IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 10, Issue 1 Ver. III (Jan – Feb. 2015), PP 27-36
www.iosrjournals.org

Implementation of an Improved Microcontroller Based Moving Message Display System

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Abstract: *The implementation of a Light Emitting Diodes (LEDs) dot matrix moving message display system which show a text containing 23 characters (i.e., GREAT DEPT. OF ELECT. ENGRG) is achieved in this work using a PIC16F648A Microcontroller, The microcontroller is programmed using Assembly language, with MPLAB software and a PIC Programmer .The LEDs are controlled by signals from the microcontroller and decade counters in a sequential manner which results in the moving message. In this work, we make use of a 49*8 dot matrix display made up of 392 low power Light Emitting Diodes (LEDs). The connection is done in such a way that the cathodes of all the LEDs on a particular column are connected together while the anodes of all the LEDs on a particular row are also connected together. This gives each row and column a separate line and allows the LEDs on each of these rows or columns to be powered by the same line. A limiting resistor for the eight (8) output lines of the microcontroller to the LEDs on the dot matrix is used. and a dynamic display scheme is also employed.. In this system, the LEDs is not lit continuously but is sequentially lit by scanning in a "vertical strobe" or "horizontal strobe". In the vertical strobe mode, information is addressed to the display by selecting a single row at a time, energizing the appropriate LED(s) in that row and proceeding to the next row. In the horizontal strobe mode, a single column is chosen at a time The dynamic display scheme employed in this work helped to improved the brightness of the display and also save energy consumed by the hardware .*

Keywords: *Decade counter, Flow-chat , LED Display ,Microcontroller ,Programming.*

I. Introduction

The use of Light Emitting Diodes (LEDs) dot matrix for creating a text display system is quite common with its usage expanding greatly in recent time. Such displays can be found in airports, where they are used to display flight information, in stock exchanges and banks to display share prices and exchange rate respectively. The wide usage of LED displays is as a result of its ability to convey information to large audiences quickly and efficiently. As LED displays are often controlled by digital technology the information can swiftly and easily be updated. This feature of LED displays has led to a great flexibility of such products in countless applications. An additional benefit of using this form of display is that LEDs are a very efficient form of illumination. Unlike incandescent bulbs, LEDs do not generate a large amount of wasted energy in the form of heat. [1]

This paper, therefore, presents the design and implementation of a moving message display system using Light emitting diode (LED) dot matrix display and a microcontroller with the following objectives:

- Designing and realizing the moving message display panel.
- Using a PIC Microcontroller to input, store, control and display the data for the message characters on a dot matrix.

The figure below is the Building blocks diagram of a Moving Message Display System.

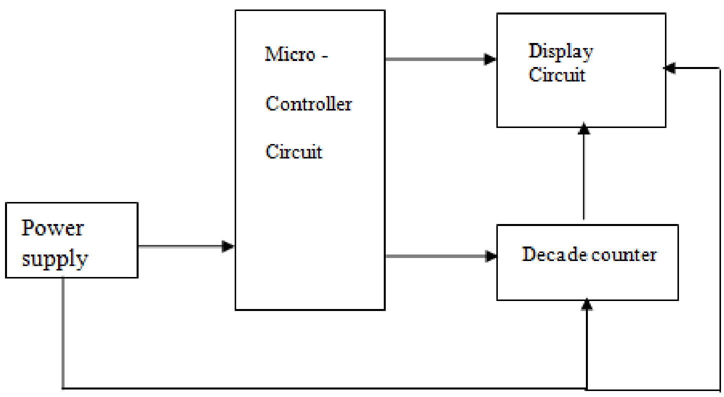


Figure. 1: Block diagram of a moving message display system

1.1 Power Supply Unit

In order to operate the system, Power. Supply is required as shown in figure 1 . The mode of application of such power will form the basis for the design of the power supply unit and it's characteristic. A dc Power Supply is needed to power the microcontroller and all the other modules .

1.2 Control Circuit

The microcontroller is the brain behind the moving message display system. It is the meeting point for all the other units. The microcontroller controls the decade counters and the rows of the dot matrix display to produce the desired alphanumeric character.

1.3 Counting Unit

In this unit, the decade counter is used. it produces the shifting action of the alphanumeric characters on the dot matrix display.

1.4 Display Unit

The display unit makes use of dot matrix to display information. The light emitting diodes are arranged properly to make an array of rows and columns [2]

II. Materials And Methods

In the implementation of this work, certain logical steps were taken into consideration in determining the hardware components. These steps followed the model of the design. Other necessary support components were identified. The detailed circuit diagram is shown in Fig. 2 and Fig. 3.

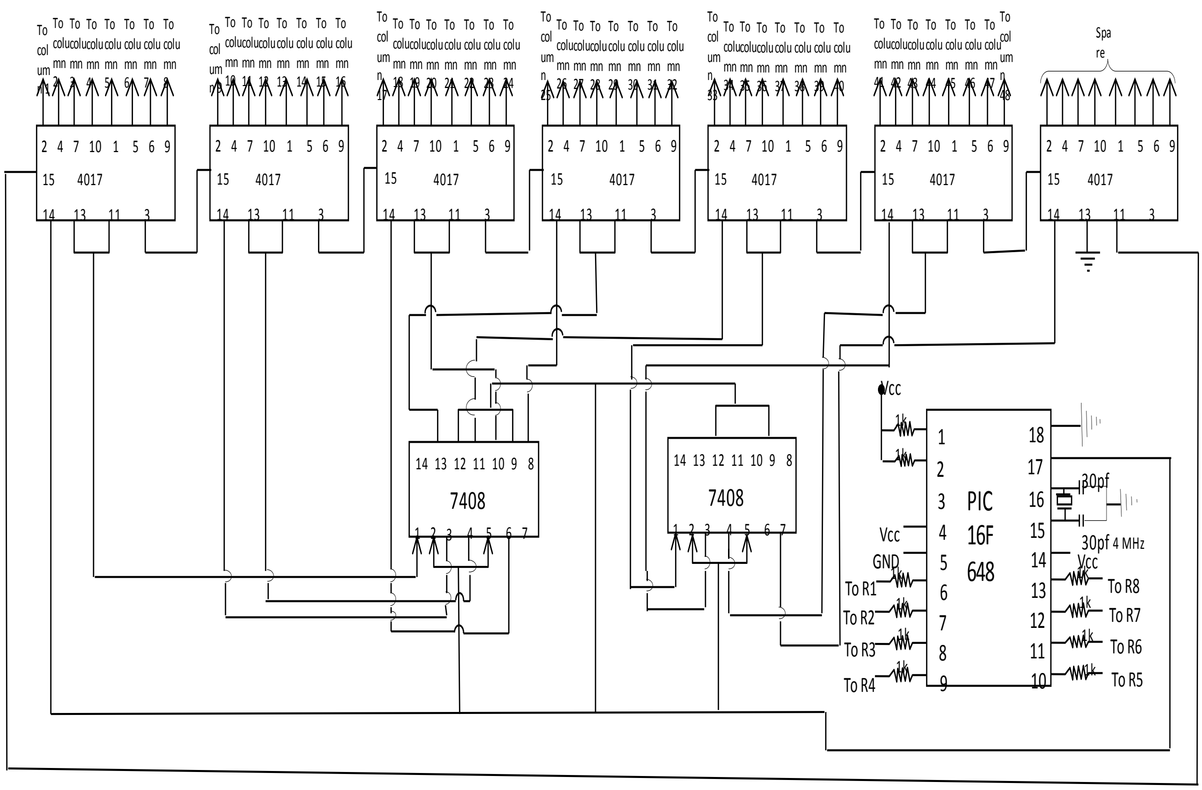


Figure 2: Detailed Circuit Diagram of Moving Message Display System.

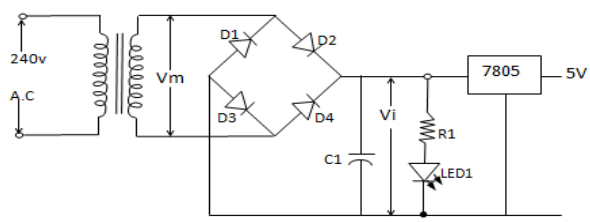


Figure 3: Power Supply Circuit

2.1 Working Principle:

The microcontroller used is the PIC16F648A shown in fig. 4. It comes with a wide variety of special features which makes it useful for a wide range of applications. The features are;

- It has a maximum frequency of operation of 20MHz
- It has 4096 words of flash program memory
- It has 256 bytes of RAM Data memory it has 256 bytes of EEPROM Data memory
- 3 timer module- TMRO, TMRI, TMR2
- 2 comparators
- USART
- Internal voltage reference
- 10 interrupt sources
- 16 1/0 pins
- Voltage range of 2.0 – 5.5 volts
- Comes in an 18-pin dual- in-line package (DIP)
- Stand – by current – 100nA (a) 2.0v, typical
- Operating current - 12µA (a) 32KHz , 2.0V, typical - 120µA (a)1MHz , 2.0V, typical
- Watching timer current - 1µA (a) 2.0V, typical
- Timer 1 oscillator current - 1.2µA (a) 32KHz, 2.0V, typical
- Dual speed internal oscillator Run- time selectable b/w 4MHz and 3.7KHz
- 4µs wake-up from sleep, 3.0V, typical

Pins 1 and 2 (i.e V_{REF} & CMPI) are connected in a pull up manner to V_{CC} through 1kΩ resistors while pin 3 is not used. Pin 4 is connected directly to V_{CC}. Pin 5 goes to ground. Pin 6 through 13 are input/output pins. In this project, they function as output pins that carry the code data in term of Os (zero) and 1_s (ones) from the microcontroller and pass these signals to the 8 rows of the dot matrix display.
Pin 14 goes to V_{CC}. Pins 15 and 16 are connected to an external oscillator (4MHz) that controls the timing sequence of the microcontroller's operation. Pin 7 is connected to pin 14 of the 1st 4017 decade counter. It activates the clocking of the 1st decade counter. [3],[4]

Pin 18 is connected to ground.

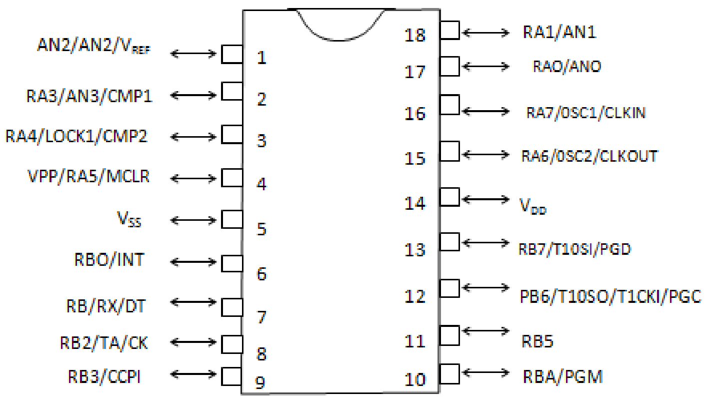


Figure 4: Pin Configuration of PIC16F648A

2.2 Peripheral Features:

• 16 I/O pins with individual direction control
• High current sink/source for direct LED drive
• Analogue comparator module with:
- Two analogue comparators
- Programmable on-chip voltage reference (VREF) module
- Selectable internal or external reference
- Comparator outputs are externally accessible
• Timer0: 8-bit timer/counter with 8-bit programmable prescaler
• Timer1: 16-bit timer/counter with external crystal/ clock capability
• Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
• Capture, Compare, PWM module
- 16-bit Capture/Compare

- 10-bit PWM
• Addressable Universal Synchronous/Asynchronous Receiver/Transmitter USART

For the CPU to execute an instruction, it takes a certain number of clock cycles. The frequency of the crystal connected to the PIC16FXX family varies from 4MHz to 37MHz, depending on the chip rating.[3], [4]

III. Hardware Design And Analysis

3.1 Size Of Transformer

$$V_{CC} = Vi = Vm - Vr\ (peak) \quad (1)$$

Where $V_{DC} = rectified\ \ voltage$

$$Vi = input\ to\ 1C\ \ recgulator$$

$$Vm = peak\ or\ \max imum\ A.C\ voltage$$

$$Vr = peak\ \ ripple\ voltage.$$

But, Vr (peak) = $\sqrt{3}\ \ Vr\ (r.m.s)$ (2)

Where, Vr (r.m.s) is the root mean square value of the ripple voltage. The rectified signal,

$$Vr\ \ (r.m.s) = \frac{1_{A.C}}{4\sqrt{3}fc} \quad (3)$$

Where f = frequency in Hertz
C = filter capacitor

To maintain regulation

$$Vr\ (peak) \leq V_m - Vi\ (min) \quad (4)$$

For IC regulator 7805:

Vi (min) = 7.5v

From equation (4), for regulation to be maintained, then:

$$V_m > Vi\ (min) \quad (5)$$

For the choice of transformer

V_m = 12v

Also,

$$I_{D.C} = 0.62\ I_{A.C} \quad (6)$$

Were $1_{D.C}$ is the total dc load in amperes drawn by the display circuit at which regulation is to be maintained.
$I_{A.C}$ is the A.C current capacity of the transform

From eqn 6

$$I_{A.C} = \frac{I_{D.C}}{0.62} \quad (7)$$

Now, for the message display circuit, total bad in amperes is given as

$$I_{A.C} = \frac{I_{D.C}}{0.62} = \frac{150m}{0.62}$$

$$= 242mA$$

Hence, the current size or capacity of the transformer should be

$$I_{A.C} \geq 242mA$$

Let $I_{A.C} = 300mA$

Also,

Since 12 > 7.5, equations (4) and (5) are satisfied, hence; regulation is possible Therefore, the size of transformer is 240v/12v, 300mA, 50Hz A.C [5]

3.2 Size of Filter Capacitor
Using equation (3)

$$Vr\ (r.m.s) = \frac{1_{D.C}}{4\sqrt{3}fc}$$

$$\Rightarrow \quad C1 = \frac{1_{D.C}}{4\sqrt{3}fVr(r.m.s)} \qquad (8)$$

From equation (2):

$$Vr\ (peak) = \sqrt{3}Vr(r.m.s)$$

$$\Rightarrow \quad Vr(r.m.s) = \frac{Vr(peak)}{\sqrt{3}} \qquad (9)$$

Putting equation (9) into (8)

$$\Rightarrow \quad C1 = \frac{I_{D.C}\sqrt{3}}{4\sqrt{3}fVr(peak)}$$

$$C1 = \frac{I_{D.C}}{4fVr_{(peak)}}$$

Where f = 50Hz

$$\Rightarrow \quad C1 = \frac{I_{D.C}}{200Vr_{(peak)}}$$

$$\therefore \quad C1 = \frac{5\times10^{-3}I_{D.C}}{Vr_{(peak)}} \qquad (10)$$

Now, from equation (4)

$$Vr(peak) \le Vm - Vi(\min)$$

Where $Vm = 12v;\ Vi(\min) = 7.5v$

$$\Rightarrow \quad V_m - Vi(\min) = 12 - 75 = 4.5V$$

Hence,

$$Vr(peak) \le 4.5v$$

Let $Vr(peak) = 0.7v$

But $I_{D.C} = 150mA$

$$\Rightarrow \quad C1 = \frac{5\times10^{-3}\times150m}{0.7}$$

$$= \frac{7.5\times10^{-4}}{0.7}$$

$$= 1.05\times10^{-3}f$$

$$= 1051\mu f$$

Choosing closest standard value,

$$\therefore C1 = 1000\mu f$$

With $C1 = 1000\mu f$

$$V_{r(peak)} = \frac{5\times10^{-3}I_{D.C}}{C}$$

$$= \frac{5\times10^{-3}\times150m}{1000\mu}$$

$$= 0.75v$$

Hence, $Vi(\min) = Vm - Vr(peak)$

$$= 12 - 0.75$$

$$= 11.25V$$

Since 11.25 > 7.5v, the regulation is very possible.
Now, the maximum operating voltage Vw of the capacitor C1 is given by

$$Vw = 1.4\ V_{D.C} \qquad (11)$$

Where $V_{D.C} = Vi = Vm - V_{r(peak)}$

$$= 12 - 0.75 = 11.25$$

$$\Rightarrow \quad Vw = 14 \times 11.25$$

$$= 15.75v$$

Let $Vw = 16v$

Thus, the size of the filter capacitor is

$$C1 = 1000\mu f,\ 16v$$

3.3 Voltage Regulation

The output voltage of the power supply unit is regulated by means of a positive IC voltage regulator: 7805

For regulation to be maintained:

$$Vi(\min) = Vm = Vr(peak)$$

Where $Vi(\min)$ is the minimum input voltage to the IC voltage regulator.

For 7805

$$Vi(\min) = +7.5v\ d.c$$

$$Vout = +5v\ d.c$$

Thus; to maintain the regulated +5v dc supply from the output of the IC regulator 7805,

$$Vi(\min) \geq +7.5v$$

Now, $Vm = 12v$;

$$V_{r(peak)} = 0.75v$$

$$Vi(\min) = 12 - 0.75 = +11.25v$$

Hence, since + 11.25 > +7.5v, regulation is possible. Thus, a regulated output of +15v d.c is supplied to the moving message display by the power supply unit.

3.4 Limiting Resistance For Power Indicator Led 1

The power indicator LED1 is used to indicate when power is supplied to the circuit. A green LED is used.

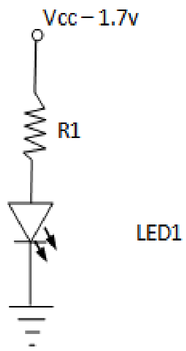


Figure 5: Power Supply Unit LED and limiting resistance.

$$R1 = \frac{V_D - 1.7}{I_L}$$

Where $V_D = 11.25V,\ I_L = 22mA$

$$\Rightarrow\ R1 = \frac{11.25 - 1.7}{22m}$$

$$= 434.1\Omega$$

Let $R1 = 470\Omega$

In summary, the list of rated components value for the power supply unit is as follows:

- Transformer = 240v / 12v, 300mA, 50Hz A.C
- D1− D4 = 1N4001
- C1 = 1000μf, 16v
- IC Regulator = 7805
- LED1 = Green
- Battery = 9v d.c

3.5 Dot Matrix Display

In this work, we make use of a 49*8 dot matrix display made up of 392 low power Light Emitting Diodes (LEDs). The connection is done such that the cathodes of all the LEDs on a particular column are connected together while the anodes of all the LEDs on a particular row are also connected together. This gives each row and column a separate line and allows the LEDs on each of these rows or columns to be powered by the same line.

The various alphanumeric characters are displayed by lighting up the LED(s) located in specific positions in the array. For better brightness of display and economy in hardware, a dynamic display scheme is used. In this scheme, the LEDs are not lit continuously but are sequentially lit by scanning in a "vertical strobe" or "horizontal strobe". In the vertical strobe mode, information is addressed to the display by selecting a single row at a time, energizing the appropriate LED(s) in that row and proceeding to the next row. In the horizontal strobe mode, a single column is chosen at a time [2]

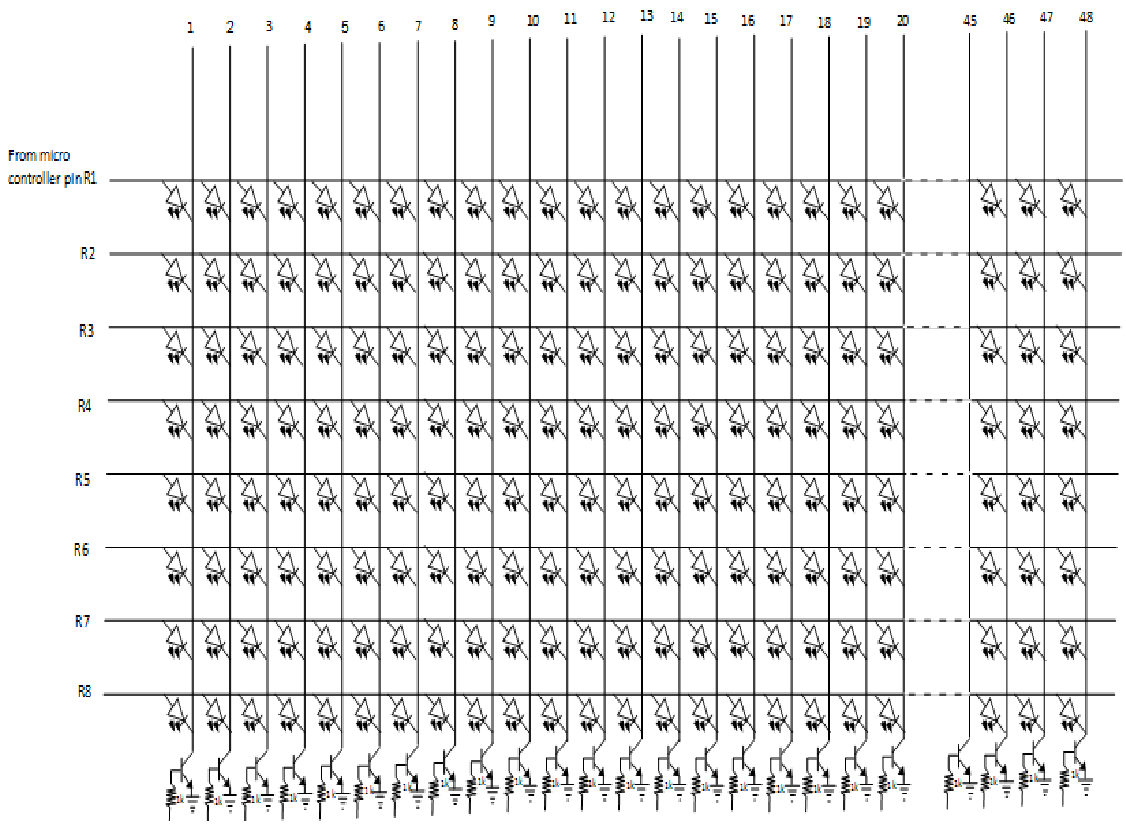


Figure. 6 Dot Matrix Display

IV. Software Design & Analysis

4.1 Assembly Language Program

. "Assembly language" and "assembler" are two different notions. The first represents a set of rules used in writing a program for a microcontroller, and the other is a program on the personal computer which translates assembly language into a language of zeros and ones. A program that is translated into "zeros" and "ones" is also called "machine language"

4.2 Representation of numbers in assembly Language

In assembly language MPLAB, numbers can be represented in decimal, hexadecimal or binary form.

Table 1: Representation of Numbers in Assembly Language

Instruction Format	Numerical Class
.240	Decimal
0Xf0	Hexadecimal
b'11110000'	Binary

Decimal numbers start with a dot, hexadecimal with 0x, and binary start with b with the number itself under quotes.

4.3 Instruction Set Description Of PIC16series Microcontroller

The Microcontroller is not like any other integrated circuit. In order to "make" a microcontroller perform a task, it has to be told exactly what to do, in other words we must write the program that the microcontroller will execute. This contains instructions, which make up the assembler or lower-level program language for PIC microcontrollers. [6]

Letters are used to represent the following parts of the instruction.
w = working register
k = Literal data, constant or variable
f = file registers
d = destination bit
b = bit position in 'f' register

4.4 The Character Map Design

The character map describes or defines the look of each character that will be displayed on the dot matrix. We have;

Table 2: Dot Matrix Display Character Map

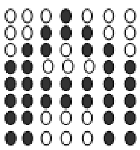
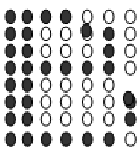
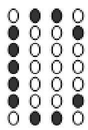
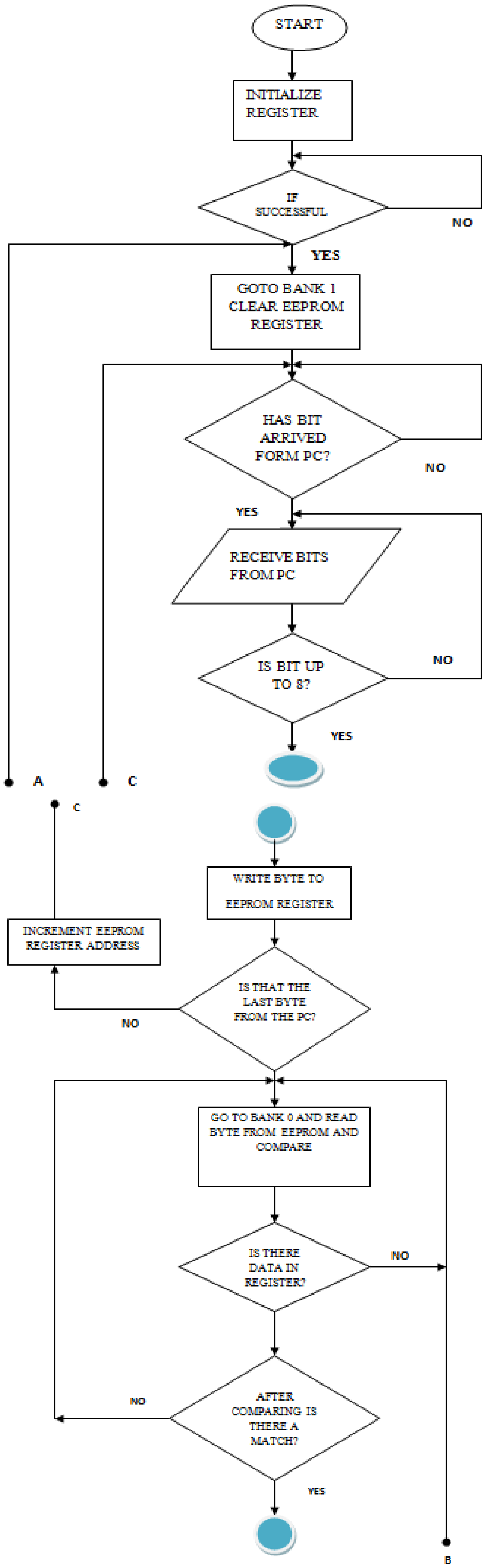
Character A	LED Display	Character Map
		RETLW 1Fh RETLW 3Fh RETLW 6Ch RETLW 0CCh RETLW 3fh RETLW 1fh
B		RETLW 0ffh RETLW 0ffh RETLW 91h RETLW 91h RETLW 71h RETLW 0eh
C		RETLW 7eh RETLW 81h RETLW 81h RETLW 42h

Figure. 7 Dot Matrix Display

4.5 Flow Chart Design

The Flow Chart of the Assembly code is shown below.


START
INITIALIZE REGISTER
IF SUCCESSFUL
NO
YES
GOTO BANK 1 CLEAR EEPROM REGISTER
HAS BIT ARRIVED FORM PC?
NO
YES
RECEIVE BITS FROM PC
IS BIT UP TO 8?
NO
YES
A
C
C
WRITE BYTE TO EEPROM REGISTER
INCREMENT EEPROM REGISTER ADDRESS
IS THAT THE LAST BYTE FROM THE PC?
NO
GO TO BANK 0 AND READ BYTE FROM EEPROM AND COMPARE
IS THERE DATA IN REGISTER?
NO
AFTER COMPARING IS THERE A MATCH?
NO
YES
B

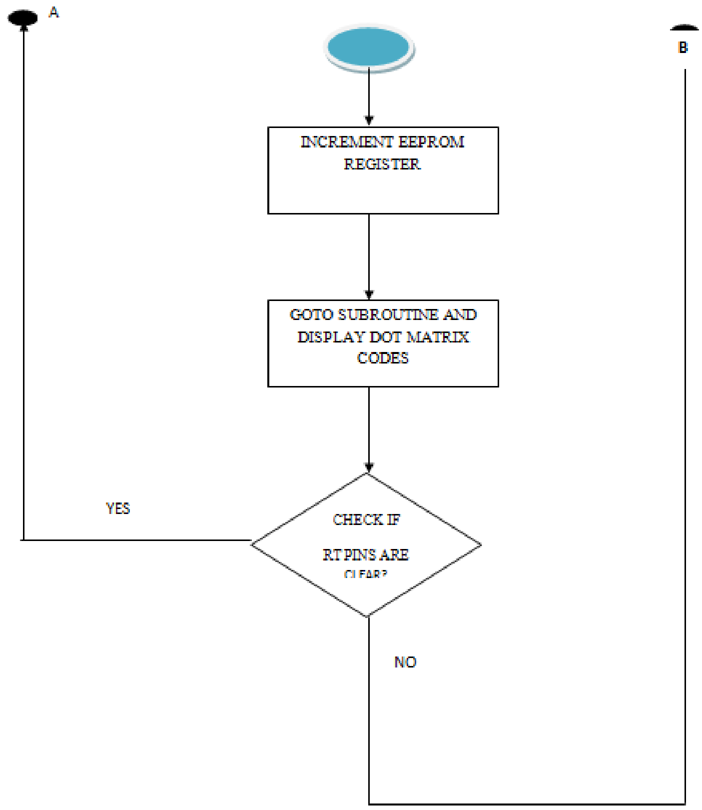


Figure 7: Flow Chart of the Assembly code.

V. Conclusion

A Moving Message Display system has been designed, analysed and implemented. The completed system was able to display the message of. text containing 23 characters (i.e., GREAT DEPT. OF ELECT. ENGRG) The system would be found useful in applications which require information to be displayed in a legible and intelligible form such as in Restaurants, Banks, Museums, etc. Its benefits cannot be over-emphasized in these days of technological advancements; however, this system design could be further improved on. On this ground, the following recommendations could be considered; A solar panel could be added to outdoor models to provide constant power supply to the system. and a Radio frequency transmitter and receiver module could be added to the system to send the information to be displayed wirelessly from a remote computer.

References

[1]. Fahmy, F. H., Sadek, S. M., Ahamed, N. M., Zahran, M. B. and Nafeh, A. A., Microcontroller-Based Moving Message Display powered by Photovoltaic Energy In: International Conference on Renewable Energies and Power Quality, Spain .2010 [Online], Available: http://www.icrepq.com/icrepq'10/726-Sadek. pdf[visited 2010, July 1]
[2]. Gupta, J.B., A Course in Electronics and Electrical measurements and instrumentation (13th Edition, S.K.kataria &Son, inc, New Delhi, 2008)
[3]. PIC Microcontroller. [Online] Available: http://en.wikipedia.org/wiki/PIC Microcontroller
[4]. CD4017B Data Sheet (1999). [Online] Available: http://www.datasheetsdir.com/cd4017+download [visited 2010, July1]
[5]. Mmom, W. ,Design of Wireless Bulletin Board, Final year Electrical Engineering Project, Faculty of Engineering, Federal University of Technology, Owerri, Nigeria, 2008.
[6]. Neboja, M., The PIC Microcontroller Book 1(Microchip Technology, Inc., USA, pp. 1 – 600. 2003)
[7]. Neamen, D. A., Electronic Circuit Analysis and Design (2nd Edition, McGraw-Hill, Inc., New York.,2001)
[8]. Boylestad, R. L. and Nashelsky, L.,Electronic Devices and Circuit Theory (7th Edition, Prentice-Hall Publications, Inc., New Jersey 1999).
[9]. Bob-Manuel, K. D. H. ,Technical Report Writing for Students, Engineers and Scientists (1st Edition, VoTex Publications, Inc., Port-Harcourt. 2003)
[10]. Wikipedia. [Online] Available: http://en.wikipedia.org/wiki [visited 2010, July 1.