MULTICOLOUR LED DISPLAY

Minor Project Report

Submitted in partial fulfillment of the requirements
For the award of the degree of

Bachelor of Technology

In

Electronics and Communication Engineering

Of

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Submitted by

Aleena Emmanuel(02)
Arun Prabhakar(08)
Arvind G Shankar(10)
Raji James(30)

Department of Electronics & Communication Engineering

Model Engineering College
Kochi 682 021

GOVERNMENT MODEL ENGINEERING COLLEGE

THRIKKAKKARA

KOCHI

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Cochin University of Science and Technology

BONAFIDE CERTIFICATE

This is to certify that the mini project report entitled

…………………...………………………………………………………………

Submitted by

…………………...………………………………………………………………

…………………...………………………………………………………………

…………………...………………………………………………………………

…………………...………………………………………………………………

…………………...………………………………………………………………

is a bonafide account of the work done by him/her under our supervision.

Mrs. Minimol M.G	**Mrs Anjana Devi**	**Mr Vinu Thomas**
Head of the Department	**Project Guide**	**Project Coordinator**

ACKNOWLEDGEMENT

At this moment of accomplishment, we are presenting our work with great pride and pleasure, we would like to express our sincere gratitude to all those who helped us in the successful completion of our venture. First of all, we would like to thank our Principal **Prof. Suresh Kumar P** who provided us with all facilities and amenities for the development of our project. We would like to thank our HOD, **Dr Mini M G** for helping us in the successful accomplishment of our project. We are exceedingly grateful to our project coordinator Assistant Professor**,** **Mr. Vinu Thomas** for his timely and valuable suggestions. We would also like to thank our project guide Senior Lecturer **Mrs.Anjana Devi** who gave us constant guidance and support throughout this journey of turbulence.

We also sincerely thank **Mr. Biju Mathew, Mrs. Geetha,** Lab Technicians, department of Electronics and Communication for their constant support and encouragement for our project.

We would also like to thank our parents and friends for their over whelming and whole hearted encouragement and support without which this would not have been successful.

Above all we thank God almighty for constantly motivating us with His love, and giving us courage at each stride to step forward with confidence and self –belief.

ABSTRACT

LED's are a fantastic way to illuminate any kind of sign, be it lettering or panels. LED Dot-Matrix Displays are a common sight nowadays on streets, malls, buildings, parks and other public places. It is a way of visual information where large LCD and other display become too much expensive. The commonly seen displays are single coloured or having 2 or 3 colours .But here multicoloured LED display is being introduced .This project provides an efficient and scalable approach to LED Dot Matrix displays.

The system is comprised of a tricolor dot matrix display panel with an interface circuit to a computer. It also comprises an executive program that runs on the computer for the display control of characters, decorative pattern or messages on the display panel. A multicolour LED Indoor Advertising Display can be used by companies to advertise even in bright day-light conditions. The display board displays any character entered from the host computer which is interfaced using USB to a microcontroller that initializes the led driver. The advantage of this project is that size of the display board can be increased row wise and column wise without making any changes in the circuitry since display board is the repetition of a small independent module.

Contents

List of Figures

Chapter 1
Project Overview

1.1 INTRODUCTION

Visual impact is the most effective mode of influencing human minds which is the main aim of adverstisements etc. A display device serves this purpose.A display device is a device for presentation of information for visual or tactile reception, acquired, stored, or transmitted in various forms. The display devices used to display information on machines, clocks, railway departure indicators and many other devices require a simple display of limited resolution. The display consists of a matrix of lights or mechanical indicators arranged in a rectangular configuration (other shapes are also possible, although not common) such that by switching on or off selected lights, text or graphics can be displayed. Various modifications has been made in the display board.

Now LED display panels are widely used throughout the world in all situations to create images for visual displays in a variety of applications including communication and visual display devices. LED array display board is a popular instrument for commercial usage. Many banks, shops and cinemas are willing to install one piece of it because of its versatility. LED array display board can be very bright and eye-catching. Display signs used for advertising or for displaying direction or other information to motorists have an important feature in common. They should be eye-catching and their information should be easy to absorb. In advertising, a signboard made of an LED display generally standing at a conspicuous location, such as a bustling road, is widely used. The LED display comprises a plurality of LEDs controlled by special hardware and software to perform moving images on a screen thereof to attract the attention of passersby. The LED array display board is used in a bank to show the current stock market value, currency exchange rate and interests rate. It can also be used in a shop to tell people the prices and other commercial information. LED display board serves the above purposes with advantages rendered by LEDs

- LEDs produce more light per watt than incandescent bulbs; this is useful in battery powered or energy-saving devices.
- LEDs can emit light of an intended color without the use of color filters that traditional lighting methods require. This is more efficient and can lower initial costs.
- The solid package of the LED can be designed to focus its light. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner.
- LEDs are ideal for use in applications that are subject to frequent on-off cycling, unlike fluorescent lamps that burn out more quickly when cycled frequently, or HID lamps that require a long time before restarting.

- LEDs, being solid state components, are difficult to damage with external shock. Fluorescent and incandescent bulbs are easily broken if dropped on the ground.
- LEDs can have a relatively long useful life.
- LEDs light up very quickly’
- LEDs can be very small and are easily populated onto printed circuit boards.

Organic light emitting diodes (OLED) are a promising technology for flat-panel displays. Owing to high brightness, fast response speed, light weight, thin and small features, full color, no viewing angle differences, no need for an LCD back-light board and low electrical consumption, an organic light emitting diode display takes the lead to substitute a twist nomadic (TN), a super twist nomadic (STN) liquid crystal display, or a small-sized thin-film transistor (TFT) LCD display. Light emitting diodes are useful in a wide range of high and low resolution display devices.

1.2 OBJECTIVE

Display technology pervades all aspects of present day life, from televisions to automobile dashboards to laptop computers to digital cameras. Single coloured LED display boards are very common nowadays. The same yellow or red coloured board is not attractive .The introduction of multicoloured LEDs into the display boards make them attractive. This project is oriented towards the development of a prototype of a multicoloured LED display board which is being controlled by an LED driver. The use of multicolour LED opens door to many applications. The display board is made on readily available components. The important requirement is that the display board should have long life expectancy, high tolerance to humidity, low power consumption and minimal heat generation. The fundamental part is a 4X4 LED module which could be repeated column wise or row wise to enlarge the display without any change in circuitry. Both single line and double line display could be affected. Motivation towards the project was to make available a readily expandable multicolour display board which can be used for multiple purposes.

1.3 SPECIFICATIONS

- 4 x 4 multicoloured LED modules (8)
- USB interface
- High speed response
- Power supply requirement :5V ,4A

Chapter 2
System Overview

2.1 BLOCK DIAGRAM

A simplified block diagram is given below.

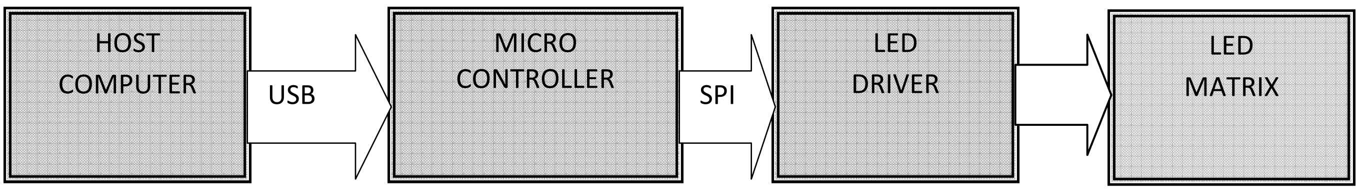


Figure 1 Block Diagram

2.1.1 LED Matrix

A 4X4 LED module is the fundamental part of the display. LED display panels use matrix addressing techniques to organize the light emitting elements or pixels into a number of rows and columns with each pixel at an intersection of a particular row and a particular column. A light emitting device (LED) display is typically supplied with data addressed from graphical memory location in accordance with a column-major display. The LED display illuminates pixels on a column basis by providing sourcing and sinking currents to diodes in the display. An LED display is typically made up of various dots arranged in a matrix pattern having rows and columns. The dots are usually called pixels where the pixels are made up of several LEDs. Illuminating the pixel requires activating an intersecting row and column thereby providing a closed current path that includes the pixel to be illuminated.

The individual LEDs emit light of three basic colours: red, green and blue. Typically, each pixel is composed of at least one LED of each colour. In LED displays, one dot is formed by utilizing a plurality of cannon ball-shaped LED lamps each having different luminescent colours. The intensity of the LEDs is usually controlled by controlling the current to the individual LEDs. This is done by means of a led driver. A pixel can produce a specific perceived colour by varying the drive to the three colours of LEDs that comprise the pixel. By controlling the current drive to each of the LEDs that makes up a pixel and in turn controlling each of the pixels that make up a matrix of pixels, an LED display device is capable of displaying a plurality of colours and light intensities so as to realize, for example, a multi-colour display. As the resolution of displays increases, the number of pixels in each row and column also increases and the amount of time available to illuminate each pixel decreases. As the illumination time decreases, each pixel must be driven with a larger current to provide a pixel intensity that maintains acceptable image intensity and viewing characteristics.

Light Emitting Diode: Multicolour LEDs are used to provide colourful display. They primarily provide three colours: red, green, and blue. By the combination of these colours in correct proportion many varieties of colour are possible. The three colours could be individually controlled as controlling three single LEDs.

2.1.2 LED Driver

The control of the LED display module is done by means of LED driver. It is programmable using microcontroller. An LED Driver has a shift register embedded that will take data in serial format and transfer it to parallel. It performs following functions:

- It controls the intensity and brightness of the display
- It controls the colour of the display
- It decides which led is to be lighted to display specific character
- It receives the input signal specifying the character to be displayed from the microcontroller which is controlled by host computer using USB interface.

2.1.3 Microcontroller

The character to be displayed is inputted from the host computer using USB interface. PIC18F4550 is used to provide the USB interface to the LED driver which controls the display. The PIC is programmed such that it provides USB interface. A self programmable PIC is used.

2.1.4 Universal Serial Bus Interface

It provides the communication between the host computer and display board. It also can provide power supply for the microcontroller.

2.2 ADVANTAGES AND APPLICATIONS

Advantages:

- No More Monotonous Same Advertisement again and again for days/months. (message to be displayed can be changed instantaneously)
- Instant, Current and Hot Topics reach the Public immediately.
- Common Display system which displays instant messages like Flash News, in Places like exhibitions, Road side Hoardings.

- Instant Message Delivery.
- Easy to change messages.
- Attractive multicolour display.
- A high density display board could be used for video display.
- Eye catching display serving the purpose of advertisements.
- Media for indoor & outdoor advertising and are clearly visible from very long distance.

Applications:

- Advertisement Hoardings with dynamic update of Flash News.
- Instant update of Petrol Prices to all petrol Bunks from a Central office.
- Stock Tickers, which displays dynamically current value of the Stocks and the trend.
- Current Prices of Commodities at different parts of the country.
- Shopping malls & retail stores.
- Railway information.
- Amusement Parks & Zoo's.
- Traffic Information.
- Pedestrian countdown system for maximum pedestrian safety.

Chapter 3
Project Design

3.1 LED MODULE

Hardware requirements:

- 4 x 4 LED array
- LED driver MAX 7219
- Resistors – 22 KΩ, 15 KΩ
- Capacitor 0.01µF

3.1.1 LED Array

It consists of 16 multicoloured LEDs arranged in 4x4 matrix format. The LED used is LED 339-1VRKGBBW-1 from ever bright. It is a multicoloured common cathode led with 2 Blue LEDs, 1 Green and 1 Red LED. It has 6 pins: 2 Blue Anodes & their common cathode, 1 Green and 1 Red anode & their common cathode. Blue LEDs have lower brightness compared to Red/Green, so there are 2 Blue LEDs in this package. Multicolour LED provides primarily blue, green, yellow colour by giving bias to appropriate pins.

Specifications:

I_f (typical forward current): 20mA

Cut in Voltage

Red: 1.6V

Green: 1.8V

Blue: 2.5V

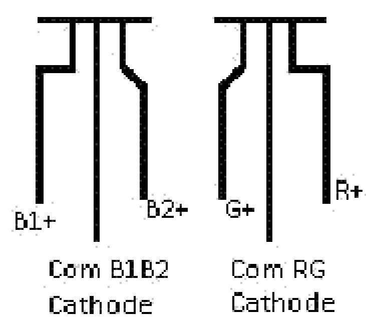


Figure 2 RGB LED Pinout

Also by varying the current to various pins a variety of colours can be obtained. The red, blue, green anode lines are connected in horizontal lines while cathode lines in vertical lines. Since the LEDs are arranged in matrix format each LED could be controlled individually.

3.1.2 LED Driver – MAX7219

LED driver used is MAX7219. It can drive 64 single LEDs. The 7219 can source up to 40mA and control an 8x8 single LED matrix. (Here 2 MAX7219 is used to control a 4X4 matrix). Individual LEDs can be turned on or off with 3 wire serial interface (CLK, DATA, LOAD). 16 Brightness steps are also provided, which can control the brightness of all the 64 LEDs. Thus it provides both software and hardware control of brightness. It drives common cathode LED display. It provides 100MHz serial interface.

The LED driver has a 16 bit shift register. Input signals are CLK, DIN, and LOAD. Serial data at DIN, sent in 16-bit packets, is shifted into the internal 16-bit shift register with each rising edge of CLK regardless of the state of LOAD. The data is then latched into either the digit or control registers on the rising edge of LOAD/CS. LOAD/CS must go high concurrently with or after the 16th rising clock edge, but before the next rising clock edge or data will be lost. Data at DIN is propagated through the shift register and appears at DOUT 16. 5 clock cycles later. Data is clocked out on the falling edge of CLK.

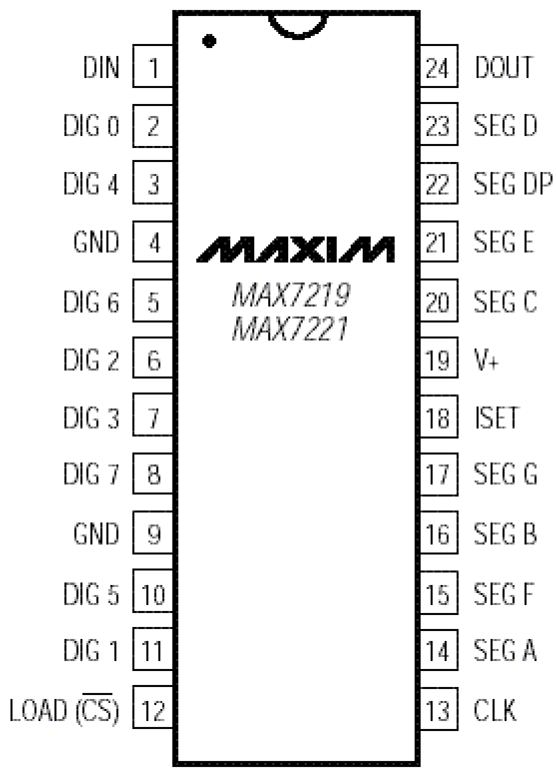


Figure 3 MAX7219 Pinout

Specifications:

Operating Supply Voltage: 5V
Shutdown Supply Current: 150µA
Operating Supply Current: 330 mA
ISEG : -40mA

Resistor (R_{SET})

The MAX7219 allows display brightness to be controlled with an external resistor (RSET) connected between V+ and ISET. It is used to set the peak segment current. The peak current sourced from the segment drivers is nominally 100 times the current entering ISET. Its minimum value should be 9.53kΩ, which typically sets the segment current at 40mA. Display brightness can also be controlled digitally by using the intensity register. Digital control of display brightness is provided by an internal pulse-width modulator, which is controlled by the lower nibble of the intensity register. The modulator scales the average segment current in 16 steps from a maximum of 31/32 down to 1/32 of the peak current set by RSET .

I_{SEG} (mA)	V_{LED} (V)				
	1.5	**2.0**	**2.5**	**3.0**	**3.5**
40	12.2	11.8	11.0	10.6	9.69
30	17.8	17.1	15.8	15.0	14.0
20	29.8	28.0	25.9	24.5	22.6
10	66.7	63.7	59.3	55.4	51.2

Figure 4 RSET vs. Segment Current and LED Forward Voltage

Design

MAX7219 can drive 64 single LEDs. A multicolour led is equal to 3 single LEDs. Thus two MAX7219 is used to drive a 4 x 4 LED module. Each MAX7219 has 8 segment lines (SEG Dp through SEG G) to control the anode (horizontal) lines of the display and 8 digit lines (DIG0 through DIG7) to control the cathode (vertical) lines. Here one MAX7219 is used to control the red and green LEDs which have a common cathode. Another MAX7219 is used to control the two blue LEDs. Only 4 digit lines of an LED driver are used.

The current value is to be set at 20mA which is the safe value for the LED. This is provided by selecting a resistance equal to 22K.

For the expansion of the display, cascading of the MAX7219s is done. This is done by connecting LOAD and CLK inputs of all the devices together and connecting DOUT to DIN on adjacent devices. DOUT is a CMOS logic-level output that easily drives DIN of successively cascaded parts.

LED Driver Circuit

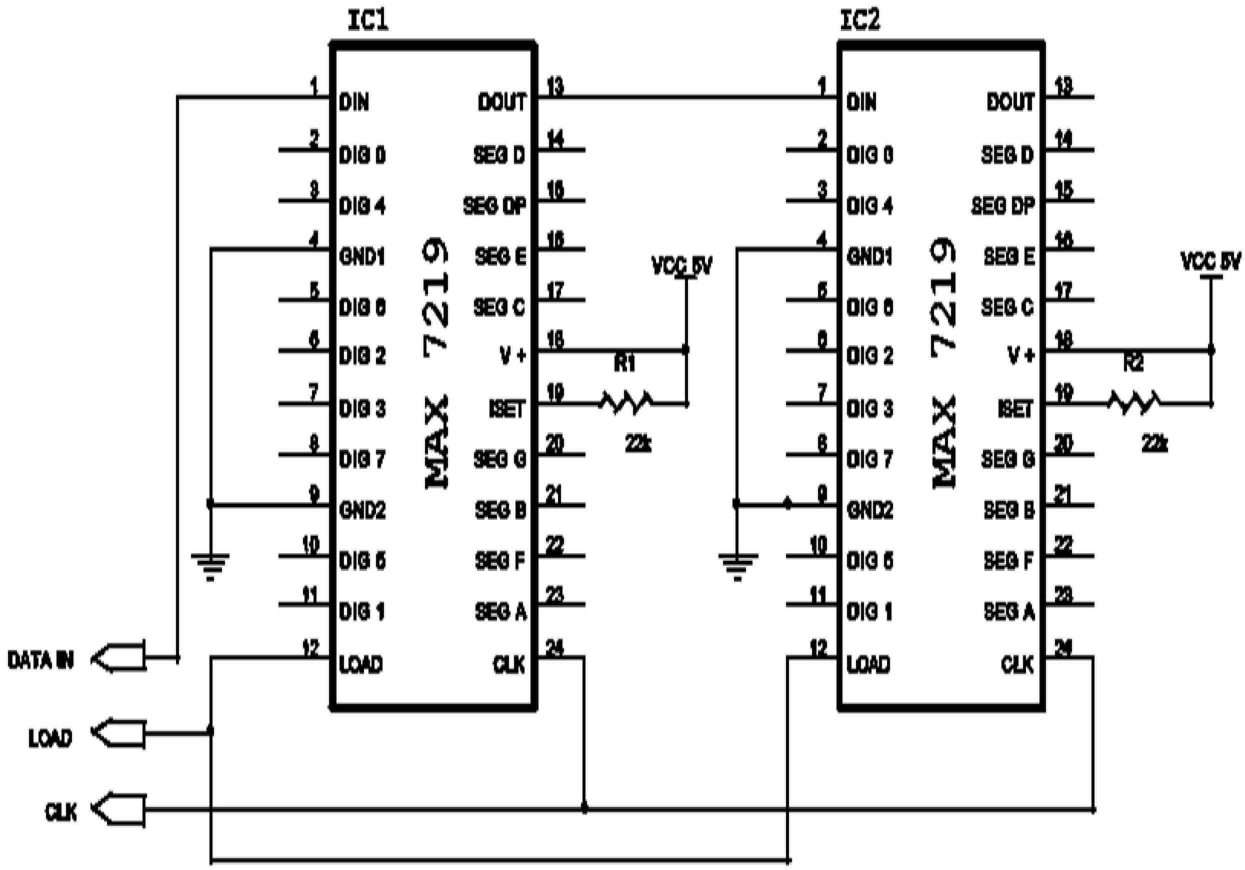


Figure 5 Led Driver Circuit

SCHEMATIC OF 4 X 4 LED MODULE

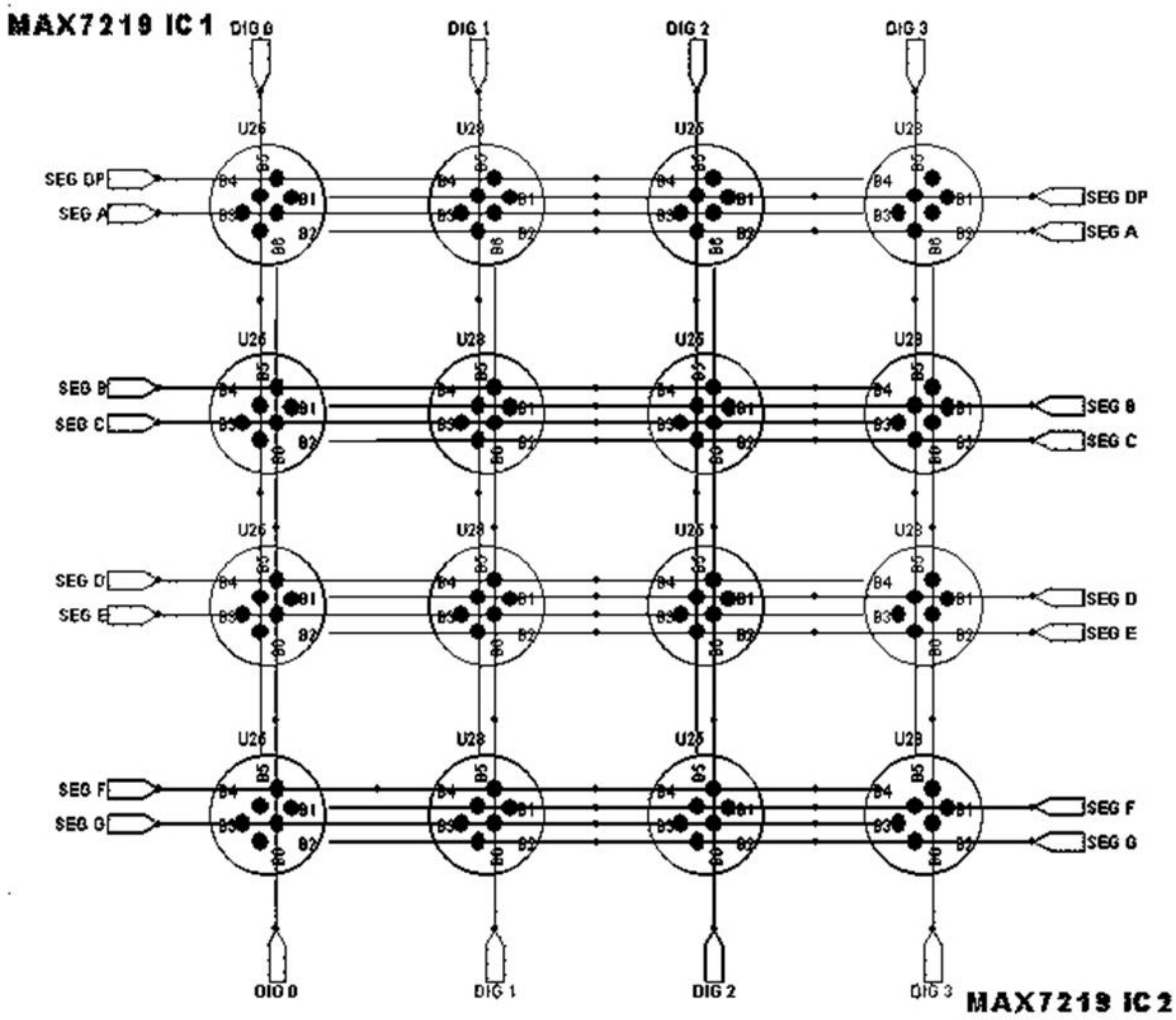


Figure 6 Led Array

3.2 USB Interface

Hardware Requirements:

- PIC18F4550
- 20MHz Crystal oscillator
- USB 2.0
- USB Connector
- Push buttons "Reset" and "Program"
- Resistors
- Capacitors
- Status LEDs

3.2.1 PIC18F4550

The Microchip® PIC18F4550 microcontroller is the heart of the board. It is a programmable microcontroller with 32Kbytes of flash program memory and 2Kbytes of general purpose SRAM. It has 13 A/D inputs making the system ideal for use in real-world monitoring applications and 18 general purpose I/O ports. There are 2 PWM channels, one 8-bit Timer and three 16-bit Timers. Auxiliary communication is provided by RS232 Communication (1 Channel), USB Communication (1 Channel), SPI (3-wire SPI Module), I^2C (with Master/Slave Mode). This PIC is provided with boot loader which enables self programming (Self-Programmable under Software Control) of the PIC. It has the following Universal Serial Bus features:

• USB V2.0 Compliant
• Low Speed (1.5 Mb/s) and Full Speed (12 Mb/s)
• Supports Control, Interrupt, Isochronous and Bulk Transfers
• Supports up to 32 Endpoints (16 bidirectional)
• 1-Kbyte Dual Access RAM for USB
• On-Chip USB Transceiver with On-Chip Voltage

It has a Flexible Oscillator Structure with following features:

• Four Crystal modes, including High Precision PLL for USB
• Two External Clock modes, up to 48 MHz
• Internal Oscillator Block:
- 8 user-selectable frequencies, from 31 kHz to 8 MHz
- User-tunable to compensate for frequency drift
• Secondary Oscillator using Timer1 @ 32 kHz

- Dual Oscillator options allow microcontroller and USB module to run at different clock speeds
- Fail-Safe Clock Monitor:
  Allows for safe shutdown if any clock stops

PIC18F4550 PINOUT

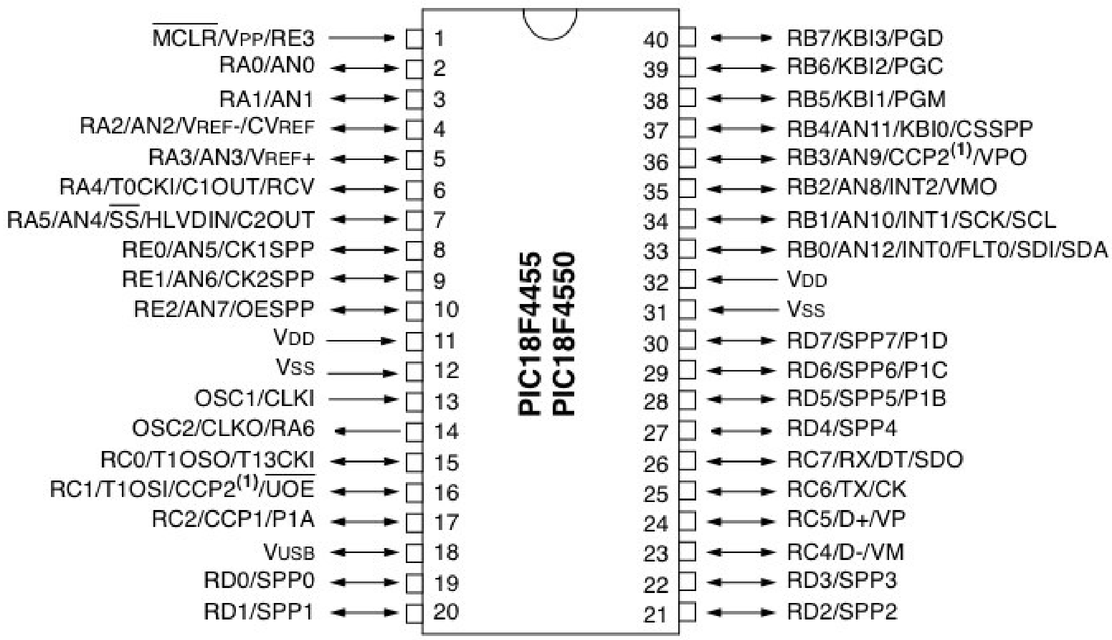


Figure 7 PIC18F4550 Pin out

It has high-current sink/source of 25 mA/25 mA. There are three external interrupts. Four Timer modules (Timer0 to Timer3) are present. It has a C Compiler Optimized Architecture with Extended Instruction Set.

Specifications

Voltage on any pin with respect to VSS	-	-0.3V to (VDD + 0.3V)
Voltage on VDD with respect to VSS	-	-0.3V to +7.5V
Total power dissipation	-	1.0W
Maximum current out of VSS pin	-	300 mA
Maximum current into VDD pin	-	250 mA

Maximum output current sunk by any I/O pin - 25 mA
Maximum output current sourced by any I/O pin - 25 mA
Maximum current sunk by all ports - 200 mA
Maximum current sourced by all ports - 200 mA

3.2.2 20MHz Crystal oscillator

The crystal oscillator is used to provide the clock for the PIC. A crystal oscillator has a very stable Q. It is equivalent to an LCR circuit. It oscillates at its resonating frequency. Here the crystal provides 20 MHz clock to the PIC. It requires resistors and capacitors to oscillate properly

3.2.3 USB 2.0

Universal Serial Bus (USB) is a serial bus standard to interface . Its features include providing power to low-consumption devices without the need for an external power supply and allowing many devices to be used without requiring manufacturer specific, individual device drivers to be installed. A USB cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data.

USB supports three data rates: A Low Speed (1.1, 2.0) rate of 1.5 Mbit/s (187.5 kB/s) that is mostly used for Human Interface Devices (HID) such as keyboards, mice, and joysticks and a Full Speed (1.1, 2.0) rate of 12 Mbit/s (1.5 MB/s). Full Speed devices divide the USB bandwidth between them in a first-come first-served basis and it is not uncommon to run out of bandwidth with several isochronous devices. All USB Hubs support Full Speed. A Hi-Speed (2.0) rate of 480 Mbit/s (60 MB/s).

Pin	Name	Cable colour	Description
1	VCC	Red	+5V
2	D−	White	Data −
3	D+	Green	Data +
4	GND	Black	Ground

Figure 8 **USB Pin Description**

The USB standard uses "A" and "B" connectors to avoid confusion:

- "A" connectors head "upstream" toward the computer.
- "B" connectors head "downstream" and connect to individual devices.

USB 2.0 has added higher maximum speed of 480 Mbit/s. The USB 2.0 specification covers all three speeds 480 Mbps, 12 Mbps, and 1.5 Mbps. USB 2.0 (High-speed USB) provides additional bandwidth for multimedia and storage applications and has a data transmission speed 40 times faster than USB 1.1.

3.2.4 USB Connector

The USB Connector is a standard "type B" connector. There are four connections in a USB cable, two of which supply power while the other two are the communication lines D+ and D-. By these pins information is transferred between the host computer and the PIC when it is being programmed, and while firmware sends or receives data with the computer if it is a HID application.

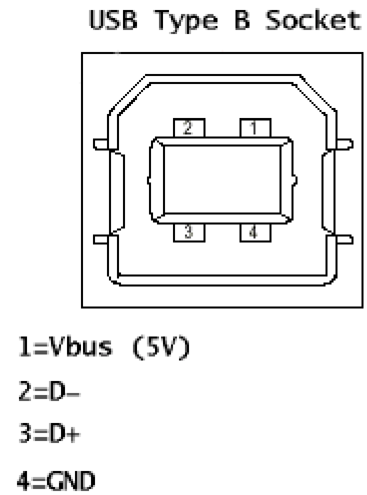


Figure 9 USB CONNECTOR

3.2.5 Push buttons "Reset" and "Program"

The two buttons are used during the process of programming the PIC. If the Reset button is pushed while holding down the Program button, the PIC will enter the boot loader mode, which will allow a new application to be loaded into the PIC. One of the general purpose I/O pins is dedicated to the "program" button to enter boot loading mode

The reset button is connecter to MCLR pin.

3.2.6 Status LEDs

They show the state of USB. The various conditions are shown below.

TABLE 1-2: USB DEVICE STATE LED STATUS

USB Device State	LED D1	LED D2
Detached	Off	Off
Attached	On	On
Powered	On	Off
Default	Off	On
Addressed	Blink	Off
Configured	Alternate Flashing	
Suspended	Fast Synchronous Flashing	

Figure 10 State LED Status

Design:

For providing the clock using crystal oscillator 22pF capacitors and 1Mohm resistors are required. They make the crystal oscillate properly. A capacitor 0.47μF is connected across the pin 18. It is required for the proper functioning of internal voltage regulator. A decoupling capacitor of value 0.1μF is connected across the power pins of USB socket. Status LEDs are connected at pins 19 and 20.

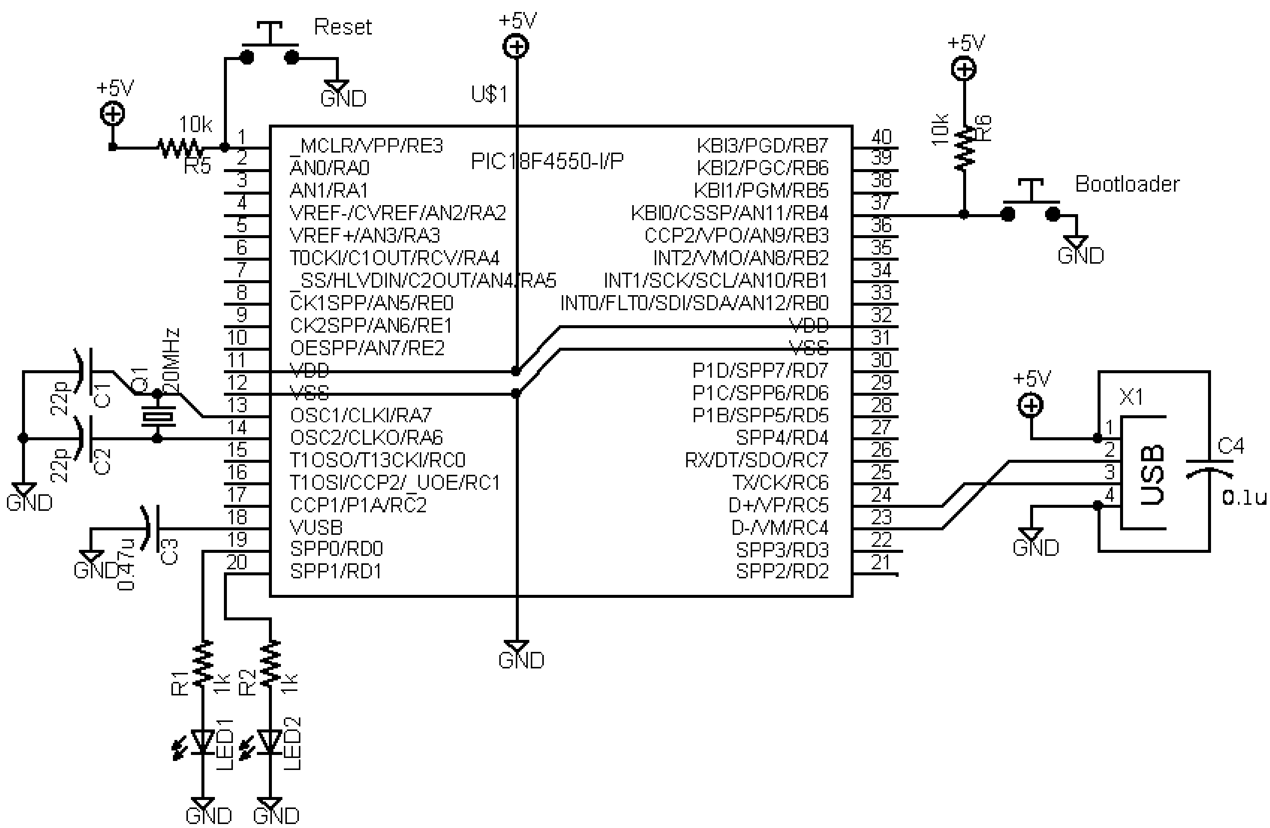


Figure 11 Schematic of the USB interface

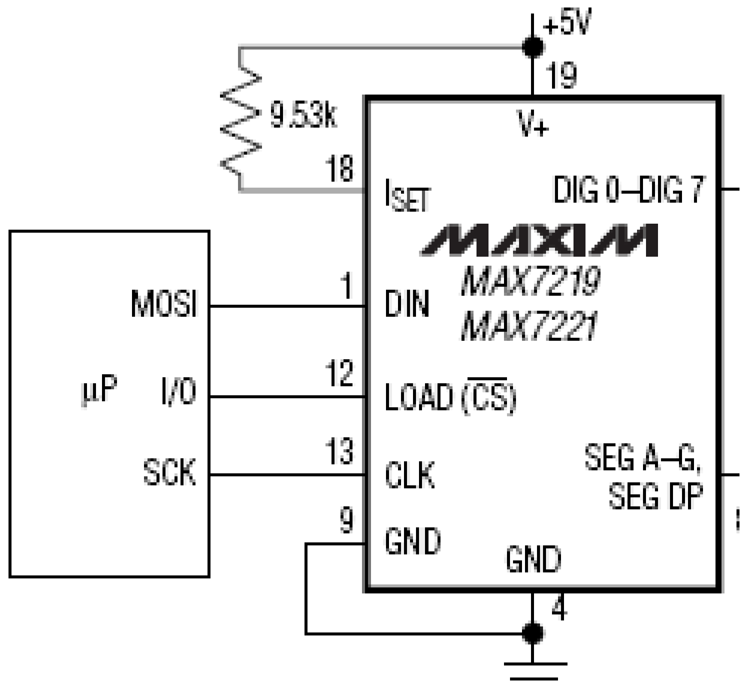


Figure 12 SCHEMATIC OF LED DRIVER WITH PIC

The SPI interface of the PIC 18f4550 is connected to the respective pins of the MAX 7219.

3.3 POWER SUPPLY

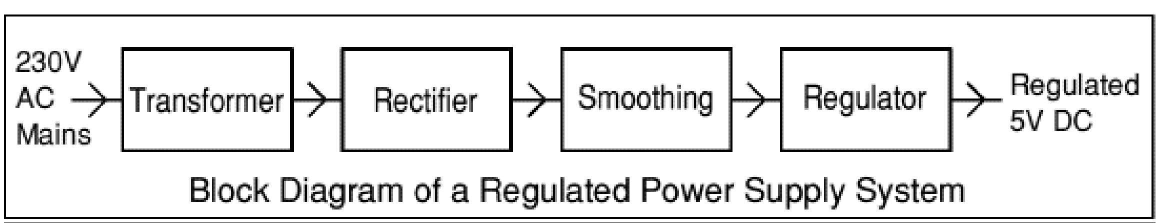


Figure 13 Basic block diagram of power supply

Hardware requirements:

- A Transformer (8-0-8V,1A)
- Bridge Rectifier (Power Diode BY127)
- Regulator IC 7805
- Power Transistor 2n2955

3.3.1 Transformer

It steps down the input 230V, 50 Hz AC to 8-0-8 V, 1A.

3.3.2 Bridge rectifier

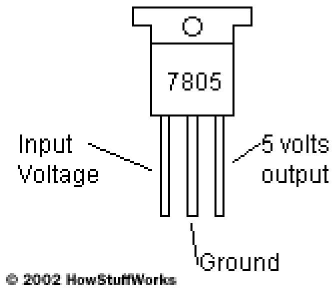
The bridge rectifier provides full wave rectification from a two wire AC input. It is formed of power diode BY127. The ac input voltage is applied to the diagonally opposite ends of the bridge. . The load resistance is connected between the other two ends of the bridge. For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state. The conducting diodes will be in series with the load resistance R_L and hence the load current flows through $R_{L.}$ For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.

3.3.3 Regulator IC 7805

The +5 volt power supply is based on the commercial 7805 voltage regulator IC. This IC contains all the circuitry needed to accept any input voltage from 8 to 18 volts and produce a steady +5 volt output, accurate to within 5% (0.25 volt). It also contains current-limiting circuitry and thermal overload protection, so that the IC won't be damaged in case of excessive load current; it will reduce its output voltage instead.

Specifications

Output Voltage	5V
Ripple rejection ratio	78dB



Input regulation	3mV
Load regulation	15mV

Figure 14 7805 Pinout

3.3.4 Power Transistor 2n2955

It is used to boost the output current.

3.4 CIRCUIT

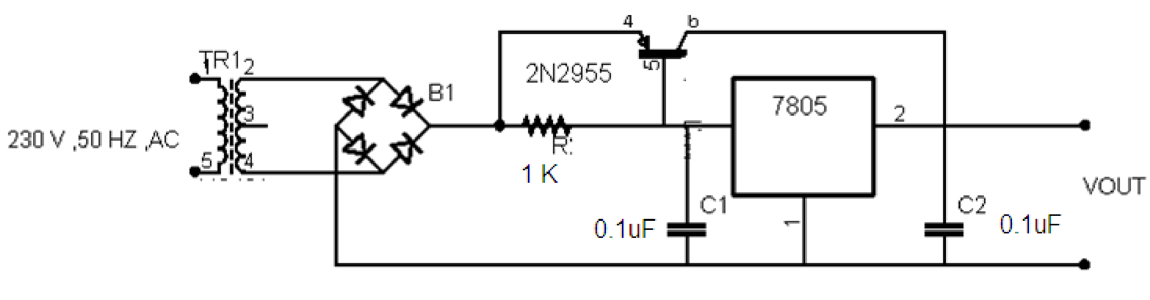


Figure 15 Power Supply Circuit

The bridge rectifier rectifies the ac input signal. This is being smoothened by the capacitor C1, the output is regulated by IC 7805. A power transistor is used to supply extra current to the load the regulator, maintaining a constant voltage. Currents up to 650mA will flow through the regulator, above this value and the power transistor will start to conduct, supplying the extra current to the load. This should be on an adequate heat sink as it is likely to get rather hot. For a 5v regulator 7805. The input voltage should be a few volts higher to allow for voltage drops. Assume 8 volts. Assume that the load will draw 5amps. The power dissipation in the transistor will be Vce * Ic or (8-5)*5=15watt.

Chapter 4
PCB Design

The software used for circuit design is EAGLE. The program consists of three main modules: Layout Editor, Schematic Editor, Auto router which is embedded in a single user interface. Therefore there is no need for converting net lists between schematics and layouts. Its General features are:

- online Forward- and Back-Annotation
- context sensitive help function
- no hardware copy protection
- multiple windows for board, schematic and library
- powerful User Language
- integrated text editor
- available for Windows und Linux

Layout Editor has following features

- maximum drawing area 1.6 x 1.6m (64 x 64 inch)
- resolution 1/10,000mm (0.1 micron)
- up to 16 signal layers
- conventional and SMT parts
- comes with a full set of part libraries
- easily create your own parts with the fully integrated library editor
- undo/redo function for ANY editing command, to any depth
- script files for batch command execution
- copper pouring
- cut and paste function for copying entire sections of a drawing
- design rule check

Schematic Editor provides the following features

- up to 99 sheets in one schematic
- electrical rule check
- gate- and pin swap
- create a board from a schematic with a single command

The PCB design comprises of three sections:

4.1 LED Array

It is a double sided PCB with the upper side of PCB comprising of the anode lines of the LEDs .the cathode lines are laid on the bottom side of the PCB. The anode lines are horizontal lines. The cathode lines are vertical lines.The track width is 10 mils. ((for 1A current). circular pads has been laid with diameter of pad 0.5 mm greater than hole diameter. Pads are laid for nodes on the top side and holes for cathodes and vice versa.

Tracks have angles of 45 degree or so (never 90 degree).

PCB for led array

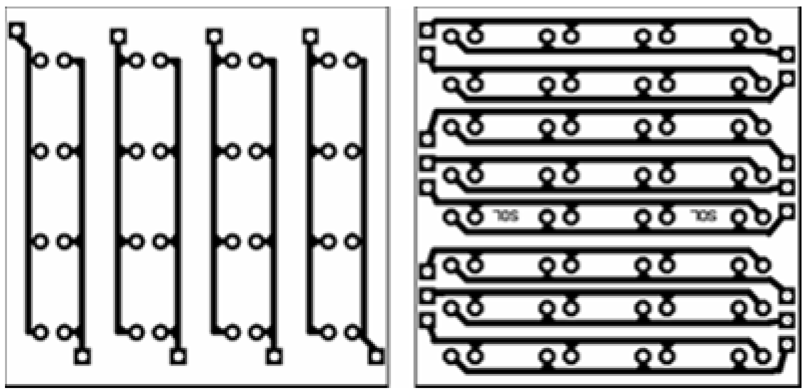


Figure 16 LED PCB

4.2 LED DRIVER CIRCUIT

This is designed as two layers PCB. The tracks never end at 90 degrees the VCC tracks (20 mils) are having greater width than normal tracks. The ground tracks are of width 40mils

Led driver PCB

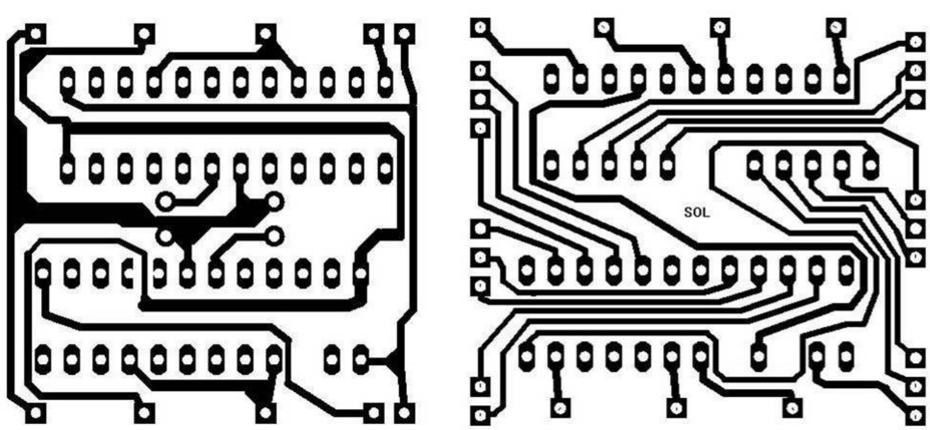


Figure 17 MAX7219 PCB

4.3 USB INTERFACE

This is single sided PCB with provisions for reset and program buttons and USB connector. The foot prints of PIC, resistors, capacitors were provide by the software

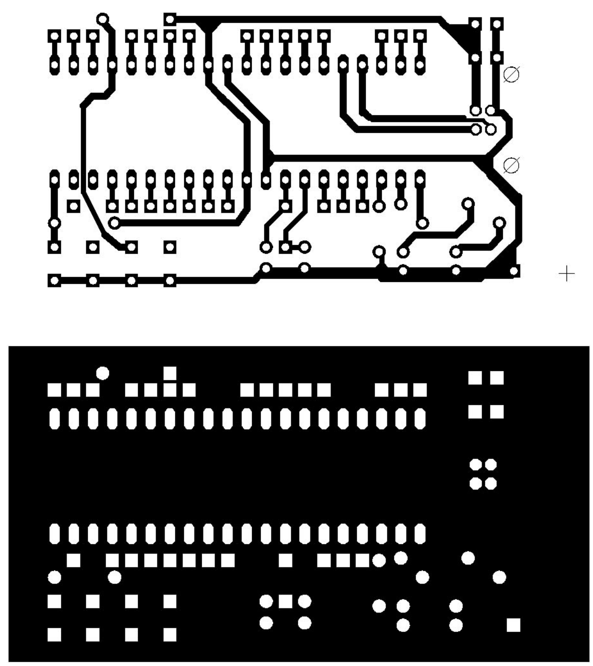
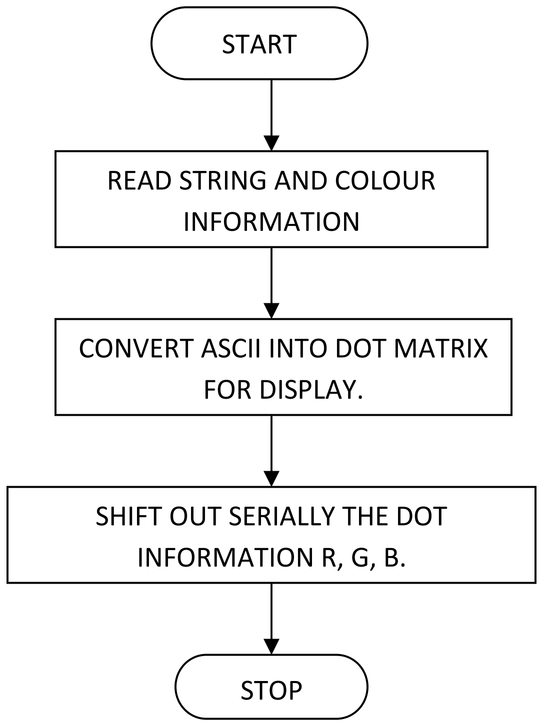


Figure 18 Microcontroller PCB

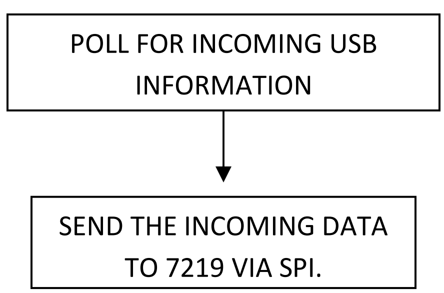
Chapter 5
Software

5.1 Flow Charts

5.1.1 Software Flow



5.1.2 Firmware Flow



5.2 Source Codes

5.2.1 Software Code

The software used to send data is written in Visual C++ 6.0

```
#include <stdio.h>
#include "windows.h"
#include "mpusbapi.h"                    // MPUSBAPI Header File

//---------------------------------------------------------------------------
// Global Vars
char vid_pid[]= "vid_04d8&pid_000c";    // Default Demo Application Firmware
char out_pipe[]= "\\MCHP_EP1";
char in_pipe[]= "\\MCHP_EP1";

DWORD temp;

HINSTANCE libHandle;
HANDLE myOutPipe;
HANDLE myInPipe;

//---------------------------------------------------------------------------
// Prototypes
void GetSummary(void);
void LoadDLL(void);
void GetUSBDemoFWVersion(void);
DWORD SendReceivePacket(BYTE *SendData, DWORD SendLength, BYTE *ReceiveData,
                    DWORD *ReceiveLength, UINT SendDelay, UINT ReceiveDelay);
void CheckInvalidHandle(void);

//Custom Functions
void Raw7219(BYTE addr,BYTE data);
void LoadHigh();
int SendString(BYTE *send_buf,BYTE len);
void MakeRGBMap(BYTE *map, char *string);


#include "io_cfg.h"
#include "usb.h"

int main(int argc, char* argv[])
{
    if(argc <= 2)
         {
                 printf("\r\n- USAGE : mdb.exe <id><len><string>");
                 return 1;
         }


         BOOLEAN bQuit;
    DWORD selection=7;
    bQuit = false;

    // Load DLL when it is necessary, i.e. on start-up!
    LoadDLL();
         LoadMap();
```

```
        setRGB[0][0]=&setR1Col;
        setRGB[0][1]=&setR2Col;
        setRGB[0][2]=&setR3Col;
        setRGB[0][3]=&setR4Col;

        setRGB[1][0]=&setG1Col;
        setRGB[1][1]=&setG2Col;
        setRGB[1][2]=&setG3Col;
        setRGB[1][3]=&setG4Col;

        setRGB[2][0]=&setB1Col;
        setRGB[2][1]=&setB2Col;
        setRGB[2][2]=&setB3Col;
        setRGB[2][3]=&setB4Col;


    // Always a good idea to initialize the handles
    myOutPipe = myInPipe = INVALID_HANDLE_VALUE;

        int i,j;
        BYTE color,rg_b,b_b;
        char string[23];
        printf("Enter the string to be displayed : ");
        gets(string);
        printf("Enter the color : \n");
        printf(" 1. Red \n");
        printf(" 2. Green \n");
        printf(" 4. Blue \n");
        printf("  : > ");
        scanf("%d", &color);

        printf("Displaying %s with colour %d ",string,color);
        printf("RG,B Brightness [0-15] : ");
        scanf("%d%d",&rg_b,&b_b);
//g_b=b_b=15;
        //strcpy(string,"11");
        //string[1]=255;
        //string[1]='+';
        //string[1]=0;
        BYTE send_buf[64];
        const int num_boards = 8;
        int offset=0;
        //color=7;

        while(1)

        {

                //for(string[0]='A';string[0]<='Z';string[0]++,color++)

                {
        i=0;
        color%=8;
        if(!color)color=1;
        //ClearBuffer(send_buf,64);
        ClearAll7219();
        BYTE ic1=0,ic2=num_boards>>1;

        int k=0,p=offset;
        while(string[i])
        {
```

```
                while(map[string[i]][k?k-1:0])
                {
                        if(ic2 == 32)goto EOI;

                        if(p >= 0)
                        {
                                (*setRGB[0][(p)%4])(ic1,ic2,(color &
1)?map[string[i]][k]:0);
                                (*setRGB[1][(p)%4])(ic1,ic2,(color &
2)?map[string[i]][k]:0);
                                (*setRGB[2][(p)%4])(ic1,ic2,(color &
4)?map[string[i]][k]:0);

                                if(p && p%4==0)
                                {
                                        ic1++;
                                        ic2++;
                                }

                        }
                        k++;
                        p++;
                }

                i++;
                k=0;
        }

EOI:
        {


                InitMax7219(num_boards,send_buf,rg_b,b_b);


                for(j=0;j<4;j++)
                {
                        Shift7219(offset-1);

                        for(int n=0;n<num_boards;n++)
                        {
                                if(num_boards-n-1 == 4)
                                        max[num_boards-n-
1].exportByteInverse(j,send_buf+2+4*n);
                                else if((num_boards-n-1 == 5) || (num_boards-n-1 ==
6))
                                        max[num_boards-n-
1].exportByteHalfInverse(j,send_buf+2+4*n);
                                else
                                        max[num_boards-n-
1].exportByte(j,send_buf+2+4*n);

                        }

                        SendString(send_buf,num_boards*4);
                }


                Sleep(300);
                //offset--;

        }
```

```
        //for(i=2;i<2+32;i++)
        //      printf("%02x ",send_buf[i]);
        //printf("\n");
        }       }

        // Always check to close all handles before exiting!
    if (myOutPipe != INVALID_HANDLE_VALUE) MPUSBClose(myOutPipe);
    if (myInPipe != INVALID_HANDLE_VALUE) MPUSBClose(myInPipe);
    myOutPipe = myInPipe = INVALID_HANDLE_VALUE;

    // Always check to close the library too.
    if (libHandle != NULL) FreeLibrary(libHandle);

    return 0;
}//end main
```

5.2.2 Firmware Code

The custom firmware code for translating the data from the Universal Serial Bus (USB) to SPI for MAX7219

```
#include <p18cxxx.h>
#include <usart.h>

#include <delays.h>

#include "system\typedefs.h"

#include "system\usb\usb.h"

#include "io_cfg.h"             // I/O pin mapping
#include "user\user.h"
#include <spi.h>

/** V A R I A B L E S ********************************************************/
#pragma udata

byte counter;
byte trf_state;

DATA_PACKET dataPacket;

/** P R I V A T E  P R O T O T Y P E S ***************************************/

void BlinkUSBStatus(void);
void ServiceRequests(void);
void InitMAX7219(void);
void SendRaw7219Packet(void);
void OutSerialData(void);
/** D E C L A R A T I O N S **************************************************/
#pragma code
void UserInit(void)
{
    mInitAllLEDs();
        InitMAX7219();
}//end UserInit


/******************************************************************************
 * Function:        void ProcessIO(void)
```

```
 *
 * PreCondition:    None
 *
 * Input:           None
 *
 * Output:          None
 *
 * Side Effects:    None
 *
 * Overview:        This function is a place holder for other user routines.
 *                  It is a mixture of both USB and non-USB tasks.
 *
 * Note:            None
 *****************************************************************************/
void ProcessIO(void)
{
    BlinkUSBStatus();
    // User Application USB tasks
    if((usb_device_state < CONFIGURED_STATE)||(UCONbits.SUSPND==1)) return;

    ServiceRequests();

}//end ProcessIO


void ServiceRequests(void)
{
    byte index;

    if(USBGenRead((byte*)&dataPacket,sizeof(dataPacket)))
    {
        counter = 0;
        switch(dataPacket.CMD)
        {
            case READ_VERSION:
                //dataPacket._byte[1] is len
                dataPacket._byte[2] = MINOR_VERSION;
                dataPacket._byte[3] = MAJOR_VERSION;
                counter=0x04;
                break;
                         case RAW_MAX_PACKET://RAW_MAX_PACKET
                                  SendRaw7219Packet();
                                  dataPacket._byte[2] = ~dataPacket._byte[2];
                                  dataPacket._byte[3] = ~dataPacket._byte[3];
                                  counter=0x06;
                break;
                         case OUT_SERIAL_DATA:
                                  OutSerialData();
                                  LOAD7219 = 1;
                                  dataPacket._byte[1]=0x02;
                                  dataPacket._byte[2]=dataPacket._byte[0];
                                  counter=0x03;
                                  break;
                         case PULSE_LOAD:
                                  LOAD7219 = 1;
                                  break;
            case RESET:
                Reset();
                break;

            default:
                break;
```

```
        }//end switch()
        if(counter != 0)
        {
            if(!mUSBGenTxIsBusy())
                USBGenWrite((byte*)&dataPacket,counter);
        }//end if
    }//end if

}//end ServiceRequests

/******************************************************************************
 * Function:        void InitMAX7219(void)
 *
 * PreCondition:    None
 *
 * Input:           None
 *
 * Output:          None
 *
 * Side Effects:    None
 *
 * Overview:        Initializes the SPI port for MAX7219
 *
 *
 * Note:
 *
 *
 *****************************************************************************/
void InitMAX7219(void)
{
        TRISCbits.TRISC7 = 0; // Enabling SPI Pins Master mode
        TRISBbits.TRISB1 = 0;

        OpenSPI(SPI_FOSC_64, MODE_00, SMPEND);

        tris_LOAD7219 = OUTPUT_PIN;
        LOAD7219 = 0;
}//end InitMAX7219

void SendRaw7219Packet()
{
        LOAD7219 = 0;

        WriteSPI(dataPacket._byte[2]);
        WriteSPI(dataPacket._byte[3]);

        dataPacket._byte[4]=0x55;
        dataPacket._byte[5]=0xAA;
        LOAD7219 = 1;
        counter = 0xff;
        while(counter--);
}

void OutSerialData()
{
        byte index;
        //dataPacket.data[DATA_SIZE-1] = 0; // Precaution null terminator
        LOAD7219 = 0;
        index = 0;
        counter = dataPacket.len;
        while(index<counter)
        {
```

```
                WriteSPI(dataPacket.data[index]);
                index++;
        }
}

/******************************************************************************
 * Function:        void BlinkUSBStatus(void)
 *
 * PreCondition:    None
 *
 * Input:           None
 *
 * Output:          None
 *
 * Side Effects:    None
 *
 * Overview:        BlinkUSBStatus turns on and off LEDs corresponding to
 *                  the USB device state.
 *
 * Note:            mLED macros can be found in io_cfg.h
 *                  usb_device_state is declared in usbmmap.c and is modified
 *                  in usbdrv.c, usbctrltrf.c, and usb9.c
 *****************************************************************************/
void BlinkUSBStatus(void)
{
    static word led_count=0;

    if(led_count == 0)led_count = 10000U;
    led_count--;

    #define mLED_Both_Off()         {mLED_1_Off();mLED_2_Off();}
    #define mLED_Both_On()          {mLED_1_On();mLED_2_On();}
    #define mLED_Only_1_On()        {mLED_1_On();mLED_2_Off();}
    #define mLED_Only_2_On()        {mLED_1_Off();mLED_2_On();}

    if(UCONbits.SUSPND == 1)
    {
        if(led_count==0)
        {
            mLED_1_Toggle();
            mLED_2 = mLED_1;        // Both blink at the same time
        }//end if
    }
    else
    {
        if(usb_device_state == DETACHED_STATE)
        {
            mLED_Both_Off();
        }
        else if(usb_device_state == ATTACHED_STATE)
        {
            mLED_Both_On();
        }
        else if(usb_device_state == POWERED_STATE)
        {
            mLED_Only_1_On();
        }
        else if(usb_device_state == DEFAULT_STATE)
        {
            mLED_Only_2_On();
        }
        else if(usb_device_state == ADDRESS_STATE)
```

```
        {
            if(led_count == 0)
            {
                mLED_1_Toggle();
                mLED_2_Off();
            }//end if
        }
        else if(usb_device_state == CONFIGURED_STATE)
        {
            if(led_count==0)
            {
                mLED_1_Toggle();
                mLED_2 = !mLED_1;       // Alternate blink
            }//end if
        }//end if(...)
    }//end if(UCONbits.SUSPND...)

}//end BlinkUSBStatus
```

Chapter 6
Conclusion

6.1 OBSERVATIONS

- Program to drive the LED driver MAX 7219 has been obtained.
- LED matrix has been implemented
- The program for USB Interface has been run successfully
- The USB Interface has been implemented

6.2 FUTURE SCOPE

- The LED Matrix could be developed for video display. Each LED represents a pixel. By the intense packing of LEDs video display is possible.
- The wireless LED board could be developed. GSM and GPRS based Designs are Public utility products for mass communication. This is a Scrolling (Moving) Message Electronic Display Board which displays the messages received as SMS or GPRS Packets.

Bibliography

Datasheets referred :

- MAX7219
- PIC18F4550
- PIC16F84A
- TLC5940A
- RGB LED

Websites referred:

www.microchip.com
www.ti.com
www.maxim-ic.com

All the information present in this document and further information is available at rgb.kitiyo.com

Appendix

APPENDIX A – COST REPORT

Figure 19 Cost Report

ITEM	COST PER UNIT(RS)	UNITS	TOTAL (RS)
RGB LED	10	128	1280
PIC 18F4550	FREE SAMPLE		
LED driver MAX 7219	FREE SAMPLE		
PCB			500
Misc Components			220
TOTAL			**2000**

APPENDIX B – DATASHEETS

- MAX7219
- PIC 18F4550