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JUDUL: Safety Cabinet Alarm System

SESI PENGAJIAN: 2007/08

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(HURUF BESAR)

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SAFETY CABINET ALARM SYSTEM

FOO KON SIAN

A thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Electrical Engineering

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

MAY 2008

I declare that this thesis entitled "Safety *Cabinet Alarmed System* "is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Name : FOO KON SIAN

Date : 16th May 2008

Specially dedicated to my beloved family and friends

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ABSTRACT

In our country, Malaysia, there are many house breaking cases happen among the citizen, especially at Johor Bharu. Because of these problems, administrator/professional/resident from various sectors really needs the alarmed system to ensure safety of their cash money or valuable things. As for this project, a safety cabinet alarm system (Anti-thief System) will be set up to ensure total security of cabinet or valuable things in various sectors. For lawyer, they need the alarm system to keep the confidential contract or any agreement of their client. If in the banking field, the banker will install alarm system to the safety locker. The safety locker is set up as a place for keeping valuable things of their customer. Software programming is implemented to build the controller system and make the system can be function perfectly. Manufacturers can apply this alarm system to any sizes of cabinets depend to requirement of customers. Hence, everyone in our country can install the alarm system in their house or office and keep their things safe.

ABSTRAK

Dalam negara kita, Malaysia, terdapat banyak kes pencerobohan rumah dan kes pencurian berlaku di kalangan rakyat, terutamanya dalan daerah Johor Bharu. Oleh kerana kes tersebut sering berlaku, golongan profesional, pentadbir and penduduk tempatan dari bidang yang berlainan amat memerlukan sistem kawalan untuk memastikan wang tunai dan barang-barang berharga mereka dalam keadaan yang selamat. Dalam projek sarjana muda saya, Sistem Kawalan Keselamatan Kabinet(Sistem Anti- Pencuri) akan didirikan untuk memastikan keselamatan sepenuhnya bagi barangan berharga yang disimpankan dalam kabinet tertentu. Peguam akan menggunakan sistem ini untuk menyimpan fail-fail pelanggan penting. Dalam sektor kewangan pula, mereka memerlukan sistem ini untuk melindungi barang yang disimpankan dalam kotak keselamatan. Perisian atau pengaturcaraan juga memainkan peranan penting dalam Sistem Kawalan saya and membolehkan sistem dapat beroperasi dengan sempurna. Usahawan boleh menggunakan sistem keselamatan tersebut terhadap pelbagai size kabinet bergantung kepada keperluan pengguna. Dengan adanya sistem ini, setiap rakyat boleh memilikinya di rumah atau pejabat masing-masing dan tidak perlu membimbangkan kehilangan barang-barang berharga lagi.

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LIST OF ABBREVIATIONS

LED	-	Light Emitting Diode
&	-	And
Sdn Bhd	-	Private Limited
I/O	-	Input or Output
LCD	-	Liquid Crystal Display
PCB	-	Printed Circuit Board
ROM	-	Read-Only Memory
RAM	-	Random-Access Memory
EPROM	-	Erasable Programmable Read Only Memory
EEPROM	-	Electrical Erasable Programmable Read Only Memory
FIFO	-	First In First Out
FILO	-	First In Last Out
IC	-	Integrated Circuit
VDD	-	Input Voltage
SCK	-	Serial Clock.
SDI	-	Serial Data Input.
D/C	-	Data/Command Input.
SCE	-	Chip Select.
GND	-	Ground.
RES	-	Reset.
MCLR	-	Master Clear
ALU	-	Arithmetic Logical Unit
DC	-	Direct Current
WDT	-	Watchdog Timer
ICD	-	In-Circuit Debug
ESR	-	Equivalent Series Resistance
AC	-	Alternating Current

DIR	-	Direction
ESD	-	Electrostatic Discharge
EN	-	Enable
H	-	High
L	-	Low

LIST OF NOTATIONS

mm	-	millimeter
cm	-	centimeter
m	-	meter
V	-	volt
W	-	walt
%	-	percent
MHz	-	mega Hertz
pF	-	pico Farad
uF	-	micro Farad
Ω	-	ohm
k Ω	-	kilo ohm

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Nowadays, safety cabinet alarm system becomes common and very important to ensure total security of cabinet or valuable things from various sectors. The safety cabinet alarm system (Electronic lock system) is a locking system which uses some form of electronics to authenticate those accessing it. The alarm systems are typically considered more secure than conventional mechanical locks and can include additional features. The alarm system is simple to use and maintain and provide a convenient method for controlling cabinet access for residents and professionals

It is known to provide electronic locks of various kinds. Such locks may generally be viewed as being made up of three parts: an authorization module for selectively allowing activation of the lock by certain keys or personnel; an electromechanical actuation system for generating the required mechanical movement of the lock mechanism; and a control system for controlling the functions performed by the actuation system in response to authorized activation of the lock.

Perhaps the most prevalent form of safety cabinet alarm system is that using a numerical code for authentication; the correct code must be entered in order for the lock to deactivate. Such locks typically provide a keypad, and some feature an audible response to each press. Combination lengths are usually between 4 and 6 digits long. This alarm system is an easy and quick retrofit for cam locks supplied as standard on a wide range of lockers, cabinets and cupboards. It can easily be fitted to lockers or cabinets, which don't have a locking device already installed, giving the user immediate and simple keypad access without the need for keys.

1.2 Objectives

The objective of this project is to develop a safety cabinet alarm system with below specification:

i.	Universal LCD	The users will be more easy and convenient to operate the alarm system.
ii.	Alarm System	If someone tries to break in the cabinet, the alarm sire will 'on' and at the same time, a message will be sending out to inform the owner.
iii.	Keyless	Using a numerical code for authentication, the correct code must be entering in order for the lock to deactivate.
iv.	Flexible	The alarm system is suitable for any size or material of cabinet.
v.	Low Cost	The components electronic and accessories in the alarm system is cheap and quality.
vi.	Repairable	All the components in the alarm system are common and easy to find in the market.
vii.	Reprogrammable	If the users forget the deactivate code, the system can be re-program to unlock the cabinet.
viii.	Auto Reset	If any interruption from power supply, the alarm system will activate the auto reset function and still can operate normally.

Table 1.1: Specification of safety cabinet alarm system

1.3 Problem Statement

In our country, Malaysia, there are many thieving and house breaking cases happen among the citizen, especially at Johor Bharu.

For example, 2 month ago, two men, believed to be Indonesians, tried to break into the house of former Inspector-General of Police Tan Sri Norian Mai in Section 8, Shah Alam. And, they tried twice. In February, burglars broke into the house of former Federal CID director Datuk Fauzi Saari and escaped with RM5,000 in cash and valuables.

That same month, former Penang police chief Datuk Albert Mah, 82, died from injuries he suffered while single-handedly fighting off five men who broke into his home in Section 5, Petaling Jaya. In Johor Bharu two men, suspected of breaking into four houses between June 11 and 14, were arrested in a raid on Kampung Melayu Pandan on Friday.

Because of these problems, administrator/ professional/ resident from various sectors really need the alarm system to ensure safety of their cash money or valuable things. For lawyer, they need the alarm system to keep the confidential contract or any agreement of their client. If in the banking field, the banker will install alarm system to the safety locker. The safety locker is set up as a place for keeping valuable things of their customer. The system also can be very useful for the businessmen who want to keep cash money, jewelry and financial reports.

Finally, with the safety cabinet alarm system, whole society will fell secure for their valuable things.

1.4 Scope of Work

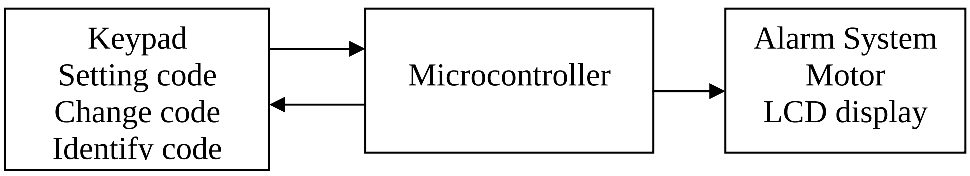
This project involves hardware and software development as explained below:

1.4.1 Hardware Development

This project consists of three parts

a) Input (keypad)
b) PIC microcontroller (PIC 16F876A)
c) Output (LCD display, alarm system, activation of cabinet)

PIC16F876A is choose to be the microcontroller to control the display of universal LCD, setting/identify/change code, keypad, motor (unlock/lock cabinet) and alarm system. In the alarm system include a internal cell phone which used to inform the authorized personnel and a siren alarm.



1.4.2 Software Development

Microcontroller is a lump of plastic, metal and purified sand, which without any software does nothing. When software controls a microcontroller, it has almost unlimited applications. “C Programming” will be used to develop the firmware to PIC microcontroller. CCS-C Compiler also used to compile the C-programming before burn it into the PIC microcontroller. Another software tool that I will used is 'Protel 99 SE' to design the circuit and create the layout for PCB.

1.5 Thesis Outline

The thesis consists of six chapters. Each chapter is described next.

Introduction: Chapter 1 serves as an introduction to the report. This chapter is the brief overview of the project where it includes the project background, objectives, scope of work, research methodology and project plan.

Literature Review: Chapter 2 discusses the literature review which is relevant for focusing on the basic concept of safety cabinet alarm system. There are some designed circuits and method will be discussed in this chapter.

Theory and Proposed System: Chapter 3 will describe the methodology taken to complete the entire project. Theory used in the safety cabinet alarm system is further explained in this chapter. The proposed system with the components and materials used is discussed here. Circuit diagram and the source code of the safety cabinet alarm system are shown in this chapter

Software Development: Chapter 4 guides to the system designed implementation and software approach used to produce this project.

Results and Discussion: Chapter 5 will show the results from the proposed system. Instructions on how to use the safety cabinet alarm system are introduced in this chapter.

Conclusion and Future Suggestions: Chapter 6 described the shortcomings experienced and suggestions solution and the conclusion. The recommendation of the project also will be discussed.

CHAPTER 2

LITERATURE REVIEW

Security is a prime concern in our day-today life. Everyone wants to be as much secure as possible. An access control for cabinet forms a vital link in a security chain. The microcontroller based digital lock for cabinet is an access control system that allows only authorized persons to access certain cabinet. The system is fully controlled by the 8 bit microcontroller AT89C2051 which has a 2Kbytes of ROM for the program memory. The password is stored in the EPROM so that we can change it at any time. The system has a Keypad by which the password can be entered through it. When the entered password equals with the password stored in the memory then the relay gets on and so that the door is opened. If we entered a wrong password for more than three times then the Alarm is switched on.

2.1 Digital Code Lock with LCD and Keypad using AT89C2051

2.1.1 A Brief Description

This project is written in C language. Its a simple project with efficient hacking prevention from Brute Force etc. The basic user lock is of 5 Digits and Master Lock is of 10 digits so it's not easy for an intruder to break the lock unless you keep the code simple. The input is taken from a 4x3 Keypad (please see the schematic for more information) and Display the user input on a 2x16 LCD. A pin is assigned as output for activating and deactivating the lock. For demonstration i have connected an LED to that pin.

2.1.2 User Side working

The user has two options either he/she can use its own 5 digit code or use the default 5 digit code. If user has to do setup his own code, then he has to enter "12345" and press '#'. After this.controller will ask for 10 Digit master password which is preprogrammed in the controller. Entering master lock, user can enter the new 5 digit code for the lock and press '#' to save it.

2.1.3 Using the Keypad

Keypad has 12 keys (4x3) starting from 1,2,3,4,5,6,7,8,9,*,0,# (please see the schematic for layout). Numeric keys are used for entering numbers. '*' is used as the Cancel key and '#' is used as the Enter key.

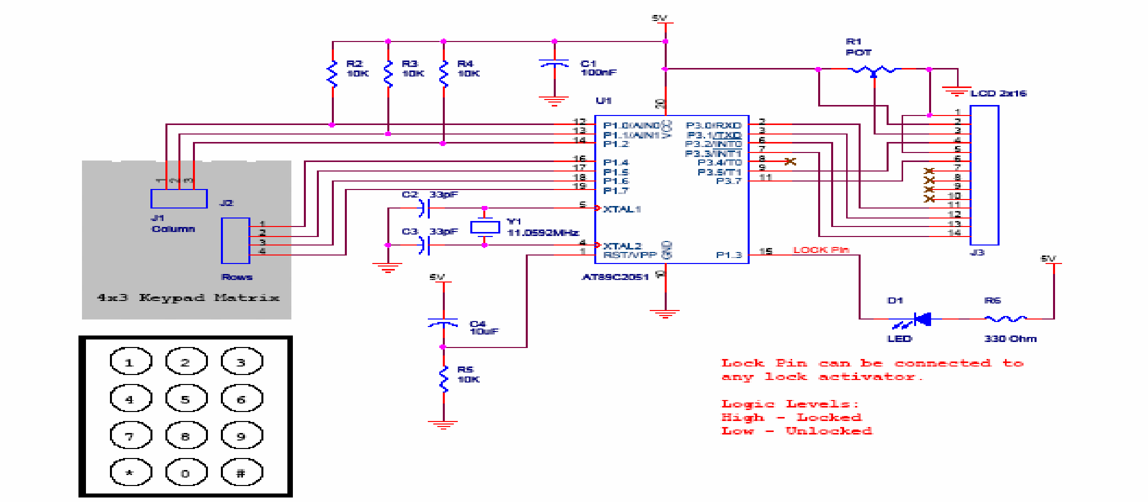


Figure 2.1: Digital Code Lock System

2.2 Security Keypad Lock

The Security Keypad Lock Project is a basic access control system. The "Code Lock" ability will allow the rightful user to deploy the platform to any property that requires simple password-protection. The "AVR" RISC microcontroller used ensures low costs. Possible applications may include: vehicle protection, electronic safes, powered door locks. The following short treatise will explain how the early version was engineered and how to use the controller to accept valid passwords. With a little external hardware, the featured systems may easily be used to disengage an electric door strike or similar system.

Access Control(s) - this is any system designed to restrict access to some type of property. Some access controls like tire spikes and boarded doors are indiscriminant in that they bar access for everyone. More useful access controls are *selective*, which is to say they operate on a pass-or-halt basis. This project is a selective access control.

Bypass Capacitor - any capacitor meant to absorb energy spikes by providing a low impedance path to ground. A bypass usually has one pin tied to ground and the other pin attached to some supply lead. In this non-precision application any capacitor type can be used, including basic ceramics.

Debouncing - a noise-canceling method used to eliminate keypad noise. This noise is inherent to most pushbuttons and switches and occurs as the contacts break/complete the circuit. Debouncing methods will either filter the noise or mute (ignore) it. This project uses software to wait for the key signals to stabilize.

EEPROM – EEPROM is a non-volatile data storage medium. Electronically Erasable Programmable Read Only Memory can reside within the microcontroller in the absence of electric power. This memory is accessible through the microcontroller's 3 EEPROM registers. EEPROM will be used to store the passwords.

Floating Pin - an input pin is said to be floating if it is not connected to anything. Floating pins may report random bit states that "float" between '1' and '0'.

Keypad - this is our input device. The keypad comprises 16 or 12 membrane buttons on a 4x4 or 4x3 matrix. Key activity is detected by monitoring the keypad's output pins and waiting for a closed circuit to appear between a *row* pin and a colum*n* pin. The keypad is a passive device.

Queue - an array of integers in which data is shifted in on one side and deleted on the other end. Queues follow FIFO ("First In First Out") behavior, whereas a stack will use a FILO ("First In Last Out") scheme. This project will use the Queue to hold key codes.

SRAM – SRAM is the volatile data storage medium. Static Random Access Memory is destroyed during power-off and reset conditions. This memory is accessible through the microcontroller’s X and Y pointer-registers and by the "**lds**" and "**sts**" commands. SRAM will contain the key press queue.

Volatility - this term will be associated with the system's memory types. The term indicates whether the memory will retain its state after power has been removed. A volatile system will be reset if power is removed. A non-volatile system will retain its latest state.

Design Concept

This console project is intended to be a low-end and low-cost system that will focus mainly on affordability and simplicity rather than connectivity or even ease-of-use. Hence this will be a stand-alone system that will not need a special communications interface. This limits the designing phase to four sub-systems: keypad, encoder, controller, and visual/mechanical interface.

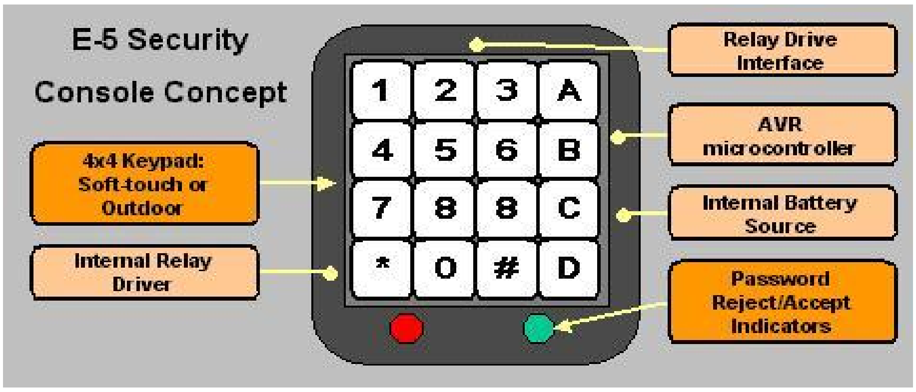


Figure 2.2: E-5 Security Concept

2.3 Simple Low-Cost Digital Code Lock

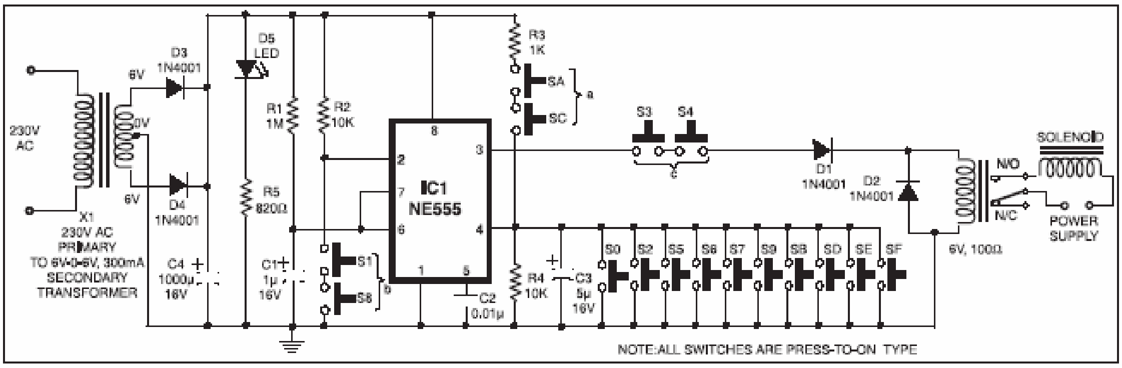


Figure 2.3: Simple Low-Cost Digital Code Lock

In those circuits a set of switches (conforming to code) are pressed one by one within the specified time to open the lock. In some other circuits, custom-built ICs are used and positive and negative logic pulses are keyed in sequence as per the code by two switches to open the lock.

A low-cost digital code lock circuit is presented in this article. Here the keying-in code is rather unique. Six switches are to be pressed to open the lock, but only two switches at a time. Thus a total of three sets of switches have to be pressed in a particular sequence. (Of these three sets, one set is repeated.) The salient features of this circuit are:

1. Use of 16 switches, which suggests that there is a microprocessor inside.
2. Elimination of power amplifier transistor to energize the relay.
3. Low cost and small PCB size.

An essential property of this electronic code lock is that it works in mono stable mode, i.e. once triggered; the output becomes high and remains so for a period of time, governed by the timing components, before returning to the quiescent low state. In this circuit, timer IC 555 with 8 pins is used. The IC is inexpensive and easily available. Its pin 2 is the triggering input pin which, when held below 1/3 of the supply voltage, drives the output to high state. The threshold pin 6, when held higher than 2/3 of the supply voltage, drives the output to low state. By applying a low-going pulse to the reset pin 4, the output at pin 3 can be brought to the quiescent low level. Thus the reset pin 4 should be held high for normal operation of the IC.

Three sets of switches SA-SC, S1- S8 and S3-S4 are pressed, in that order, to open the lock. On pressing the switches SA and SC simultaneously, capacitor C3 charges through the potential divider comprising resistors R3 and R4, and on releasing these two switches, capacitor C3 starts discharging through resistor R4. Capacitor C3 and resistor R4 are so selected that it takes about five seconds to fully discharge C3.

Depressing switches S1 and S8 in unison, within five seconds of releasing the switches SA and SC, pulls pin 2 to ground and IC 555 is triggered. The capacitor C1 starts charging through resistor R1. As a result, the output (pin 3) goes high for five seconds (i.e. the charging time T of the capacitor C1 to the threshold voltage, which is calculated by the relation T=1.1 R1 x C1 seconds).

Within these five seconds, switches SA and SC are to be pressed momentarily once again, followed by the depression of last code-switch pair S3-S4. These switches connect the relay to output pin 3 and the relay is energized. The contacts of the relay close and the solenoid pulls in the latch (forming part of a lock) and the lock opens. The remaining switches are connected between reset pin 4 and ground. If any one of these switches is pressed, the IC is reset and the output goes to its quiescent low state. Possibilities of pressing these reset switches are more when a code breaker tries to open the lock.

LED D5 indicates the presence of power supply while resistor R5 is a current limiting resistor. The given circuit can be recoded easily by rearranging connections to the switches as desired by the user.

2.4 Nokia 3310 LCD Driver using a PIC

This library includes functions for controlling the Nokia 3310 LCD (PCD8544 controller) and also a 5x7 font. Currently the table used only works on 16F, but should not take much to modify it to work with 18F PICs. It only uses 5 IO pins, so a smaller PIC could be used. The font however takes up a lot of ROM (the example program's code size is 1305). If the text print functions (and the font) is not used it is of course much smaller, but also much less useful.

Figure 2.4: Nokia 3310 LCD Driver using a PIC

Showing the LCD connected to an 16F877 PIC. On the right is my DIY Wisp628. The interface board between the LCD and the PIC consists of two caps (required for the LCD controller), a few 1K resistors in series with the data lines, and a LM317 to regulate the 5V down to 3V which the LCD requires.

2.5 Nokia 3310 Graphical LCD Demo

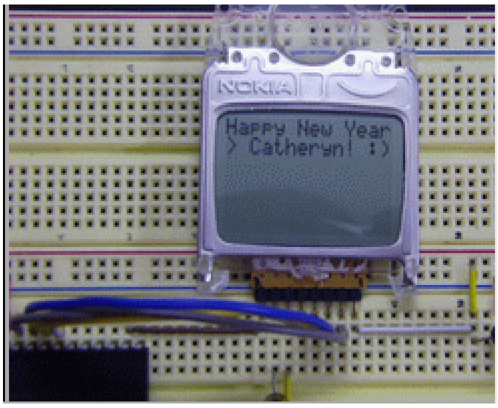


Figure 2.5: Nokia 3310 PCD8544 Based Graphical LCD Demo

Ah. Happy New Year!! This is one cool graphical LCD. Not only it is easy to programmed, the Nokia 3310 LCD also consumes low power. The Nokia 3310 is based on a PCD8544 Controller which is manufactured by Philips. With this controller, you can easily interface any PICs to it via SPI.

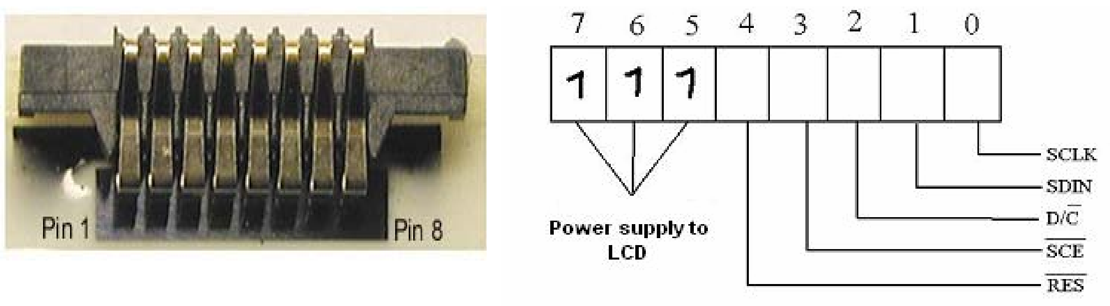


Figure 2.6: Nokia 3310 Pin Connector

Its pin out is as follows:-

1 - VDD ==> Input voltage.

2 - SCK ==> Serial Clock.

3 - SDI ==> Serial Data Input.

4 - D/C ==> Data/Command Input.

5 - SCE ==> Chip Select.

6 - GND ==> Ground.

7 - VOUT ==> VLCD.

8 - RES ==> Reset.

There are quite a few source codes available out there on how to control the LCD with a PIC. One good instance can be found in Michel Bavin's website. His firmware was coded in CCS-C. He has done a great job by providing good explanations on the functions of his Nokia 3310 LCD codes. I do not have CCS-C, therefore I decided to translate some of his codes to Hi-Tech C and add a little feature to it. Both codes use 'bit-banging' SPI.

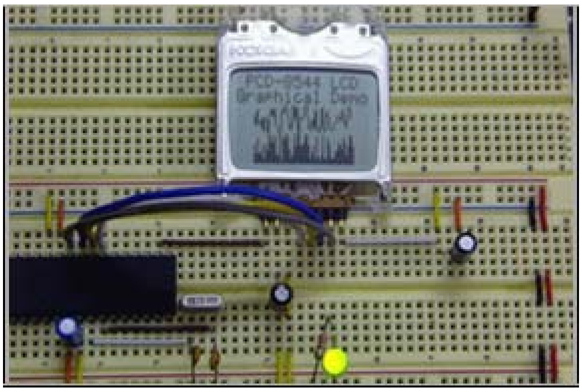


Figure 2.7: LCD Nokia 3310

There, the picture to the left is another snapshot of it. Here, a function to plot a smooth continuous line and its plot time is surprisingly rather fast. There's also the typical bar plot as shown below. The firmware provided here runs a demo program at main ( ) to generate random numbers and plotting them on the LCD using both bar and continuously line plot. Simply adjust the delay in the program to control the speed of the plot. It's cool to see animation, rather than a still picture

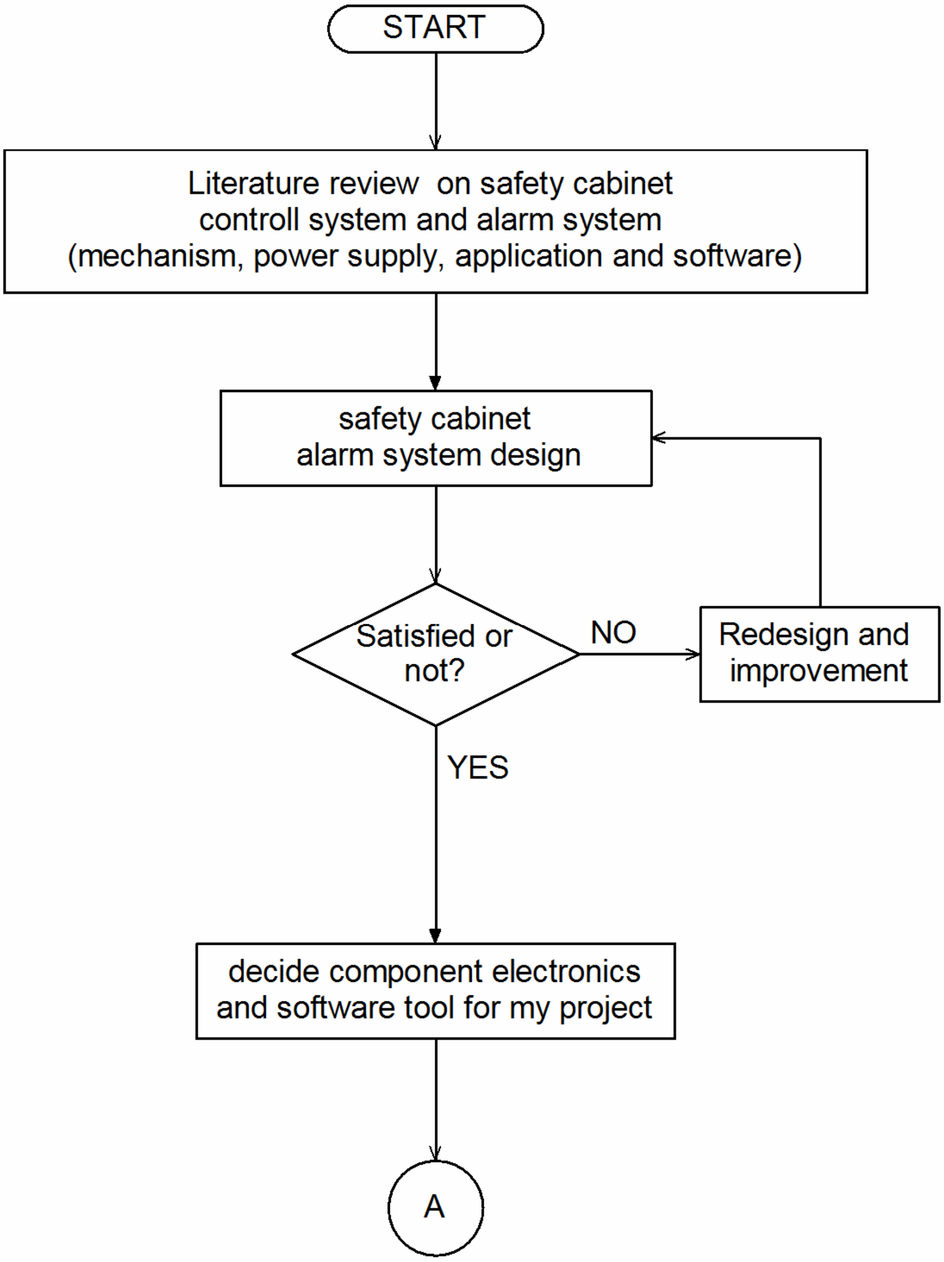
CHAPTER 3

THEORY AND PROPOSED SYSTEM

This chapter presents the application tools and components of the project. The schematic diagrams and software are used to describe the methodology to complete this project.

3.1 Flow Diagram

The flow diagram as shown in Figure 3.1 shows the process flow of the project. All the process mentioned are important in completing the project. First of all, the project requires study of basic principles of safety cabinet and LCD display. Next, Additional system consists of hardware and software is designed. Install the safety alarm system to the cabinet. Safety cabinet alarm system will play the important role to ensure total security of cabinet or valuable things for various sectors. The project is considered done when all the requirements is fulfilled.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Literature review on safety cabinet
controll system and alarm system
(mechanism, power supply, application and software)
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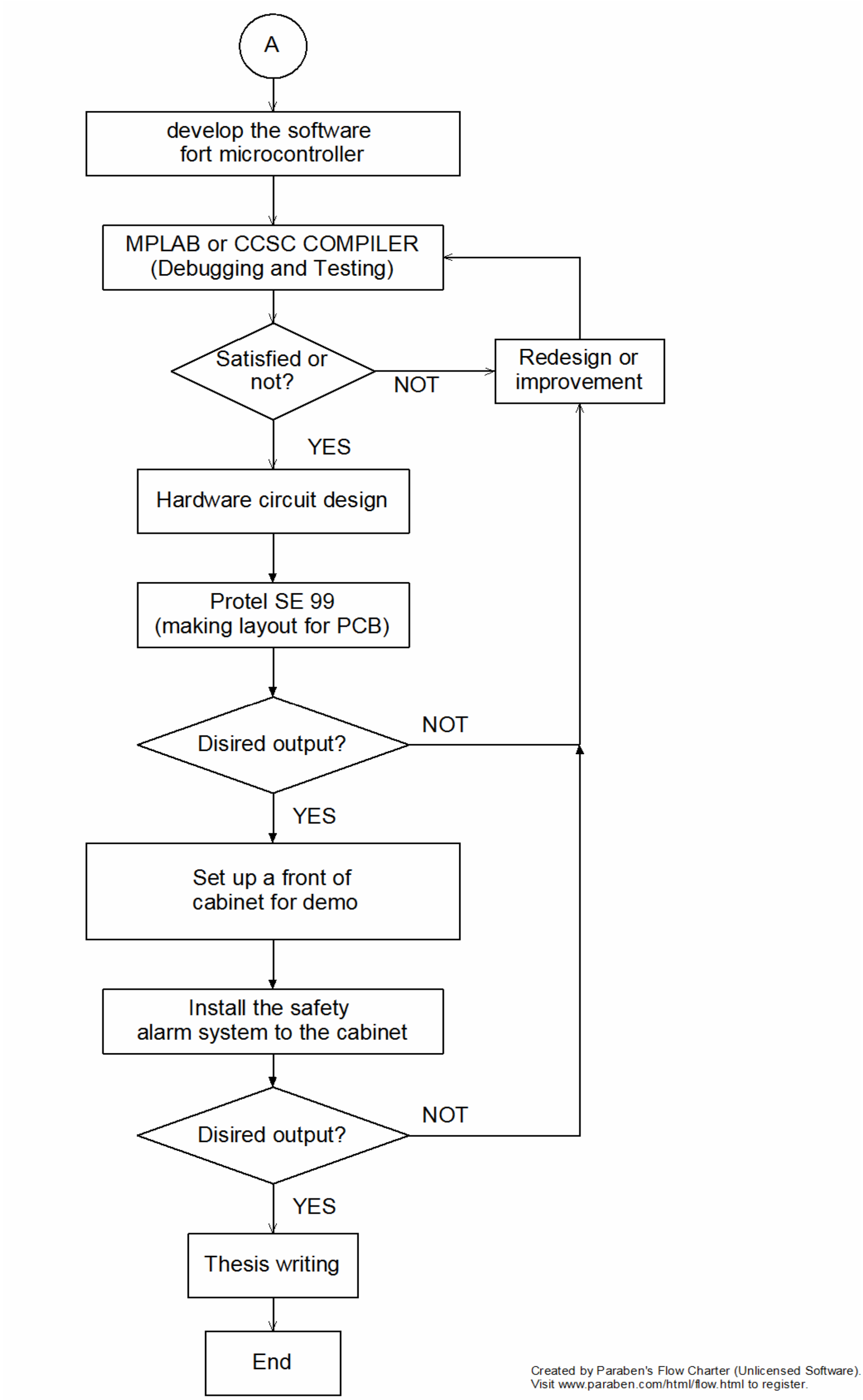

Figure 3.1: Flow diagram of the project

3.2 Application Tools

Application tools are the equipments that used to design and develop the safety cabinet alarm system. There are including Microchip MPLAB ICD 2, Protel SE 99, and C compiler (CCSC compiler).

3.2.1 Microchip MPLAB ICD 2

The MPLAB ICD 2 is a low-cost in-circuit debugger (ICD) and in-circuit serial programmer. MPLAB ICD 2 is intended to be used as an evaluation, debugging and programming aid in a laboratory environment. The MPLAB ICD 2 offers these features:

i. Real-time and single-step code execution
ii. Breakpoints, Register and Variable Watch/Modify
iii. In-circuit debugging
iv. Target VDD monitor
v. Diagnostic LEDs
vi. .MPLAB IDE user interface
vii. RS-232 serial or USB interface to a host PC

The MPLAB ICD 2 allows you to:

i. Debug your source code in your own application
ii. Debug your hardware in real-time
iii. A supported device using Microchip's ICSP. Protocol

3.2.1.1 Modular Interface Connections

MPLAB ICD 2 is connected to the target PIC MCU with the modular interface cable, which is a six conductor cable. The pin numbering for the MPLAB ICD 2 connector is shown from the bottom of the target PC board in Figure 3-1.

Note: The ICD cable has mirror imaged connections on each end, and connections on the MPLAB ICD 2 module are the opposite of connections shown here.

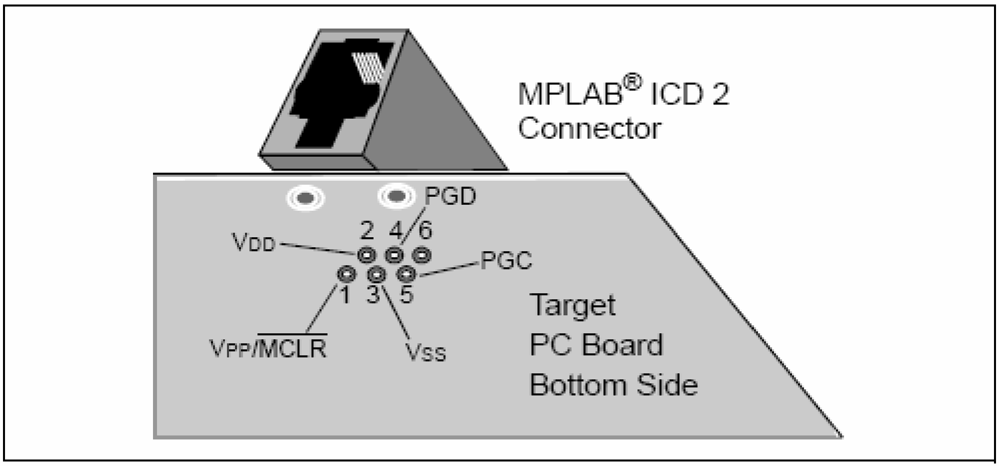

Figure 3.2: Pin Numbering for Modular Connector

Figure 1.3 shows the interconnections of the MPLAB ICD 2 to the modular connector on the target board. There are six pins on the ICD connector, but only five are used. The diagram also shows the wiring from the connector to the PIC MCU device on the target PC board. A pull-up resistor (usually around 10k Ohm) is recommended to be connected from the VPP/MCLR line to VDD so that the line may be strobe low to reset the PIC MCU. Although pin 2 (VDD) can supply a limited amount of power to the target application under certain conditions, for the purposes of these descriptions, pins 2 and 3 (VSS) are omitted. They are shown on the diagram for completeness, but in the following descriptions only three lines are active and relevant to core MPLAB ICD 2 operation: VPP/MCLR, PGC and PGD. Not all PIC MCUs have the AVDD and AVSS lines, but if they are present on the target PIC MCU, all must be connected in order for MPLAB ICD 2 to operate.

Note: In the following discussions, VDD is ignored. But be aware that the target VDD is also used to power the output drivers in MPLAB ICD 2. This allows level translation for target low-voltage operation. If MPLAB ICD 2 does not have voltage on its VDD line (pin 2 of the ICD connector), either from power being supplied to the target by MPLAB ICD 2 or from a separate target power supply, it will not operate.

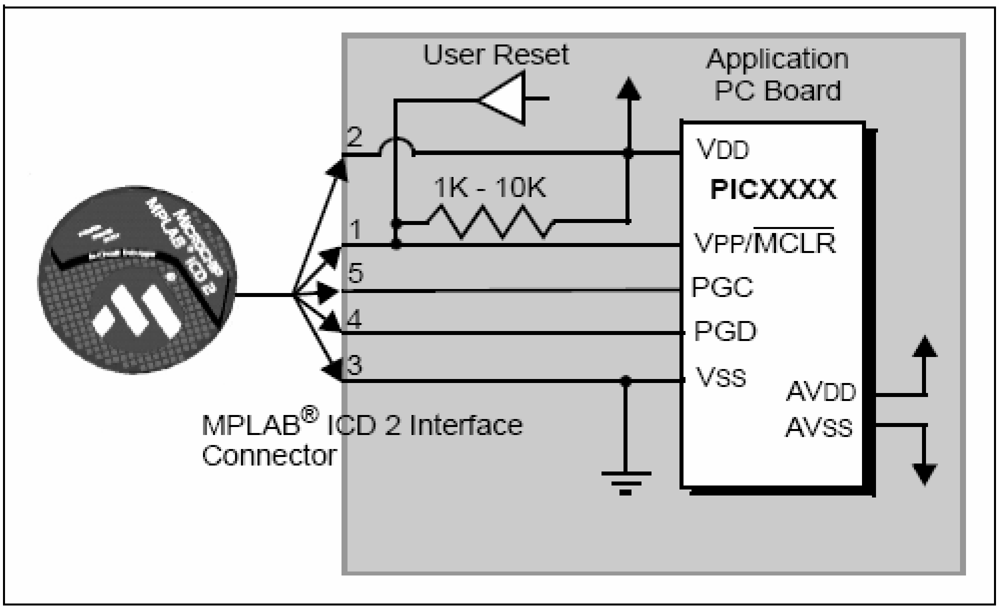

Figure 3.3: MPLAB® ICD 2 Connection to Target Board

3.2.1.2 Debug Mode

There are two steps to using MPLAB ICD 2 as a debugger. The first requires that an application be programmed into the target PIC MCU. The second uses the internal in-circuit debug hardware of the target Flash PIC MCU to run and test the application program. These two steps are directly related to the MPLAB IDE operations:

1. Programming the code into the target.
2. Using the debugger to set breakpoints and run.

If the target PIC MCU cannot be programmed correctly, MPLAB ICD 2 will not be able to debug. Figure 3-3 shows the basic interconnections required for programming. Note that this is the same as Figure 1-2, but for the sake of clarity, the VDD and VSS lines from MPLAB ICD 2 are not shown.

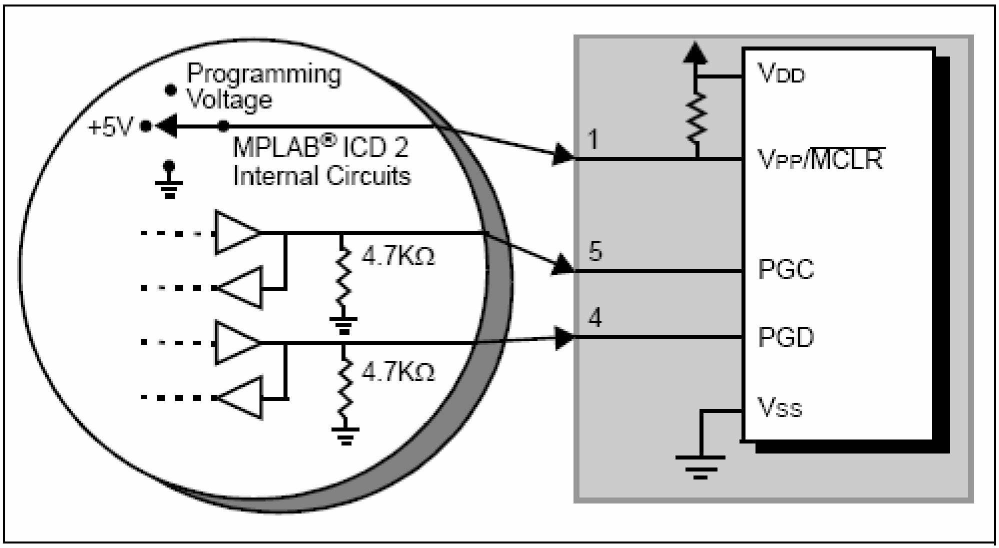

Figure 3.4: Proper Connections For Programming

A simplified diagram of some of the internal interface circuitry of the MPLAB ICD 2 is shown. For programming, no clock is needed on the target PIC MCU, but power must be supplied. When programming, MPLAB ICD 2 puts programming levels on VPP, sends clock pulses on PGC and serial data via PGD. To verify that the part has been programmed correctly, clocks are sent to PGC and data is read back from PGD. This conforms to the ICSP protocol of the PIC MCU under development.

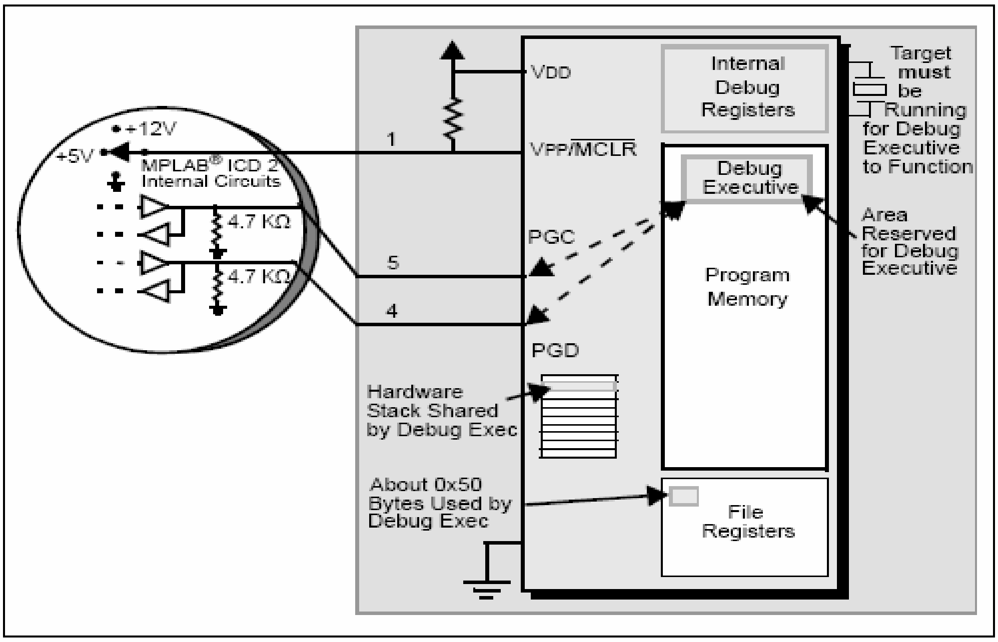

Figure 3.5: Illustrates the MPLAB ICD 2 ready for debugging.

3.2.1.3 Programmer Mode

When using the Programmer>Program selection to program a device, the in-circuit debug registers should be disabled in the MPLAB IDE so the MPLAB ICD 2 will program only the target application code and the Configuration bits (and EEPROM data, if available and selected) into the target PIC MCU. The debug executive will not be loaded. In this mode the MPLAB ICD 2 can only toggle the MCLR line to reset and start the target. A breakpoint cannot be set, and register contents cannot be seen or altered. The MPLAB ICD 2 programs the target using ICSP. No clock is required while programming, and all modes of the processor can be programmed, including code-protect, Watchdog Timer enabled and table read protect.

Note: A header board is required to debug smaller pin count parts with the MPLAB ICD 2. These parts can be programmed without the header by connecting the VPP, PGC and PGD lines as described previously.

3.2.2 Protel SE 99

Protel SE 99 includes a powerful design synchronization tool, that makes it very easy to transfer design information from the schematic to the PCB (and back again). The Synchronizer will automatically extract the component and connectivity information from the schematic, locate the required footprints in the PCB libraries and place them in the PCB workspace, then add the connection lines between connected component pins. You use the synchronizer to initially transfer your design from the schematic documents to a PCB design document, and also to synchronize design changes made in either the PCB or the schematic documents.

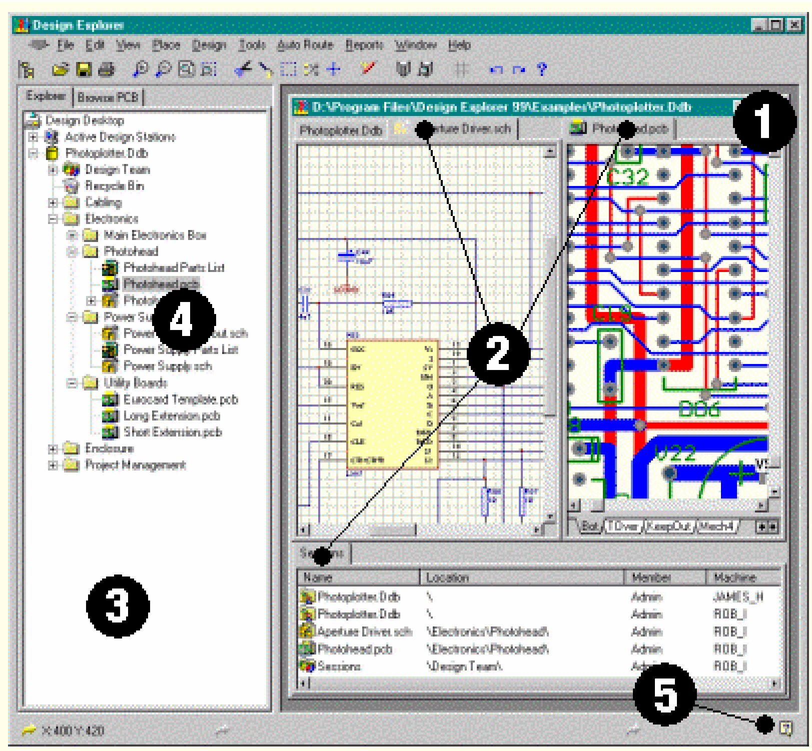

Figure 3.6: Protel SE 99

1 Design Window

This is the main editing window. It displays the contents of open documents and folders. Each open design database will have its own design window. To open a document or folder, click on its name in the navigation tree. To split the design window in order show multiple documents simultaneously, right-click on a document tab and select one of the Split options from the popup menu. To close a document, right-click on its document tab and select Close from the popup menu.

2 Document tabs

Each open document or folder is shown by a tab in the design window. Click on a document's tab to make it active. The active tab is indicated by a document or folder icon in the tab area. To split the design window in order show multiple documents simultaneously, right-click on a document tab and select one of the Split options from the popup menu. To close a document, right-click on its document tab and select Close from the popup menu.

3 Design Manager Panel

The Design Manager panel is used to display the Explorer navigation tree, which provides a Windows Explorer-like hierarchical tree view of the design desktop, allowing you to navigate the various documents and folders contained in each design database. The Design Manager panel is also used to display document editor-specific browse panels. Available panels are shown as tabs at the top of the Design Manager panel. To show or hide the Design Manager panel, select View » Design Manager from the menus.

4 Navigation Tree

The Explorer navigation tree provides a Windows Explorer-like hierarchical tree view of the design desktop, allowing you to navigate the various documents and folders contained in each design database. Click on a document or folder in the navigation tree to open it in the design window.

5 Help Advisor

Click the Help Advisor icon at the right-hand side of the status bar to open the natural language help search facility.

3.2.3 C compiler (CCSC compiler)

The CCS C Compiler features provide ample function for your development needs, including: standard C pre-processor directives, operators & statements, built-in libraries supporting all chips, MPLAB® IDE integration, source code drivers, automatic linking for multiple code pages and much more.

Features include:

- 1, 8, 16 and 32 bit integer types and 32 bit floating point.
- Standard one bit type (Short Int) permits the compiler to generate very efficient Bit oriented code.
- #BIT and #BYTE will allow C variables to be placed at absolute addresses to map registers to C variables.
- Bit Arrays
- Fixed Point Decimal
- Constants (including strings and arrays) are saved in program memory.
- Flexible Handling of Constant Data
- Variable Length Constant Strings
- Address mod Capability To Create User Defined Address Spaces In Memory Device

The CCS C Compiler for PIC10, PIC12, PIC14, PIC16, and PIC18 microcontrollers has over 180 Built-in Functions to access PIC® MCU hardware is easy and produces efficient and highly optimized code. Functions such as timers, A/D, EEPROM, SSP, PSP, USB, The compiler can handle inline or separate functions, as well as parameter passing in re-usable registers. Transparent to the user, the compiler handles calls across pages automatically and analyzes program structure and call tree processes to optimize RAM and ROM Usage.

The compiler runs under Windows 95, 98, ME, NT4, 2000, XP, Vista, or Linux. It outputs hex and debug files that are selectable and compatible with popular emulators and programmers including the MPLAB® IDE for source level debugging.

3.3 Components and Materials

Please refer Table 3.1 for the list of components and materials used in traffic light driver.

No	List of Components or Materials	Quantity
1.	PIC 16F876A	1
2.	0.1uF capacitor	3
3.	10 uF capacitor	3
4.	1uF capacitor	2
5.	470 nF capacitor	1
6.	330 nF capacitor	1
7.	22 pF capacitor	2
8.	1.8k Ω resistor	1
9.	510Ω resistor	2
10.	470Ω resistor	8
11.	47kΩ resistor	1
12.	1N4148 diode	3
13.	20MHz crystal	1
14.	74LCX245	1
15.	AS1117-2.85V	1
16.	Connector 4 pin	1

17.	Connector 6 pin	1
18.	LCD_3310	1
19.	LED	8
20.	NPN transistor	4
21.	Casing Nokia Phone 3310	1
22.	Hand Phone	1
23.	L293D	1
24.	PCB board	1
25.	Header 2 pin	7
26.	Header 3 pin	1
27.	Stripe Board	1

Table 3.1: List of components and materials

3.3.1 PIC 16F876A (Microcontroller)

A microcontroller (or MCU) is a computer-on-a-chip. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). The only difference between a microcontroller and a microprocessor is that a microprocessor has three parts - ALU, Control Unit and registers (like memory), while the microcontroller has additional elements like ROM, RAM etc.

3.3.1.1 High-Performance RISC CPU

i. Only 35 single-word instructions to learn
ii. All single-cycle instructions except for program branches, which are two-cycle
iii. Operating speed: DC – 20 MHz clock input DC – 200 ns instruction cycle
iv. 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

3.3.1.2 Special Microcontroller Features

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

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			
PIC16F876A	14.3K	8192	368	256	22	5	2	Yes	Yes	Yes	2/1	2

Figure 3.7: Special Microcontroller Features

3.3.1.3 Pin Diagrams

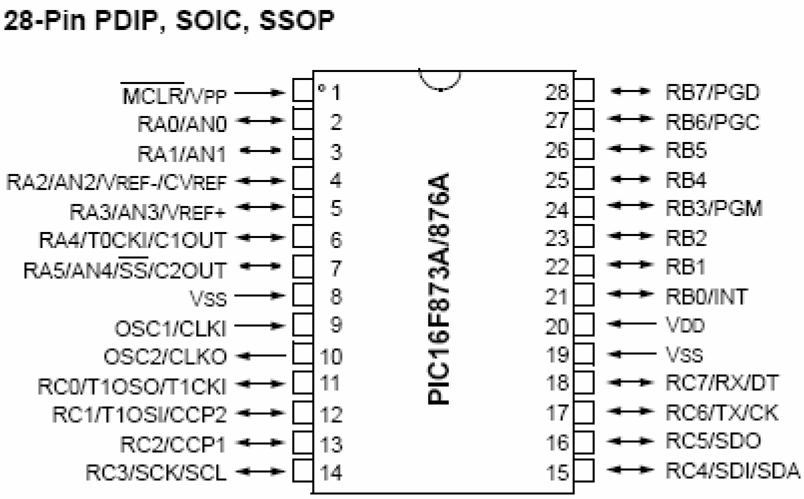

Figure 3.8: Pin Diagrams

3.3.1.4 Memory Organization

There are three memory blocks in each of the PIC16F87XA devices. The program memory and data memory have separate buses so that concurrent access can occur and is detailed in this section. The EEPROM data memory block is detailed in Section 3.0 “Data EEPROM and Flash Program Memory”.

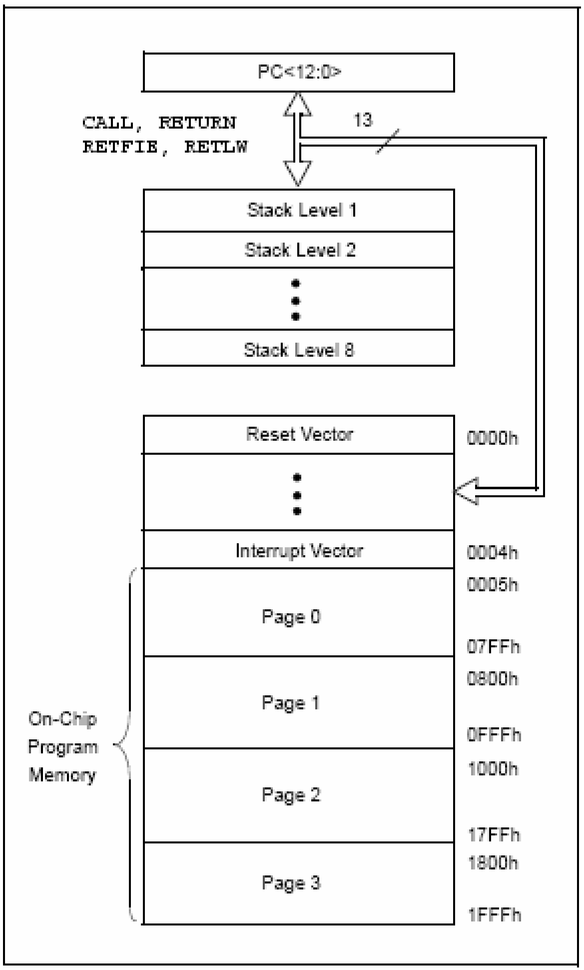

Figure 3.9: Program Memory Map and Stack

3.3.1.5 Timer1 Operation in Synchronized Counter Mode

Counter mode is selected by setting bit TMR1CS. In this mode, the timer increments on every rising edge of clock input on pin RC1/T1OSI/CCP2 when bit T1OSCEN is set, or on pin RC0/T1OSO/T1CKI when bit T1OSCEN is cleared. If T1SYNC is cleared, then the external clock input is synchronized with internal phase clocks. The synchronization is done after the prescaler stage. The prescaler stage is an asynchronous ripple counter. In this configuration, during Sleep mode, Timer1 will not increment even if the external clock is present since the synchronization circuit is shut-off. The prescaler, however, will continue to increment.

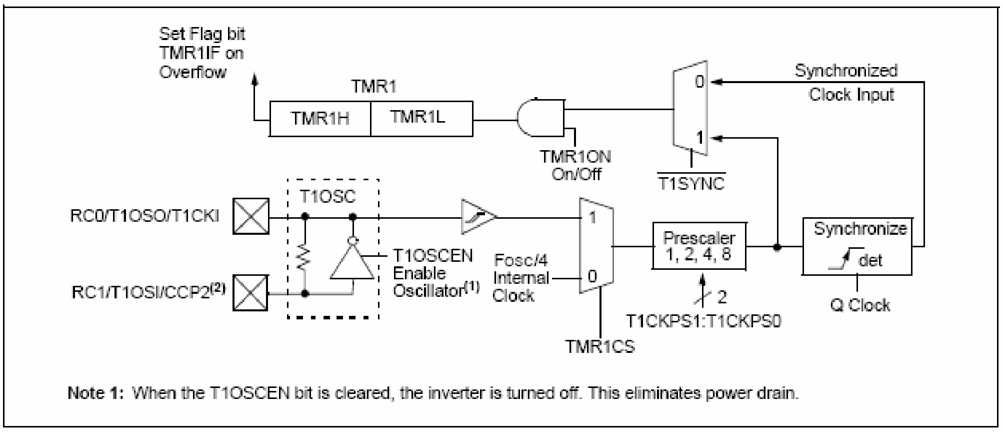

Figure 3.10: Timer 1 Block Diagram

3.3.2 LCD

The Nokia 3310 LCD is a nice small graphical LCD, suitable for a lot of various projects. The display is 38*35 mm, with an active display surface of 30*22 mm, and a 84*48 pixel resolution. The display is easy to interface, using standard SPI communication. A 1-10 uF electrolytic capacitor from VOUT to GND, is the only external component needed.

i. Logic supply voltage range VDD to VSS : 2.7 to 3.3 V
ii. Low power consumption, suitable for battery operated systems
iii. Temperature range: -25 to +70 °C

3.3.2.1 Electrical Interface specification

Pin	Signal	Description	Port
1	VDD	Power Input. Logic supply voltage range VDD to GND : 2.7 to 3.3 V	Power
2	SCLK	Serial clock. Input for the clock signal: 0.0 to 4.0 Mbits/s.	Input
3	SDIN	Serial data. Input for the data line.	Input
4	D/C	Mode Select. To select either command/address or data input.	Input
5	SCE	Chip enable input. The enable pin allows data to be clocked in. The signal is active LOW.	Input
6	GND	Ground	Power
7	VOUT	Ouptut voltage. **Add external 1-10 uF electrolytic capacitor from VOUT to GND**	Power
8	RES	External reset. This signal will reset the device and must be applied to properly initialize the chip. signal is active LOW.	Input

Figure 3.11: Electrical Interface specification

3.3.3 AS1117

3.3.3.1 Features

i. Guaranteed 800mA Output
ii. Terminal Adjustable Or Fixed 1.5V, 2.5V, 2.85V, 3V, 3.3V & 5V
iii. Very Low Quiescent Current
iv. Low Dropout Voltage Of 1.2 Volts At Full Load
v. Extremely Tight Load And Line Regulation
vi. Very Low Temperature Coefficient
vii. Fixed 2.85V Device For SCSI-II Active Terminator
viii. Logic-Controlled Electronic Shutdown
ix. Internal Over current Limiting & Thermal Overload Protection
x. Surface Mount Package SOT-223, TO-252, TO-220, SOT-89, TO-263, & SO-8

3.3.3.2 Product Description

The ALPHA Semiconductor AS1117 is a low power positive-voltage regulator designed to meet 800mA output current and comply with SCSI-II specifications with a fixed output voltage of 2.85V. This device is an excellent choice for use in battery-powered applications, as active terminators for the SCSI bus, and portable computers. The AS1117 features very low quiescent current and very low dropout voltage of 1.2V at a full load and lower as output current decreases. AS1117 is available as an adjustable or fixed 2.85V, 3V, 3.3V, and 5V output voltages. The AS1117 is offered in a 3-pin surface mount package SOT-223, TO-252, TO-220, SOT-89 & TO-263. The output capacitor of 10mF or larger is needed for output stability of AS1117 as required by most of the other regulator circuits. Use of ALPHA Semiconductor's design, processing and testing techniques make our AS1117 superior over similar products.

3.3.3.2 Application Notes External Capacitor

To ensure the stability of the AS1117 an output capacitor of at least 10mF (tantalum)or 50mF (aluminum) is required. The value may change based on the application requirements on the output load or temperature range. The capacitor equivalent series resistance (ESR) will effect the AS1117 stability. The value of ESR can vary from the type of capacitor used in the applications. The recommended value for ESR is 0.5W. The output capacitance could increase in size to above the minimum value. The larger value of output capacitance as high as 100mF can improve the load transient response.

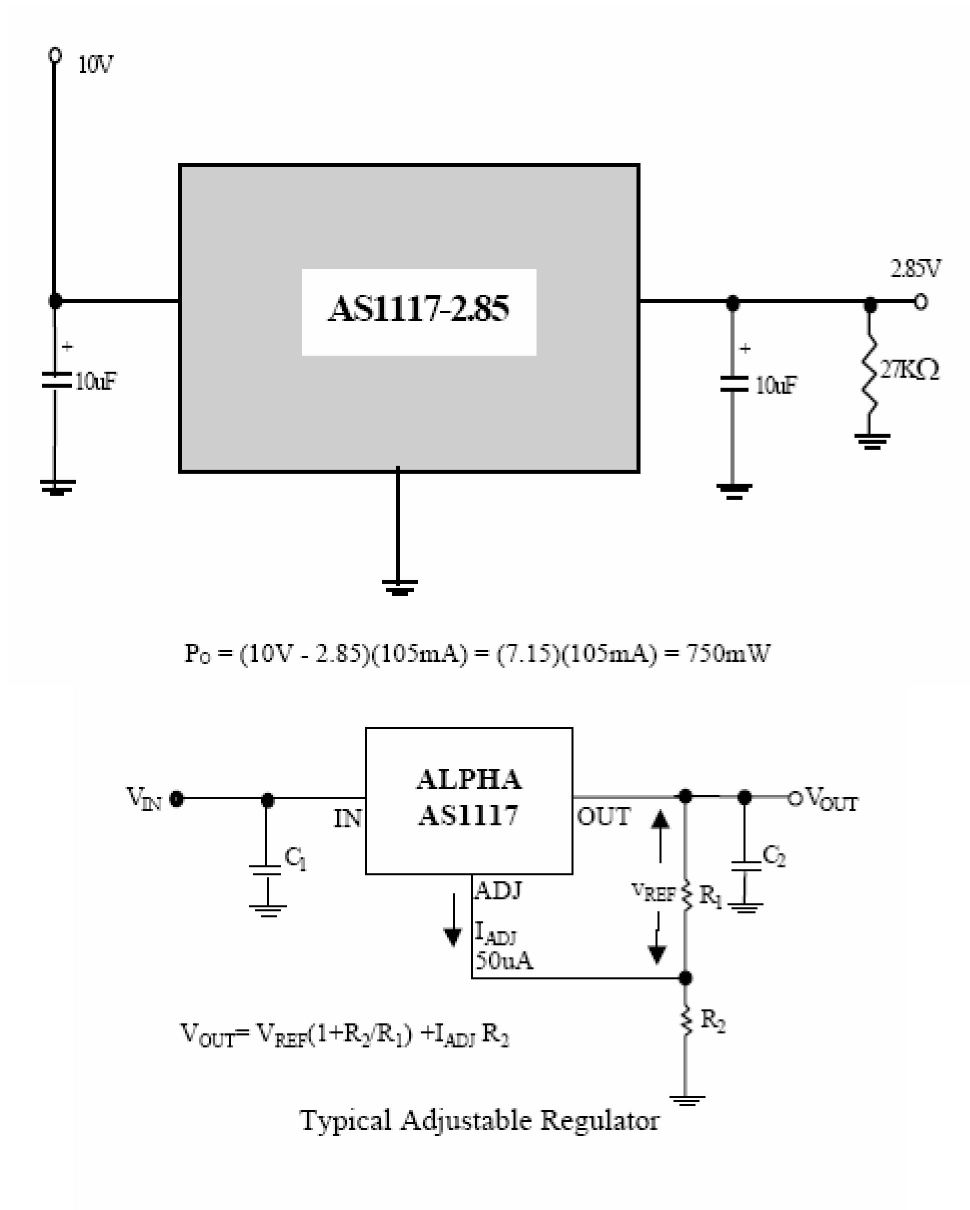

Figure 3.12: Application Notes External Capacitor

3.3.4 74LCX245

3.3.4.1 Features

xi. 5V Tolerant Inputs and Outputs
xii. High Speed: T_{PD} = 7.0 ns (MAX.) at VCC = 3V
xiii. Power Down Protection On Inputs And Outputs
xiv. Symmetrical Output Impedance: $|I_{OH}| = I_{OL}$ = 24mA (MIN) at VCC = 3V
xv. PCI Bus Levels Guaranteed At 24 mA
xvi. Balance Propagation Delay: $t_{PLH} \cong t_{PHL}$
xvii. Operating Voltage Range: V_{CC} (OPR) = 2.0V to 3.6V
xviii. Pin and Function Compatible With 74 SERIES 245
xix. Latch-Up Performance Exceeds 500mA
xx. ECD Performance: HBM > 2000V, MM > 200V

3.3.4.2 Description

The 74LCX245 is a low voltage CMOS OCTAL BUS TRANSCEIVER (3-STATE) fabricated with sub-micron silicon gate and double-layer metal wiring C2MOS technology. It is ideal for low power and high speed 3.3V applications; it can be interfaced to 5V signal environment for both inputs and outputs. It has same speed performance at 3.3V than 5V AC/ACT family, combined with lower power consumption. This IC is intended for two way asynchronous communication between data buses; the direction of data transmission is determined by DIR input. The enable input G can be used to disable the device so that the buses are effectively isolated.
All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage. All floating bus terminals during High Z state must be held HIGH or LOW.

3.3.4.3 Pin Description

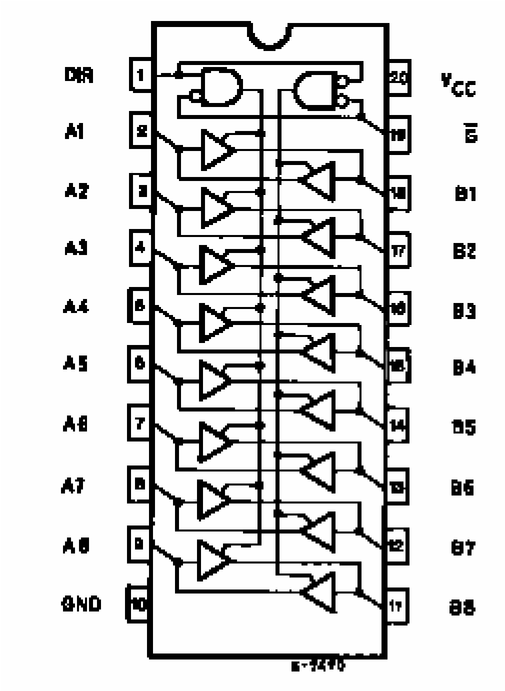

Figure 3.13: Pin Connection and IEC Logic Symbols

PIN N°	SYMBOL	NAME AND FUNCTION
1	DIR	Directional Control
2, 3, 4, 5, 6, 7, 8, 9	A1 to A8	Data Inputs/Outputs
18, 17, 16, 15, 14, 13, 12, 11	B1 to B8	Data Inputs/Outputs
19	$\overline{G}$	Output Enable Input
10	GND	Ground (0V)
20	V_{CC}	Positive Supply Voltage

Table 3.2: Pin Description

3.3.4.4 Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	-0.5 to +7.0	V
V_I	DC Input Voltage	-0.5 to +7.0	V
V_O	DC Output Voltage (OFF State)	-0.5 to +7.0	V
V_O	DC Output Voltage (High or Low State) (note 1)	-0.5 to V_{CC} + 0.5	V
I_{IK}	DC Input Diode Current	- 50	mA
I_{OK}	DC Output Diode Current (note 2)	- 50	mA
I_O	DC Output Current	± 50	mA
I_{CC}	DC Supply Current per Supply Pin	± 100	mA
I_{GND}	DC Ground Current per Supply Pin	± 100	mA
T_{stg}	Storage Temperature	-65 to +150	°C
T_L	Lead Temperature (10 sec)	300	°C

Table 3.3: Absolute Maximum Ratings

3.3.4.5 Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage (note 1)	2.0 to 3.6	V
V_I	Input Voltage	0 to 5.5	V
V_O	Output Voltage (OFF State)	0 to 5.5	V
V_O	Output Voltage (High or Low State)	0 to V_{CC}	V
I_{OH}, I_{OL}	High or Low Level Output Current (V_{CC} = 3.0 to 3.6V)	± 24	mA
I_{OH}, I_{OL}	High or Low Level Output Current (V_{CC} = 2.7V)	± 12	mA
T_{op}	Operating Temperature	-55 to 125	°C
dt/dv	Input Rise and Fall Time (note 2)	0 to 10	ns/V

Table 3.4: Recommended Operating Conditions

3.3.5 L293D

3.3.5.1 Features

i. Wide Supply-Voltage Range: 4.5 V to 36 V
ii. Separate Input-Logic Supply
iii. Internal ESD Protection
iv. Thermal Shutdown
v. High-Noise-Immunity Inputs
vi. Functionally Similar to SGS L293 and SGS L293D
vii. Output Current 1 A Per Channel (600 mA for L293D)
viii. Peak Output Current 2 A Per Channel (1.2 A for L293D)
ix. Output Clamp Diodes for Inductive Transient Suppression (L293D)

3.3.5.2 Description

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are activated and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

3.3.5.3 Block Diagram

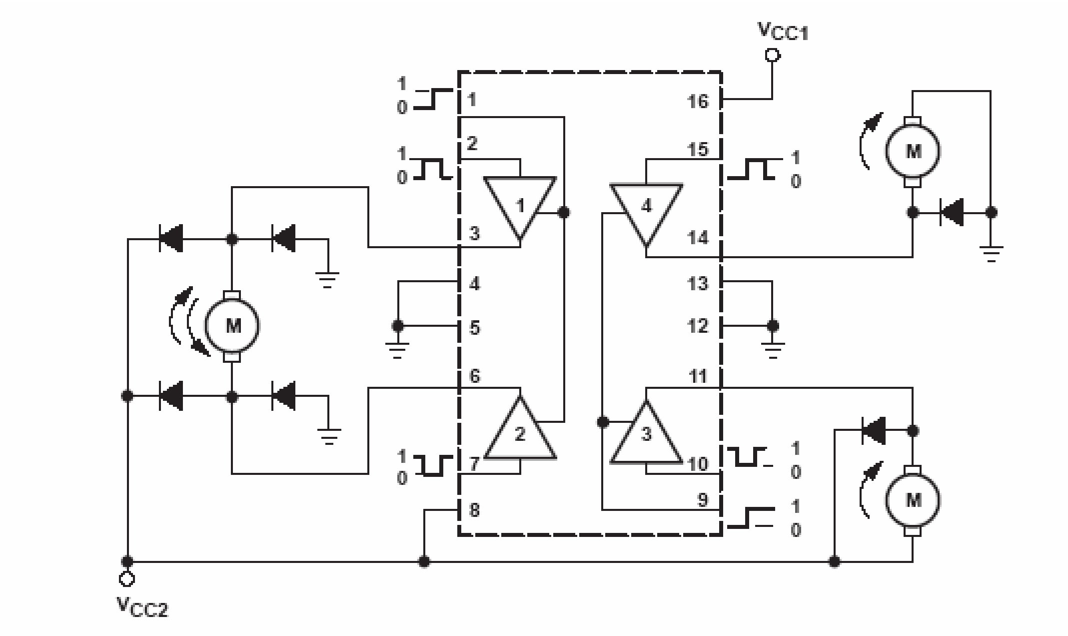

Figure 3.14 Block Diagram

FUNCTION TABLE
(each driver)

INPUTS†		OUTPUT
A	EN	Y
H	H	H
L	H	L
X	L	Z

H = high level, L = low level, X = irrelevant, Z = high impedance (off)
† In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.

Table 3.5: Functional Table

3.3.5.4 Recommended Operating Conditions

			MIN	MAX	UNIT
	Supply voltage	V_{CC1}	4.5	7	V
		V_{CC2}	V_{CC1}	36	
V_{IH}	High-level input voltage	$V_{CC1} \le 7$ V	2.3	V_{CC1}	V
		$V_{CC1} \ge 7$ V	2.3	7	V
V_{IL}	Low-level output voltage		−0.3†	1.5	V
T_A	Operating free-air temperature		0	70	°C

† The algebraic convention, in which the least positive (most negative) designated minimum, is used in this data sheet for logic voltage levels.

Table 3.6: Recommended Operating Conditions

3.4 Schematic Diagram for Control System

3.4.1 Microcontroller (PIC16F876A)

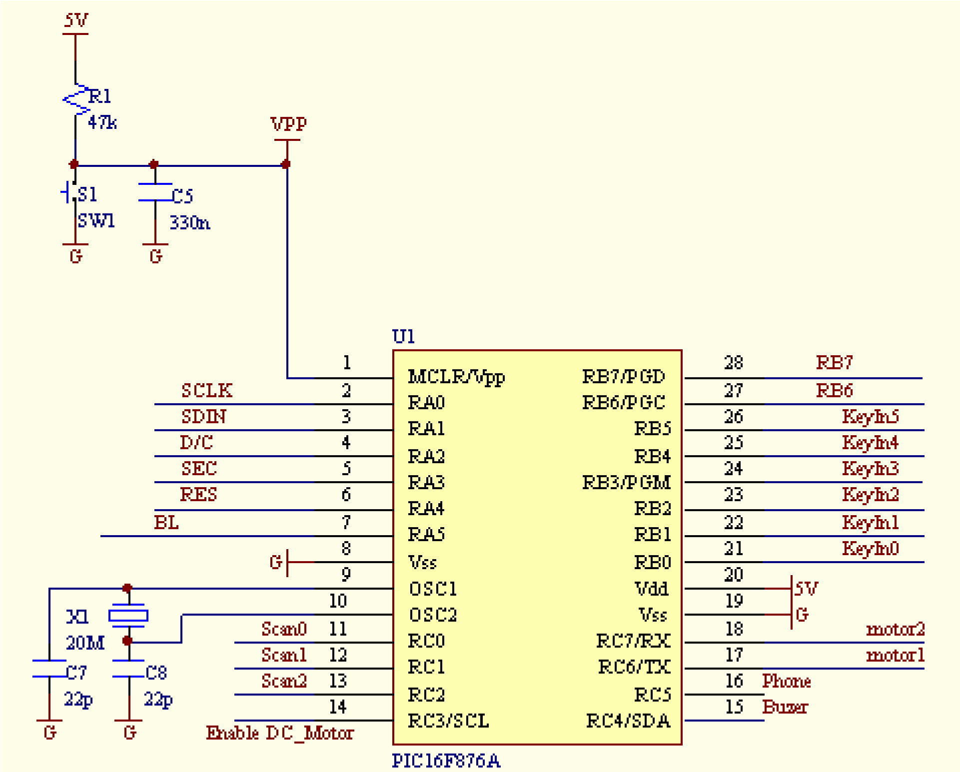

Figure 3.17: Microcontroller (PIC16F876A)

The microcontroller PIC 16F876A is used to scan the keypad, change/identify/set password, authorizes the lock and control the alarm system. In order to burn the firmware to PIC processor, the pin 1 (MCLK), pin 8 (Vss), pin 20 (5V), pin 27 (RB6) and pin 28 (RB7) must connected to the Microchip ICD 2. Pin 2 (SCLK), pin 3 (SDIN), pin 4 (D/C), pin 5 (SEC), and pin 6 (RES) is connected to IC 74LCX245. This IC is intended for two way asynchronous communication between data buses. Pin 11 (Scan 0), Pin 12 (Scan 1), and Pin 13 (Scan 3) is used to scan the keypad for pressed by somebody. The pin 14 (Enable DC_Motor), pin 17 (motor1) and pin 18 (motor2) are connected to L293D (driver for DC motor) for authorizing the lock. Pin 15 (Buzzer) and Pin 16 (Phone) are used to activate the alarm system. Then, pin 21 (KeyIn0), pin 22 (KeyIn1), pin 23 (KeyIn2), pin 24 (KeyIn3), pin 25 (KeyIn4) and pin 26 (KeyIn5) are used to pull up the voltage to 5 volt for keypad scanning.

3.4.2 Step down 5 volt to 2.8 volt for LCD

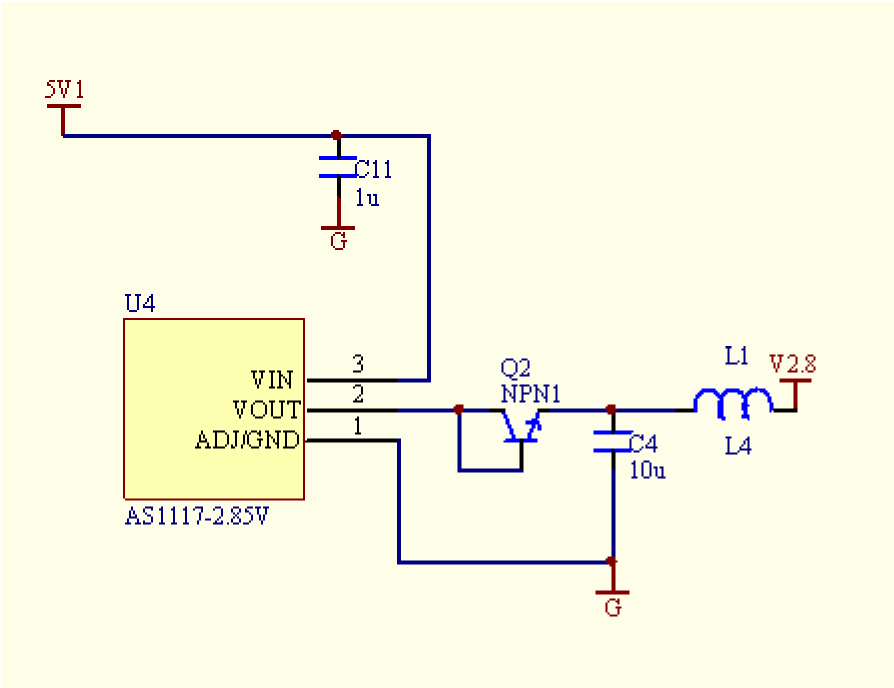

Figure 3.18: Step down 5 volt to 2.8 volt for LCD

The operating voltage for LCD is 2.7 volt to 3.3 volt. So the AS1117-2.85V is used to step down 5 volt input voltage to 2.8 volt. The ALPHA Semiconductor AS1117 is a low power positive-voltage regulator designed to meet 800mA output current and comply with SCSI-II specifications with a fixed output voltage of 2.85V.

3.4.3 Interfacing between 74LCX245 and LCD

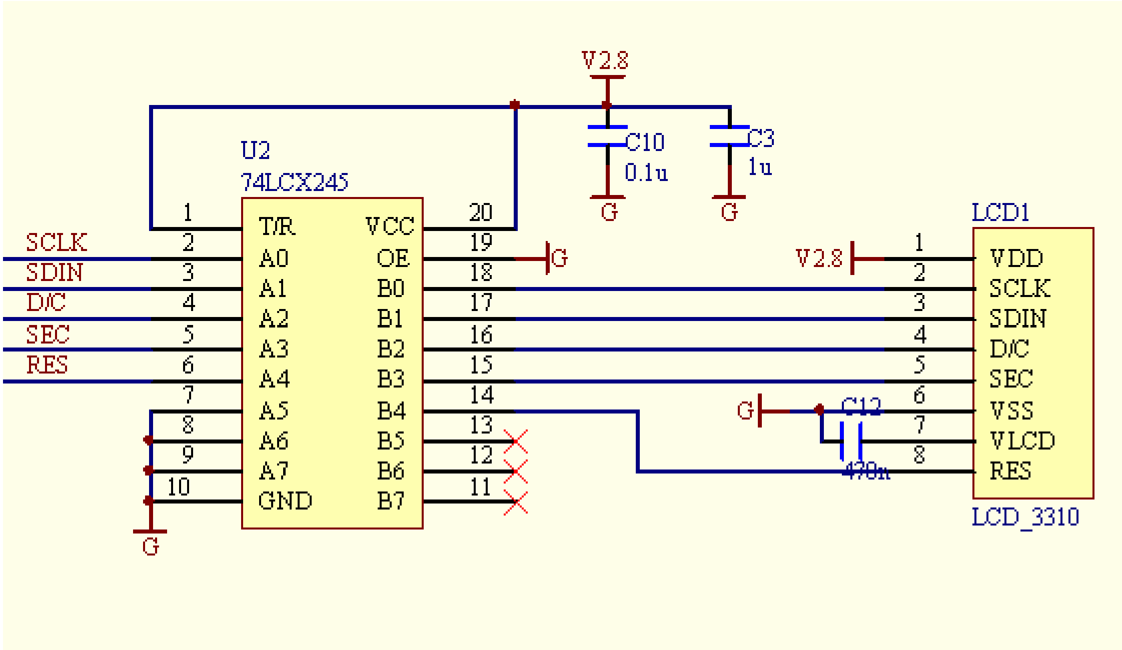

Figure 3.19: Interfacing between 74LCX245 and LCD

74LCX245 is the driver for the LCD_3310 and operating at 2.8 volt. The pin 2 (SCLK), pin 3 (SDIN), pin 4 (D/C), pin 5 (SEC), and pin 6 (RES) are connected to microcontroller (PIC 16F876A).

3.4.4 LED for Keypad

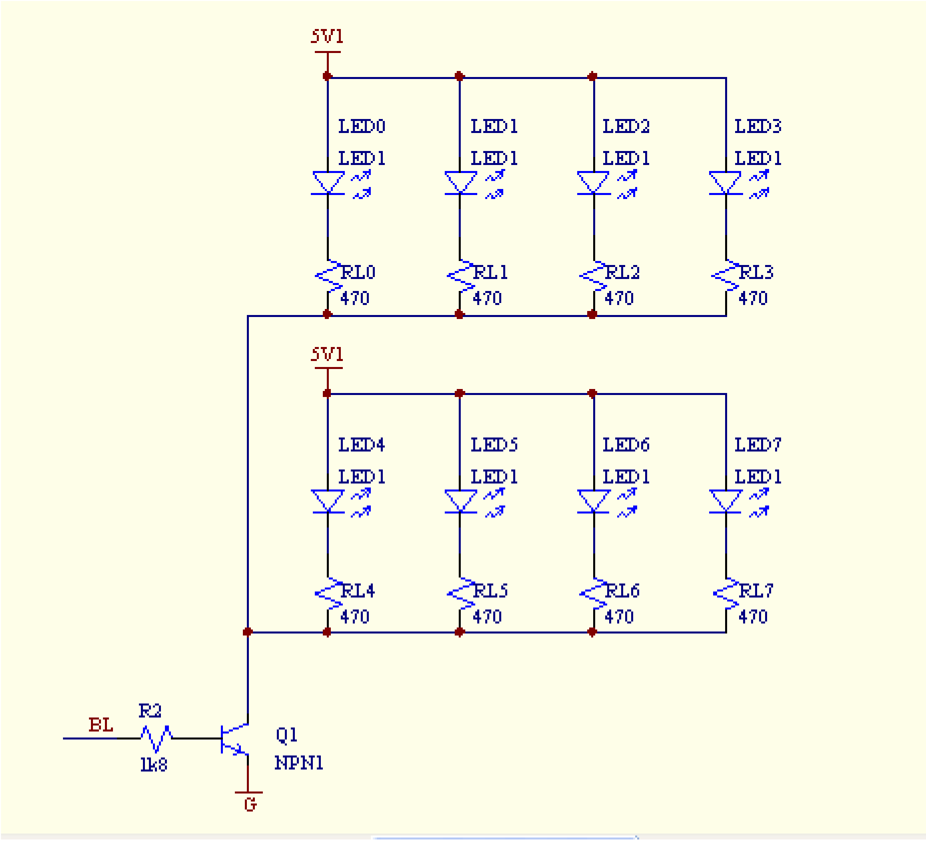

Figure 3.20 LED for Keypad

The base of the NPN Q1 is connected to microcontroller. When the pin BL is high, the Vce will become zero and the LED1, LED2, LED3, LED4, LED5, LED6, LED7, and LED8 will be ‘on’. It will make the keypad has been seen more clearly.

3.4.5 Keypad

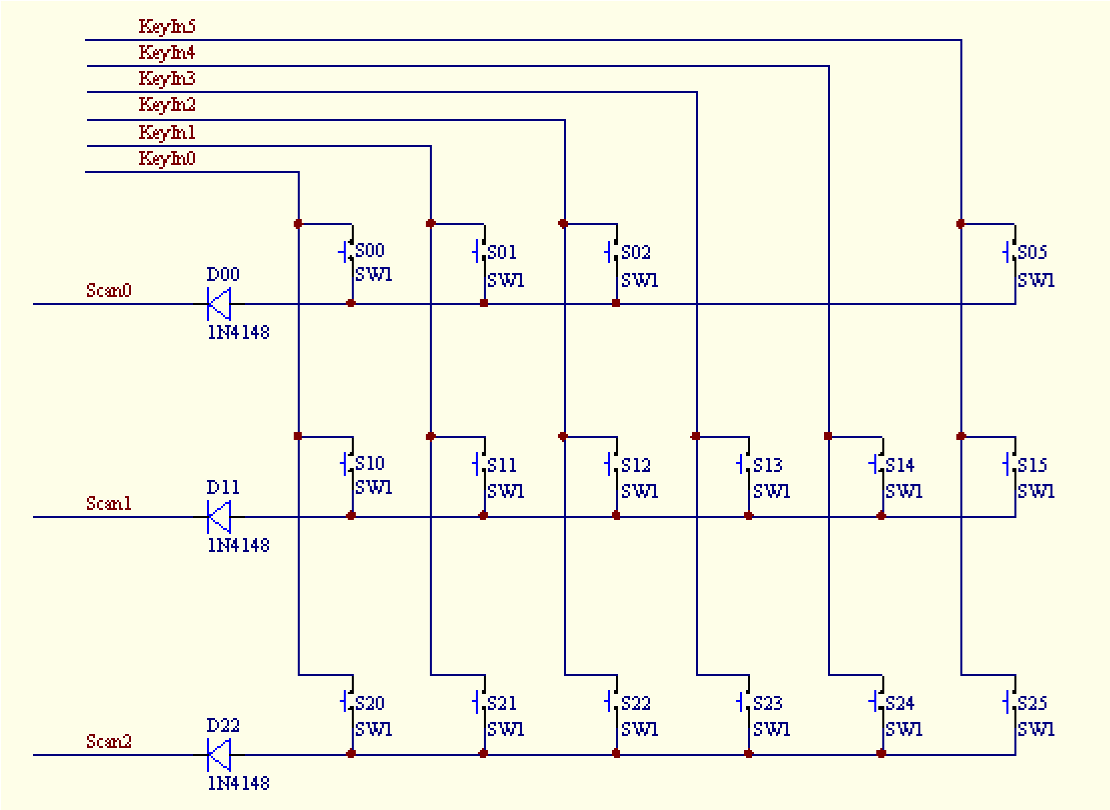

Figure 3.21: Keypad

This is the schematic diagram of the keypad. The pin KeyIn 1, KeyIn 2, KeyIn 3, KeyIn 4, KeyIn 5, and KeyIn 0 is always be 'HIGH'. The control system will scan the keypad every 10 ms. During the scanning period, the scan0 will be 'LOW' and follow by scan1 and scan 2. So if the SW! is pressed when the Scan0 is 'LOW', the KeyIn0 will become 'LOW' and the others KeyIn is 'HIGH'. From here, the microcontroller can detect what the switch is pressed by user.

3.4.6 L293D

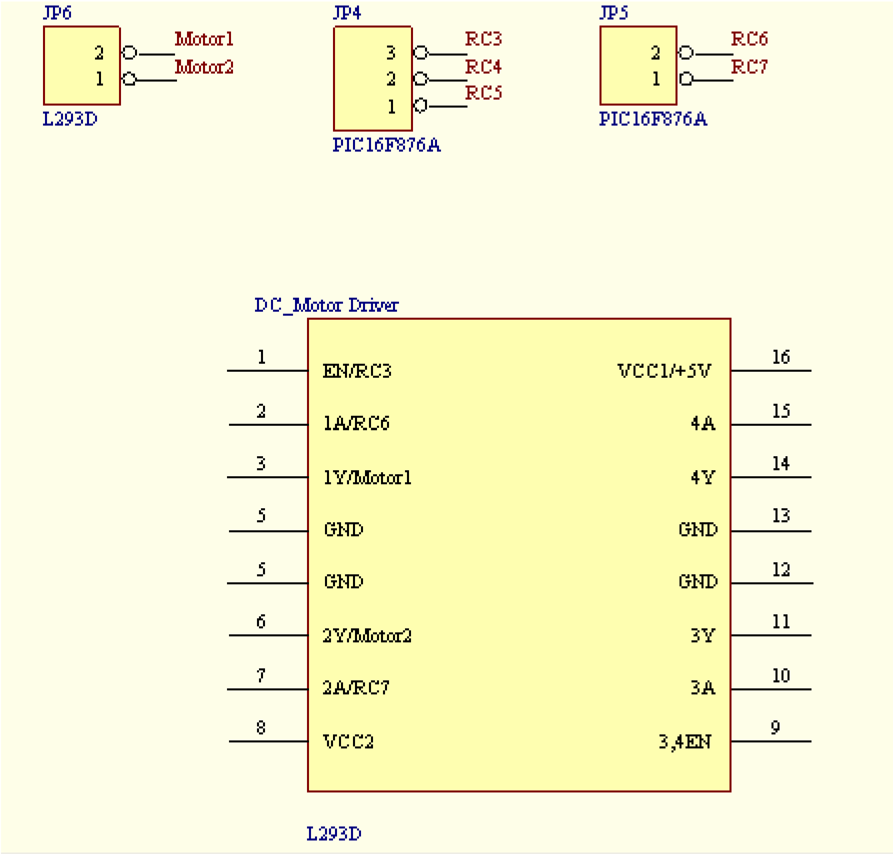

Figure 3.22: L293D

The JP4, JP5, and JP6 are the connector for microcontroller and motor for the lock. When the pin 1 (EN) is ‘H’, pin 2 (1A) is ‘L’ and pin 7 is ‘H’, the DC motor will turn clockwise and the door will unlocked. For locking the door, pin 1 (EN) is ‘H’, pin 2 (1A) is ‘H’ and pin 7 is ‘L’, the DC motor will turn anti-clockwise. However the Vcc1 and Vcc2 must connect to power supply.

CHAPTER 4

SOFTWARE DEVELOPMENT

4.1 Overall Structure

A program is made up of the following four elements in a file: **Comment, Pre-Processor Directive, Data Definition and Function Definition.** Every C program must contain a main function which is the starting point of the program execution. The program can be split into multiple functions according to their purpose and the functions could be called from main or the sub functions. In a large project functions can also be placed in different C files or header files that can be included in the main C file to group the related functions by their category. CCS C also requires to include the appropriate device file using #include directive to include the device specific functionality. There are also some preprocessor directives like #fuses to specify the fuses for the chip and #use delay to specify the clock speed. The functions contain the data declarations, definitions, statements and expressions. The compiler also provides a large number of standard C libraries as well as other device drivers that can be included and used in the programs. CCS also provides a large number of built-in functions to access the various peripherals included in the PIC microcontroller.

4.2 Statements

STATEMENT	EXAMPLE

if (expr) stmt; [else stmt;]	if (x==25)
	x=1;
	else
	x=x+1;

while (expr) stmt;	while (get_rtcc()!=0) putc('n');

do stmt while (expr);	do {
	putc(c=getc());
	} while (c!=0);

for (expr1;expr2;expr3) stmt;	for (i=1;i<=10;++i) printf("%u\r\n",i);

switch (expr) {
case cexpr: stmt; //one or more case
[default:stmt]
... }
	switch (cmd) {
	case 0: printf("cmd 0");
	break;
	case 1: printf("cmd 1");
	break;
	default: printf("bad cmd");
	break; }

return [expr];	return (5);
goto label;	goto loop;
label: stmt;	loop: I++;

break;	break;
continue;	continue;
expr;	i=1;
;	;
{[stmt]} Zero or more	{a=1; b=1;}

Table 4.1 Statements

4.3 Operators

+	Addition Operator
+=	Addition assignment operator, x+=y, is the same as x=x+y
&=	Bitwise and assignment operator, x&=y, is the same as x=x&y
&	Address operator
&	Bitwise and operator
^=	Bitwise exclusive or assignment operator, x^=y, is the same as x=x^y
^	Bitwise exclusive or operator
|=	Bitwise inclusive or assignment operator, x|=y, is the same as x=x|y
|	Bitwise inclusive or operator
?:	Conditional Expression operator

- -	Decrement
/=	Division assignment operator, x/=y, is the same as x=x/y
	Division operator
==	Equality
>	Greater than operator
>=	Greater than or equal to operator
++	Increment
*	Indirection operator
!=	Inequality
<<=	Left shift assignment operator, x<<=y, is the same as x=x<<y
<	Less than operator
<<	Left Shift operator
<=	Less than or equal to operator
&&	Logical AND operator
!	Logical negation operator
ll	Logical OR operator
%=	Modules assignment operator x%=y, is the same as x=x%y
%	Modules operator
*=	Multiplication assignment operator, x*=y, is the same as x=x*y
*	Multiplication operator
~	One's complement operator
>>=	Right shift assignment, x>>=y, is the same as x=x>>y
>>	Right shift operator
->	Structure Pointer operation
-=	Subtraction assignment operator
-	Subtraction operator
sizeof	Determines size in bytes of operand

Table 4.2: Operators

4.4 Data Definitions

This section describes what the basic data types and specifiers are and how variables can be declared using those types. In CCS C all the variables should be declared before it is used. They can be defined inside a function (local) or outside all functions (global). This would affect the visibility and life of the variables.

4.4.1 Basic Types

Type Specifier	
int1	Defines a 1 bit number
int8	Defines an 8 bit number
int16	Defines a 16 bit number
int32	Defines a 32 bit number
char	Defines a 8 bit character
float	Defines a 32 bit floating point number
short	By default the same as int1
Int	By default the same as int8
long	By default the same as int16
void	Indicates no specific type

Table 4.3: Basic Types

Note: All types, except float, by default are unsigned; however, maybe preceded by unsigned or signed. Short and long may have the keyword INT following them with no effect. Also see #TYPE to change the default size.

SHORT is a special type used to generate very efficient code for bit operations and I/O. Arrays of bits (INT1 or SHORT) in RAM are now supported. Pointers to bits are not permitted

4.4.2 Declarations

A declaration specifies a type qualifier and a type specifier, and is followed by a list of one or more variables of that type.

For e.g.:

```
int a,b,c,d;
mybit e,f;
mybyte g[3][2];
char *h;
colors j;
struct data_record data[10];
static int i;
extern long j;
```

Variables can also be declared along with the definitions of the special types.

For eg:

enum colors{red, green=2,blue}i,j,k; // colors is the enum type and i,j,k are variables of that type

4.4.3 Using Program Memory for Data

CCS C Compiler provides a few different ways to use program memory for data. The different ways are discussed below:

Constant Data:

The const qualifier will place the variables into program memory. The syntax is const type specifier id [cexpr] = {value}
If the keyword CONST is used before the identifier, the identifier is treated as a constant. Constants should be initialized and may not be changed at run-time. This is an easy way to create lookup tables.

For e.g.:

const int table[16]={0,1,2...15}

For placing a string into ROM

const char cstaring[6]={"hello"}

You can also create pointers to constants

const char *cptr;

cptr = string;

The #org preprocessor can be used to place the constant to specified address blocks.

For eg:

#ORG 0x1C00, 0x1C0F

CONST CHAR ID[10]= {"123456789"};

This ID will be at 1C00.

Note: some extra code will proceed the 123456789.

A new method allows the use of pointers to ROM. The new keyword for compilation modes CCS4 and ANSI is ROM and for other modes it is _ROM. This method does not contain extra code at the start of the structure.
For e.g:

char rom commands[] = {“put|get|status|shutdown”};

The function label address can be used to get the address of the constant. The constant variable can be accessed in the code. This is a great way of storing constant data in large programs. Variable length constant strings can be stored into program memory.

For PIC18 parts the compiler allows a non-standard c feature to implement a constant array of variable length strings. The syntax is:

```
const char id[n] [*] = { "strint", "string" ...};
```

Where n is optional and id is the table identifier. For example:

```
const char colors[] [*] = { "Red", "Green", "Blue"};
```

#ROM directive:

Another method is to use #rom to assign data to program memory, the usage is #rom address ={data, data,..,data}.
For eg:

#rom 0x1000={1,2,3,4,5} //will place 1,2,3,4,5 to rom addresses starting at 0x1000
This can be used for strings #rom address={"hello"}
// the string will be null terminated
This method can only be used to initialize the program memory.

Built-in-Functions:

The compiler also provides built-in functions to place data in program memory, they are:

i. **write_program_eeprom(address,data)**- writes 16 bit data to program memory
ii. **write_program_memory(address, dataptr, count)**; writes count bytes of data from dataptr to address in program memory.

Please refer to the help of these functions to get more details on their usage and limitations regarding erase procedures. These functions can be used only on chips that allow writes to program memory. The compiler uses the flash memory erase and write routines to implement the functionality.

The data placed in program memory using all the three methods above can be read form user code using:

- **read_program_eeprom (address)**- reads 16 bits data from the address in program memory.
- **read_program_memory (address, dataptr, count)** -Reads count bytes from program memory at address to RAM at dataptr.

These functions can be used only on chips that allow reads from program memory. The compiler uses the flash memory read routines to implement the functionality

4.5 Firmware (Microcontroller)

4.5.1 Pseudo Code

1. Setup – initialize LCD and alarm system
2. Hold for keystroke.
3. match keystroke to EEPROM password
4. Check the length password.
5. if 6 digits entered, begin validation
   else goto step[3]
6. if correct code, disengage lock.
   else check number failures.
7. if 3rd failures, defensive lockout and activate alarm system
8. goto setup(step[1])

4.6 Parts of My Software

```
//*********************************************
// Source Code for Safety Cabinet alarm System
// Firmware for Microcontroller (PIC 16F876A)
//*********************************************

#include <16F876A.h>
#device *=16 ADC=8 //16bit pointer, 8-bit ADC
#use delay(clock=20000000) //20M Hertz
//Initial Configuration Bits
#fuses  HS,NOWDT,PROTECT,PUT,NOWRT,BROWNOUT,NOLVP



//************************************
//Constant Data be plced in ROM
//************************************

//Display Number '1','2','3','4','5','6',7'','8','9','0'
const int8 bmpc[10][7] = {{0, 0x3e, 0x51, 0x49, 0x45, 0x3e, 0},
                          {0, 0x00, 0x42, 0x7f, 0x40, 0x00, 0},
                          {0, 0x42, 0x61, 0x51, 0x49, 0x46, 0},
                          {0, 0x21, 0x41, 0x45, 0x4b, 0x31, 0},
                          {0, 0x18, 0x14, 0x12, 0x7f, 0x10, 0},
                          {0, 0x27, 0x45, 0x45, 0x45, 0x39, 0},
                          {0, 0x3c, 0x4a, 0x49, 0x49, 0x30, 0},
                          {0, 0x01, 0x71, 0x09, 0x05, 0x03, 0},
                          {0, 0x36, 0x49, 0x49, 0x49, 0x36, 0},
                          {0, 0x06, 0x49, 0x49, 0x29, 0x1e, 0}};
```

Examples

{0, 0x3e, 0x51, 0x49, 0x45, 0x3e, 0}

0x00	=	0000 0000
0x3e	=	00**11** **111**0
0x51	=	0**1**0**1** 000**1**
0x49	=	0**1**00 **1**00**1**
0x45	=	0**1**00 0**1**0**1**
0x3e	=	00**11** **111**0
0x00	=	0000 0000
Hex		binary

Display ‘0’

{0, 0x00, 0x42, 0x7f, 0x40, 0x00, 0}

0x00	=	0000 0000
0x00	=	0000 0000
0x42	=	0**1**00 00**1**0
0x7f	=	0**111** **1111**
0x40	=	0**1**00 0000
0x00	=	0000 0000
0x00	=	0000 0000
Hex		binary

Display ‘1’

{0, 0x42, 0x61, 0x51, 0x49, 0x46, 0}

0x00	=	0000 0000
0x42	=	0**1**00 00**1**0
0x61	=	0**11**0 000**1**
0x51	=	0**1**0**1** 000**1**
0x49	=	0**1**00 **1**00**1**
0x46	=	0**1**00 0**11**0
0x00	=	0000 0000
Hex		binary

Display ‘2’

{0, 0x21, 0x41, 0x45, 0x4b, 0x31, 0}

0x00	=	0000 0000
0x21	=	00**1**0 000**1**
0x41	=	0**1**00 000**1**
0x45	=	0**1**00 **1**00**1**
0x4b	=	0**1**00 **1**0**11**
0x31	=	0**11**0 000**1**
0x00	=	0000 0000
Hex		binary

Display ‘3’

```
//Display "Mark"
const int8 bmpc_2b[7] = {0, 0x7f, 0x7f, 0x7f, 0x7f, 0x7f, 0};  // display all
const int8 bmpc_2c[7] = {0, 0x02, 0x01, 0x51, 0x09, 0x06, 0};  // display '?'
const int8 bmpc_2d[7] = {0, 0x00, 0x60, 0x60, 0x00, 0x00, 0};  // display '.'
const int8 bmpc_2e[7] = {0, 0x08, 0x08, 0x08, 0x08, 0x08, 0};  // display '-'
const int8 bmpc_2f[7] = {0, 0x00, 0x41, 0x22, 0x14, 0x08, 0};  // display '>'
const int8 bmpc_30[7] = {0, 0x08, 0x14, 0x22, 0x41, 0x00, 0};  // display '<'
const int8 bmpc_31[7] = {0x49, 0x2a, 0x1c, 0x7f, 0x1c, 0x2a, 0x49};  // display '*'
const int8 bmpc_32[7] = {0x18, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18};  // display '--'
const int8 bmpc_33[7] = {0x18, 0x18, 0xf8, 0xf8, 0, 0, 0};  // display '-|'
const int8 bmpc_34[7] = {0, 0, 0xf8, 0xf8, 0x18, 0x18, 0x18};  // display '|-'
const int8 bmpc_35[7] = {0, 0, 0x1f, 0x1f, 0x18, 0x18, 0x18};  // display '|_'
const int8 bmpc_36[7] = {0x18, 0x18, 0x1f, 0x1f, 0, 0, 0};  // display '_|'
const int8 bmpc_37[7] = {0, 0, 0xff, 0xff, 0, 0, 0};  // display '|'
const int8 bmpc_40h[7] = {0, 0, 0, 0, 0, 0, 0};// display 'blank'

//Display  Character from 'A' to 'Z'
const int8 bmpc_AAMM[13][7] = { {0, 0x7e, 0x11, 0x11, 0x11, 0x7e, 0}, //A...M
                                {0, 0x7f, 0x49, 0x49, 0x49, 0x36, 0},
                                {0, 0x3e, 0x41, 0x41, 0x41, 0x22, 0},
                                {0, 0x7f, 0x41, 0x41, 0x22, 0x1c, 0},
                                {0, 0x7f, 0x49, 0x49, 0x49, 0x41, 0},
                                {0, 0x7f, 0x09, 0x09, 0x09, 0x01, 0},
                                {0, 0x3e, 0x41, 0x49, 0x49, 0x7a, 0},
                                {0, 0x7f, 0x08, 0x08, 0x08, 0x7f, 0},
                                {0, 0x00, 0x41, 0x7f, 0x41, 0x00, 0},
                                {0, 0x20, 0x40, 0x41, 0x3f, 0x01, 0},
                                {0, 0x7f, 0x08, 0x14, 0x22, 0x41, 0},
                                {0, 0x7f, 0x40, 0x40, 0x40, 0x40, 0},
                                {0, 0x7f, 0x02, 0x0c, 0x02, 0x7f, 0}};
```

```
const int8 bmpc_NNZZ[13][7] = { {0, 0x7f, 0x04, 0x08, 0x10, 0x7f, 0}, //N...Z
                                {0, 0x3e, 0x41, 0x41, 0x41, 0x3e, 0},
                                {0, 0x7f, 0x09, 0x09, 0x09, 0x06, 0},
                                {0, 0x3e, 0x41, 0x51, 0x21, 0x5e, 0},
                                {0, 0x7f, 0x09, 0x19, 0x29, 0x46, 0},
                                {0, 0x46, 0x49, 0x49, 0x49, 0x31, 0},
                                {0, 0x01, 0x01, 0x7f, 0x01, 0x01, 0},
                                {0, 0x3f, 0x40, 0x40, 0x40, 0x3f, 0},
                                {0, 0x1f, 0x20, 0x40, 0x20, 0x1f, 0},
                                {0, 0x3f, 0x40, 0x38, 0x40, 0x3f, 0},
                                {0, 0x63, 0x14, 0x08, 0x14, 0x63, 0},
                                {0, 0x07, 0x08, 0x70, 0x08, 0x07, 0},
                                {0, 0x61, 0x51, 0x49, 0x45, 0x43, 0}};

//Display  Character from 'a' to 'z'
const int8 bmpc_am[13][7] = {{0, 0x20, 0x54, 0x54, 0x54, 0x78, 0}, //a...m
                             {0, 0x7f, 0x48, 0x44, 0x44, 0x38, 0},
                             {0, 0x38, 0x44, 0x44, 0x44, 0x20, 0},
                             {0, 0x38, 0x44, 0x44, 0x48, 0x7f, 0},
                             {0, 0x38, 0x54, 0x54, 0x54, 0x18, 0},
                             {0, 0x08, 0x7e, 0x09, 0x01, 0x02, 0},
                             {0, 0x0c, 0x52, 0x52, 0x52, 0x3e, 0},
                             {0, 0x7e, 0x08, 0x04, 0x04, 0x78, 0},
                             {0, 0x00, 0x44, 0x7d, 0x40, 0x00, 0},
                             {0, 0x20, 0x40, 0x44, 0x3d, 0x00, 0},
                             {0, 0x7f, 0x10, 0x28, 0x44, 0x00, 0},
                             {0, 0x00, 0x41, 0x7f, 0x40, 0x00, 0},
                             {0, 0x7c, 0x04, 0x18, 0x04, 0x78, 0}};
```

```
const int8 bmpc_nz[13][7] = { {0, 0x7c, 0x08, 0x04, 0x04, 0x78, 0},
                              {0, 0x38, 0x44, 0x44, 0x44, 0x38, 0},
                              {0, 0x7c, 0x14, 0x14, 0x14, 0x08, 0},
                              {0, 0x08, 0x14, 0x14, 0x18, 0x7c, 0},
                              {0, 0x7c, 0x08, 0x04, 0x04, 0x08, 0},
                              {0, 0x48, 0x54, 0x54, 0x54, 0x20, 0},
                              {0, 0x04, 0x3f, 0x44, 0x40, 0x20, 0},
                              {0, 0x3c, 0x40, 0x40, 0x20, 0x7c, 0},
                              {0, 0x1c, 0x20, 0x40, 0x20, 0x1c, 0},
                              {0, 0x3c, 0x40, 0x30, 0x40, 0x3c, 0},
                              {0, 0x44, 0x28, 0x10, 0x28, 0x44, 0},
                              {0, 0x0c, 0x50, 0x50, 0x50, 0x3c, 0},
                              {0, 0x44, 0x64, 0x54, 0x4c, 0x44, 0}};
```

The programming ‘C’ has been used to develop the firmware for the microcontroller 16F876A. ‘C’ language has been chosen because it is the high level language and can be compiled to any type of assembly languages which is suitable to the microcontroller that been used.

CHAPTER 5

RESULTS AND DISCUSSION

Chapter 5 will show the results from the proposed system. Instructions on how to use the safety cabinet alarm system are introduced in this chapter.

5.1 System Overview

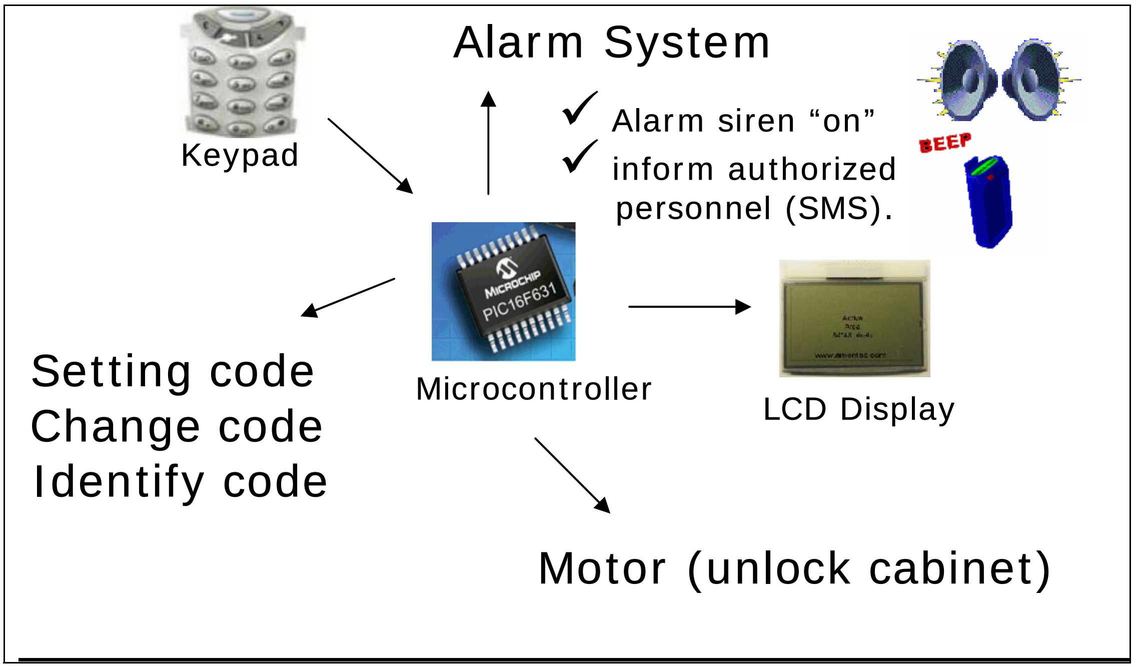

Figure 5.1: System Overview

I used PIC microcontroller be main controller in my control system. First PIC used to identify what button that is press on the keypad. The keypad is the Nokia phone keypad and used to enter the safety code. There are 2 parts in the alarm system. If someone tries to break in the cabinet, the alarm siren will be on and at the same time a message (SMS) will be send out to inform the authorized personnel through the internal cell phone at the safety cabinet. PIC also programmed to identify/ change/ set the code. With the display of LCD, the owner will be more easy or convenient to operate the control system. When the code is right, the motor will be trigger to unlock the cabinet.

5.2 Project Overview

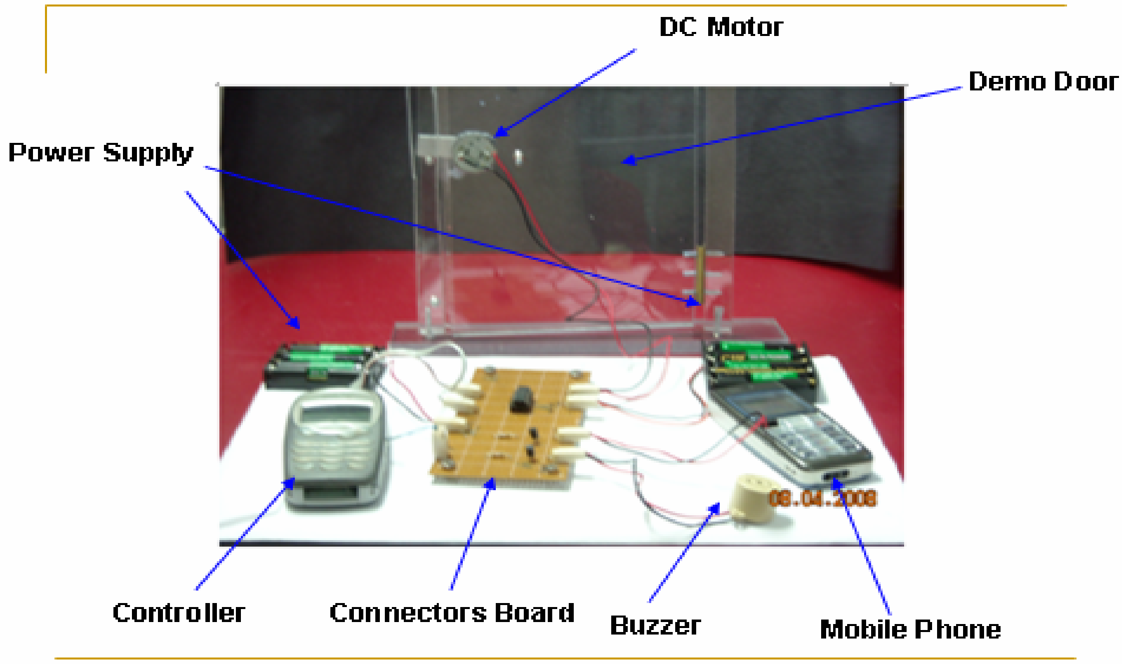

Figure 5.2: Project Overview

5.2.1 User Manual

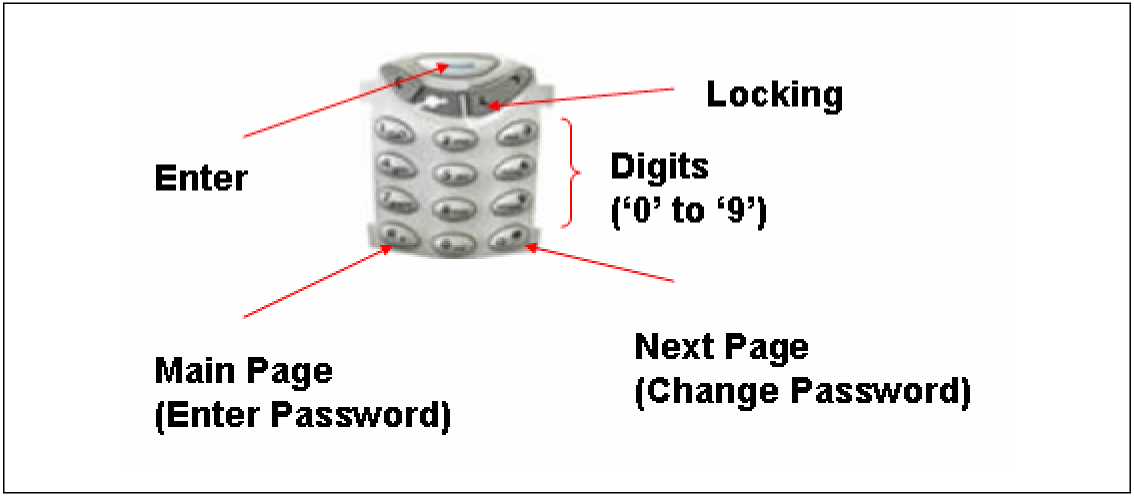

Figure 5.3: Keypad

main page

next page

Figure 5.4: LCD Pages

When the power supply is 'on', the LCD will display "UNEVERSITI TEKNOLOGI MALAYSIA" for 3 seconds. It aims to promote the company name and identify the model of the products. After the 3 seconds, the LCD will display the main page and ask for password. If you need to activate the cabinet lock, you need to enter the correct password and press "Enter" button by using the keypad. The combination length is 6 digits long. When the correct password is entered, the LCD will display "unlock" that means the lock already activated and you can access the cabinet now.

If the password is wrong, the LCD will display “INVALID CODE” for 1 second, and then you need to enter the password again to activate the cabinet lock. If the invalid code is entered for 3 times, the LCD will display “WARNING”, the alarm system will be on. The alarm siren will be ‘on’ and at the same time, a message will be sending out to inform the authorized person through the mobile phone. In order to switch off the alarm system, button “ * ” must be pressed and the LCD will display will main page again. At this time, you need to enter correct password to switch off the alarm system.

For the password changing, the button “ # ” must be pressed. The LCD will display next page” Change Password ?”. If you want to change password, the button “Enter” must be pressed. The system will ask for old password. When the password is right, you need to enter the new password for 2 times to confirm the new password. After the password changed successfully, the LCD will display “Password Changed” for 1 second, the main page will display again.

5.3 PCB Layout

5.3.1 Controller Layout (Top Layer)

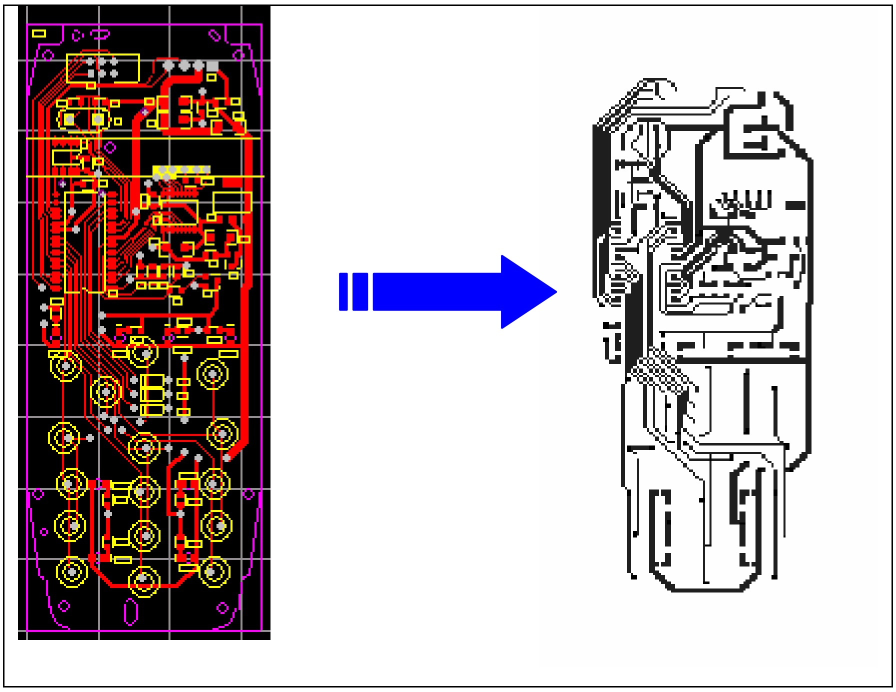

Figure 5.5: Controller Layout (Top Layer)

5.3.2 Controller Circuit (Top Layer)

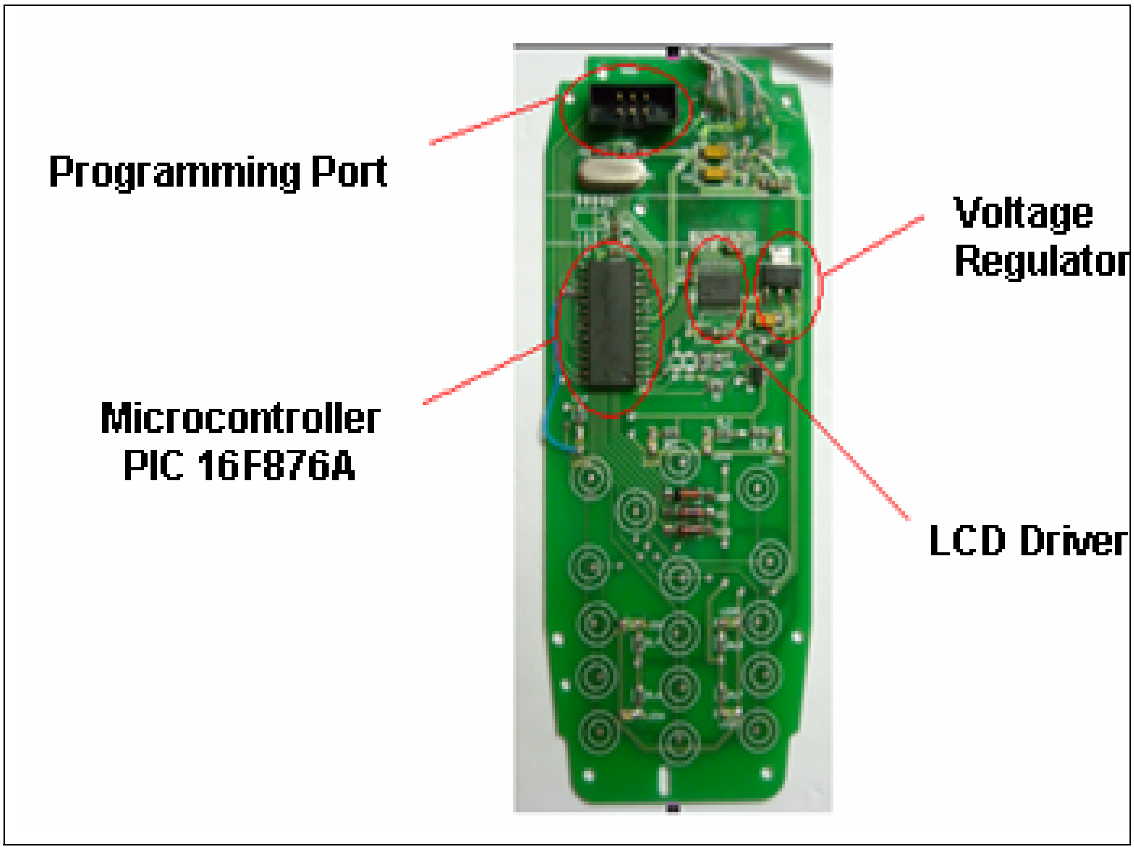

Figure 5.6: Controller Circuit (Top Layer)

5.3.3 Controller Layout (Bottom Layer)

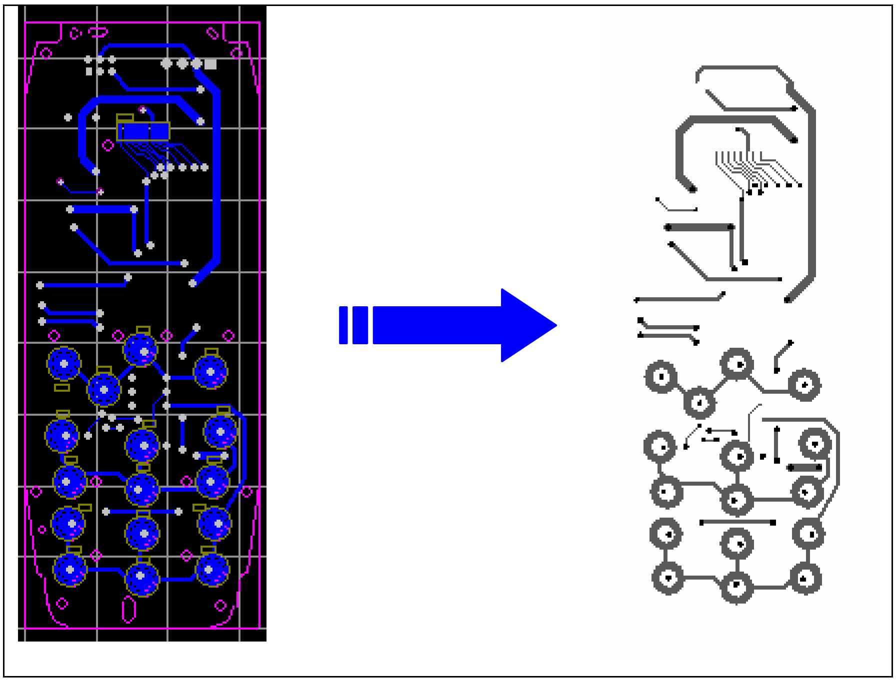

Figure 5-7: Controller Layout (Bottom Layer)

5.3.4 Controller Circuit (Bottom Layer)

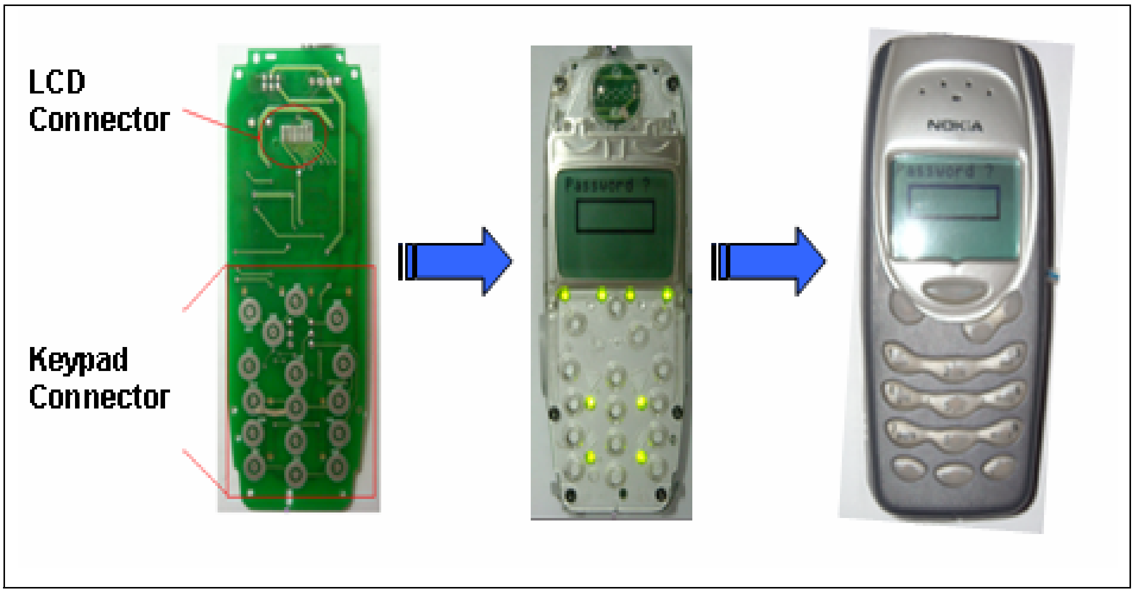

Figure 5-8: Controller Circuit (Bottom Layer)

5.4 Connector's Board

This connector's board has 7 pieces 2-pin header (3 controller header, 2 DC power supply header, mobile phone header, buzzer header, and motor header).

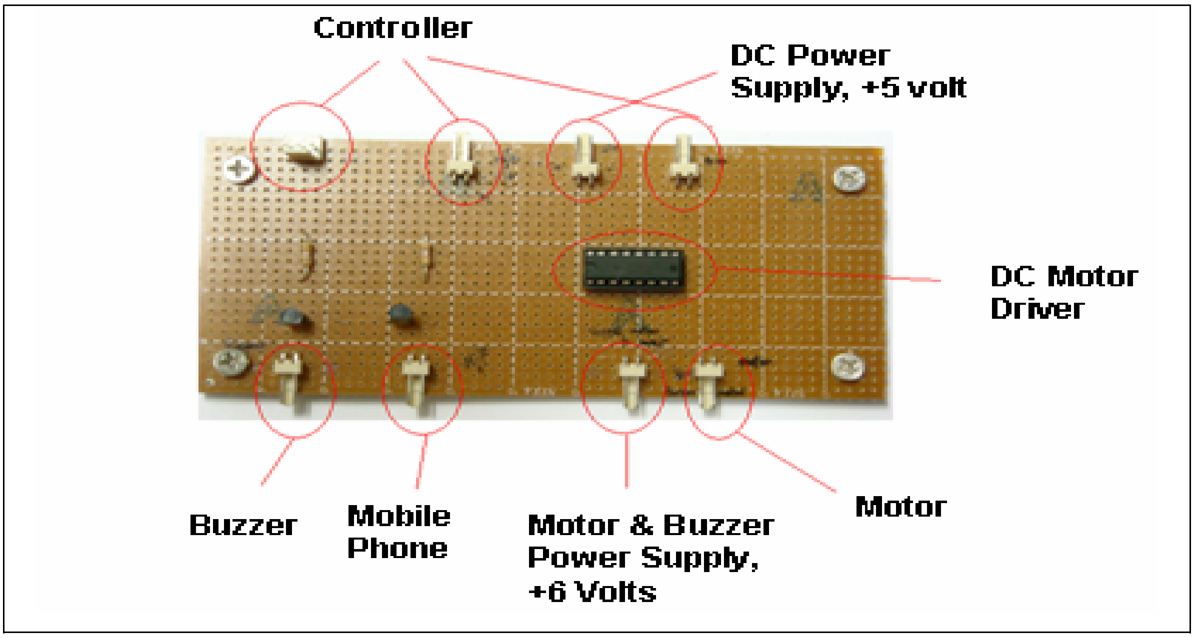

Figure 5.9: Connector's Board

From this chapter, the safety cabinet alarm system has been fully explained. Hence the users can understand the whole development of this alarm system.

CHAPTER 6

CONCLUSION AND FUTURE SUGGESTIONS

6.1 Conclusion

As a conclusion, the project is to come out with the hardware of safety cabinet alarm system. The safety cabinet alarm system will increase the security cabinet and make society feel secure to their valuable things. The specifications of the safety cabinet alarm system are universal LCD alarm system, keyless, flexible, low cost, repairable, reprogrammable auto reset.

6.1 Future Suggestions / Projection

In this project there are plenty of rooms for improvement to further enhance the project in terms of functionality and reliability. Due to time constraint and lack of sources, a few suggestions are suggested here for better advancement on the safety cabinet alarm system in future.

a) **Manual Authentication**
   If black out occurs, the users still can certain manual key to activate the lock and access the cabinet.

b) **Second Authentication**
   In order to increase security of the cabinet, this system need second authentication such as fingerprint or image processing to access the cabinet.

c) **Improve The Mechanical Part.**
   The cabinet must be built by certain concrete materials that are not easy to break in. The cabinet should be fire and water proof to make the safety of valuable things.

d) **Continuous Power Supply**
   Actually the safety cabinet alarm system need continuous power supply to operate continually. Rechargeable battery as the backup power supply to make sure the system is working in 24 hour per day.

The knowledge I acquired from this project from this project will be essential for me to equip myself for the future electronic industry which is changing rapidly.

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APPENDIX

Source Code

```
//*********************************************
// Source Code for Safety Cabinet Control System
// Firmware for Microcontroller (PIC 16F876A)
//*********************************************

//Name        : FOO KON SIAN
//IC Number  : 840905025205
//Matric No  : AE040061
//Course      : 4SEE
//Department : INSEED, FKE
//Supervisor : EN Ismail Bin Ariffin


#include <16F876A.h>
#device *=16 ADC=8        //16bit pointer, 8-bit ADC
#use delay(clock=20000000) //20M Hertz
//Initial Configuration Bits
#fuses  HS,NOWDT,PROTECT,PUT,NOWRT,BROWNOUT,NOLVP


typedef struct {
            int1       bit0;
            int1       bit1;
            int1       bit2;
            int1       bit3;
            int1       bit4;
            int1       bit5;
            int1       bit6;
            int1       bit7;
} flags;

//************************
//Initial value for Port A
//Initial value for Port B
//Initial value for Port C
//************************
#define TRISA              0b00000000
#define TRISB              0b11111111
#define TRISC              0b10000000
#define  Port_Ai           0b00001000
#define  Port_Bi           0b00000000
#define  Port_Ci           0b00000000

//*************************************
//Label for Port A, Port B, and Port C
//*************************************

//PortA
#define  SCLK_H            output_high(PIN_A0)
#define  SCLK_L            output_low(PIN_A0)
#define  SDIN_H            output_high(PIN_A1)
```

```
#define  SDIN_L output_low(PIN_A1)
#define  DC_H    output_high(PIN_A2)
#define  DC_L    output_low(PIN_A2)
#define  SEC_H  output_high(PIN_A3)
#define  SEC_L  output_low(PIN_A3)
#define  RES_H  output_high(PIN_A4)
#define  RES_L  output_low(PIN_A4)
#define  BL_H    output_high(PIN_A5)
#define  BL_L    output_low(PIN_A5)
//Port B
#define KeyIn0   input(PIN_B0)
#define KeyIn1   input(PIN_B1)
#define KeyIn2   input(PIN_B2)
#define KeyIn3   input(PIN_B3)
#define KeyIn4   input(PIN_B4)
#define KeyIn5   input(PIN_B5)
//Port C
#define  Scan0_H          output_high(PIN_C0)
#define  Scan0_L          output_low(PIN_C0)
#define  Scan1_H          output_high(PIN_C1)
#define  Scan1_L          output_low(PIN_C1)
#define  Scan2_H          output_high(PIN_C2)
#define  Scan2_L          output_low(PIN_C2)
#define  EN_H             output_high(PIN_C3)
#define  EN_L             output_low(PIN_C3)
#define Buzer_L           output_low(PIN_C4)
#define Buzer_H            output_high(PIN_C4)
#define Phone_L           output_low(PIN_C5)
#define Phone_H           output_high(PIN_C5)
#define motor1_L          output_low(PIN_C6)
#define motor1_H          output_high(PIN_C6)
#define motor2_L          output_low(PIN_C7)
#define motor2_H          output_high(PIN_C7)

flags     sys01;
#define  flg_10ms          sys01.bit0


//*************************************
//Declare for Integer
//*************************************

int8      tmp;
int8      tmp00 ;
int8      tmp01 ;
int8      tmp02 ;
int8      cnt01 ;
int8      cnt02 ;
int8      cnt03 ;
int8      Dgt_cnt;
int8      bmp_org;
int8      bmp_Bcnt;
int8      tmr10ms;
int8      counter;
int8      change;
int8      keyNew;
```

```
int8     KeyFlag;
int8     skip;
int8     Skip_2;
int8     SKIP_3;
int8     loop;
int8     keytmp;
int8     keyCnt;
int8     keyNew_2;
int8     keyNew_1;
int8     reset;
int8     shf;
int8     shftmp;
int8     shfct;
int8     cursor;
int8     CsrMarker;
int8     confirm;
int8     code;
int8     try;
int8     DispPg;
int8     bUpdateLCD;
int8     i, k;
int8     W_REG;
int8     page;
int8     FSR;
int8     INDF;
int8     PCLATH;
int8     Temp;

//*************************************
//Constant Data be plced in ROM
//*************************************

//Display Number '1','2','3','4','5','6',7",'8','9','0'
const int8 bmpc[10][7] = {{0, 0x3e, 0x51, 0x49, 0x45, 0x3e, 0},
                          {0, 0x00, 0x42, 0x7f, 0x40, 0x00, 0},
                          {0, 0x42, 0x61, 0x51, 0x49, 0x46, 0},
                          {0, 0x21, 0x41, 0x45, 0x4b, 0x31, 0},
                          {0, 0x18, 0x14, 0x12, 0x7f, 0x10, 0},
                          {0, 0x27, 0x45, 0x45, 0x45, 0x39, 0},
                          {0, 0x3c, 0x4a, 0x49, 0x49, 0x30, 0},
                          {0, 0x01, 0x71, 0x09, 0x05, 0x03, 0},
                          {0, 0x36, 0x49, 0x49, 0x49, 0x36, 0},
                          {0, 0x06, 0x49, 0x49, 0x29, 0x1e, 0}};

//Display "Mark"
const int8 bmpc_2b[7] = {0, 0x7f, 0x7f, 0x7f, 0x7f, 0x7f, 0};  // display all
const int8 bmpc_2c[7] = {0, 0x02, 0x01, 0x51, 0x09, 0x06, 0};  // display '?'
const int8 bmpc_2d[7] = {0, 0x00, 0x60, 0x60, 0x00, 0x00, 0};  // display '.'
const int8 bmpc_2e[7] = {0, 0x08, 0x08, 0x08, 0x08, 0x08, 0};  // display '-'
const int8 bmpc_2f[7] = {0, 0x00, 0x41, 0x22, 0x14, 0x08, 0};  // display '>'
const int8 bmpc_30[7] = {0, 0x08, 0x14, 0x22, 0x41, 0x00, 0};  // display '<'
const int8 bmpc_31[7] = {0x49, 0x2a, 0x1c, 0x7f, 0x1c, 0x2a, 0x49};  // display '*'
const int8 bmpc_32[7] = {0x18, 0x18, 0x18, 0x18, 0x18, 0x18, 0x18};  // display '--'
const int8 bmpc_33[7] = {0x18, 0x18, 0xf8, 0xf8, 0, 0, 0};  // display '-|'
const int8 bmpc_34[7] = {0, 0, 0xf8, 0xf8, 0x18, 0x18, 0x18};  // display '|-'
const int8 bmpc_35[7] = {0, 0, 0x1f, 0x1f, 0x18, 0x18, 0x18};  // display '|_'
```

```
const int8 bmpc_36[7] = {0x18, 0x18, 0x1f, 0x1f, 0, 0, 0};  // display '_|'
const int8 bmpc_37[7] = {0, 0, 0xff, 0xff, 0, 0, 0};  // display '|'
const int8 bmpc_40h[7] = {0, 0, 0, 0, 0, 0, 0};//dislay'blank'

//Display  Character from 'A' to 'Z'
const int8 bmpc_AAMM[13][7] = { {0, 0x7e, 0x11, 0x11, 0x11, 0x7e, 0}, //A...M
                                {0, 0x7f, 0x49, 0x49, 0x49, 0x36, 0},
                                {0, 0x3e, 0x41, 0x41, 0x41, 0x22, 0},
                                {0, 0x7f, 0x41, 0x41, 0x22, 0x1c, 0},
                                {0, 0x7f, 0x49, 0x49, 0x49, 0x41, 0},
                                {0, 0x7f, 0x09, 0x09, 0x09, 0x01, 0},
                                {0, 0x3e, 0x41, 0x49, 0x49, 0x7a, 0},
                                {0, 0x7f, 0x08, 0x08, 0x08, 0x7f, 0},
                                {0, 0x00, 0x41, 0x7f, 0x41, 0x00, 0},
                                {0, 0x20, 0x40, 0x41, 0x3f, 0x01, 0},
                                {0, 0x7f, 0x08, 0x14, 0x22, 0x41, 0},
                                {0, 0x7f, 0x40, 0x40, 0x40, 0x40, 0},
                                {0, 0x7f, 0x02, 0x0c, 0x02, 0x7f, 0}};


const int8 bmpc_NNZZ[13][7] = { {0, 0x7f, 0x04, 0x08, 0x10, 0x7f, 0}, //N...Z
                                {0, 0x3e, 0x41, 0x41, 0x41, 0x3e, 0},
                          {0, 0x7f, 0x09, 0x09, 0x09, 0x06, 0},
                                {0, 0x3e, 0x41, 0x51, 0x21, 0x5e, 0},
                                {0, 0x7f, 0x09, 0x19, 0x29, 0x46, 0},
                                {0, 0x46, 0x49, 0x49, 0x49, 0x31, 0},
                                {0, 0x01, 0x01, 0x7f, 0x01, 0x01, 0},
                                {0, 0x3f, 0x40, 0x40, 0x40, 0x3f, 0},
                                {0, 0x1f, 0x20, 0x40, 0x20, 0x1f, 0},
                                {0, 0x3f, 0x40, 0x38, 0x40, 0x3f, 0},
                                {0, 0x63, 0x14, 0x08, 0x14, 0x63, 0},
                                {0, 0x07, 0x08, 0x70, 0x08, 0x07, 0},
                                {0, 0x61, 0x51, 0x49, 0x45, 0x43, 0}};

//Display  Character from 'a' to 'z'
const int8 bmpc_am[13][7] = {{0, 0x20, 0x54, 0x54, 0x54, 0x78, 0}, //a...m
                            {0, 0x7f, 0x48, 0x44, 0x44, 0x38, 0},
                            {0, 0x38, 0x44, 0x44, 0x44, 0x20, 0},
                            {0, 0x38, 0x44, 0x44, 0x48, 0x7f, 0},
                            {0, 0x38, 0x54, 0x54, 0x54, 0x18, 0},
                            {0, 0x08, 0x7e, 0x09, 0x01, 0x02, 0},
                            {0, 0x0c, 0x52, 0x52, 0x52, 0x3e, 0},
                            {0, 0x7e, 0x08, 0x04, 0x04, 0x78, 0},
                            {0, 0x00, 0x44, 0x7d, 0x40, 0x00, 0},
                            {0, 0x20, 0x40, 0x44, 0x3d, 0x00, 0},
                            {0, 0x7f, 0x10, 0x28, 0x44, 0x00, 0},
                            {0, 0x00, 0x41, 0x7f, 0x40, 0x00, 0},
                            {0, 0x7c, 0x04, 0x18, 0x04, 0x78, 0}};


const int8 bmpc_nz[13][7] = { {0, 0x7c, 0x08, 0x04, 0x04, 0x78, 0},
                              {0, 0x38, 0x44, 0x44, 0x44, 0x38, 0},
                              {0, 0x7c, 0x14, 0x14, 0x14, 0x08, 0},
                          {0, 0x08, 0x14, 0x14, 0x18, 0x7c, 0},
                              {0, 0x7c, 0x08, 0x04, 0x04, 0x08, 0},
                              {0, 0x48, 0x54, 0x54, 0x54, 0x20, 0},
```

```
                                        {0, 0x04, 0x3f, 0x44, 0x40, 0x20, 0},
                                        {0, 0x3c, 0x40, 0x40, 0x20, 0x7c, 0},
                                        {0, 0x1c, 0x20, 0x40, 0x20, 0x1c, 0},
                                        {0, 0x3c, 0x40, 0x30, 0x40, 0x3c, 0},
                                        {0, 0x44, 0x28, 0x10, 0x28, 0x44, 0},
                                        {0, 0x0c, 0x50, 0x50, 0x50, 0x3c, 0},
                                        {0, 0x44, 0x64, 0x54, 0x4c, 0x44, 0}};

//display "UNIVERSITI"
const char con_sole1[12] = {'U', 'N', 'I', 'V', 'E', 'R', 'S', 'I', 'T', 'I', 0xa2, 0xa2};
 //display "TEKNOLOGI"
const char con_sole2[12] = {'T', 'E', 'K', 'N', 'O', 'L', 'O', 'G', 'I', 0xa2, 0xa2, 0xa2};
 //display "MALAYSIA"
const char con_sole3[12] = {'M', 'A', 'L', 'A', 'Y', 'S', 'I', 'A', 0xa2, 0xa2, 0xa2, 0xa2};



#define  rd             RdFlg.bit0
#define  sentRd         RdFlg.bit4

//***********************************************************
// RAM variables (Array)
//***********************************************************
int8  LCDRow0[12];
int8  LCDRow1[12];
int8  LCDRow2[12];
int8  LCDRow3[12];
int8  LCDRow4[12];
int8  LCDRow5[12];
int8  digit[6];
int8  second[6];
int8  save[6];

//***********************************************************
// LCD Display Program
//***********************************************************

void dly0()
{
        cnt01 = W_REG;

dly01:
        cnt02 = 0x1f;
dly02:
        cnt03 = 0xff;
dly03:
        cnt03--;
        if (cnt03 != 0) goto dly03;
dly04:
        cnt02--;
        if (cnt02 != 0) goto dly02;
dly05:
        cnt01--;
        if (cnt01 != 0) goto dly01;
}
```

```
void dly1()
{
	W_REG = 8;
	dly0();
}

void dly2()
{
	W_REG = 2;
	dly0();
}

void dly3()
{
	W_REG = 1;
	dly0();
}


void shf8()
{
	W_REG = 8;
	shfct = W_REG;

Shf8a:
	SCLK_L;
	Temp = shf;
	rotate_left(&shf,1);
	if(Temp < 0x80)
	{
		goto	shfb0;
	}
	SDIN_H; //bit 1
	goto shfclk;

shfb0:
	SDIN_L; //bit 0

shfclk:
	SCLK_H;

ckshfct:
	shfct--;
	if(shfct != 0)
	{
		goto shf8a;
	}
shf8b:
	SCLK_L;
	SDIN_L;
}

void ShfCmd()
{
	shf = W_REG;
	DC_L;
```

```
		shf8();
}

//shift
void shfdata()
{
		shf = W_REG;
		DC_H;
		shf8();
}


void sdly1()
{
		//nop
		return;
}


//row data
void d_row()
{
		shftmp = W_REG; //row data
		cnt03 = 0x54;

d_row2:
		W_REG = shftmp; //row data
		ShfData();
		cnt03--;
		if(cnt03 != 0)
		{
				goto d_row2;
		}
}

void Init_LCD_row() //cmd
 {
		W_REG = (W_REG + 0b01000000);
		SEC_L; //enable clk
		ShfCmd();
		W_REG = 0b10000000;
		ShfCmd();
		SEC_H; //disable clk
		SEC_L; //disable clk
		W_REG = 0b10101100; //initial data
//		W_REG = 0; //initial data
		d_row();
		SEC_H; //disable clk
}



//Init LCD
void Init_LCD()
{
```

```
//Init LCD starts here
        dly2();
        SEC_H; //disable clk
        DC_H;
        sdly1();
        RES_H; //release reset
        dly3();

go00:
        SEC_L; // enable clk
        W_REG = 0b00100100;
        ShfCmd();
        for(i=0; i<6; i++)
        {
                W_REG = i;
                Init_LCD_row();
        }

        SEC_L; //enable clk
        W_REG = 0b00100000;
        ShfCmd();

        SEC_H; //disable clk
        dly1();
        dly1();

        SEC_L; //enable clk
        W_REG = 0b00100000;
        ShfCmd();
        W_REG = 0b00001100;
        ShfCmd();
        SEC_H; //disable clk
        dly1();
        dly1();
}

//Update 1 digit LCD Data
void LCD_dgt()
{

Nxt_CHAR_B:
        bmp_org++;
        if(--bmp_Bcnt != 0) goto Nxt_CHAR_B;
        return;

LCD_dgt_num:
        W_REG = 0x08;
        PCLATH = W_REG;
        bmp_Bcnt = 0x07;

Nxt_num_B:
        W_REG = bmp_org;
        W_REG = W_REG + CsrMarker;
        ShfData();
        bmp_org++;
        if (--bmp_Bcnt != 0)
```

```
        {
                goto Nxt_num_B;
        }
        return;

Chk_cursor_pos:
        return;
}

//Update 1 row
void Udp_row()
{
        W_REG = W_REG + 0x40;
        SEC_L; //enable clk
        ShfCmd();
        W_REG = 0x80;
        ShfCmd();
        SEC_H; //disable clk
        W_REG = 0x0c; //dgt count
        Dgt_cnt = W_REG;
        SEC_L; //enable clk

Nxt_dgt:
        CsrMarker = 0;
        if (DispPg != 0) goto Nxt_dgt0;

        if (cursor == FSR)
        {
                CsrMarker = 0x80;
        }

Nxt_dgt0:
        #asm
                movf INDF,W
        #endasm
        LCD_dgt();
        #asm
                incf FSR,F
        #endasm
}


//LCD Display Program

void Udp_LCD()
{
        Udp_row();

}


void Udp_LCD0()
{
        Udp_LCD();
}
```

```
//*************************************
// To Interupt Every 10 ms
//*************************************
#INT_TIMER1
void IRQ_T1()
{
	set_timer1(0xe796);		//10ms (0xe796)
	enable_interrupts(INT_TIMER1);
	flg_10ms = 1;
}

//*************************************
// Functions for LCD Display
//*************************************

void display_blank()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_40h[i];
		shfdata();
	}

}

void display_AAMM(int8 x)
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_AAMM[x][i];
		shfdata();
	}
}

void display_NNZZ(int8 x)
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_NNZZ[x][i];
		shfdata();
	}
}

void display_am(int8 x)
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_am[x][i];
		shfdata();
	}
}

void display_nz(int8 x)
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_nz[x][i];
		shfdata();
	}
}
```

```
void display(int8 x)
{
	for (i=0; i<7; i++) {
		W_REG = bmpc[x][i];
		shfdata();
	}
}

void display_cursor()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_40h[i] | 0x80;
		shfdata();
	}
}

void display_all()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_2b[i];
		shfdata();
	}

}

void display_question()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_2c[i];
		shfdata();
	}

}

void display_dot()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_2d[i];
		shfdata();
	}

}

void display_minus()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_2e[i];
		shfdata();
	}

}

void display_greater()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_2f[i];
```

```
		shfdata();
	}

}

void display_lower()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_30[i];
		shfdata();
	}

}

void display_line()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_32[i];
		shfdata();
	}

}

void display_vertical()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_37[i];
		shfdata();
	}

}


void display_box45()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_33[i];
		shfdata();
	}

}

void display_box135()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_34[i];
		shfdata();
	}

}

void display_box225()
{
	for (i=0; i<7; i++) {
		W_REG = bmpc_35[i];
		shfdata();
```

```
        }

}

void display_box315()
{
        for (i=0; i<7; i++) {
                W_REG = bmpc_36[i];
                shfdata();
        }

}

void display_star()
{
        for (i=0; i<7; i++) {
                W_REG = bmpc_31[i];
                shfdata();
        }

}

void show_char()
{

        if (W_REG == 0xa2) {
                display_blank();
                return; }


        if ((W_REG >= 0x41) && (W_REG <= 0x4D)) {          //A...M
                W_REG -= 0x41;
                display_AAMM(W_REG);
                return;
        }

        if ((W_REG >= 0x4E) && (W_REG <= 0x5A)) {          //N...Z
                W_REG -= 0x4E;
                display_NNZZ(W_REG);
                return;
        }

        if ((W_REG >= 0x61) && (W_REG <= 0x6d)) {          //a...m
                W_REG -= 0x61;
                display_am(W_REG);
                return;
        }

        if ((W_REG >= 0x6e) && (W_REG <= 0x7a)) {          //n...z
                W_REG -= 0x6e;
                display_nz(W_REG);
                return;
        }

        if ((W_REG >= 0x30) && (W_REG <= 0x39)) {          //0..9
                W_REG -= 0x30;
```

```
            display(W_REG);
            return;
        }

        if (W_REG == 0x3f) {
            display_question();
            return; }

        if (W_REG == 0x2e) {
            display_dot();
            return; }

        if (W_REG == 0x2d) {
            display_minus();
            return; }

        if (W_REG == 0x3e) {
            display_greater();
            return; }

        if (W_REG == 0x3c) {
            display_lower();
            return; }


        if (W_REG == 0x2a) {
            display_star();
            return; }

        if (W_REG == 0x11) {
            display_box45();
            return; }

        if (W_REG == 0x12) {
            display_box135();
            return; }

        if (W_REG == 0x13) {
            display_box225();
            return; }

        if (W_REG == 0x14) {
            display_box315();
            return; }

        if (W_REG == 0x15) {
            display_line();
            return; }

        if (W_REG == 0x16) {
            display_vertical();
            return; }

    }
```

```
void display_char()
{
	for(k=0; k<12; k++){
		W_REG = LCDRow0[k];
		show_char();
		}

	for(k=0; k<12; k++){
		W_REG = LCDRow1[k];
		show_char();
		}

	for(k=0; k<12; k++){
		W_REG = LCDRow2[k];
		show_char();
		}

	for(k=0; k<12; k++){
		W_REG = LCDRow3[k];
		show_char();
		}

	for(k=0; k<12; k++){
		W_REG = LCDRow4[k];
		show_char();
		}

	for(k=0; k<12; k++){
		W_REG = LCDRow5[k];
		show_char();
		}
}

void clear()
{
	for(i=0; i<12; i++){
		LCDRow2[i] = 0xa2;
		LCDRow3[i] = 0xa2;
		LCDRow4[i] = 0xa2;
		LCDRow5[i] = 0xa2;
	}
}

void upper_box()
{
	LCDRow1[0] = 0xa2;
	LCDRow1[1] = 0x12;
	for(i=2; i<10; i++){
		LCDRow1[i] = 0x15;
	}
	LCDRow1[10] = 0x11;
	LCDRow1[11] = 0xa2;

	clear();

	LCDRow2[0] = 0xa2;
```

```
            LCDRow2[1] = 0x16;
            for(i=2; i<10; i++){
                        LCDRow2[i] = 0xa2;
            }

            LCDRow2[10] = 0x16;
            LCDRow2[11] = 0xa2;

            LCDRow3[0] = 0xa2;
            LCDRow3[1] = 0x13;
            for(i=2; i<10; i++){
                        LCDRow3[i] = 0x15;
            }
            LCDRow3[10] = 0x14;
            LCDRow3[11] = 0xa2;

            for(i=0; i<12; i++){
       LCDRow4[i] = 0xa2;
       LCDRow5[i] = 0xa2;
            }


}

//************************************
// Pages In LCD display
//************************************

void page_0()
{
            for(i=0; i<12; i++){
       LCDRow0[i] = con_sole1[i];
       LCDRow1[i] = con_sole2[i];
       LCDRow2[i] = con_sole3[i];
            }

            for(i=0; i<12; i++){
            LCDRow3[i] = 0xa2;
       LCDRow4[i] = 0xa2;
       LCDRow5[i] = 0xa2;
            }

}


void page_1()       //Password ?
{
            LCDRow0[0]  = 'P';
            LCDRow0[1]  = 'a';
            LCDRow0[2]  = 's';
            LCDRow0[3]  = 's';
            LCDRow0[4]  = 'w';
            LCDRow0[5]  = 'o';
            LCDRow0[6]  = 'r';
            LCDRow0[7]  = 'd';
            LCDRow0[8]  = 0xa2;
```

```
        LCDRow0[9]  = 0x3f; //'?'
        LCDRow0[10] = 0xa2;
        LCDRow0[11] = 0xa2;
        upper_box();

}


void page_2()      //Change password ?
{
        LCDRow0[0] = 'C';
        LCDRow0[1] = 'h';
        LCDRow0[2] = 'a';
        LCDRow0[3] = 'n';
        LCDRow0[4] = 'g';
        LCDRow0[5] = 'e';
        for(i=6; i<12; i++) {
                        LCDRow0[i] = 0xa2;
                                }
        LCDRow1[0]  = 'P';
        LCDRow1[1]  = 'a';
        LCDRow1[2]  = 's';
        LCDRow1[3]  = 's';
        LCDRow1[4]  = 'w';
        LCDRow1[5]  = 'o';
        LCDRow1[6]  = 'r';
        LCDRow1[7]  = 'd';
        LCDRow1[8]  = 0xa2;
        LCDRow1[9]  = 0x3f; //'?'
        LCDRow1[10] = 0xa2;
        LCDRow1[11] = 0xa2;
        clear();
}

void password()
{
        LCDRow1[0]  = 'P';
        LCDRow1[1]  = 'a';
        LCDRow1[2]  = 's';
        LCDRow1[3]  = 's';
        LCDRow1[4]  = 'w';
        LCDRow1[5]  = 'o';
        LCDRow1[6]  = 'r';
        LCDRow1[7]  = 'd';
        LCDRow1[8]  = 0xa2;
        LCDRow1[9]  = 0x3f; //'?'
        LCDRow1[10] = 0xa2;
        LCDRow1[11] = 0xa2;


        LCDRow2[0] = 0xa2;
        LCDRow2[1] = 0x12;
        for(i=2; i<10; i++){
                LCDRow2[i] = 0x15;
        }
        LCDRow2[10] = 0x11;
```

```
        LCDRow2[11] = 0xa2;

        LCDRow3[0] = 0xa2;
        LCDRow3[1] = 0x16;
        for(i=2; i<10; i++){
                LCDRow3[i] = 0xa2;
        }
        LCDRow3[10] = 0x16;
        LCDRow3[11] = 0xa2;

        LCDRow4[0] = 0xa2;
        LCDRow4[1] = 0x13;
        for(i=2; i<10; i++){
                LCDRow4[i] = 0x15;
        }
        LCDRow4[10] = 0x14;
        LCDRow4[11] = 0xa2;


        for(i=0; i<12; i++){
                LCDRow5[i] = 0xa2;
        }


}


void page_3()       //Old Password ?
{
        LCDRow0[0] = 'O';
        LCDRow0[1] = 'l';
        LCDRow0[2] = 'd';
        for(i=3; i<12; i++){
                LCDRow0[i] = 0xa2;
        }

        password();
}


void page_4()       //New Password ?
{
        try = 0;
        LCDRow0[0] = 'N';
        LCDRow0[1] = 'e';
        LCDRow0[2] = 'w';
        for(i=3; i<12; i++){
                LCDRow0[i] = 0xa2;
        }

        password();
}

void page_9()       //Confirm ?
{
```

```
		LCDRow0[0]  = 'C';
		LCDRow0[1]  = 'o';
		LCDRow0[2]  = 'n';
		LCDRow0[3]  = 'f';
		LCDRow0[4]  = 'i';
		LCDRow0[5]  = 'r';
		LCDRow0[6]  = 'm';
		LCDRow0[7]  = 0xa2;
		LCDRow0[8]  = 0x3f; //'?'
		LCDRow0[9]  = 0xa2;
		LCDRow0[10] = 0xa2;
		LCDRow0[11] = 0xa2;

		upper_box();


}

void page_5()	//Password Changed
{
		try = 0;
		code = 0;
		LCDRow0[0]  = 'P';
		LCDRow0[1]  = 'a';
		LCDRow0[2]  = 's';
		LCDRow0[3]  = 's';
		LCDRow0[4]  = 'w';
		LCDRow0[5]  = 'o';
		LCDRow0[6]  = 'r';
		LCDRow0[7]  = 'd';
		LCDRow0[8]  = 0xa2;
		LCDRow0[9]  = 0xa2;
		LCDRow0[10] = 0xa2;
		LCDRow0[11] = 0xa2;

		LCDRow1[0]  = 'C';
		LCDRow1[1]  = 'h';
		LCDRow1[2]  = 'a';
		LCDRow1[3]  = 'n';
		LCDRow1[4]  = 'g';
		LCDRow1[5]  = 'e';
		LCDRow1[6]  = 'd';
		for(i=7; i<12; i++){
			LCDRow1[i] = 0xa2;
		}
		clear();

}

void page_6()	//Invalid Code
{
		try++;
		counter = 0;

		for(i=0; i<12; i++){
			LCDRow0[i] = 0xa2;
```

```
            LCDRow1[i] = 0xa2;
            LCDRow3[i] = 0xa2;
            LCDRow4[i] = 0xa2;
            LCDRow5[i] = 0xa2;
        }

        LCDRow2[0]  = 'I';
        LCDRow2[1]  = 'n';
        LCDRow2[2]  = 'v';
        LCDRow2[3]  = 'a';
        LCDRow2[4]  = 'l';
        LCDRow2[5]  = 'i';
        LCDRow2[6]  = 'd';
        LCDRow2[7]  = 0xa2;
        LCDRow2[8]  = 'C';
        LCDRow2[9]  = 'o';
        LCDRow2[10] = 'd';
        LCDRow2[11] = 'e';


}

void page_7()       //Warning !
{

        for(i=0; i<12; i++){
            LCDRow0[i] = 0xa2;
            LCDRow1[i] = 0xa2;
            LCDRow3[i] = 0xa2;
            LCDRow4[i] = 0xa2;
            LCDRow5[i] = 0xa2;
        }

        LCDRow2[0]  = 0xa2;
        LCDRow2[1]  = 0xa2;
        LCDRow2[2]  = 'W';
        LCDRow2[3]  = 'a';
        LCDRow2[4]  = 'r';
        LCDRow2[5]  = 'n';
        LCDRow2[6]  = 'i';
        LCDRow2[7]  = 'n';
        LCDRow2[8]  = 'g';
        LCDRow2[9]  = 0xa2;
        LCDRow2[10] = 0xa2;
        LCDRow2[11] = 0xa2;


}

void page_8()       //Unlock !
{
        try = 0;
        code = 0;

        for(i=0; i<12; i++){
            LCDRow0[i] = 0xa2;
```

```
            LCDRow1[i] = 0xa2;
            LCDRow3[i] = 0xa2;
            LCDRow4[i] = 0xa2;
            LCDRow5[i] = 0xa2;
        }

        LCDRow2[0]  = 0xa2;
        LCDRow2[1]  = 0xa2;
        LCDRow2[2]  = 'U';
        LCDRow2[3]  = 'n';
        LCDRow2[4]  = 'l';
        LCDRow2[5]  = 'o';
        LCDRow2[6]  = 'c';
        LCDRow2[7]  = 'k';
        LCDRow2[8]  = 0xa2;
        LCDRow2[9]  = 0xa2;
        LCDRow2[10] = 0xa2;
        LCDRow2[11] = 0xa2;

}


void pages()
{
         if(page == 1) page_1();
         if(page == 2) page_2();
         if(page == 3) page_3();
         if(page == 4) page_4();
         if(page == 9) page_9();

}

//*************************************
// Count Numbers of Entered Digit
//*************************************

void counter_1()
{
        if(change == 0){
        switch(counter){
                case 0:   digit[0] = tmp;
                            counter++;
                              break;
                case 1:   digit[1] = tmp;
                            counter++;
                              break;
                case 2:   digit[2] = tmp;
                            counter++;
                              break;
                case 3:   digit[3] = tmp;
                            counter++;
                              break;
                case 4:   digit[4] = tmp;
                            counter++;
                              break;
                case 5:   digit[5] = tmp;
```

```
                        counter++;
                        break;
            case 6:     counter++;
                        }
                }
        if(change == 1){
        switch(counter){
            case 0:     second[0] = tmp;
                        counter++;
                        break;
            case 1:     second[1] = tmp;
                        counter++;
                        break;
            case 2:     second[2] = tmp;
                        counter++;
                        break;
            case 3:     second[3] = tmp;
                        counter++;
                        break;
            case 4:     second[4] = tmp;
                        counter++;
                        break;
            case 5:     second[5] = tmp;
                        counter++;
                        break;
            case 6:     counter++;
                        change = 0;
                        }
                }
}

//***********************************
// Display 'Star' for each entered code
//***********************************

void set_star_1()  //In page_1
{
        switch(counter){
            case 0:     LCDROW2[3] = 0X2a;
                        break;
            case 1:     LCDROW2[4] = 0X2a;
                        break;
            case 2:     LCDROW2[5] = 0X2a;
                        break;
            case 3:     LCDROW2[6] = 0X2a;
                        break;
            case 4:     LCDROW2[7] = 0X2a;
                        break;
            case 5:     LCDROW2[8] = 0X2a;
                        break;
                        }
}

void set_star_2()  //In page_3
{
        switch(counter){
```

```
                case 0:   LCDROW3[3] = 0X2a;
                              break;
                case 1:   LCDROW3[4] = 0X2a;
                              break;
                case 2:   LCDROW3[5] = 0X2a;
                              break;
                case 3:   LCDROW3[6] = 0X2a;
                              break;
                case 4:   LCDROW3[7] = 0X2a;
                              break;
                case 5:   LCDROW3[8] = 0X2a;
                              break;
                              }
}

//*******************************************
// Make Sure Only 6 Digits for Any Password
//*******************************************

void check_counter()
{
        if(counter >= 7 ){
                        page_6();
                        SEC_L;
                        display_char();
                        SEC_H;
                        delay_ms(1000);
                        if(page == 1)page_1();
                        if(page == 3)page_3();
                        if(page == 4 || page == 9)page_4();
                        counter = 0;
                            }
}

//***************************
// Save Digits For Password
//***************************

void save_digit()
{
        save[0] = 0x32;
        save[1] = 0x33;
        save[2] = 0x34;
        save[3] = 0x35;
        save[4] = 0x36;
        save[5] = 0x37;
}


//*****************
// Check Password
//*****************

void check_password()
{
        code = 0;
```

```
        read_program_memory(0x1800, save, 6);
        if(save[0] == 0xff){save_digit();}
        if(digit[0] == save[0]) code++;
        if(digit[1] == save[1]) code++;
        if(digit[2] == save[2]) code++;
        if(digit[3] == save[3]) code++;
        if(digit[4] == save[4]) code++;
        if(digit[5] == save[5]) code++;
        digit[0] = 88;

}

void check_new_password()
{
        confirm = 0;
        if(digit[0] == second[0]) confirm++;
        if(digit[1] == second[1]) confirm++;
        if(digit[2] == second[2]) confirm++;
        if(digit[3] == second[3]) confirm++;
        if(digit[4] == second[4]) confirm++;
        if(digit[5] == second[5]) confirm++;

}

//*****************
// Change Password
//*****************

void change_password()
{
        save[0] = digit[0];
        save[1] = digit[1];
        save[2] = digit[2];
        save[3] = digit[3];
        save[4] = digit[4];
        save[5] = digit[5];
        write_program_memory(0x1800, save, 6);
}

//******************************************
// Identify The Pressed Button at Keypad
//******************************************

void press_1()
{
        tmp = 0x31;
        counter_1();
        check_counter();
}

void press_2()
{
        tmp = 0x32;
        counter_1();
        check_counter();
}
```

```
void press_3()
{
        tmp = 0x33;
         counter_1();
        check_counter();
}

void press_4()
{
        tmp = 0x34;
         counter_1();
        check_counter();
}

void press_5()
{
        tmp = 0x35;
        counter_1();
        check_counter();
}

void press_6()
{
        tmp = 0x36;
        counter_1();
        check_counter();
}

void press_7()
{
        tmp = 0x37;
        counter_1();
        check_counter();
}

void press_8()
{
        tmp = 0x38;
        counter_1();
        check_counter();
}

void press_9()
{
        tmp = 0x39;
        counter_1();
        check_counter();
}

void press_0()
{
        tmp = 0x30;
        counter_1();
        check_counter();
}
```

```
void confirm_page_next()
{
		page = 2;
		pages();
}

void confirm_page_back()
{
		page = 1;
		pages();
}

void keytest()
{
		int8 x;
		for (x=0; x<6; x++) {
				if ( bit_test(keytmp, 0) == 0) {
						keyNew = keyCnt;
						skip_2 = 1;
						KeyFlag = 1;
								}
						shift_right(&keytmp,1,1);
						keyCnt++;
				}
}

void identify_key()
{
		KeyFlag = 0;
		keycnt  = 0;
		keytmp = tmp00;
		keytest();
		if(KeyFlag == 0) {
				keytmp = tmp01;
				keytest();
		}
		if(KeyFlag == 0) {
				keytmp = tmp02;
				keytest();
		}
}

void confirm_key()
{

		if(keyNew == 6) {
						bUpdateLCD = 1;
						if (page == 1) {set_star_1();
										press_1();		}

						if (page == 3) { set_star_2();
										press_1();		}

					if (page == 4 || page == 9) {
```

```
                    if(page == 4) set_star_2();
                    if(page == 9) set_star_1();
                    press_1();
                                }
        }

if(keyNew == 7) {
        bUpdateLCD = 1;
        if (page == 1) { set_star_1();
                    press_2();      }

        if (page == 3) { set_star_2();
                    press_2();      }

      if (page == 4 || page == 9) {
                    if(page == 4) set_star_2();
                    if(page == 9) set_star_1();
                    press_2();
                                }
        }

if(keyNew == 8) {
        bUpdateLCD = 1;
        if (page == 1) {
                   set_star_1();
                   press_3();
                            }
        if (page == 3) { set_star_2();
                    press_3();      }
      if (page == 4 || page == 9) {
                    if(page == 4) set_star_2();
                    if(page == 9) set_star_1();
                    press_3();
                                }
            }
if(keyNew == 9) {
        bUpdateLCD = 1;
        if (page == 1) { set_star_1();
                    press_4();      }

        if (page == 3) { set_star_2();
                    press_4();      }

      if (page == 4 || page == 9) {
                    if(page == 4) set_star_2();
                    if(page == 9) set_star_1();
                    press_4();
                                }
    }

 if(keyNew == 10) {
        bUpdateLCD = 1;
        if (page == 1) {set_star_1();
                   press_5();       }

        if (page == 3) { set_star_2();
```

```
                        press_5();      }

            if (page == 4 || page == 9) {
                        if(page == 4) set_star_2();
                        if(page == 9) set_star_1();
                        press_5();
                                        }
        }


if(keyNew == 11) {bUpdateLCD = 1;
                if (page == 1) { set_star_1();
                        press_6();      }

                if (page == 3) { set_star_2();
                        press_6();      }

            if (page == 4 || page == 9) {
                        if(page == 4) set_star_2();
                        if(page == 9) set_star_1();
                        press_6();
                                        }
        }


if(keyNew == 12) {bUpdateLCD = 1;
                if (page == 1) {set_star_1();
                        press_7();      }

                if (page == 3) { set_star_2();
                        press_7();      }

            if (page == 4 || page == 9) {
                        if(page == 4) set_star_2();
                        if(page == 9) set_star_1();
                        press_7();
                                        }
        }


if(keyNew == 13) {bUpdateLCD = 1;
                if (page == 1) { set_star_1();
                        press_8();      }
                if (page == 3) { set_star_2();
                        press_8();      }
            if (page == 4 || page == 9) {
                        if(page == 4) set_star_2();
                        if(page == 9) set_star_1();
                        press_8();
                                        }
        }


if(keyNew == 14) {bUpdateLCD = 1;
                if (page == 1) {
                        set_star_1();
```

```
                        press_9();
                                }
                if (page == 3) { set_star_2();
                        press_9();          }
            if (page == 4 || page == 9) {
                        if(page == 4) set_star_2();
                        if(page == 9) set_star_1();
                        press_9();
                                    }
        }


    if(keyNew == 16) {bUpdateLCD = 1;
                if (page == 1) {set_star_1();
                        press_0();          }

                if (page == 3) { set_star_2();
                        press_0();          }

            if (page == 4 || page == 9) {
                        if(page == 4) set_star_2();
                        if(page == 9) set_star_1();
                        press_0();
                                    }
                        }
}


void confirm_key2()
{
    if(keyNew == 1) {bUpdateLCD = 1;//enter
        if (page == 1) {
                check_password();
                if(code == 6) { page_8();
                        Buzer_L;
                        motor1_H;
                        motor2_L;
                        EN_H;
                        delay_ms(12);
                        EN_L;}

                else {page_6();
                    SEC_L;
                    display_char();
                    SEC_H;
                    delay_ms(1000);
                    pages();}
                }

        if (page == 9) {
                change = 0;
                if(counter == 6){
                        counter = 0;
                        check_new_password();
                    if(confirm == 6) {
                            change_password();
```

```
                                        page_5();
                                        SEC_L;
                                        display_char();
                                        SEC_H;
                                        delay_ms(1000);
                                        page = 1;
                                        pages();
                                        }
                        else {      page_6();
                                    SEC_L;
                                    display_char();
                                    SEC_H;
                                    delay_ms(1000);
                                    page = 4;
                                    pages();
                                    return;
                            }
                        }
                else {
                        page_6();
                        SEC_L;
                        display_char();
                        SEC_H;
                        delay_ms(1000);
                        page = 4;
                        pages();
                        return;
                            }
                }

if (page == 4) {if(counter == 6) {
                                    page = 9;
                                    pages();
                                    change = 1;
                                    }
                else {
                        page_6();
                        SEC_L;
                        display_char();
                        SEC_H;
                        delay_ms(1000);
                        page_4();
                    }
            }
if (page == 3) {
                check_password();
                if(code == 6) {page = 4;
                            pages();
                                        }
                else {
                        page_6();
                        SEC_L;
                        display_char();
                        SEC_H;
                        delay_ms(1000);
                        pages();
```

```
                                        }
                                    }

                if (page == 2) {page = 3;
                                    pages();
                                    return;}
        counter = 0;
        }

        if(keyNew == 2) { //press down
                         bUpdateLCD = 1;
                         counter = 0;
                         confirm_page_back();
                         motor1_L;
                         motor2_H;
                         EN_H;
                         delay_ms(12);
                         EN_L;

                        }

        if(keyNew == 5) {  //press up
                         bUpdateLCD = 1;
                         Phone_H;
                         delay_ms(1000);
                         Phone_L;
                        }

        if(keyNew == 15){    //
                         bUpdateLCD = 1;
                         counter = 0;
                         confirm_page_back();
                        }

        if(keyNew == 17) {          //press next
                          bUpdateLCD = 1;
                          counter = 0;
                          confirm_page_next();
                         }
}


//**************
// Scan for key
//**************

void scan_key()
{
        Scan0_L;
        delay_us(10);
        tmp00 = input_b()| 0xC0;
        Scan0_H;

        Scan1_L;
        delay_us(10);
        tmp01 = input_b()| 0xC0;
```

```
        Scan1_H;

        Scan2_L;
        delay_us(10);
        tmp02 = input_b()| 0xC0;
        Scan2_H;
}

//****************************
// Activate Alarm System
//****************************

void security()
{
        if(try == 3) {    page_7();
                          SEC_L;
                          display_char();
                          SEC_H;
                          Phone_H;
                          delay_ms(1000);
                          Phone_L;
                          Buzer_H;
                          try = 0;
                     }
}

//*******************
// Initiation System
//*******************

void Init()
{
        port_b_pullups(TRUE);
        output_a(PORT_Ai);
        output_b(PORT_Bi);
        output_c(PORT_Ci);
        set_tris_a(TRISA);
        set_tris_b(TRISB);
        set_tris_c(TRISC);
        Init_LCD();
        SEC_L;
        page_0();
        SEC_L;
        display_char();
        SEC_H;
        Phone_L;
        Buzer_L;
        EN_L;
        BL_H;
        delay_ms(3000);
        page_1();
        SEC_L;
        display_char();
        SEC_H;
        Scan0_H;
        Scan1_H;
```

```
        Scan2_H;
        save_digit();
        page = 1;
        counter = 0;
        code = 0;
        change = 0;
        try = 0;
        setup_timer_1(T1_INTERNAL | T1_DIV_BY_8);
        set_timer1(0xe796);        //10ms
        enable_interrupts(INT_RDA);
        enable_interrupts(GLOBAL);
        enable_interrupts(INT_TIMER1);
}



void main()
{
        Init();

        mainloop:
        do {
        } while (!flg_10ms);
        flg_10ms = 0;
        if (skip_3 == 0){    scan_key();
                             identify_key();
                            }
        if (loop == 0) keyNew_1 = keyNew;
        if (loop == 1) { keyNew_2 = keyNew;
                             reset = 1;
                       }
        loop++;
        if (reset == 1) {
                loop = 0;
                reset = 0;
        }
        if (skip_2 == 1){
                skip_2 = 0;
                if(keyNew_1 == keyNew_2) skip = 1;
        }
        if (skip == 1){
                confirm_key();
                confirm_key2();
                keyNew_1 = 21;
                keyNew_2 = 22;
                skip = 0;
                skip_3 = 1;
        }
        tmr10ms++;
        if(tmr10ms <= 9) goto mainloop;
        security();
        tmr10ms = 0;
        skip = 0;
        skip_3 = 0;
        loop = 0;
        keyCnt = 0;
```

```
        keyNew = 20;
        keyNew_1 = 21;
        keyNew_2 = 22;

        if (bUpdateLCD) {
                        SEC_L;
                        display_char();
                        SEC_H;
                        bUpdateLCD = 0;
                        }

check_key:
        scan_key();
        if (tmp00 == 0xff){
                if (tmp01 == 0xff){
                        if(tmp02 == 0xff) { goto mainloop;}
                }
        }
        goto check_key;
}
```