

WIRELESS ELECTRONIC NOTICE BOARD

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ABSTRACT

This project is designed to develop a Wireless Electronic Notice Board. It is widely used to display latest information anywhere such as faculty, shop, mosque and other places. This Wireless Electronic Notice Board offers the flexibility to user to control the information display within 25m range. The information is transmitted using RF as wireless technique. The Wireless Electronic Notice Board consists of two module; transmitter and receiver module. There are five parts in transmitter module and four parts in receiver module. In transmitter module, there are keypad, Liquid Crystal Display (LCD), Microcontroller, encoder and transmitter. In receiver module there are receiver, decoder, microcontroller, and dot matrix. This project is based on MC68HC11A1 microcontroller. Assembly language is used to program the microcontroller.

CHAPTER 1

INTRODUCTION

1.1 Background

Microcontrollers are used in the industrial world to control many types of equipment, ranging from consumer to specialized devices. They have replaced the older types of microcontrollers, including microprocessor. Furthermore, there is a growing need for offline support of a computers main processor. The demand will grow as more equipment uses more intelligence. Applications range from controlling engines in modern automobiles to controlling laser printer and other computer peripherals. One consumer application is a washing machine controller that can adjust the wash cycle based on the load size, fabric type and amount of dirt. Technology has evolved to the point where this same washing machine could be connected to the internet. We can envision a future with wearable computing where wristwatch-type devices could communicate with and control the washing machine using wireless networking

Generally there are lots of microcontrollers produce in order to fulfill the needs of control. One of the most popular is Motorola 68HC11. The 68HC11 microcontroller is relatively easy to work with, yet they have most of the features essential for a complete control system. Thus student of control automation can use them to work with control systems at the component level. The interested layperson can also use them as tools to understand and experiment with computer and data communications systems. Although the futuristic vision to use newer processors, the 68HC11 is a great tool for learning about embedded control fundamentals because it is simple. [1]

In this particular project, Motorola 16HC11 will be used as the controller. This microcontroller offers various functions that are suitable to design an electronic notice board. It is very flexible because in can be expanded to unlimited numbers of port. It makes designer's work become easier.

1.2 Objectives of the Project

Presently almost all electronic notice boards are designed using wired system. One of the drawbacks of the design is the system is inflexible in term of placement. The common notice board cannot be placed anywhere because of the messy wire.

The aim of this project is to develop a wireless notice board that will be used at the faculty in order to display latest information. Wireless electronics notice board is developed as user friendly notice board with wireless concept that offers the flexibility to control the notice board within range 25 meters. The input of the system is 4X4 keypad. The keypad is connected to the electronic notice board by using RF technology.

1.3 Organization of the Thesis

This thesis consists of six chapters. The first chapter will give an overview of the project as well as the objective of the project.

Chapter 2 covers the layout of the project. It describes the various modules developed, basic operation and theory of each module. All of the eight modules are described briefly in this chapter.

The detailed of project design is discussed in chapter 3. It reviews the hardware description of each circuitry and component used in this project. The descriptions include the function, operations, advantages and their roles in operating the whole system.

Chapter 4 elaborates software development of this project. It discusses the approach of the system by using flow chart. Testing software of each module is described.

Chapter 5 explains the testing and result of each module. The result of system effectiveness is also discussed.

Chapter 6 summarized the project outcome. A few suggestions are proposed to enhance the current design.

CHAPTER 2

PROJECT DISCRPTION

2.1 Introduction

Electronic notice board is a common device that is used to display information. The information or messages are displayed using dot matrix. The wireless system for dot matrix display is a method using Radio Frequency as transmission medium. The system consists of two modules; transmitter and receiver. The transmitter module is used by a user to place a message through an input module such as keypad or keyboard. The information then transmitted using RF technology to the receiver. It then will be decoded and displayed on electronic notice board.

Figure 2.1 is a simple block diagram of wireless electronic notice board. The system is divided into six modules. The modules are:

- Keypad Module
- Microcontroller Module (expended mode)

- Liquid Crystal Display Module
- Encoder and Decoder Module
- Transmitter and Receiver Module
- Dot Matrix Module

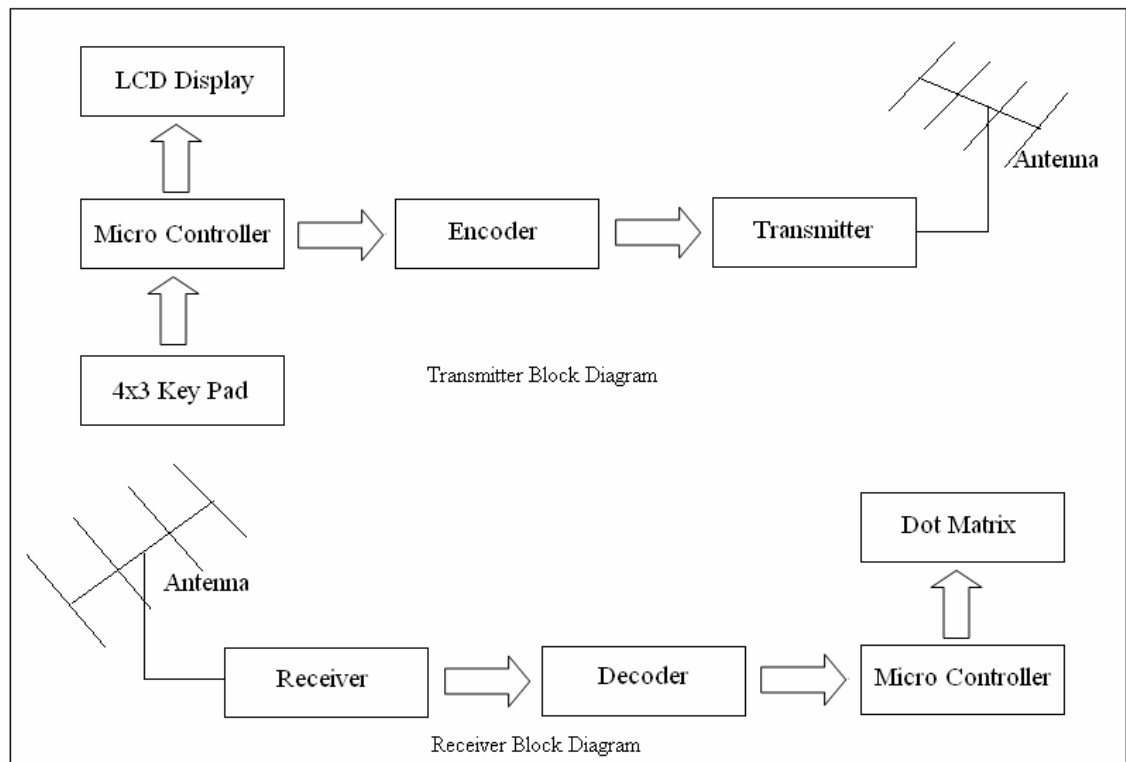


Figure 2.1: Block diagram of wireless electronic notice board

2.2 Transmitter

Transmitter is a device that is used to transmit signal to free space at certain frequency. The signal source is modulated by carrier into a modulated signal to ensure it

is received by a receiver. The transmitter used in this project is FM-TX1 that operates at 433.92MHz.

The transmitter is designed to work in pair with receiver FM-RX1. With additional simple antenna, the transmitter can be used to transmit data up to 200m range. The range depends on several factors. One of the elements that is antenna design. In theory, the 200m quote range is a reliable range over open ground using $\frac{1}{4}$ whip antenna at both end with 1.5m above ground. Smaller antenna, interference or building will reduce the reliable range to 25-30m range. Increase the size of the antenna and slower the data transfer will increase the reliable range.

2.2 Receiver

The receiver is used to receive signal from free space through the antenna. The modulated signal is then demodulated to obtain the original signal. Demodulation process is important to separate between carrier signal and modulating signal. Like the transmitter, the frequency of receiver that used is 433.92MHz. The type of the receiver is FM-RX1.

The characteristic of a receiver must be similar with transmitter. If the characteristic is not equal, the data cannot be transferred to the receiver. FM-RX1 can receive data from FM-TX1 in the range of 200m in open and 25-30m when there are obstacles. The range is also influenced by the size of the antenna and the environment. The larger antenna, the better receive.

2.3 Antenna

Antenna is the most important part in wireless project. It is an interface between the transmission line and the space to propagate electronic wave. It converts the electrical energy into electromagnetic wave for transmitter. Similarly, on the received side, the electromagnetic signal is converted back to electric signal. Antenna is a passive device that power radiated by transmitting antenna cannot be greater than the power entering the transmitter. The antenna is reciprocal that means the same design can works equally well as a transmitting or a receiving antenna. In this project there are three types of antenna that can be implemented in the project. They are helical antenna, loop antenna and whip antenna.

Helical antenna is a wire coil antenna. This antenna is efficient because of small size. It is designed by winding 0.5mm enameled copper wire on a 3.2mm diameter cylinder to form wire coil.

Loop antenna on the other hand, is a loop of PCB track, tuned by fixed or variable capacitor to ground at the hot end. Loop antenna has a high immunity to proximity detune but the performance is ineffective.

On contrary, whip antenna is a wire rod antenna, PCB track or combination connected directly to the transmitter or receiver. The optimum length is 17cm ($\frac{1}{4}$ wave/433.92MHz). It is important to ensure the antenna is well away from hot spot in the circuit to avoid serious detuning. [3]

The antenna choice is important to ensure maximum performance.

2.5 Encoder and Decoder

Encoder and decoder are used in the project to ensure only the intended receiver receives the signal. This is due to the fact that the signal is broadcasted using radio wave. Thus, it allows the signal to be received by any receiver with the same frequency. The devices also play a role to convert data from parallel to serial and conversely.

The type of encoder and decoder that will be used in this project is HT12E and HT12D. Both of these devices have 255 possible addresses. Data transmitted use 4 bits while address uses 8 bits. Only the receiver with the same address as the transmitter will receive the signal.

2.6 Keypad

Keypad is a device that is used to key in the data to microcontroller. The most common keypad is 4X4 where it contains of 4 rows and 4 columns as shown in figure 2.2 .

In order to simplify the design, a keypad encoder (74922) is used. Table 2.1 is a simplified truth table of keypad encoder.

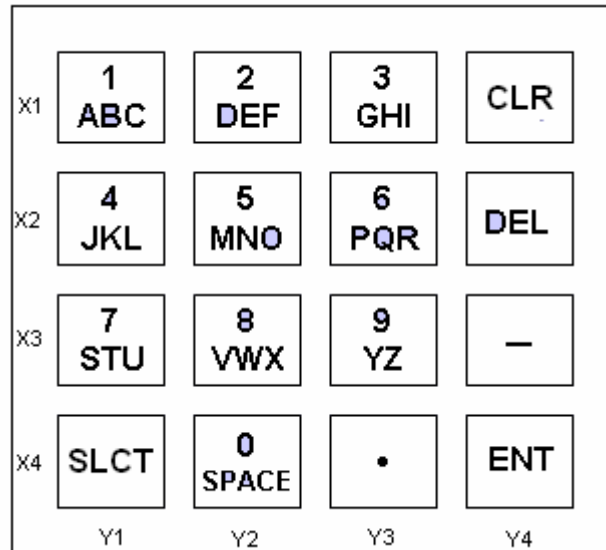


Figure 2.2: Key column and rows

Table 2.1: Truth table of keypad encoder

Switch Position	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
	Y1,X1	Y1,X2	Y1,X3	Y1,X4	Y2,X1	Y2,X2	Y2,X3	Y2,X4	Y3,X1	Y3,X2	Y3,X3	Y3,X4	Y4,X1	Y4,X2	Y4,X3	Y4,X4	Y5*,X1	Y5*,X2	Y5*,X3	Y5*,X4	
D																					
A	A	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
T	B	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
A	C	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0
O	D	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
U	E*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
T																					

2.7 Microcontroller

MC68HC11 is the most widely used microcontroller in today's technology. The microcontroller can operate in four mode of operation. They are bootstrap mode, single chip mode, special test mode and expanded mode. Due to the limited of the input/output and memory, the expanded mode is used in this project.

Figure 2.3 is a simple block diagram for brief diagram on microcontroller 68HC11 expanded mode.

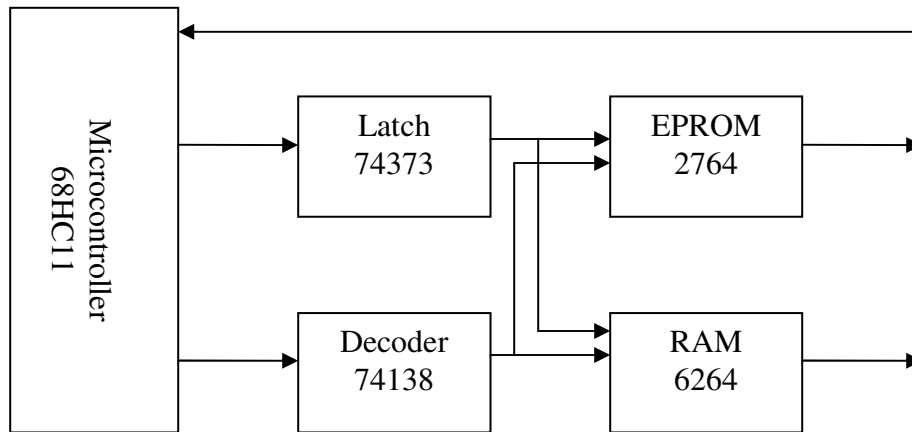


Figure 2.3: MC6811A1 expanded mode block diagram

The circuit consists of microcontroller, latch, decoder, EPROM and RAM. Latch is used to demultiplex between data bus and address bus. The decoder is used to select input/output and memory.

The normal expanded mode is activated by setting MODA and MODB in high logic state. This is done by directly connected to VCC via resistor 4.7k ohm. EPROM is a non-volatile memory and normally is used to store permanent program or data. On the other hand, RAM is a volatile memory and it is only used for temporary storage.

2.8 Dot Matrix

Dot matrix is widely used as output module due to its flexibilities performance and cost. 8X8 dot matrix is chosen in this project and its configuration is shown in figure 2.4. Since there are 64 LEDs in a single dot matrix, transistors are used to drive the dot matrix. Dot matrix display in this project is consisted of 2 blocks of 8X8 dot matrix.

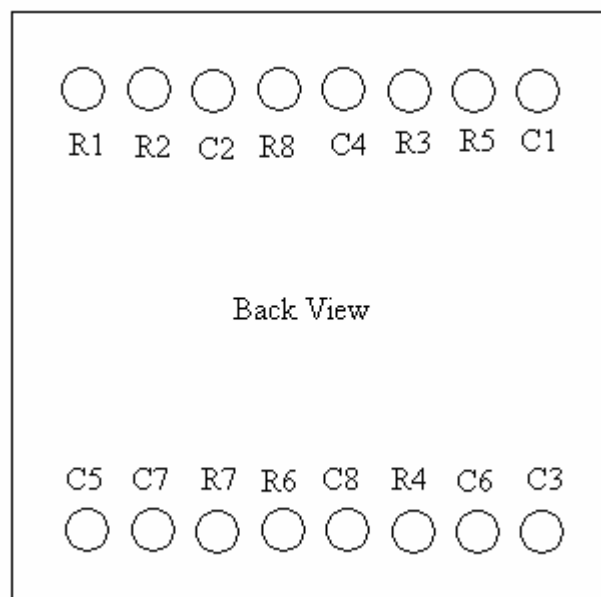


Figure 2.4: Pin Configuration of 8X8 dot matrix

2.9 Liquid Crystal Display (LCD)

Liquid crystal display (LCD) is another common output device. There are various type and model of LCD available in the market. One of them is given in figure 2.5. Table 2.2 shows the pin configuration for LCD.

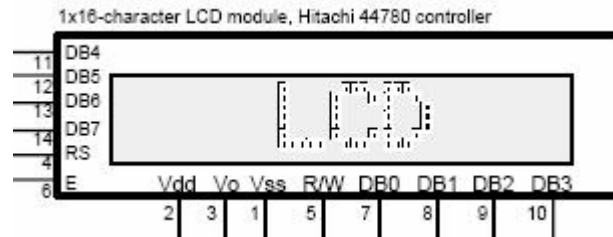


Figure 2.5: LCD ACM 1602A panel

Table 2.2: LCD pin configuration

Pin No.	Symbol	Level	Pin Description	Function
1	Vss	-	Ground	0V
2	Vdd	-	Supply voltage for logic	+5V
3	Vo	-	LCD contrast adjust	By user
4	RS	H/L	Register select	H: Data; L: Instruction code
5	R/W	H/L	Read / write	H: Data read, L: Data write
6	E	H, H→L	Enable	Start signal for data read/write
7	DB0	H/L	Data bit 0	8-bit interface
8	DB1	H/L	Data bit 1	8-bit interface
9	DB2	H/L	Data bit 2	8-bit interface
10	DB3	H/L	Data bit 3	8-bit interface
11	DB4	H/L	Data bit 4	4-bit or 8-bit interface
12	DB5	H/L	Data bit 5	4-bit or 8-bit interface
13	DB6	H/L	Data bit 6	4-bit or 8-bit interface
14	DB7	H/L	Data bit 7	4-bit or 8-bit interface
15	A	-	Anode for LED backlight	Power supply for LED/EL backlights
16	K	-	Cathode for LED backlight	Power supply for LED/EL backlights

The role of LCD in the electronic notice board is to reveal the information at the transmitter before it is transmitted. This will allow user to update, replace and cancel the information.

2.10 Operation of the System

The basic operation of the system is to send information from transmitter to receiver and reveal the information on the dot matrix which is located a distance away by using wireless technology. At the transmitter, the users key-in the information by using keypad and the information will be displayed on the LCD. The user may change, replace or even delete the information using the proper key.

If the user is satisfied with the data information, he can transmit the data to the receiver by pressing appropriate key to send the information.

Then the data are transmitted using FM-TX1 transmitter as shown in figure 2.6. The data normally are converted from parallel to serial and encoded before they are transmitted. Antenna plays an important role to ensure all the data transmitted to the destination.

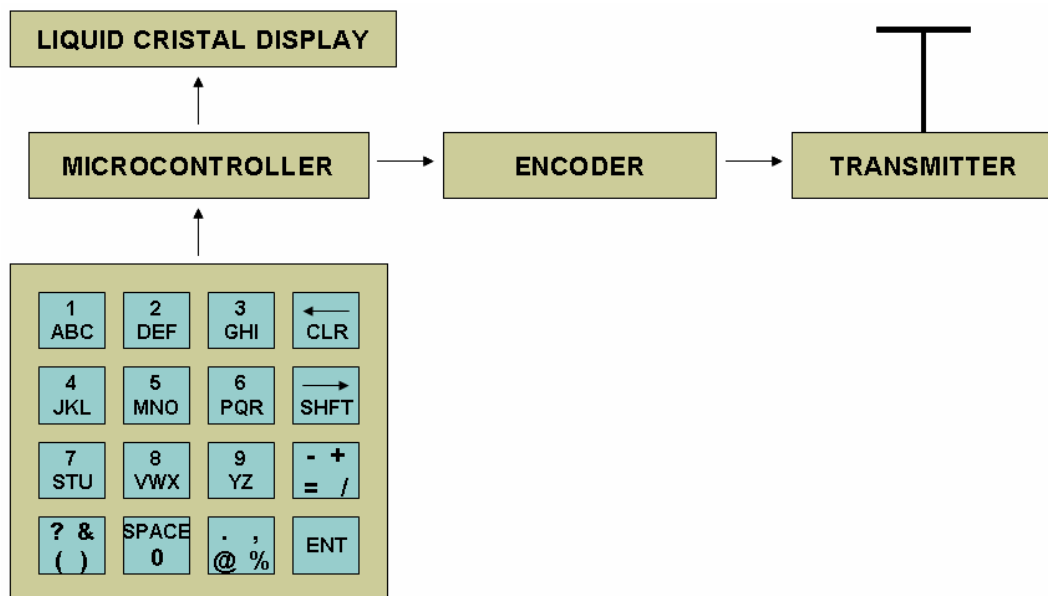


Figure 2.6: Transmitter block diagram

At the receiver, the data is decoded and converted into parallel data. Then the data is transferred to microcontroller and displayed on the dot matrix as shown in figure 2.7.

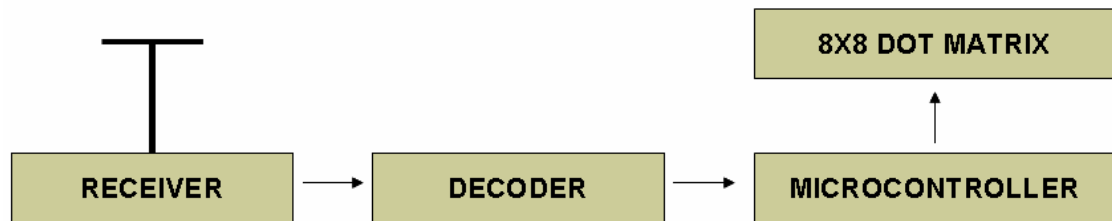


Figure 2.7: Receiver block diagram

CHAPTER 3

HARDWARE DESIGN

3.1 Introduction

This chapter describes the hardware design and connection of each component in the project. The function of the component will also be discussed in this chapter.

Wire wrapping technique is used to connect the various components. This technique is implemented reliability, durability, cost and easy to perform trouble shooting.

3.2 Microcontroller MC68HC11

The 68HC11 is a powerful 8-bit data, 16-bit address microcontroller from Motorola with an instruction set that is similar to the older 68xx (6801, 6805, 6809) parts. Depending on the variety, the 68HC11 has built-in EEPROM/OTPROM, RAM, digital I/O, timers, A/D converter, PWM generator, and synchronous and asynchronous communications channels (RS232 and SPI). Typical current draw is less than 10mA. Figure 3.1 shows the layout of microcontroller MC68HC11.[2]

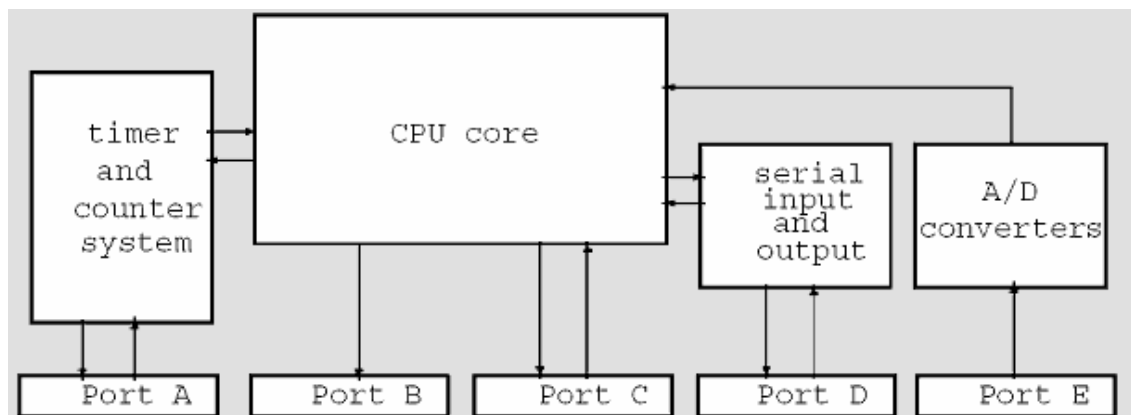


Figure 3.1: The layout of microcontroller MC68HC11

3.2.1 Architecture

The M68HC11 is optimized for low power consumption and high-performance operation at bus frequencies up to 4 MHz. The CPU has two 8 bit accumulators (A & B) that can be concatenated to provide a 16 bit double accumulator (D). Two 16 bit index

registers are present (X & Y) to provide indexing to anywhere in the memory map. Having the two index registers means the 68HC11 is very good for processing data. Although an eight bit processor, the 68HC11 has some 16 bit instructions (add, subtract, 16 * 16 divide, 8 * 8 multiply, shift, and rotates). A 16 bit stack pointer is also present, and instructions are provided for stack manipulation. Typically multiplexed address and data bus. [2]

Other features include:

- Powerful bit-manipulation instructions
- Six powerful addressing modes (Immediate, Extended, Indexed, Inherent and Relative)
- Power saving STOP and WAIT modes
- Memory mapped I/O and special functions

3.2.2 Memory

The M68HC11 Family leads in microcontroller memory technology. In fact, the 68HC711E9 was the first device to integrate EPROM and EEPROM technologies on the same chip. In many applications, the M68HC11 provides a single chip solution with mask programmed ROM or user-programmable EPROM. [2]

The M68HC11 Family's RAM uses a fully static design, and the contents can be preserved during periods of processor inactivity.

One Time Programmable (OTP) and windowed EPROM versions of M68HC11 devices are offered across the family providing a cost effective, user-programmable ROM facility for small volume prototypes and development runs. Secure EPROM devices are also available for applications where code is at risk of being compromised.

The M68HC11's EEPROM is ideal for the secure storage of essential calibration, diagnostic and security information. A 4 channel Direct Memory Access (DMA) unit on some devices permits fast data transfer between two blocks of memory (including externally mapped memory in expanded mode), between registers or between registers and memory.[2]

3.2.3 Timer

The industry standard M68HC11 timer provides flexibility, performance and ease of use. The system is based on a free-running 16-bit counter with a programmable prescaler, overflow interrupt, and separate function interrupts. Additional M68HC11 timer features include: [2]

- Fixed periodic rate interrupts
- Computer Operating Properly (COP) protection against software failures
- Pulse accumulator for external event counting or gated time accumulation
- An optional PWM offering up to six channels and up to 16 bit PWM outputs
- Optional event counter system for advanced timing operations
- Multiple input capture functions and multiple output compares

It also provides a selection of timer sub systems geared towards timing-intensive applications; each supported by additional features associated with specific family members, including:

- Input Captures
- Output Compares
- Real-Time Interrupt
- Pulse Accumulator
- Watchdog function

3.2.4 A/D Converter

A/D systems are available with 8 to 12 channels and 8 and 10 bit resolution. The A/D is software programmable to provide single or continuous conversion modes. The M68HC11 Family now also offers D/A conversion for added versatility. [2]

3.2.5 Serial Communications Interface (SCI)

The SCI features a full duplex Universal Asynchronous Receiver/ Transmitter system, using the non-return-to zero (NRZ) format for microcontroller-to-PC connections, or to form a serial communications network connecting several widely distributed microcontrollers. Through the SCI, the built-in bootstrap interface allows in-circuit programming, and facilitates diagnostic and test operation of your application.[2]

Data format - 1 Start, 8 or 9 data, and one stop bit.

Data rate - 150 - 312500 Baud (312500 is using 4 MHz E clock)

3.2.6 Serial Peripheral Interface (SPI)

Synchronous serial communications comprises CLK, DATA IN, DATA OUT and optionally chip selects. As well as using specific SPI devices, it is very easy to expand I/O using the SPI and standard logic devices (e.g. 74HC595 and 74HC165). The SPI also enables synchronous communication between the microcontroller and peripheral, devices such as: [2]

- Shift registers
- Liquid Crystal Display (LCD) drivers
- Analog to Digital Converters
- Other microprocessors

3.2.7 Pulse Width Modulation

The M68HC11 Family offers a selection of Pulse Width Modulation (PWM) options to support a variety of applications. Up to six PWM channels can be selected to create continuous waveforms with programmable rates and software selectable duty cycles from 0 to 100%.

Figure 3.2 and table 3.1 shows the programmer's model and the memory map address for MC68HC11 microcontroller.

7	A	7	B	0	8-bit accumulators A and B or 16-bit double accumulator D
15			D	0	
15			X	0	index register X
15			Y	0	index register Y
15			SP	0	stack pointer
15			PC	0	program counter

Figure 3.2: Programmer's Model

Table 3.1: Memory map

Memory Map of the MC68HC11A8 Microprocessor.	
Memory Address	Function
\$0000 - \$00FF	RAM memory (256 bytes)
\$0100 - \$0FFF	unused
\$1000 - \$103F	special registers (64 bytes)
\$1040 - \$B5FF	unused
\$B600 - \$B7FF	EEPROM memory (512 bytes)
\$B800 - \$DFFF	unused
\$E000 - \$FFFF	ROM memory (8192 bytes)

In this project, expanded mode is used because of its flexibility to expand to unlimited port. Figure 3.3 shows the circuitry of microcontroller MC68HC11 expanded mode.

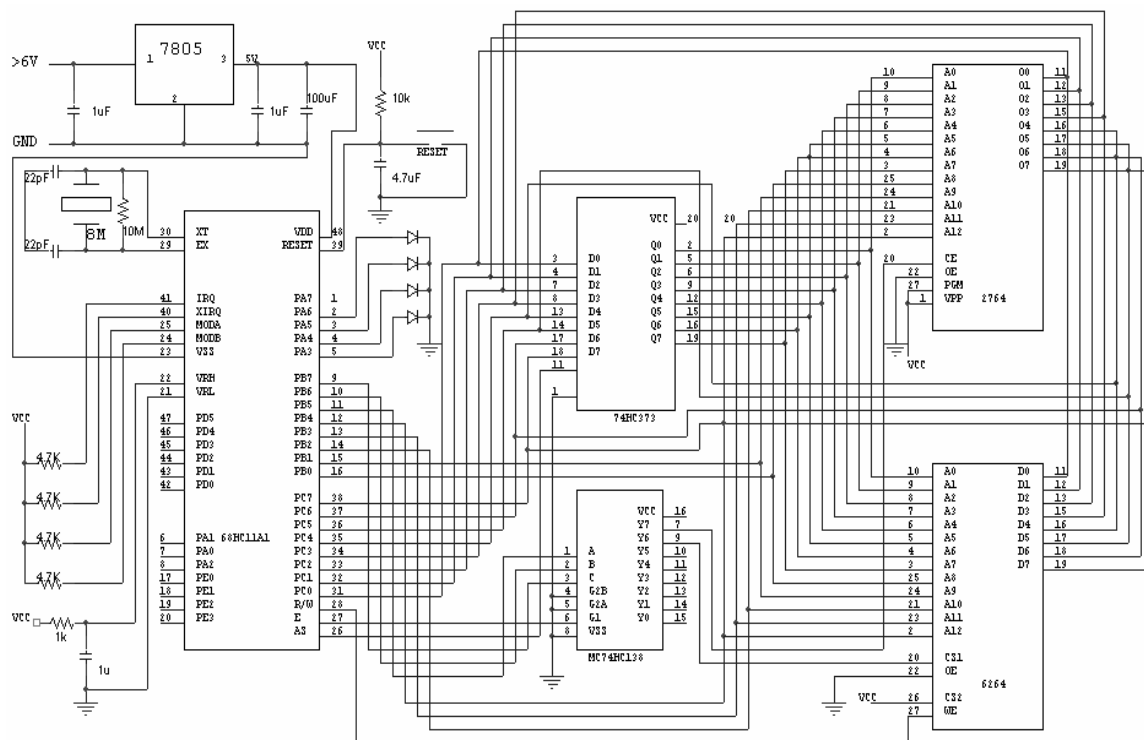


Figure 3.3: MC68HC11 expanded mode circuit

3.3 Dot Matrix

LED dot matrix display is used to display any messages that are key-in by user. The LED dot matrix that is used in this project consists of 2 blocks and 8X8 matrixes. The position of the least significant bit (LSB) and most significant bit (MSB) of the display need to be initialized.

Figure 3.4 shows the pin configuration of a single block dot matrix.

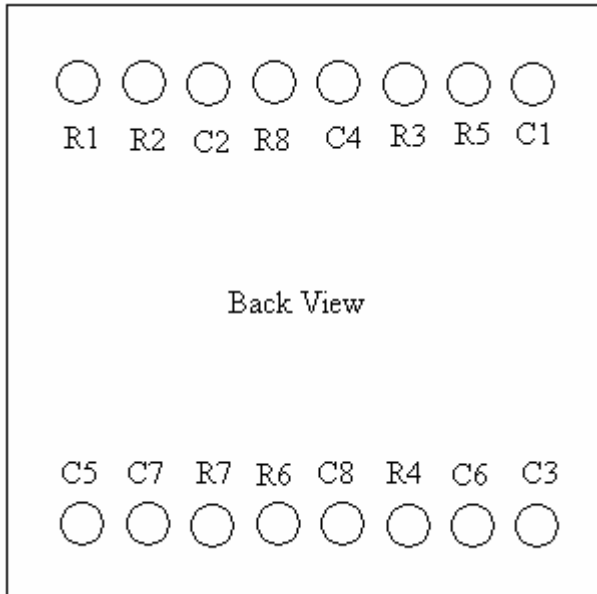


Figure 3.4: Dot Matrix pin configuration

The scrolling mechanism of the light on LED from the first column to the last column is applied in this board so as to display fixed or scroll characters. It is controlled by microcontroller system through decoder by enabling and disabling certain latches. Basically, only one column for each LED dot matrix will lit up at one time. But due to the eye insensitivity, user cannot tell the different. The scrolling mechanism means the LED lighting up simultaneously to display fixed or scrolling messages.

Initially, the first column for LED display blocks is lit up. It is followed by second column while the other column is lit off. The process will continue until the last column. Then the process is repeated to produce a character or word in accordance to user request. The lit off the LED is so fast, so that all of the LED looks like lit up at the same time.

The latch played the major role in controlling the data into rows and columns for the LED. This process is controlled by software written in assembly language for microcontroller MC68HC11A1.

For example, to display B in the dot matrix, a set of hex numbers instructions must be given to the microcontroller for rows and columns. The numbers are \$81, \$B5, \$B5, \$CB for rows and \$C3 for columns. Logic '0' will lit up the LED on the Dot Matrix. Figure 3.5 is an example of dot matrix display.

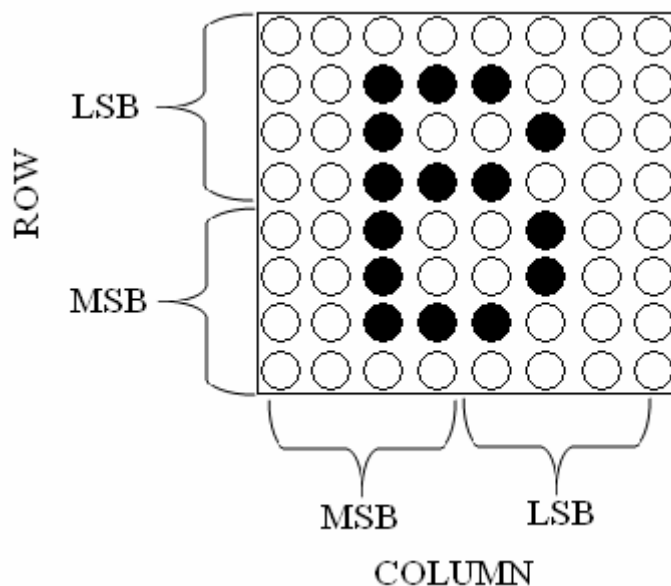


Figure 3.5: How dot matrix works.

Figure 3.6 is a circuit connection for two dot matrices. Each dot matrix request the use of a latch to control the display mechanism. A transistor is used for each column to drive current to the display.