biggest disadvantages was that the battery exhibited a very marked negative temperature coefficient. This meant that as the cell temperature rose, the internal resistance fell. This could pose considerable charging problems particularly with the relatively simple charging systems employed for lead-acid type batteries. [3]

2.2.7 Nickel Cadmium (NiCd) Specification

Table 2.2.7: Nickel Cadmium (NiCd) Battery Specification.

Energy/weight	40–60 Wh/kg
Energy/size	50–150 Wh/L
Power/weight	150W/kg
Charge/discharge efficiency	70%–90%
Self-discharge rate	10%/month
Cycle durability	2000 cycles
Nominal Cell Voltage	1.24 V

2.3 PIC Controller Circuit

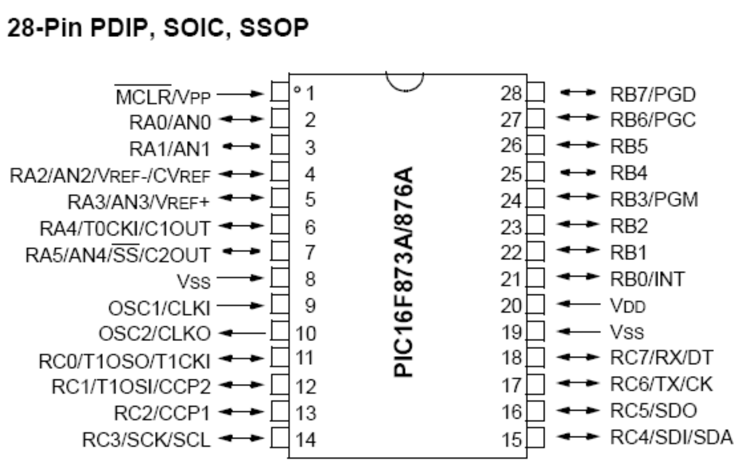


Figure 2.3: Microcontroller.

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division [4].PICs are popular with developers due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability[5].

2.3.1 Origins

1) The original PIC was built to be used with GI's new 16-bit CPU, the CP1600.While generally a good CPU, the CP1600 had poor I/O performance, and the 8-bit PIC was developed in 1975 to improve performance of the overall system by offloading I/O tasks from the CPU.
2) The PIC used simple microcode stored in ROM to perform its tasks, and although the term wasn't used at the time, it is a RISC design that runs one instruction per cycle (4 oscillator cycles).
3) In 1985 General Instruments spun off their microelectronics division, and the new ownership cancelled almost everything — which by this time was mostly out-of-date. The PIC, however, was upgraded with EPROM to produce a programmable channel controller, and today a huge variety of PICs are available with various on-board peripherals (serial communication modules, UARTs, motor control kernels, etc.) and program memory from 512 words to 32k words and more[7].

2.3.2 PIC Memory organization

A PIC Microcontroller chip combines the function of m icroprocessor, ROM program memory, some RAM memory and input-output interface in one single package which is economical and easy to use . The PIC – Logicator system is designed to be used to program a range of 8,18, 28 pin reprogrammable PIC microcontroller which provide a variety of input –output, digital input and analogue input options to suit students project uses [7].

Reprogrammable "FLASH Memory" chips have been selected as the most economical for student use. If a student needs to amend to control system as the project is evaluated and developed, the chip can simply be taken out of the product and reprogrammed with an edited version of the floe sheet . The PIC devices generally feature is sleep mode (power saving), watchdog timer and various crystal or RC oscillator configuration, or an external clock.[7]

2.3.3 PIC development support

Within a series, there are still many device variants depending on what hardware resources the chip features [6].

- general purpose i/o pins
- internal clock oscillators
- 8/16 Bit Timers with Internal EEPROM Memory
- Synchronous/Asynchronous Serial Interface USART
- MSSP Peripheral for I²C and SPI Communications
- Capture/Compare and PWM modules
- Analog-to-digital converters
- USB, Ethernet, CAN interfacing support and external memory interface.
- Integrated analog RF front ends (PIC16F876A)

2.3.4 PIC Simulator IDE

Figure 2.3.4: PIC Simulator IDE Software Window.

PIC Simulator IDE is powerful application that supplies PIC developers with user-friendly graphical development environment for Windows with integrated simulator (emulator), Basic compiler, assembler, disassembler and debugger. [11]

2.3.5 PIC Simulator IDE main features

- Main simulation interface showing internal microcontroller architecture.
- FLASH program memory editor, EEPROM data memory editor, hardware stack viewer
- Microcontroller pinout interface for simulation of digital I/O and analog inputs.
- Variable simulation rate, simulation statistics.
- Breakpoints manager for code debugging with breakpoints support. PIC assembler, interactive assembler editor for beginners, PIC disassembler.

- Powerful PIC Basic compiler with smart Basic source editor.
- PIC Basic compiler features: three basic data types (1-bit, 1-byte, 2-byte), optional 4-byte (32-bit) data type with 32-bit arithmetics, arrays, all standard PIC Basic language elements, optional support for structured language, high level language support for using internal EEPROM memory.[11]

2.4 Monitoring Circuit

2.4.1 LCD modules

Figure 2.4.1: 16 x 2 Alphanumeric LCD Module Features

A **liquid crystal display** (**LCD**) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.[6]

2.4.2 16 x 2 Alphanumeric LCD Module Features

- Intelligent, with built-in Hitachi HD44780 compatible LCD controller and RAM providing simple interfacing
- 61 x 15.8 mm viewing area
- 5 x 7 dot matrix format for 2.96 x 5.56 mm characters, plus cursor line
- Can display 224 different symbols
- Low power consumption (1 mA typical)
- Powerful command set and user-produced characters
- TTL and CMOS compatible and
- Connector for standard 0.1-pitch pin headers. [6]

2.5 Voltage Regulator LM317 & LM7805

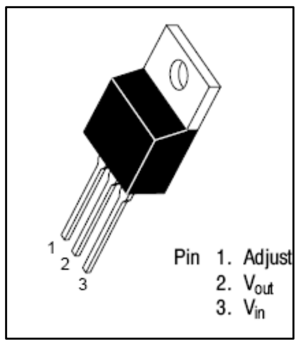


Figure 2.5: LM317 Electronic Component

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. LM317 is type of Adjustable voltage regulator that also available in circuit configurations that allow the user to set the output voltage to a desired regulated value [10].

The regulated output voltage is given by:

$$\mathbf{V_{out} = V_{ref} (1 + R_2/R_1) + I_{Adj}R_2} \quad \text{……………………………. } \mathbf{(1)}$$

2.6 Mosfet

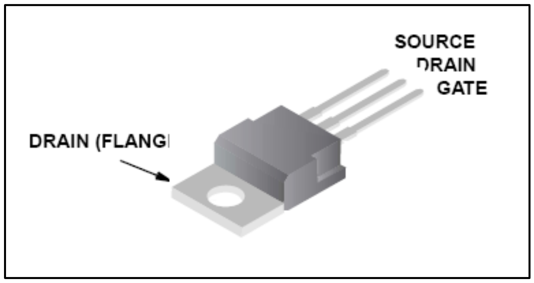


Figure 2.6: Mosfet

The metal–oxide–semiconductor field-effect transistor (MOSFET, MOS-FET, or MOS FET) is a device used to amplify or switch electronic signals. It is by far the most common field-effect transistor in both digital and analog circuits. The MOSFET is composed of a channel of n-type or p-type semiconductor material. [12]

2.7 PIC USB programmer

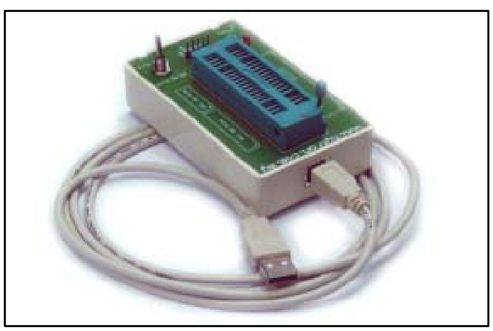


Figure2.7: PIC USB programmer device.

PIC USB programmer is device that uses to burn the Hex.file format into PIC controller. It's easy to use by connect one side of the cable to the programmer and one side to the USB port of the computer. Conducting by the software, the burner will execute connect direct into the PIC microcontroller. [13]

2.8 Summary

In this chapter, a new approach are suggested for giving the voltage output as desired was presented by selecting appropriate device in designing the project. Few methods have been discovering to relate it to the researcher's study. In the next chapter, will present and evaluate concept, framework and associate research that have been conducted.

CHAPTER III

METHODOLOGY

3.1 Introduction

For this project, the design divided into two parts, hardware and software. The circuit operations consist of charging, controlling and monitoring circuit. Microcontroller will be use as the central processing units for the charging and displaying LCD screen. The block diagram of the system is shown in Figure 3.1 below.

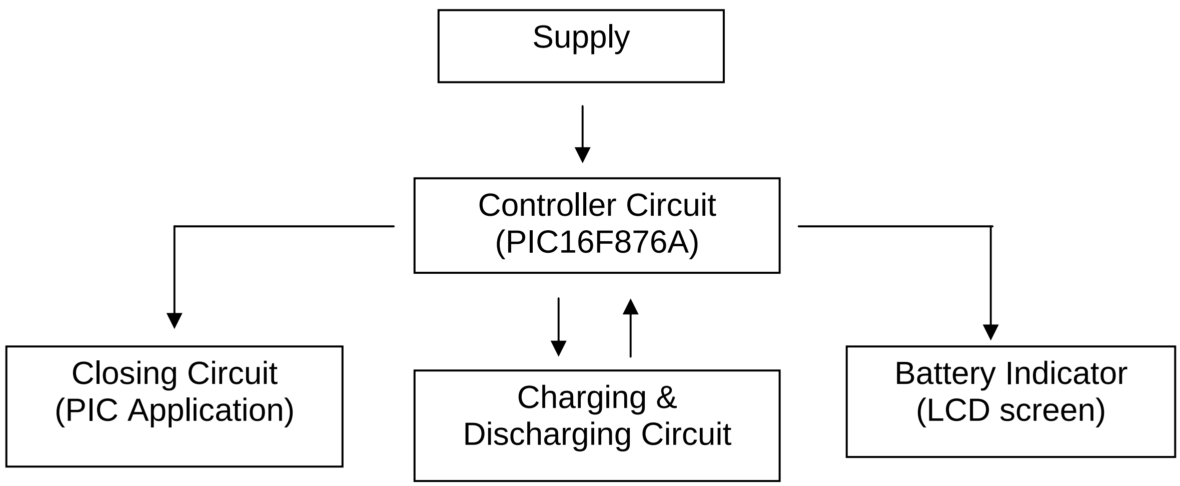


Figure 3.1.1: Block diagram of develop battery charger.

Figure 3.1.1 shows that the system is connected to the controller circuit as shows in figure 3.1 above. Charging and discharging circuit operated fully controlled by controller. Meanwhile, the battery on the charging circuit gives the analog input for measurement. In the microcontroller, the output from the battery is displayed on LCD and closing circuit activated when the digital signal is send to the charging circuit due to program setting.

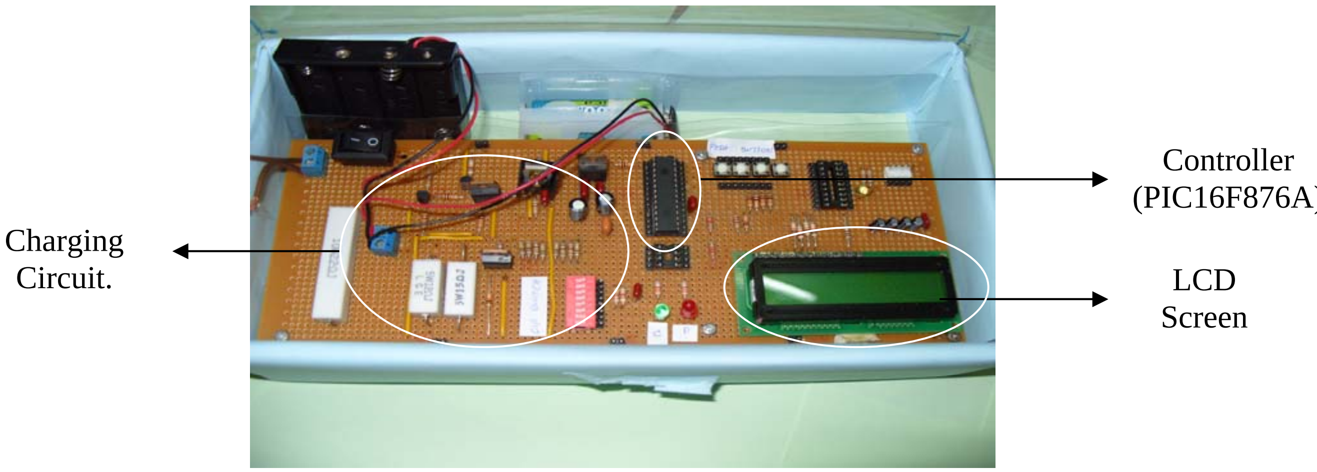


Figure 3.1.2: The picture of Battery Charge with Alphanumeric LCD Monitoring.

Figure 3.1.2 shows the picture of the project. The project circuits divided into three parts namely, the charging circuit, controller and the LCD module. Each part of the project will be discussed in the following section.

3.2 Hardware Implementation

This section will discuss about the component that are used, including, regulated voltage, charging circuit, microcontroller PIC16F876A, and 16 x 2 character LCD module.

3.3 Regulated Voltage

The components used mostly need a constant dc voltage supply of 5V. To meet these requirements, a dc regulator, IC 7805 is used. The IC is build to regulate DC input and provide a constant dc output of 5Vdc

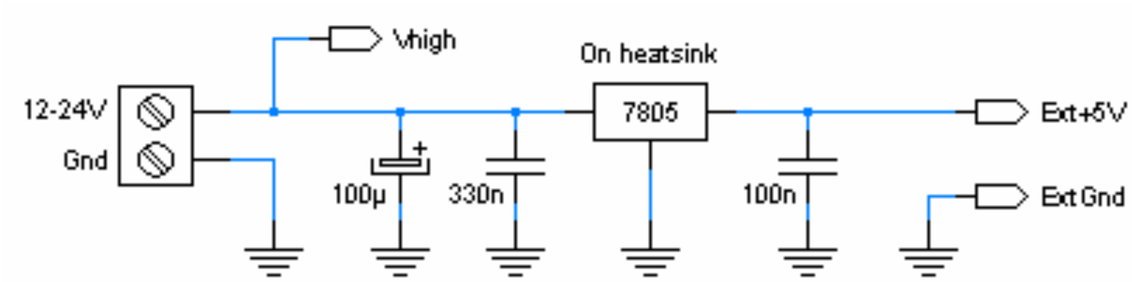


Figure 3.3.1: Schematic circuit of 5V dc voltage regulator

3.4 Charging circuit

Charging circuit is used to receive DC (24V -16V) voltage from the power supply. This circuit consists of important component such as voltage regulator, MOSFET, diode, and transistor to operate the system then charging the battery. Figure 3.2.2 below, show the connection of the charging circuit.

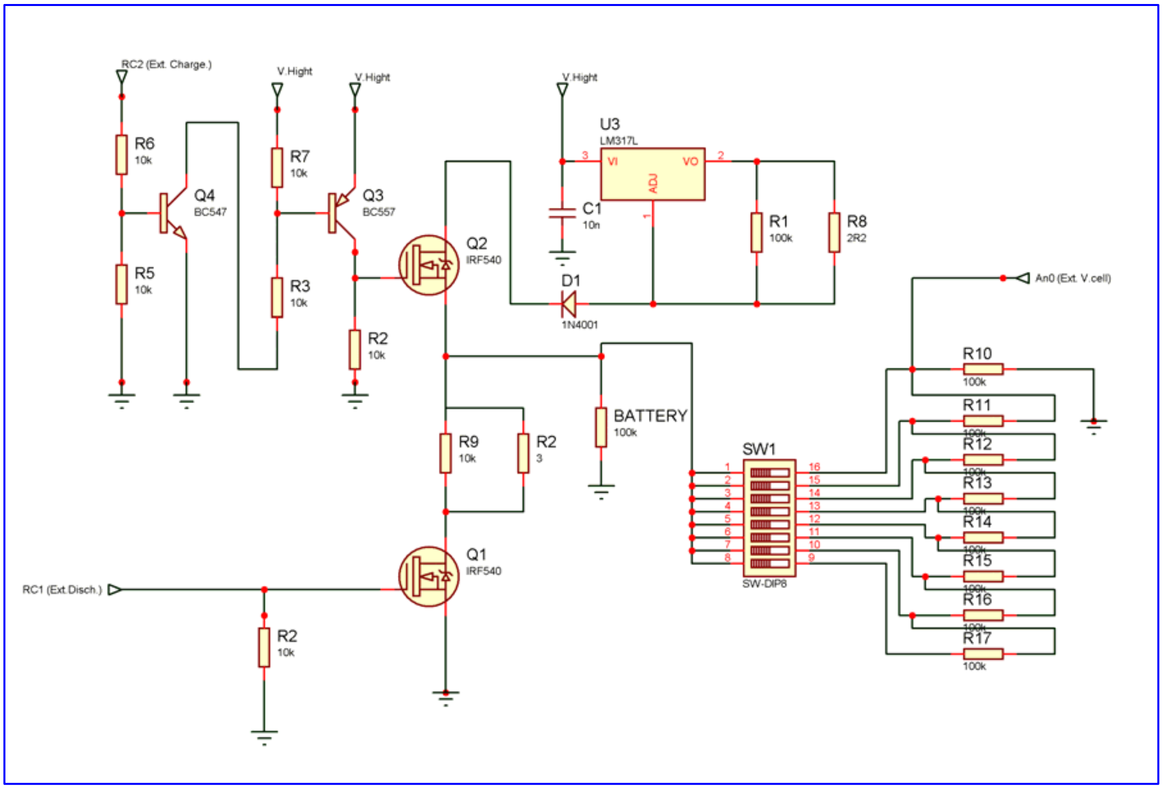


Figure 3.4.1: Schematic of charging circuit

Figure 3.4.1 shows a voltage regulator Lm317 receives DC voltage (12-24V) from the supply to allow constant current to the circuit. Lm317 is used as adjustable regulator it able to supporting input voltage of 3V to 40V and output voltage between 1.25V and 37V. Since the charger need to charge battery in range of 1V to 16 V this device is exceed the requirement. During the charging process, overheat occasionally occur cause from the output is exceed the rated current, thus LM317 can resolve this problem because it's also can functions as a current limiter and automatically reduce its output current if an overheat condition occurs under load.

Diode acts to allow currents to flow in one direction. In this project, Diode is used to assure the current from the cells is not drain after completely charged. Actually, diode types IN4001 is used in this circuit.

The MOSFET is a voltage control device differs from Bipolar Junction Transistor (BJT) which current control device. It is relatively simple to turn on and off, which gives it an advantages over a BJT. As a switch, MOSFET will activate when gate legs receive voltage from the sources. Too switch automatically, MOSFET Gate's are connected to transistor that receives voltage from the PIC. When the MOSFET is activate, current flow through the MOSFET then charging the Battery.

During the charging process, voltage and current will flow through Dip switch then filtered by series resistor before send to PIC. Dip switch is a set of manual electric switches. Here, its function to select no of series resistor that need to decrease the value of voltage thus the PIC pin AN0 only can read analog input between 0 to 5V dc only.

After the components specifications are determine, the charging circuit at Figure 3.4.2 was simulate using Orcad Pspice software. It's important to make sure the circuit is operate and the electronic component that selected is suitable for the safety spec.

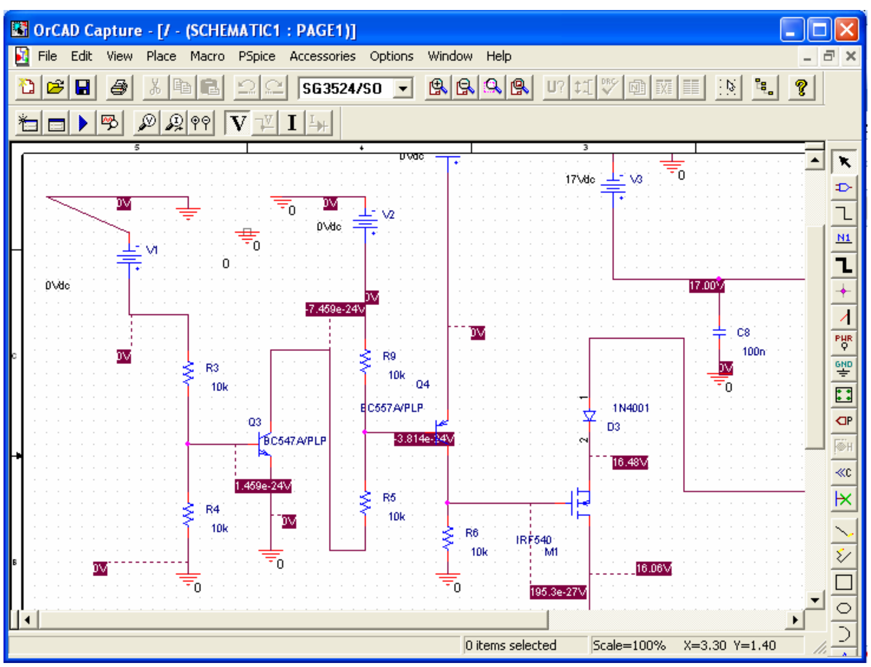


Figure 3.4.2: Hardware simulation using Orcad Pspice software.

3.5 PIC16F876A Microcontroller

The PIC16F876A works as central controller for this project. It is manufactured by Microchip Technology Inc. It has 3 ports which is the most important specification to be implemented in this project. The PIC16F876A features used in this project are as follows.

1 Analog to digital module

2 Memory

3 Programming language (Depend on programmer)

The circuit configuration of battery charger is shown in the figure below. Parallel push buttons that connect from Pin 21 to pin 24 is function as input of controller to select the menu program from the LCD screen. It, operate when receive high input from 5v of dc supply.

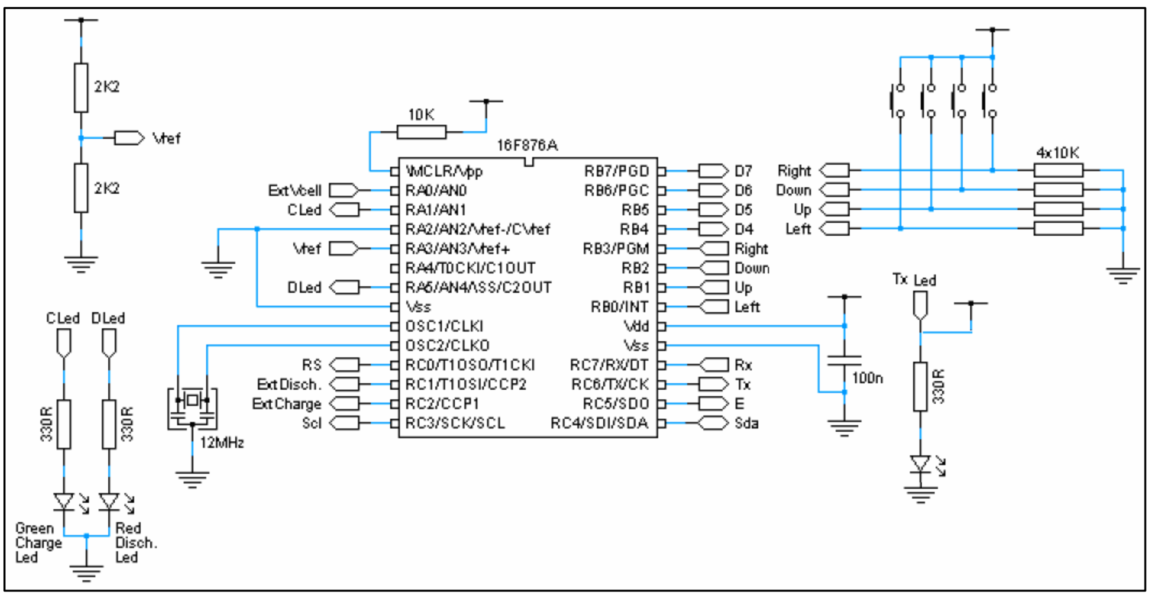


Figure 3.5.1: Schematic for PIC16F876A

Table 3.5 below, shows the pin configuration for charger develop. PIC16F876A can be operated in 4 different oscillator modes. This includes LP (low power crystal). XT (crystal/resonator), HS (High-speed crystal/resonator). An HS mode has been chosen for this project. The PIC16F876A will have an external clock sources to drive the OSC1/CLCK1 pin. The resonator used is 12MHz. AN0 is analog input and the pins are connecting directly to battery for measure its voltage. This pin has limited reading that only can read voltage value below than 5V dc voltage.

Table 3.5: Pin connection of PIC16F876A for Battery charger developed.

Pin No.	Pin Name	Description	Application
1	Vdd	Positive Supply	Voltage regulator to PIC
8	Vss	Ground reference	Ground reference
9	OSC1	For Oscillator Or resonator	Using 12 MHz reasonator
10	OSC2		
2	RA0/AN0	Analog input channel	Input from other circuit.
25-28	RB(4-7)	Input/output port	Data line for LCD
21-24	RB(0-3)	Input/output port	Data line for Push Button
11-13	RC(0-3)	Input/output port	Data line charging circuit

3.6 16 x 2 Characters LCD

For displaying the output, the 16 x 2 character LCD is used. The LCD 16 character per line and 2 lines display. It supports 4-bit and 8-bit data input which 4-bit data inputs are used in this project. Data is transmitted using port C and control bits in on port B. RS pin is used for register selection while R/W is for reading or writing the data on the LCD. The E pin is used to enable the LCD. LCD is enable when the pin is in ‘low’ state. The LCD comes with backlight which can be turned on by supplying the voltage on pin 15 and 16. Figure below show the schematic of LCD screen.

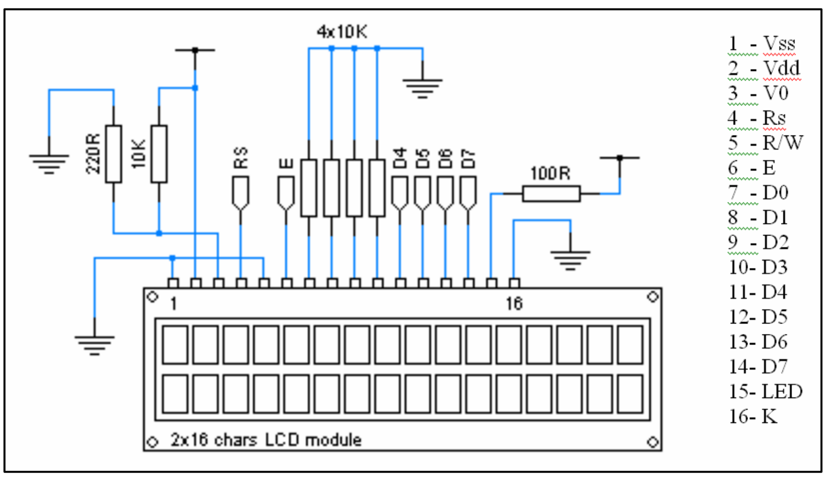


Figure 3.6: Schematic Of LCD screen

3.7 Software implementation

For software implementation, PIC Simulator IDE is used to program the PIC basic language. The BASIC language is easier to understand compare to assembly language programming. From the Figure 3.3.1 above, Program is writing using coding word then compiles it after finished. Program will compile then assemble it into hex file before burning it using the PIC USB programmer. This compiler is suitable to use by beginner programmer because this compiler provides it own tools and program example for learning process.

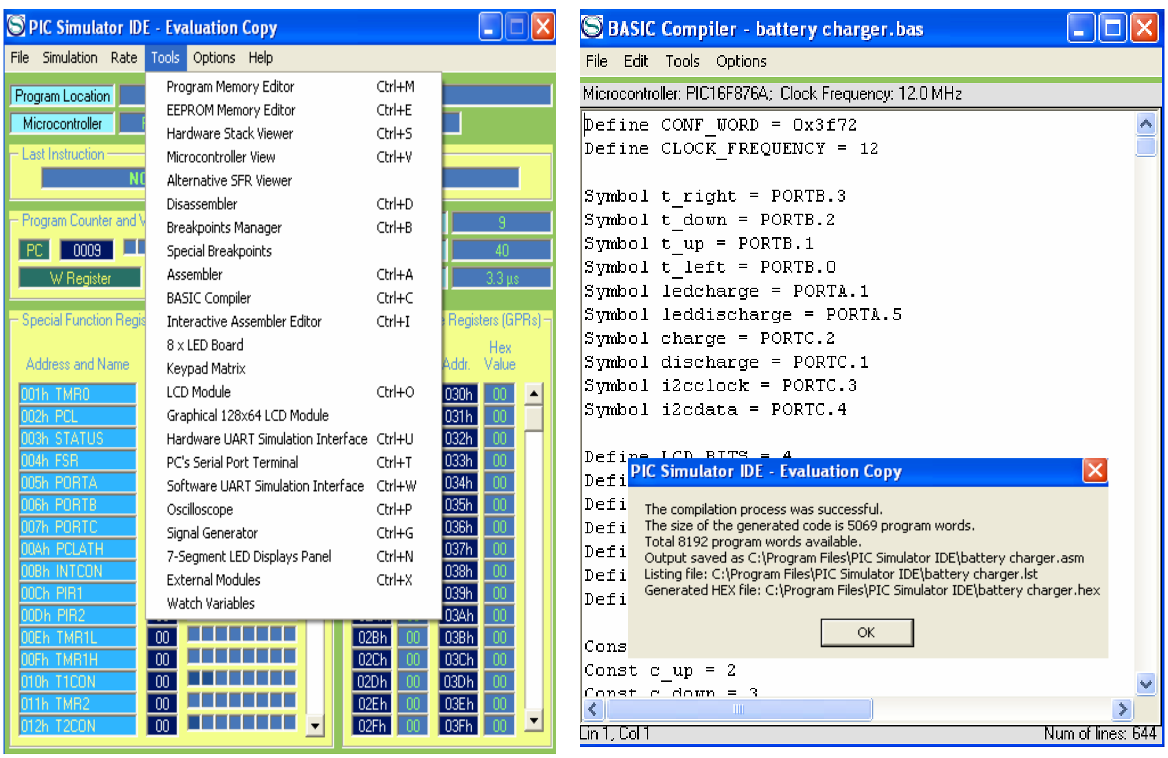


Figure 3.7: Writing the PIC program using PIC simulator IDE.

3.8 Main Program flow chart

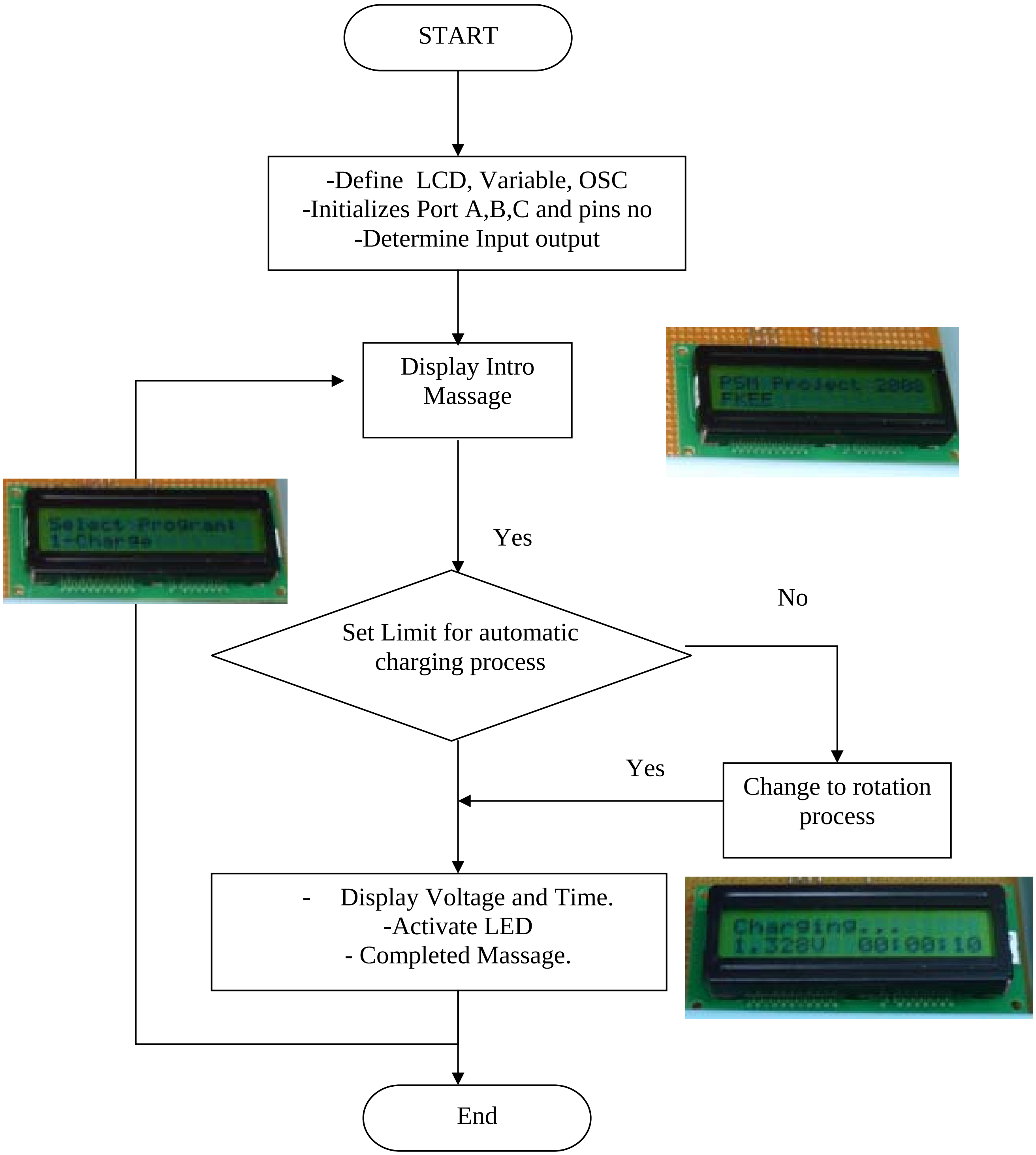


Figure 3.8: Main Program flow chart

Main Program flow chart is shown in Figure 3.8 above. Firstly, when the switch is on, process of defining the coding is starting. All the port, LCD, input/output pin activated during this process. After that, message will display on the LCD screen starting with display intro message and then come out with select menu program. When menu program was selected using the push button near the controller circuit, program starting set the limit, then process run until the loop receive it final. Limit automatic setup is important to make sure the battery was not overcharge and the appropriate value can be represent next. During the process, LCD will display the times done and voltage value on that time.

At the same time, PIC16F876A controlled the LED indicator which green LED for charging process and red for discharging process. There is also a yellow LED, which is blinking every 5 second function to inform that the program is continuously run the program selected. At the end, when the battery is fully charge the PIC automatically stop the looping and completed message displayed on the LCD screen. Program will loop back at the intro coding. The whole programs coding are display on appendix.

3.8.1 Programming of Intro program

The intro program is mainly about introduction show about the project and actually the sub program that connect to main program. This code display the researcher's name and other information during switch on the charger. Using timer delay, the word will convert during 2 second per two line word before others program can be executed. Before display the second variable, the old program should be clearing. At the end, program executes to return back to main program.

welcome:	Sub Program Name
Lcdcmdout LcdClear	
Lcdout "PSM Project 2008"	
Lcdcmdout LcdLine2Home	
Lcdout "FKEE "	Massage Display on screen
WaitMs 2000	
Lcdcmdout LcdClear	
Lcdout "By : Mohd Hapiz"	
Lcdcmdout LcdLine2Home	
Lcdout "Ec05025 "	
WaitMs 2000	Timer Delay
Lcdcmdout LcdClear	Clearing Screen
Lcdout "Supervise By"	
Lcdcmdout LcdLine2Home	
Lcdout "En Ruhaizad"	
WaitMs 3000	
Return	Return Loop

3.8.2 Program Coding for Charging Process

This program mainly setup to conduct charging process. This program work using looping concept, and gosub concept that connect sub program to main program. This program also using high output pins to energize the LED lamp. During the charging program, the indicator green LED will on, show the charging process is occur and LED will write word “Charging”. When the battery is fully charge, the program will automatically stop the charging process. LED will off, and LCD will display “Complete”.

```
prog_charge:
charge = 1
ledcharge = 1
Gosub initroutine
Lcdout "Charging..."
Lcdcmdout LcdLine2Home
While finish = 0
	If signalfiltertype = 1 Then Gosub getvfinal1
	If signalfiltertype = 2 Then Gosub getvfinal2
	If signalfiltertype = 3 Then Gosub getvfinal3
	If vfinal > vmax Then vmaxdelay = vmaxdelay + 1
	If vmaxdelay = 5 Then
		If vmaxnum < 5 Then vmaxnum = vmaxnum + 1
		vmax = vfinal
		vmaxdelay = 0
	Endif
	If peakdetect = 1 Then
		vfinal = vfinal + peakgap
		If vfinal <= vmax Then finish = 1
		vfinal = vfinal - peakgap
		If vmaxnum < 5 Then finish = 0
	Endif
	If minutes < mintime Then
		finish = 0
		vmax = vfinal
		vmaxdelay = 0
	Endif
	If vfinal < minvalue Then
		finish = 0
		vmax = vfinal
		vmaxdelay = 0
	Endif
	If minutes >= maxtime Then finish = 1
```

charge = 1 → Output Set to High

Gosub initroutine → Loop to Sub Program

While finish = 0 → Automatic stop process

```
Gosub settime
        Gosub showvoltage
        Gosub serialroutine
        If key = c_left Then finish = 1
        key = 0
Wend
Lcdcmdout LcdLine1Clear
Lcdout "Completed!"
charge = 0         ----------------->      Set Output to Low
ledcharge = 0
Gosub endroutine
WaitMs 3000
Return
```

3.9 Burning file Into PIC using PIC USB programmer

The burning process is mainly about the method to written the coding done into PIC16F876A. There are two methods for burning the program code, first is interface it directly to computer using printer port and coding circuit. Second, is using the PIC USB programmer, a device that uses to write the programming code into the microcontroller. This device only can burn the file which is in the hex.file format and also, more economically because it not need extra driver circuit compare to method one. In term of cost, this project has been use method two to reprogram the PIC16F876A. PIC USB programmer is come with its own software (winPic800) to execute the coding into the microcontroller. Figure 3.9 below, show the WinPic800 is burned the Hex.file codes into microcontroller.

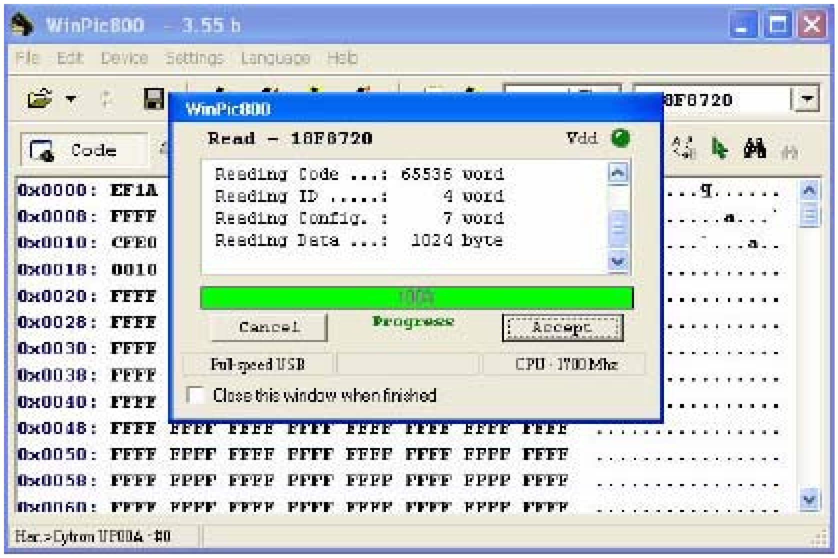


Figure 3.9: Program burned using USB PIC burner connects to WinPic800 software.

3.10 Summary

This chapter has discussed about methodology or step that researcher's apply in order to perform this project included software and hardware. The reasons for the selection of methods are state briefly in this chapter. The Figure 3.10 above show the whole of the charger picture and fully circuit of the charger will show in appendix.B

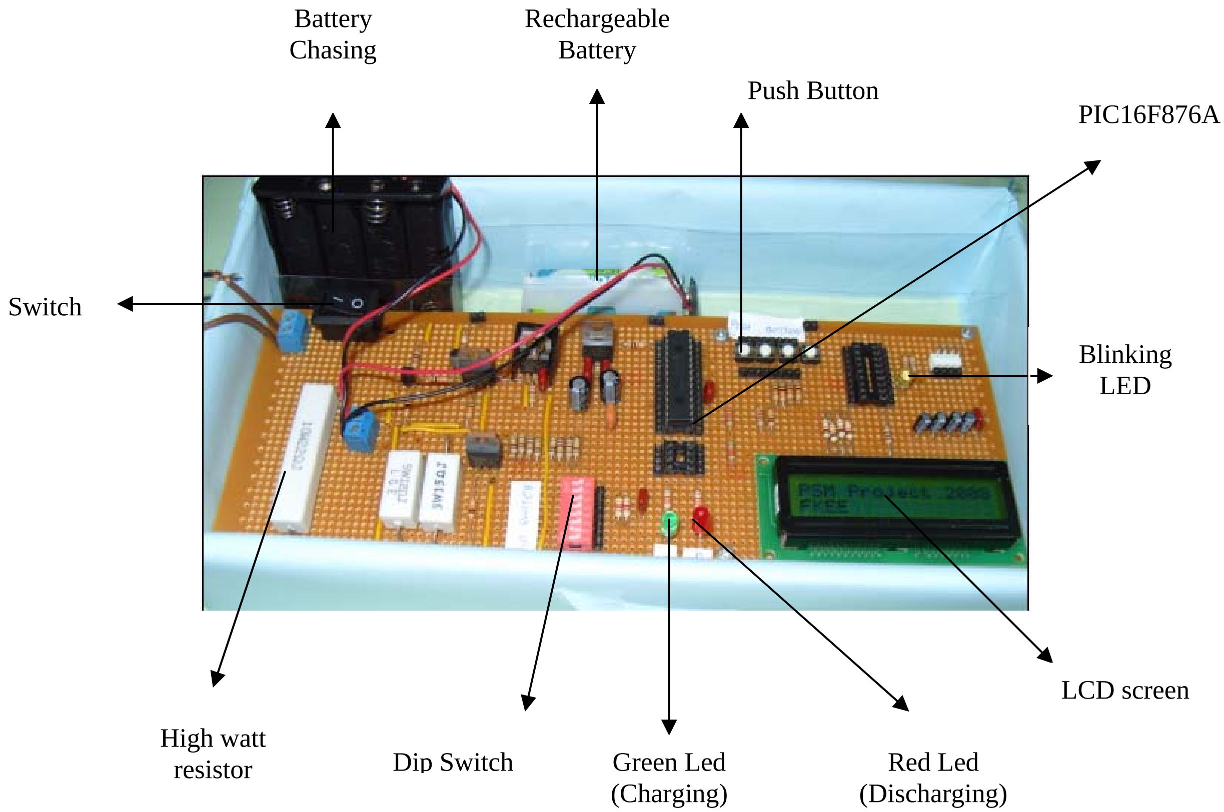


Figure 3.10: Picture of battery charger circuit.

CHAPTER IV

RESULT AND DISCUSSION

4.1 Introduction

The charge design has been successful in achieving all objective. The chargers have been successfully finished charging the battery and the voltage can be displayed on LCD screen. A number of measurement need to be made during battery charging in order to control the voltage, time and monitor the battery. This chapter consists of the discussion on the result from the outputs of the charging process occur. Graph and Table provide researchers to illustrate the output of the project. From the result, the charger circuit that been developed is suitable to use and the data analysis will collect for researcher’s discussion. There are also some discussion about the problem occur during the install and troubleshoot the project.

4.2 Result of Experiment

This experiment is made before the monitoring and controller circuit is determined. The project objective is to study about the function, abilities and testing the component in charging circuit. The data of the experiment is show on Table 4.1 below.

Table 4.1: MOSFET Operation.

	Voltage at Drain to Sources	
Gate Voltage	**Theory (simulation)**	**Actual**
6	8.341	8.46
8	8.341	8.46
10	8.341	8.46
12	8.341	8.46
14	8.341	8.46
16	12.85	12.76
18	14.85	14.9
20	16.48	16.8
22	16.48	16.8
24	16.48	16.8

From the experiment, the MOSFET is activated using the transistor output as a switching. It's pushes variable voltage between 6V to 24V into the gate legs of the MOSFET. From the Table 4.1 above, MOSFET (IRF570) allow 16.8V as maximum value that can cross into it. The simulation using Orcad software is mostly same with the actual value. From the result, we can conclude that:

i. Charging circuit is function according to the specification.
ii. Variable no of battery can be charge at one time.
iii. The data from the simulation can be accepted and use as reference.
iv. Project can forward to the next step.

4.3 Charging Graph

From the graph showed on Figure 4.3.1 above. This graph is plotted during the process of charging one battery and the value of voltage and time is referring to the data that come out in LCD screen. Before the battery is charge, the voltage value was taken and the battery is tested with bulb. The observation data can be referred to Figure 4.3.2 below.

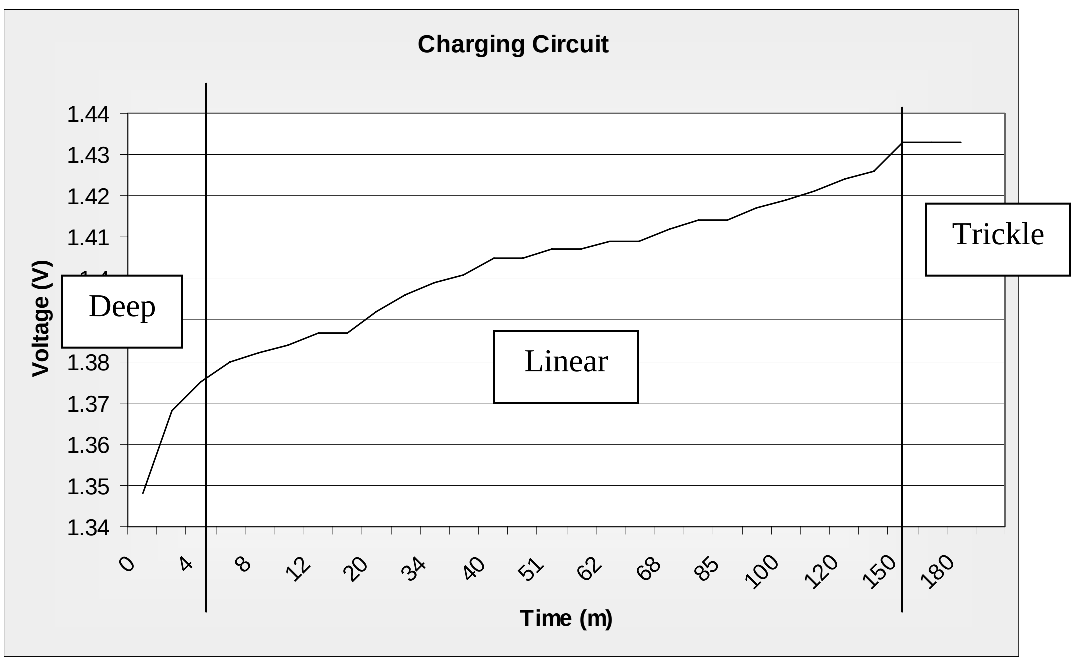


Figure 4.3.1: Analysis of Battery during Charging Process

Table 4.3.1: Battery Testing.

	Voltage	**Testing Bulb**
Before	1.348	Off
After	1.436	On

For overall, the time need to charge the battery until it's fully charge are about two our. The line graph can divide it into three sections, deep charging, linear charging and trickle charging. Deep charging is the stage where the voltage value increased fast at the starting of the charging process. Deep charging occur about 4 minute, followed by linear and trickle charge.

The next stage was linear stage, this stage occurring at long period of time. On this stage, the voltage value is increase linear in graph and actually the stage where the cells are starting storage the voltage and current capacity. The last stage was Trickle charge stage, is actually the stage that cell is fully charge, and occurs at about 15 minute. After 15 minute the cell will overcharge. Thus, the program for microcontroller detects and stopped the charging process during the trickle charge is provided. For information, Overcharge is stage that caused damage to the chemistry cells in the battery.

From the table 4.3.1, the battery is tested with a bulb to see the battery condition. Before charging process occurs the battery voltage reading is 1.348V with condition of bulb is off. The battery voltage after charging is 1.436V with condition of bulb is on. From the observation, the charger successfully charges the battery. Then, Calculation is made to determine the coefficient of charging time.

Voltage /min = coefficient for time

1.436V / 150min = 9.57×10^{-3}

Example;

2V of cell want to discharge.

2 V / 9.57×10^{-3} = 209 min

4.4 Discharging Process

Discharge is process of release stored energy and purpose to reduce cells looses storage capacity. From Figure 4.4.1 a graph of discharging fully charging cell has been plot and 50 min is needed to discharge fully energy battery with voltage 1.3V. Compare to Figure 4.4.2 using used battery, it only taking just about 8 minute and 30 second only. It can be concluded that the time to discharge is effected by the voltage of the battery. The discharging process is stop at 0.244V by set limited program to make sure the battery is not fully drain that can cause damage to the battery.

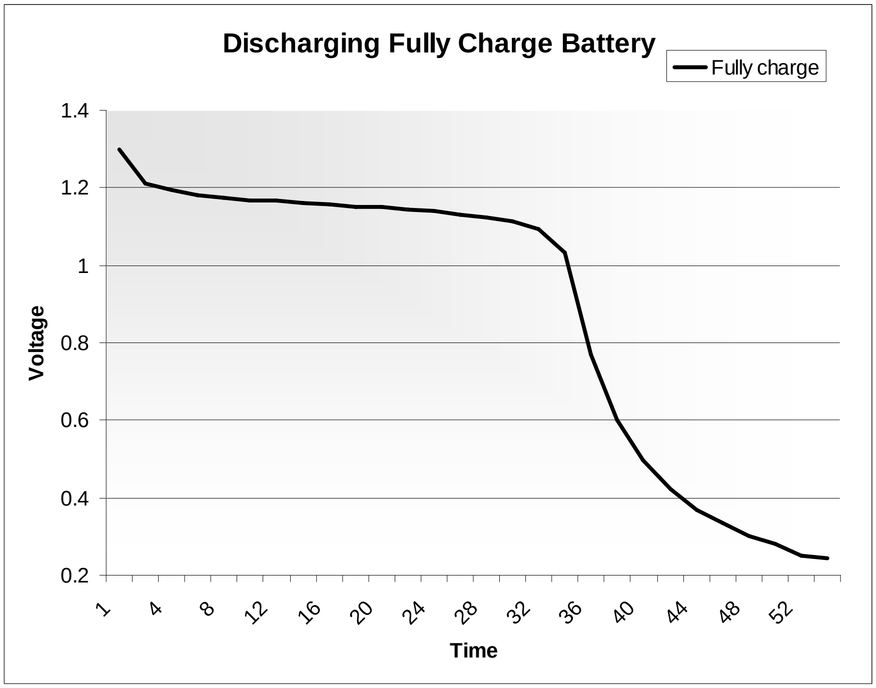


Figure 4.4.1: Analysis of Battery during Discharging Process

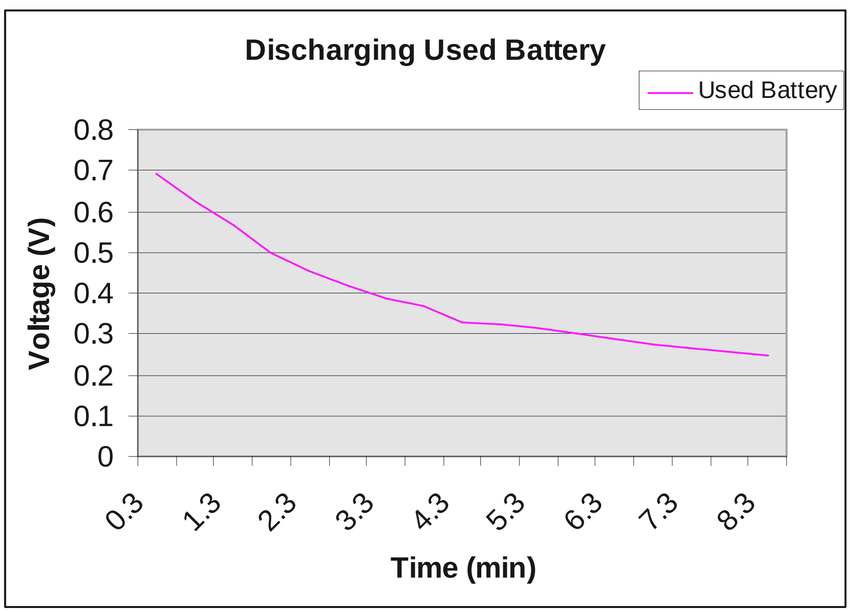


Figure 4.4.2: Analysis of Used Battery during Discharging Process

Table 4.4.1: Battery Testing.

	Full charge	Test Bulb	Used Battery	Test Bulb
Before	1.3	On	0.693	On
After	0.244	Off	0.244	Off

From Table 4.3.2, the battery is tested with a bulb to see the battery condition. Before discharging process occurs the battery voltage reading is 1.3V with condition of bulb is off. The battery voltage after charging is 0.244V with condition of bulb is on. From the observation, the charger successfully discharges the battery. Then, Calculation is made to determine the coefficient of discharge time.

Voltage /min = coefficient for time

1.3V / 50min = 0.026

Example;

1V of cell want to discharge.

1 V / 0.026 = 38.46min

4.5 Problem and solution

This chapter consist of discussion about the problem occur during, before and after the process of making the charger. The cause and effect will discuss in this chapter and adding with the way to overcome the problem. The problem discuss on this chapter is categorize as a major problem that occur on the project and gives big effect to the project.

These problems occur during taking the charging data. It’s started a few second after the switch on the charger, then cause the screen lamp was off and the message on the screen is wiped. After that moment, the charger screen cannot display high bit of instruction and the contrast of message is not clear. To find the cause of problem, the datasheet of the LCD screen has been referred. The resistor and circuit connection between supply and LCD screen was checked. The problem causes by the wrapping wire that connect dc supply have been touching directly to the LCD supply. From discussion and referring datasheet, the LCD internal EPROM was damage by the short circuit. For solution, the wire was put out and LCD screen was changed. After installation, the new LCD screen was function normally.

During the charging process, the resistors that absorb the battery capacity have been hot and then burned. This is caused by inappropriate choosing the type of resistor. Too reduce the effect, 2 solutions has been taken. First, same resistance with the same value but using the high watt resistor is select to absorb the voltage and current given. Secondly, adding two resistor and parallel it to reduce or divide the current through the resistor during the discharging process.

This problem occurs when to display voltage value more than 5V. Since, the charger needs to charge batteries that have voltage below than 16V. So, the problem solve at the software and hardware implementation. Software are setup by making equation to read battery below than 5 V, then software is setup to decrease the value of voltage before entering the PIC. For hardware, series parallel resistor is connecting to make sure only voltage below than 5V will enter the PIC. By adding the Dip switch as manual control switch, this problem is solve where the user need to select the switch due to number of battery that want to charge. To get the all value the user need to calculate it manually. For example:

Voltage display on LCD screen.	= 1.25V
No of battery charge (select at Dip switch)	= 3

Using manual calculation.

$$1.25V \times 3 = 3.75V$$

Hence, the actual battery value is 3.75V

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The report views the successfully design and implementation of a battery charger with Alphanumeric LCD module monitoring. The charger design consists of hardware and software implementation, which divide into three parts. Charging circuit is provided to charge the battery, controller to control the whole operation and the LCD screen as output to send message for user.

For overall, processes to developed battery charger have been successfully setup and the new battery chargers are developed. All the objective and scope of the project is achieved, a battery charger with LCD screen displays the voltage values, and times are ready to use.

Furthermore, the rechargeable battery types supported by the charger are nickel Cadmium and Nikel Metal Hydride, as these are the most common in portable applications. The charging process are difference for other charger which related with both voltage and current control required.

These chargers have interesting ability compare to the charger at the market. Protection from overcharge increased the lifetime of the battery, nice LCD monitor with important data display give important information to user, and the most important it's build in lower coast

5.2 Recommendation

Here are some recommendation for this project that should be added in future development:

1 Use Microcontroller with more Input/output to add and program more features to battery charger for make it more interesting and useable. For example, adding temperature sensor and buzzer when finish the charging process

2 This project can be continue by interface the hardware into computer, then develop software to analysis the process using graph or table. The Suggestion software is Visual Basic.

3 Changes the circuit charging by come out with fast charging concept for shortens the charging time. With high current, these chargers capable to charge even a car battery.

4 This battery charger only can display voltage below than 5V and use manual selected number of battery. Here, more advance program should be developed to change no of cells to charge using PIC controller. Improvement also could be done by adding GET IC as a switch to select the resistor that use to filter voltage of cells.

5.3 Commercialization

By referring to appendix C, the cost of this project is RM 110.35. The components of this project were bought at electronic shop at Kuantan and also available at Faculty of Electrical & Electronic laboratory. Though the future recommendation discussed earlier, the project is ready to be commercialized in the market. On the other hand, to make sure it's competitive with other battery charger in the market, this battery charger suppose to redesign back to make it more compact in size. The cost could be reduced about 40% in price if the components are bought in mass number.

REFERENCES

[1] 19 January 2007, Citing Internet source URL http://en.wikipedia.org/wiki/Battery_charger

[2] F.D. Heavey and R. Engleman, "*Method and apparatus for charging batteries*," U.S. Patent 4 956 597, 1990.

[3] 27 October 2008, Citing Internet source URL http://www.buchmann.ca/chap2-page2.asp

[4] 28 October 2008, Citing Internet source URL http://en.wikipedia.org/wiki/Nickel-cadmium_battery.

[5] 27 October 2008, Citing Internet source URL http://en.wikipedia.org/wiki/PIC_microcontroller

[6] 27 October 2008, Citing Internet source URL http://en.wikipedia.org/wiki/Liquid_crystal_display

[7] 18 January 2007, Citing Internet source URL http://www.flhs.org.uk/Departments/technology/Word/PIC.htm

[8] F.D. Heavey, R. Engleman, *Method and Apparatus for Charging Batteries*, US Patent No.4,956,597, 1990.

[10] R. J. Kakalec, "A feedback-controlled ferroresonant voltage regulator, " *ZEEE Trans. Magnetics*, March 1970, pp. 4-8.

[11] 27 October 2008, Citing Internet source URL http://www.oshonsoft.com/pic.html

[12] Robert L.Boylestad & Louis Nashelsky (2006). *Electronic Devices And Circuit Theory*. Pearson, Prentice Hall.

[13] Nov 2007. Cytron User manual. Cytron technology Sdn.Bhd

APPENDIX A

PIC Programming

```
Define CONF_WORD = 0x3f72
Define CLOCK_FREQUENCY = 12

Symbol t_right = PORTB.3
Symbol t_down = PORTB.2
Symbol t_up = PORTB.1
Symbol t_left = PORTB.0
Symbol ledcharge = PORTA.1
Symbol leddischarge = PORTA.5
Symbol charge = PORTC.2
Symbol discharge = PORTC.1
Symbol i2cclock = PORTC.3
Symbol i2cdata = PORTC.4

Define LCD_BITS = 4
Define LCD_DREG = PORTB
Define LCD_DBIT = 4
Define LCD_RSREG = PORTC
Define LCD_RSBIT = 0
Define LCD_EREG = PORTC
Define LCD_EBIT = 5

Const c_right = 1
Const c_up = 2
Const c_down = 3
Const c_left = 4

Dim vin As Word
Dim i As Byte
Dim j As Byte
Dim an0 As Word
Dim vmod As Word
Dim vfinal As Word

Dim v(13) As Word
Dim vmax As Word
Dim vmaxdelay As Byte
Dim vmaxnum As Byte

Dim finish As Bit
Dim address As Word
Dim seconds As Byte
Dim minutes As Word
Dim hours As Byte

Dim voltage As Word
Dim voltage1 As Word
Dim voltage2 As Word
Dim cnt As Word
Dim sample As Word
Dim program As Byte
Dim phase As Byte
```

```
Dim key As Byte

Dim dischargelimit As Word
Dim signalfiltertype As Byte
Dim peakgap As Byte
Dim peakdetect As Byte
Dim mintime As Byte
Dim minvalue As Word
Dim maxtime As Word

PORTA = 0
PORTB = 0
PORTC = 0
TRISA.1 = 0
TRISA.5 = 0
TRISC.2 = 0
TRISC.1 = 0
AllDigital
ADCON1 = 0x0f
Lcdinit
WaitMs 1000

newprogram:
Gosub welcome
Gosub selectprogram
If program = 1 Then Gosub prog_charge
If program = 2 Then Gosub prog_discharge
If program = 3 Then Goto prog_combine
If program = 4 Then Goto prog_features
Goto newprogram
End

welcome:
Lcdcmdout LcdClear
Lcdout "PSM Project 2008"
Lcdcmdout LcdLine2Home
Lcdout "Initializing..."
WaitMs 3000
Return

selectprogram:
phase = 1
Lcdcmdout LcdClear
Lcdout "Select Program:"
loop1:
Lcdcmdout LcdLine2Clear
If phase = 1 Then Lcdout "1-Charge"
If phase = 2 Then Lcdout "2-Discharge"
If phase = 3 Then Lcdout "3-Combine"
If phase = 4 Then Lcdout "4-Features"

Gosub waitkey
If key = c_down Then
    phase = phase + 1
    If phase = 5 Then phase = 1
    Goto loop1
Endif
```

```
If key = c_up Then
    phase = phase - 1
    If phase = 0 Then phase = 4
    Goto loop1
Endif
If key = c_right Then program = phase
If key = c_left Then program = 0
Return

waitkey:
key = 0
If t_right = 1 Then key = c_right
If t_up = 1 Then key = c_up
If t_down = 1 Then key = c_down
If t_left = 1 Then key = c_left
If key = 0 Then Goto waitkey
Gosub debounce
Return

getkey:
key = 0
If t_right = 1 Then key = c_right
If t_up = 1 Then key = c_up
If t_down = 1 Then key = c_down
If t_left = 1 Then key = c_left
If key > 0 Then Gosub debounce
Return

debounce:
If t_right = 1 Then i = 0
If t_up = 1 Then i = 0
If t_down = 1 Then i = 0
If t_left = 1 Then i = 0
i = i + 1
WaitMs 10
If i < 10 Then Goto debounce
Return

scankey:
If t_right = 1 Then key = c_right
If t_up = 1 Then key = c_up
If t_down = 1 Then key = c_down
If t_left = 1 Then key = c_left
Return


initroutine:
Lcdcmdout LcdClear
Lcdout "Starting..."
WaitMs 3000
Gosub getvin
For i = 1 To 12
    v(i) = vin
Next i
vmax = 0
vmaxdelay = 0
vmaxnum = 0
```

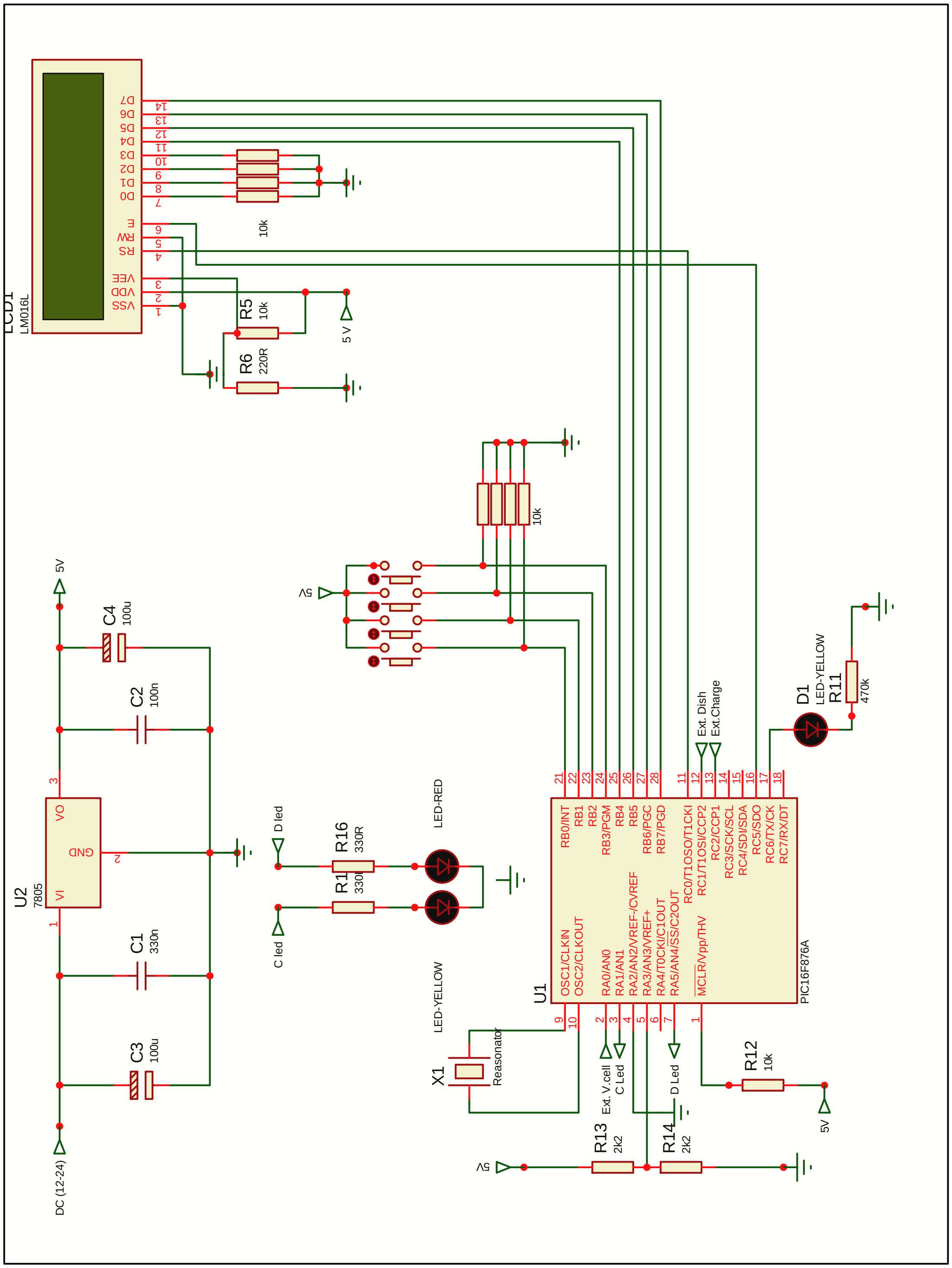
```
finish = 0
seconds = 251
minutes = 0
hours = 0
key = 0

Lcdcmdout LcdClear
Return

prog_discharge:
discharge = 1
leddischarge = 1
Gosub initroutine
Lcdout "Discharging..."
Lcdcmdout LcdLine2Home
signalfiltertype = 1
dischargelimit = 290
While finish = 0
    If signalfiltertype = 1 Then Gosub getvfinal1
    If vfinal <= dischargelimit Then finish = 1
    Gosub settime
    Gosub showvoltage
    If key = c_left Then finish = 1
    key = 0

Wend
Lcdcmdout LcdLine1Clear
Lcdout "Completed!"
discharge = 0
leddischarge = 0
WaitMs 3000
Return

prog_charge:
charge = 1
ledcharge = 1
Gosub initroutine
Lcdout "Charging..."
Lcdcmdout LcdLine2Home
While finish = 0
    If signalfiltertype = 1 Then Gosub getvfinal1
    If vfinal > vmax Then vmaxdelay = vmaxdelay + 1
    If vmaxdelay = 5 Then
        If vmaxnum < 5 Then vmaxnum = vmaxnum + 1
        vmax = vfinal
        vmaxdelay = 0
    Endif
    If peakdetect = 1 Then
        vfinal = vfinal + peakgap
        If vfinal <= vmax Then finish = 1
        vfinal = vfinal - peakgap
        If vmaxnum < 5 Then finish = 0
    Endif
    If minutes < mintime Then
        finish = 0
        vmax = vfinal
        vmaxdelay = 0
```

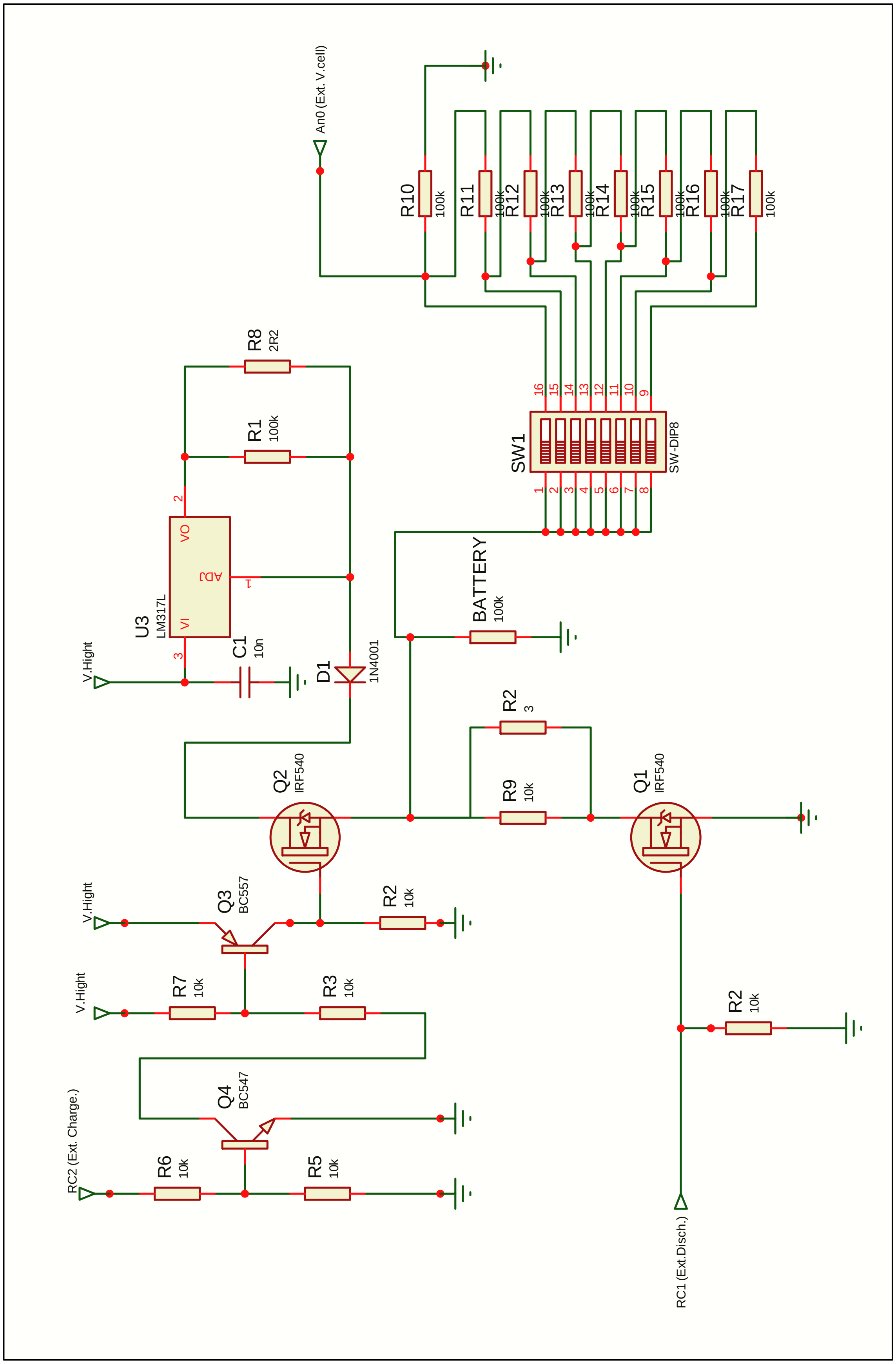
```
    Endif
    If vfinal < minvalue Then
        finish = 0
        vmax = vfinal
        vmaxdelay = 0
    Endif
    If minutes >= maxtime Then finish = 1
    Gosub settime
    Gosub showvoltage
    If key = c_left Then finish = 1
    key = 0
Wend
Lcdcmdout LcdLine1Clear
Lcdout "Completed!"
charge = 0
ledcharge = 0
WaitMs 3000
Return

prog_combine:
Gosub prog_discharge
WaitMs 10000
Gosub prog_charge
Goto newprogram
Return

prog_features:
Lcdcmdout LcdClear
Lcdout "PSM Project 2008"
Lcdcmdout LcdLine2Home
Lcdout " FKEE "
WaitMs 3000

Lcdcmdout LcdClear
Lcdout "By : Mohd Hapiz"
Lcdcmdout LcdLine2Home
Lcdout " Ec05025 "
WaitMs 3000

Lcdout " Supevise By "
Lcdcmdout LcdLine2Home
Lcdout " En Ruhaizad "
WaitMs 3000
Return

getvin:
vin = 0
For i = 1 To 60
    Adcin 0, an0
    vin = vin + an0
    Gosub scankey
    WaitMs 83
Next i
vmod = vin Mod 60
vin = vin / 60
If vmod >= 30 Then vin = vin + 1
Return
```

```
getvfinal1:
For i = 1 To 11
    j = i + 1
    v(i) = v(j)
Next i
Gosub getvin
v(12) = vin
vfinal = 0
For i = 1 To 12
    vfinal = vfinal + v(i)
Next i
vmod = vfinal Mod 12
vfinal = vfinal / 12
If vmod >= 6 Then vfinal = vfinal + 1
Return

showvoltage:
'0V=0  2.5V=1023  2500/1023=2.444
voltage = (vfinal * 2) + (vfinal * 4 / 10)
voltage = voltage + (vfinal * 4 / 100) + (vfinal * 4 / 1000)
voltage1 = voltage / 1000
voltage2 = voltage Mod 1000
Lcdcmdout LcdLine2Clear
Lcdout #voltage1, "."
If voltage2 < 100 Then Lcdout "0"
If voltage2 < 10 Then Lcdout "0"
Lcdout #voltage2, "V  "
hours = minutes / 60
If hours < 10 Then Lcdout "0"
Lcdout #hours, ":"
hours = minutes Mod 60
If hours < 10 Then Lcdout "0"
Lcdout #hours, ":"
If seconds < 10 Then Lcdout "0"
Lcdout #seconds
Return


settime:
seconds = seconds + 5
If seconds >= 60 Then
    seconds = 0
    minutes = minutes + 1
Endif
Return
```

APPENDIX B

The schematic circuit of battery charger.





An0 (Ext. V.cell)
R10
R11
R12
R13
R14
R15
R16
R17
100k
R8
2R2
R1
100k
SW1
SW-DIP8
U3
LM317L
VO
VI
ADJ
C1
10n
V.Hight
D1
1N4001
BATTERY
100k
R2
3
R9
10k
Q2
IRF540
Q1
IRF540
Q3
BC557
R2
10k
R7
10k
R3
10k
Q4
BC547
R6
10k
R5
10k
RC2 (Ext. Charge.)
RC1 (Ext.Disch.)

APPENDIX C

Datasheet PIC 16F876A

MICROCHIP

PIC16F87XA

28/40/44-Pin Enhanced Flash Microcontrollers

Devices Included in this Data Sheet:

- PIC16F873A
- PIC16F874A
- PIC16F876A
- PIC16F877A

High-Performance RISC CPU:

- Only 35 single-word instructions to learn
- All single-cycle instructions except for program branches, which are two-cycle
- Operating speed: DC – 20 MHz clock input
  DC – 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to other 28-pin or 40/44-pin PIC16CXXX and PIC16FXXX microcontrollers

Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during Sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I^2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) – 8 bits wide with external $\overline{RD}$, $\overline{WR}$ and $\overline{CS}$ controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Analog Features:

- 10-bit, up to 8-channel Analog-to-Digital Converter (A/D)
- Brown-out Reset (BOR)
- Analog Comparator module with:
  - Two analog comparators
  - Programmable on-chip voltage reference (V_{REF}) module
  - Programmable input multiplexing from device inputs and internal voltage reference
  - Comparator outputs are externally accessible

Special Microcontroller Features:

- 100,000 erase/write cycle Enhanced Flash program memory typical
- 1,000,000 erase/write cycle Data EEPROM memory typical
- Data EEPROM Retention > 40 years
- Self-reprogrammable under software control
- In-Circuit Serial Programming™ (ICSP™) via two pins
- Single-supply 5V In-Circuit Serial Programming
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving Sleep mode
- Selectable oscillator options
- In-Circuit Debug (ICD) via two pins

CMOS Technology:

- Low-power, high-speed Flash/EEPROM technology
- Fully static design
- Wide operating voltage range (2.0V to 5.5V)
- Commercial and Industrial temperature ranges
- Low-power consumption

Device	Program Memory		Data SRAM (Bytes)	EEPROM (Bytes)	I/O	10-bit A/D (ch)	CCP (PWM)	MSSP		USART	Timers 8/16-bit	Comparators
	Bytes	# Single Word Instructions						SPI	Master I^2C			
PIC16F873A	7.2K	4096	192	128	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F874A	7.2K	4096	192	128	33	8	2	Yes	Yes	Yes	2/1	2
PIC16F876A	14.3K	8192	368	256	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F877A	14.3K	8192	368	256	33	8	2	Yes	Yes	Yes	2/1	2

1.0 DEVICE OVERVIEW

This document contains device specific information about the following devices:

- PIC16F873A
- PIC16F874A
- PIC16F876A
- PIC16F877A

PIC16F873A/876A devices are available only in 28-pin packages, while PIC16F874A/877A devices are available in 40-pin and 44-pin packages. All devices in the PIC16F87XA family share common architecture with the following differences:

- The PIC16F873A and PIC16F874A have one-half of the total on-chip memory of the PIC16F876A and PIC16F877A
- The 28-pin devices have three I/O ports, while the 40/44-pin devices have five
- The 28-pin devices have fourteen interrupts, while the 40/44-pin devices have fifteen
- The 28-pin devices have five A/D input channels, while the 40/44-pin devices have eight
- The Parallel Slave Port is implemented only on the 40/44-pin devices

The available features are summarized in Table 1-1. Block diagrams of the PIC16F873A/876A and PIC16F874A/877A devices are provided in Figure 1-1 and Figure 1-2, respectively. The pinouts for these device families are listed in Table 1-2 and Table 1-3.

Additional information may be found in the PICmicro® Mid-Range Reference Manual (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip web site. The Reference Manual should be considered a complementary document to this data sheet and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules.

TABLE 1-1: PIC16F87XA DEVICE FEATURES

Key Features	PIC16F873A	PIC16F874A	PIC16F876A	PIC16F877A
Operating Frequency	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
Flash Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory (bytes)	128	128	256	256
Interrupts	14	15	14	15
I/O Ports	Ports A, B, C	Ports A, B, C, D, E	Ports A, B, C	Ports A, B, C, D, E
Timers	3	3	3	3
Capture/Compare/PWM modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Analog Comparators	2	2	2	2
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions
Packages	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN

TABLE 1-2: PIC16F873A/876A PINOUT DESCRIPTION

Pin Name	PDIP, SOIC, SSOP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKI OSC1 CLKI	9	6	 I I	ST/CMOS(3)	Oscillator crystal or external clock input. Oscillator crystal input or external clock source input. ST buffer when configured in RC mode; otherwise CMOS. External clock source input. Always associated with pin function OSC1 (see OSC1/CLKI, OSC2/CLKO pins).
OSC2/CLKO OSC2 CLKO	10	7	 O O	—	Oscillator crystal or clock output. Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode. In RC mode, OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1 and denotes the instruction cycle rate.
$\overline{\text{MCLR}}$/VPP $\overline{\text{MCLR}}$ VPP	1	26	 I P	ST	Master Clear (input) or programming voltage (output). Master Clear (Reset) input. This pin is an active low Reset to the device. Programming voltage input.
					PORTA is a bidirectional I/O port.
RA0/AN0 RA0 AN0	2	27	 I/O I	TTL	 Digital I/O. Analog input 0.
RA1/AN1 RA1 AN1	3	28	 I/O I	TTL	 Digital I/O. Analog input 1.
RA2/AN2/VREF-/CVREF RA2 AN2 VREF- CVREF	4	1	 I/O I I O	TTL	 Digital I/O. Analog input 2. A/D reference voltage (Low) input. Comparator VREF output.
RA3/AN3/VREF+ RA3 AN3 VREF+	5	2	 I/O I I	TTL	 Digital I/O. Analog input 3. A/D reference voltage (High) input.
RA4/T0CKI/C1OUT RA4 T0CKI C1OUT	6	3	 I/O I O	ST	 Digital I/O – Open-drain when configured as output. Timer0 external clock input. Comparator 1 output.
RA5/AN4/$\overline{\text{SS}}$/C2OUT RA5 AN4 $\overline{\text{SS}}$ C2OUT	7	4	 I/O I I O	TTL	 Digital I/O. Analog input 4. SPI slave select input. Comparator 2 output.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-2: PIC16F873A/876A PINOUT DESCRIPTION (CONTINUED)

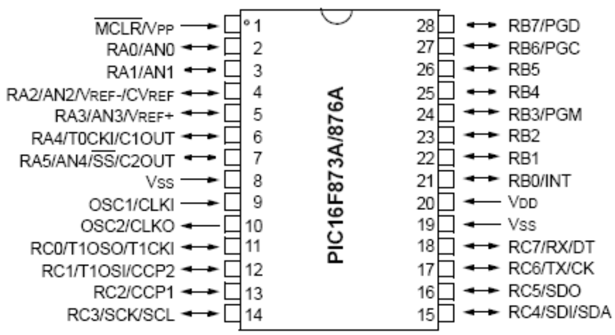
Pin Name	PDIP, SOIC, SSOP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
					PORTB is a bidirectional I/O port. PORTB can be software programmed for internal weak pull-ups on all inputs.
RB0/INT	21	18		TTL/ST(1)	
RB0			I/O		Digital I/O.
INT			I		External interrupt.
RB1	22	19	I/O	TTL	Digital I/O.
RB2	23	20	I/O	TTL	Digital I/O.
RB3/PGM	24	21		TTL	
RB3			I/O		Digital I/O.
PGM			I		Low-voltage (single-supply) ICSP programming enable pin.
RB4	25	22	I/O	TTL	Digital I/O.
RB5	26	23	I/O	TTL	Digital I/O.
RB6/PGC	27	24		TTL/ST(2)	
RB6			I/O		Digital I/O.
PGC			I		In-circuit debugger and ICSP programming clock.
RB7/PGD	28	25		TTL/ST(2)	
RB7			I/O		Digital I/O.
PGD			I/O		In-circuit debugger and ICSP programming data.
					PORTC is a bidirectional I/O port.
RC0/T1OSO/T1CKI	11	8		ST	
RC0			I/O		Digital I/O.
T1OSO			O		Timer1 oscillator output.
T1CKI			I		Timer1 external clock input.
RC1/T1OSI/CCP2	12	9		ST	
RC1			I/O		Digital I/O.
T1OSI			I		Timer1 oscillator input.
CCP2			I/O		Capture2 input, Compare2 output, PWM2 output.
RC2/CCP1	13	10		ST	
RC2			I/O		Digital I/O.
CCP1			I/O		Capture1 input, Compare1 output, PWM1 output.
RC3/SCK/SCL	14	11		ST	
RC3			I/O		Digital I/O.
SCK			I/O		Synchronous serial clock input/output for SPI mode.
SCL			I/O		Synchronous serial clock input/output for I^2C mode.
RC4/SDI/SDA	15	12		ST	
RC4			I/O		Digital I/O.
SDI			I		SPI data in.
SDA			I/O		I^2C data I/O.
RC5/SDO	16	13		ST	
RC5			I/O		Digital I/O.
SDO			O		SPI data out.
RC6/TX/CK	17	14		ST	
RC6			I/O		Digital I/O.
TX			O		USART asynchronous transmit.
CK			I/O		USART1 synchronous clock.
RC7/RX/DT	18	15		ST	
RC7			I/O		Digital I/O.
RX			I		USART asynchronous receive.
DT			I/O		USART synchronous data.
VSS	8, 19	5, 6	P	—	Ground reference for logic and I/O pins.
VDD	20	17	P	—	Positive supply for logic and I/O pins.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

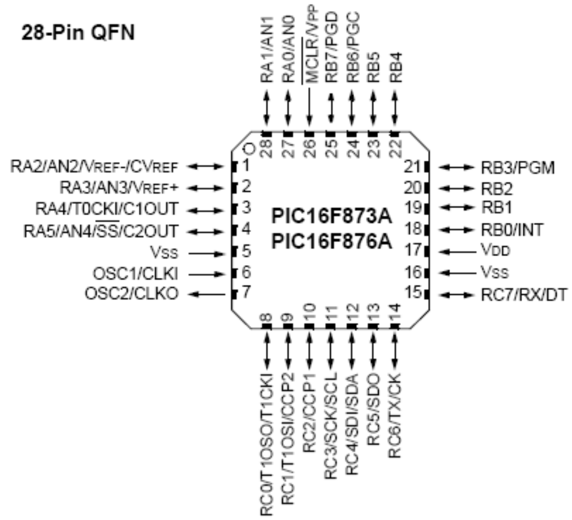
Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

Pin Diagrams

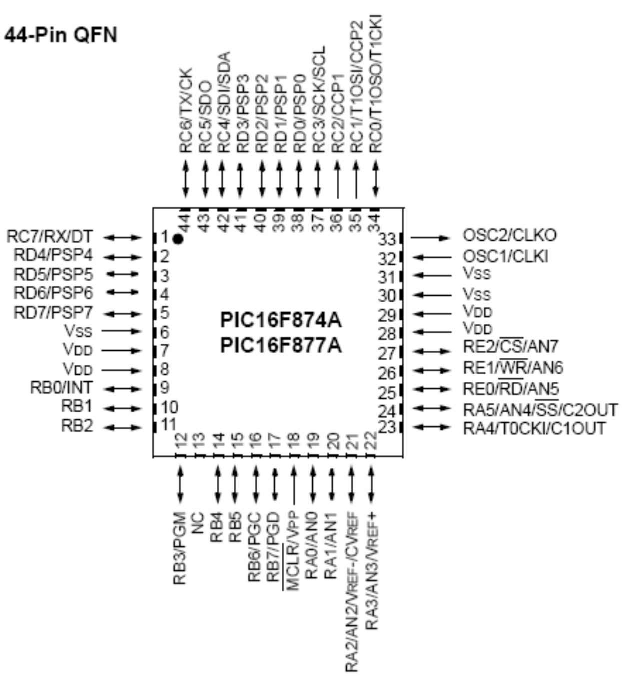
28-Pin PDIP, SOIC, SSOP



28-Pin QFN



44-Pin QFN



17.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Ambient temperature under bias ....-55 to +125°C

Storage temperature .... -65°C to +150°C

Voltage on any pin with respect to V_{SS} (except V_{DD}, $\overline{MCLR}$. and RA4) .... -0.3V to (V_{DD} + 0.3V)

Voltage on V_{DD} with respect to V_{SS} .... -0.3 to +7.5V

Voltage on $\overline{MCLR}$ with respect to V_{SS} **(Note 2)** ....0 to +14V

Voltage on RA4 with respect to Vss ....0 to +8.5V

Total power dissipation **(Note 1)** 1.0W

Maximum current out of V_{SS} pin ....300 mA

Maximum current into V_{DD} pin ....250 mA

Input clamp current, I_{IK} (V_I < 0 or V_I > V_{DD})..........± 20 mA

Output clamp current, I_{OK} (V_O < 0 or V_O > V_{DD}) ....± 20 mA

Maximum output current sunk by any I/O pin..........25 mA

Maximum output current sourced by any I/O pin ....25 mA

Maximum current sunk by PORTA, PORTB and PORTE (combined) **(Note 3)**..........200 mA

Maximum current sourced by PORTA, PORTB and PORTE (combined) **(Note 3)**..........200 mA

Maximum current sunk by PORTC and PORTD (combined) **(Note 3)** ....200 mA

Maximum current sourced by PORTC and PORTD (combined) **(Note 3)** ....200 mA

Note 1: Power dissipation is calculated as follows: Pdis = V_{DD} x {I_{DD} - $\sum I_{OH}$} + $\sum$ {(V_{DD} - V_{OH}) x I_{OH}} + $\sum$(VOl x I_{OL})

2: Voltage spikes below V_{SS} at the $\overline{MCLR}$ pin, inducing currents greater than 80 mA, may cause latch-up. Thus, a series resistor of 50-100Ω should be used when applying a "low" level to the $\overline{MCLR}$ pin rather than pulling this pin directly to V_{SS}.

3: PORTD and PORTE are not implemented on PIC16F873A/876A devices.

† NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

APPENDIX D

Datasheet Mosfet IRF570

FAIRCHILD SEMICONDUCTOR®

NOT RECOMMENDED FOR NEW DESIGNS
POSSIBLE SUBSTITUTE PRODUCT
IRF540N

IRF540, RF1S540SM

January 2002

28A, 100V, 0.077 Ohm, N-Channel Power MOSFETs

These are N-Channel enhancement mode silicon gate power field effect transistors. They are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. All of these power MOSFETs are designed for applications such as switching regulators, switching convertors, motor drivers, relay drivers, and drivers for high power bipolar switching transistors requiring high speed and low gate drive power. These types can be operated directly from integrated circuits.

Formerly developmental type TA17421.

Ordering Information

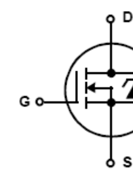
PART NUMBER	PACKAGE	BRAND
IRF540	TO-220AB	IRF540
RF1S540SM	TO-263AB	RF1S540SM

NOTE: When ordering, use the entire part number. Add the suffix 9A to obtain the TO-263AB variant in the tape and reel, i.e., RF1S540SM9A.

Features

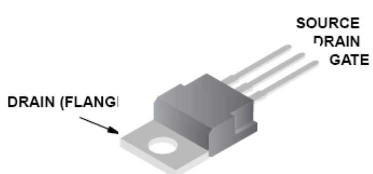
- 28A, 100V
- $r_{DS(ON)} = 0.077\Omega$
- Single Pulse Avalanche Energy Rated
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance
- Related Literature
  - TB334 “Guidelines for Soldering Surface Mount Components to PC Boards”

Symbol

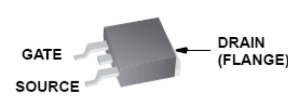


Packaging

JEDEC TO-220AB



JEDEC TO-263AB



Absolute Maximum Ratings $T_C = 25^oC$, Unless Otherwise Specified

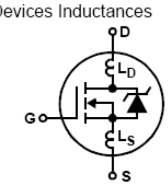
		IRF540, RF1S540SM	UNITS
Drain to Source Breakdown Voltage (Note 1)	V_{DS}	100	V
Drain to Gate Voltage (R_{GS} = 20kΩ) (Note 1)	V_{DGR}	100	V
Continuous Drain Current	I_D	28	A
$T_C = 100^oC$	I_D	20	A
Pulsed Drain Current (Note 3)	I_{DM}	110	A
Gate to Source Voltage	V_{GS}	±20	V
Maximum Power Dissipation	P_D	120	W
Dissipation Derating Factor		0.8	W/^{o}C
Single Pulse Avalanche Energy Rating (Note 4)	E_{AS}	230	mJ
Operating and Storage Temperature	T_J, T_{STG}	-55 to 175	^{o}C
Maximum Temperature for Soldering			
Leads at 0.063in (1.6mm) from Case for 10s	T_L	300	^{o}C
Package Body for 10s, See Techbrief 334	T_{pkg}	260	^{o}C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

1. $T_J = 25^oC$ to $T_J = 150^oC$.

Electrical Specifications $T_C = 25^oC$, Unless Otherwise Specified

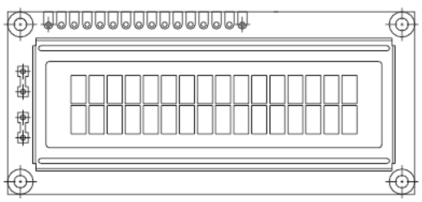
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Drain to Source Breakdown Voltage	BV_{DSS}	I_D = 250μA, V_{GS} = 0V (Figure 10)	100	-	-	V
Gate to Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}$, I_D = 250μA	2	-	4	V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 95V, V_{GS} = 0V	-	-	25	μA
		V_{DS} = 0.8 x Rated BV_{DSS}, V_{GS} = 0V, $T_J = 150^oC$	-	-	250	μA
On-State Drain Current (Note 2)	$I_{D(ON)}$	V_{DS} > $I_{D(ON)}$ x $r_{DS(ON)\,MAX}$, V_{GS} = 10V (Figure 7)	28	-	-	A
Gate to Source Leakage Current	I_{GSS}	V_{GS} = ±20V	-	-	±100	nA
Drain to Source On Resistance (Note 2)	$r_{DS(ON)}$	I_D = 17A, V_{GS} = 10V (Figures 8, 9)	-	0.060	0.077	Ω
Forward Transconductance (Note 2)	g_{fs}	V_{DS} ≥ 50V, I_D = 17A (Figure 12)	8.7	13	-	S
Turn-On Delay Time	$t_{d(ON)}$	V_{DD} = 50V, I_D ≈ 28A, R_G ≈ 9.1Ω, R_L = 1.7Ω MOSFET Switching Times are Essentially Independent of Operating Temperature	-	15	23	ns
Rise Time	t_r		-	70	110	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	40	60	ns
Fall Time	t_f		-	50	83	ns
Total Gate Charge (Gate to Source + Gate to Drain)	$Q_{g(TOT)}$	V_{GS} = 10V, I_D = 28A, V_{DS} = 0.8 x Rated BV_{DSS}, $I_{g(REF)}$ = 1.5mA (Figure 14) Gate Charge is Essentially Independent of Operating Temperature	-	38	59	nC
Gate to Source Charge	Q_{gs}		-	8	-	nC
Gate to Drain "Miller" Charge	Q_{gd}		-	21	-	nC
Input Capacitance	C_{ISS}	V_{DS} = 25V, V_{GS} = 0V, f = 1MHz (Figure 11)	-	1450	-	pF
Output Capacitance	C_{OSS}		-	550	-	pF
Reverse Transfer Capacitance	C_{RSS}		-	100	-	pF
Internal Drain Inductance	L_D	Measured From the Contact Screw on Tab To Center of Die / Modified MOSFET Symbol Showing the Internal Devices Inductances 	-	3.5	-	nH
		Measured From the Drain Lead, 6mm (0.25in) from Package to Center of Die	-	4.5	-	nH
Internal Source Inductance	L_S	Measured From the Source Lead, 6mm (0.25in) From Header to Source Bonding Pad	-	7.5	-	nH
Thermal Resistance Junction to Case	$R_{\theta JC}$		-	-	1.25	^{o}C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	Free Air Operation	-	-	80	^{o}C/W
	$R_{\theta JA}$	RF1S540SM Mounted on FR-4 Board with Minimum Mounting Pad	-	-	62	^{o}C/W

APPENDIX E

Datasheet 16 x 2 Character LCD

LCD-016M002B
Vishay

16 x 2 Character LCD



FEATURES

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply

MECHANICAL DATA

ITEM	STANDARD VALUE	UNIT
Module Dimension	80.0 x 36.0	mm
Viewing Area	66.0 x 16.0	mm
Dot Size	0.56 x 0.66	mm
Character Size	2.96 x 5.56	mm

ABSOLUTE MAXIMUM RATING

ITEM	SYMBOL	STANDARD VALUE			UNIT
		MIN.	TYP.	MAX.	
Power Supply	VDD-VSS	- 0.3	–	7.0	V
Input Voltage	VI	- 0.3	–	VDD	V

NOTE: VSS = 0 Volt, VDD = 5.0 Volt

ELECTRICAL SPECIFICATIONS

ITEM	SYMBOL	CONDITION		STANDARD VALUE			UNIT
				MIN.	TYP.	MAX.	
Input Voltage	VDD	VDD = + 5V		4.7	5.0	5.3	V
		VDD = + 3V		2.7	3.0	5.3	V
Supply Current	IDD	VDD = 5V		–	1.2	3.0	mA
Recommended LC Driving Voltage for Normal Temp. Version Module	VDD - V0	- 20 °C		–	–	–	V
		0°C		4.2	4.8	5.1	
		25°C		3.8	4.2	4.6	
		50°C		3.6	4.0	4.4	
		70°C		–	–	–	
LED Forward Voltage	VF	25°C		–	4.2	4.6	V
LED Forward Current	IF	25°C	Array	–	130	260	mA
			Edge	–	20	40	
EL Power Supply Current	IEL	Vel = 110VAC:400Hz		–	–	5.0	mA

DISPLAY CHARACTER ADDRESS CODE:

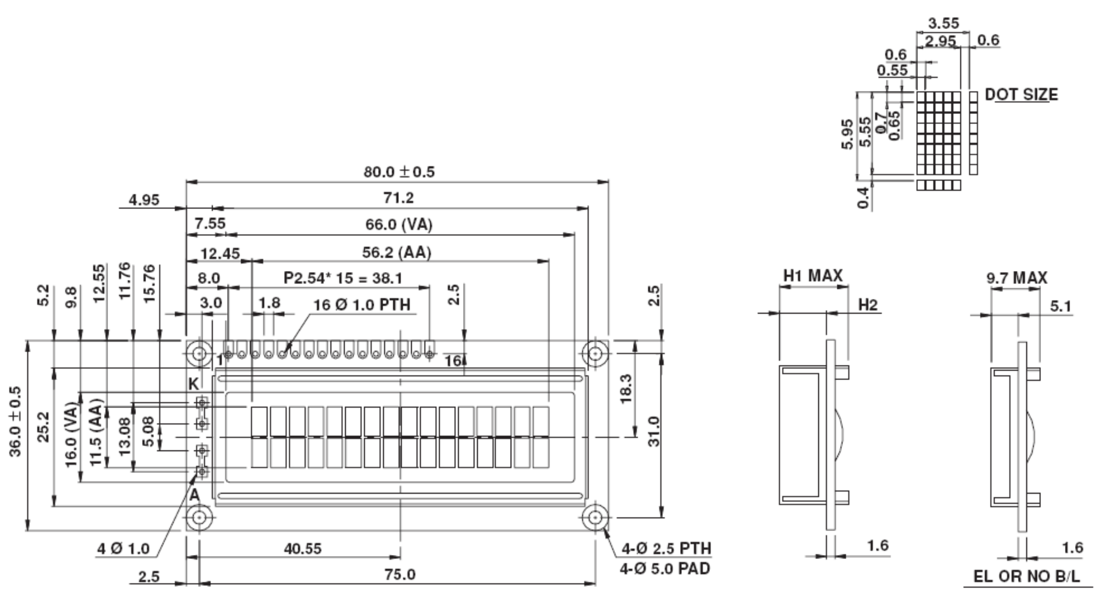
Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	00	01														0F
DD RAM Address	40	41														4F

LCD-016M002B

Vishay 16 x 2 Character LCD

PIN NUMBER	SYMBOL	FUNCTION
1	Vss	GND
2	Vdd	+ 3V or + 5V
3	Vo	Contrast Adjustment
4	RS	H/L Register Select Signal
5	R/$\overline{W}$	H/L Read/Write Signal
6	E	H →L Enable Signal
7	DB0	H/L Data Bus Line
8	DB1	H/L Data Bus Line
9	DB2	H/L Data Bus Line
10	DB3	H/L Data Bus Line
11	DB4	H/L Data Bus Line
12	DB5	H/L Data Bus Line
13	DB6	H/L Data Bus Line
14	DB7	H/L Data Bus Line
15	A/Vee	+ 4.2V for LED/Negative Voltage Output
16	K	Power Supply for B/L (OV)

DIMENSIONS in millimeters



LED - H/L B/L

	HIGH	LOW
H1	13.2	12.1
H2	8.6	7.5

APPENDIX F

Cost of project

FAKULTI KEJURUTERAAN ELEKTRIK & ELEKTRONIK
UNIVERSITI MALAYSIA PAHANG (UMP)

BORANG PEMBELIAN KOMPONEN/BAHAN PSM

Sila isi secara **bertaip** dalam **3** salinan dan hantar bersama **1** salinan litar projek berkaitan
Komponen yang rosak kerana kecuaian pelajar tidak boleh diganti

Nama Pelajar:	Mohd Hapiz Bin Arbain	**Nama Penyelia:**	En Ruhaizad Bin Ishak
ID No:	EC05025	**Tajuk Projek :**	Battery Charger with LCD display

Bil	Bahan/Komponen	Spesifikasi	Anggaran Harga / unit	Kuantiti	Anggaran Harga
1	Resistor	10K	0.1	16	1.6
2		100k	0.1	10	1
3		100	0.1	1	0.1
4		220	0.1	1	0.1
5		330	0.1	2	0.2
6		2.2k	0.1	2	0.2
7	7W	5.6	0.7	1	0.7
8	5W	12	0.5	1	0.5
9	Electrolyte Capacitor	100uF	1.2	2	2.4
10	Capacitor	330nF	0.6	1	0.6
11		100uF	0.6	2	1.2
12		100nF	0.6	3	1.2
13	Voltage Regulator	7805	1.5	1	1.5
14	LED	Red	0.2	1	0.2
15		Green	0.2	2	0.4
16	Switch	On/Of	1.50	1	1.5
17	Resonator	12MHz	8.00	1	8.00
18	Mosfet	IRF 540	4.00	2	8
19	IC base	28pins	0.3	1	0.3
20	Battery Chasing	2slots	2	1	2
21	LM317	Voltage regulator	2.5	1	2.5
22	Alphanumeric LCD module	16x2 char line. (module size 84x44x10)	26.00	1	26.00
23	PC Board	Medium	6.50	1	6.5

24	Switch	push button	1.5	4	6
25	Connector		1.5	2	3
26	MOSFET	IRF540	4.00	2	8
27	Transistor	BC 557	0.6	1	0.6
28		BC 547	0.8	1	0.8
29	PIC16F876A	Microcontroller	25.00	1	25.00
30	Diode	IN4001	0.25	1	0.25
JUMLAH ANGGARAN HARGA					**110.35**

APPENDIX G

Picture of Battery charger with alphanumeric LCD display