EMBEDDED SYSTEMS

LAB MANUAL

Course Code	**:**	**AEC111**
Regulations	**:**	**IARE - R16**
Class	**:**	**VII Semester**
Branch	**:**	**ECE**

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Lab Objective:

An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular kind of application device. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines, and toys (as well as the more obvious cellular phone and PDA) are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with a programming interface, and embedded systems programming is a specialized occupation.

An **embedded system** is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually *embedded* as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

INTRODUCTION ABOUT LAB

There are 30 systems (Dell) installed in this Lab. Their configurations are as follows:

Processor	**:**	**Intel(R) core (TM) - i3 -4150**
CPU RAM	**:**	**4 GB**
Hard Disk	**:**	**500 GB**
Mouse	**:**	**Optical Mouse**
Network Interface card	**:**	**Present**

Software

1 All systems are configured in DUAL BOOT mode i.e, Students can boot from Windows 07.This is very useful for students because they are familiar with different Operating Systems so that they can execute their programs in different programming environments.

2 Each student has a separate login for database access

3 Software installed: Keil Micro vision, OFFICE-07, Systems are provided for students in the1:1 ratio.

4 Systems are assigned numbers and same system is allotted for students when they do the lab.

LAB CODE

1. Students should report to the concerned labs as per time table schedule.
2. Students who turn up late to the labs will in no case be permitted to do the program scheduled for the day.
3. After completion of the program, certification of the concerned staff in-charge in the observation book is necessary.
4. Students should bring a notebook of about 100 pages and should enter the reading/observations into
5. the notebook while performing the experiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate last session should be submitted and certified by the staff member in-charge.
7. Not more than three students in a group are permitted to perform the experiment on a setup.
8. The group-wise division made in the beginning should be adhered to and no mix up student among different groups will be permitted later.
9. The components required pertaining to the experiment should be collected from stores in-charge after duly filling in the requisition form.
10. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
11. Any damage of the equipment or burn-out of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.
12. Students should be present in the labs for the total scheduled duration.
13. Students are required to prepare thoroughly to perform the experiment before coming to Laboratory.
14. Procedure sheets/data sheets provided to the student's groups should be maintained neatly and to be returned after the experiment.

List of Lab Excercises

EMBEDDED SYSTEMS – Lab Programs List	
Submission – 1	
Week – 1	Design and develop a reprogrammable embedded computer using 8051 microcontrollers and to show the following aspects. a. Programming b. Execution c. Debugging To Demonstrate the Tool Chain for Keil IDE (Embedded Systems Development Tool Chain) with the example of LED Blinking Program.
Week – 2	Program to toggle all the bits of port P1 continuously with 250 ms delay. Program to toggle only the bit P1.5 continuously with some delay
Week – 3	Program to interface a switch and a buzzer to two different pins of a port such that the buzzer should sound as long as the switch is pressed.
Week – 4	Program to interface LCD data pins to port P1 and display a message on it
Week – 5	Program to 4*4 interface keypad. Whenever a key is pressed, it should be displayed on LCD
Week – 6	Program to interface seven segment display using 89V51RD2
Week – 7	Program for serial communication between microcontrollers to PC communication the data should be transfer from microcontroller to PC terminal window using 89V51RD2.
Week – 8	Program for serial communication between microcontroller to PC communication the data should be transfer from microcontroller to PC terminal window using 89V51RD2.
Week – 9	Develop necessary interfacing circuit to read data from i) temperature sensor and process using 89V51RD2, the data has to display terminal window
Week – 10	Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise directions
Week – 11	Program to verify run 2 to 3 tasks simultaneously on P89V51RD2 SDK. Use LCD interface, LED interface, Serial communication.

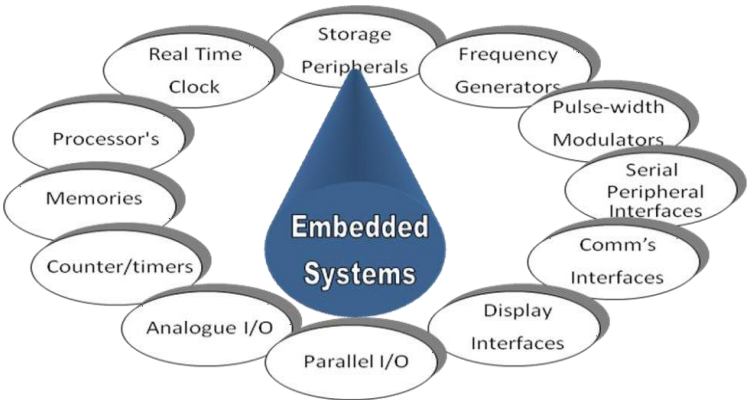
Week – 12	Program to interface ADC device with P89V51RD2 and display value on LCD
Week – 13	Program to interface DAC device with P89V51RD2 and observer the analog output in CRO
Week – 14	Program to interface Relay with P89V51RD2 using transistor
Week – 15	Program to toggle LEDS using simple INTERRUPT

Description about ES Concepts:

Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reason such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs. Embedded systems are not always separate devices. Most often they are physically built-in to the devices they control.

The software written for embedded systems is often called firmware, and is stored in read-only memory or Flash memory chips rather than a disk drive. It often runs with limited computer hardware resources: small or no keyboard, screen, and little memory. Embedded systems range from no user interface at all — dedicated only to one task — to full user interfaces similar to desktop operating systems in devices such as PDAs. Simple embedded devices use buttons, LEDs, and small character- or digit-only displays, often with a simple menu system.

Embedded Systems components:

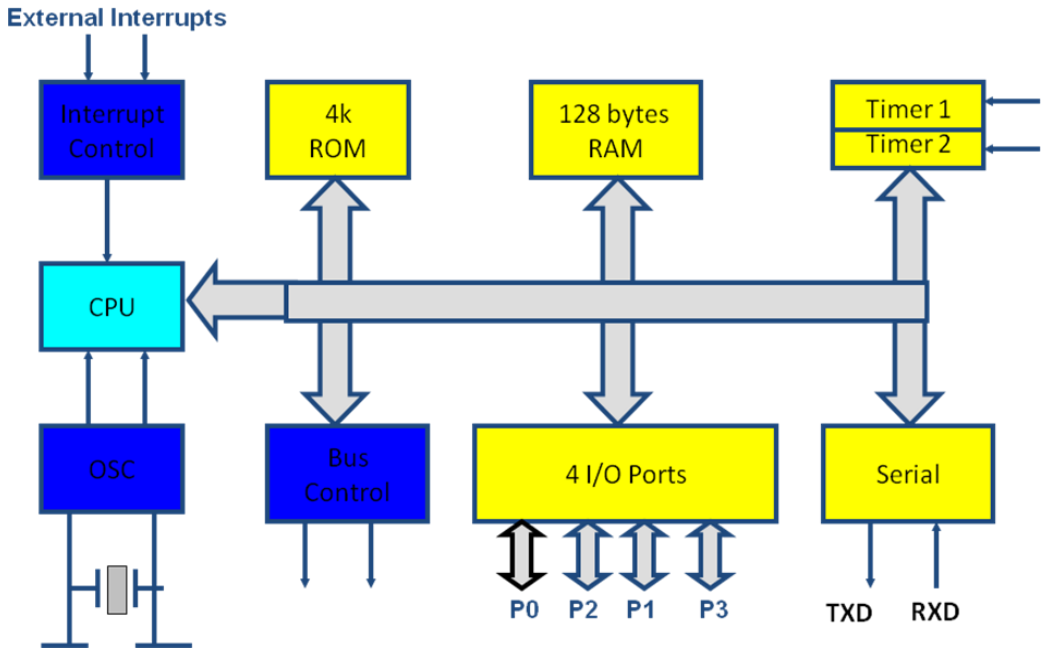


Introduction to 8051 Microcontroller:

- Microcontroller is a device which integrates number of components of a microprocessor system onto a single chip. It typically includes:-
- CPU (Central Processing unit)
- RAM & ROM
- I/O inputs & outputs – Serial & Parallel
- Timers
- Interrupt Controller

By including the features that are specific to the task (Control), Cost is relatively low. Microcontroller are a "one chip solutions" which drastically reduces parts count and design costs.

Block Diagram:



8051 Basic Components:

- 4K bytes internal ROM
- 128 bytes internal RAM
- Four 8-bit I/O ports (P0 - P3).
- Two 16-bit timers/counters
- One serial interface

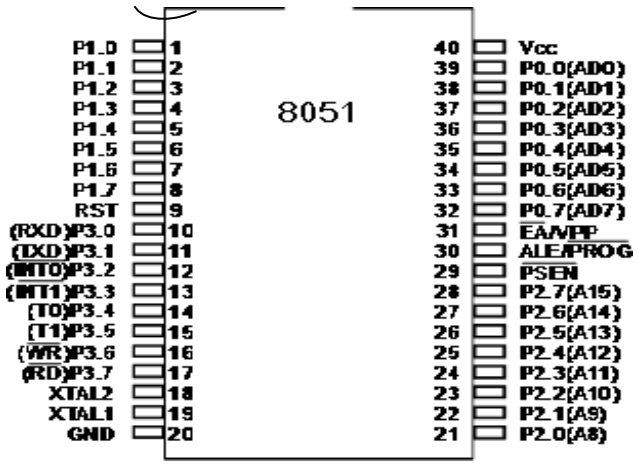
8051 features:

- 4K bytes ROM
- 128 bytes RAM
- Four 8-bit I/O ports
- Two 16-bit timers
- Serial interface
- 64K external code memory space
- ALU
- Working Registers
- Clock Circuits
- Timers and Counters
- Serial Data Communication.

8051 CPU Registers:

- A (8-bit Accumulator)
- B (8-bit register for Mul &Div)
- PSW (8-bit Program Status Word)
- SP (8-bit Stack Pointer)
- PC (16-bit Program Counter)
- DPTR (16-bit Data Pointer)

Pin Description of the 8051:



- The 8051 is a 40 pin device, but out of these 40 pins, 32 are used for I/O
- 24 of these are dual purpose, i.e. they can operate as I/O or a control line or as part of address or date bus.

8051 Development Board
(P89V51RD2)

On board Peripherals:

1) hex-key pad
2) seven segment display
3) serial peripheral interface (spi)
4) led' display
5) analog to digital converter
6) lm35 temperature sensor
7) digital to analog converter
8) rtc battery
9) eeprom (i2c)
10) rtc
11) lcd display
12) gnd and vcc
13) lcd contrast (potentiometer)
14) p89v51rd2
15) crystal oscillator
16) max232
17) serial port connector
18) stepper motor driver
19) buzzer
20) reset button
21) push button switches
22) slide switches
23) ps/2 connector
24) relay output connector
25) power supply slide switch
26) power jack
27) 7805 voltage regulator
28) bridge rectifier
29) relay

Overview:

The UTS-MC-KIT-M7.3 has got P89V51RD2 microcontroller which has got 64KiloBytes of on chip Flash memory and 1 KiloBytes of RAM. The kit is has got on board 11.0592MHz crystal for generating the on chip clock of 11.0592MHz.

A Key feature of the board is it has got so many interfaces, with different on board peripherals and has got expansion capability to add any further sensor and peripherals in future. This prototype board is very easy to use for 8051 architecture. This board is interfaced with LED's, 7 SEG display, LCD display, Pushbutton. This Board can also be interfaced with PC via serial communication and can be viewed through hyper terminal. The LCD display can be connected easily through connectors. No soldering work /No lose contact/ just plug in the berg connectors.

The board has got on chip peripherals like on board 32 KB bytes of RAM, Eight Light Emitting Diodes, four Push Buttons, Four Seven Segment Displays, 16X2 Liquid Crystal Character Display(LCD), Analog to Digital Converter, LM35 Temperature sensor, SPI based ADC, Hex Keypad, Buzzer relay, steeper motor driver interface, Real time clock, RS-232 serial interface.

Component Description:
Microcontroller

The P89V51RD2 device contains a non-volatile 64KB Flash program memory.

In-System Programming (ISP) allows the user to download new code while the microcontroller sits in the application. A default serial loader (boot loader) program in ROM allows serial In-System programming of the Flash memory via the UART without
the need for a loader in the Flash code.

This device executes one machine cycle in 6 clock cycles, hence providing twice the speed of a conventional 80C51. An OTP configuration bit lets the user select conventional 12 clock timing if desired.

This device is a Single-Chip 8-Bit Micro controller manufactured in advanced CMOS process and is a derivative of the 80C51 micro controller family. The instruction set is 100% compatible with the 80C51 instruction set.

The device also has four 8-bit I/O ports, three 16-bit timer/event counters, a multisource, and four-priority-level, nested interrupt structure, an enhanced UART and on-chip oscillator and timing circuits.

The added features of the P89V51RD2 makes it a powerful micro controller for applications that require pulse width modulation, high-speed I/O and up/down counting capabilities such as motor control.

Experimental Procedure for Keil4 IDE

(For all the experiments this procedure is same)

The RVision IDE is, for most developers, the easiest way to create embedded system programs. This chapter describes commonly used RVision features and explains how to use them.

RVision is a Windows application that encapsulates the Keil microcontroller development tools as well as several third-party utilities. RVision provides everything you need to start creating embedded programs quickly. RVision includes an advanced editor, project manager, and make utility, which work together to ease your development efforts, decreases the learning curve, and helps you to get started with creating embedded applications quickly.

There are several tasks involved in creating a new embedded project:

- Creating a Project File
- Using the Project Windows
- Creating Source Files
- Adding Source Files to the Project
- Using Targets, Groups, and Files
- Setting Target Options, Groups Options, and File Options
- Configuring the Startup Code
- Building the Project
- Creating a HEX File

The below section provides a step-by-step tutorial that shows you how to create an embedded project using the RVision IDE.

Downloading the hex file to the target using Flash magic Software:

Open the Flash Magic tool for downloading into the Microcontroller Board. Click on Device menu select option you will be popped up with a window named choose device. Under choose device options select 8051 and click on Ok button to open flash magic tool to download the hex file in to the MC

Terminal Software for Check the Serial port Data receiving from Microcontroller to PC:

Terminal is a simple serial port (COM) terminal emulation program. It can be used for communication with different devices such as modems, routers, embedded microcontroller systems, GSM phones, GPS modules... It is very useful debugging tool for serial communication applications

EXPERIMENT – 1(a)

Design and development of a Reprogrammable Embedded System Computer using 8051 Microcontroller

Aim: Design and develop a reprogrammable embedded system board using 8051 microcontrollers and to show following aspects.

1. Programming
2. Execution
3. Debugging

Hardware Requirement:

Soldering Iron, Tweezer, Cutter, Multimeter, Components as per table1.1.

Software Requirement:

1. Flash Magic tool.

2. Keil evaluation software

Description:

1.3.1 Embedded System:- Embedded systems are those systems that are similar to computer (they can be termed as computer on a chip) but are designed for some specific task, they may have lesser components (be in size or in count) associated to it, then PC. They may or may not contain all components of a computer system. For more definitions one may refer links below.

Unlike PC, Embedded systems are designed to perform some specific task and generally are not designed for performing multiple tasks.

Block Diagram of an Embedded System:

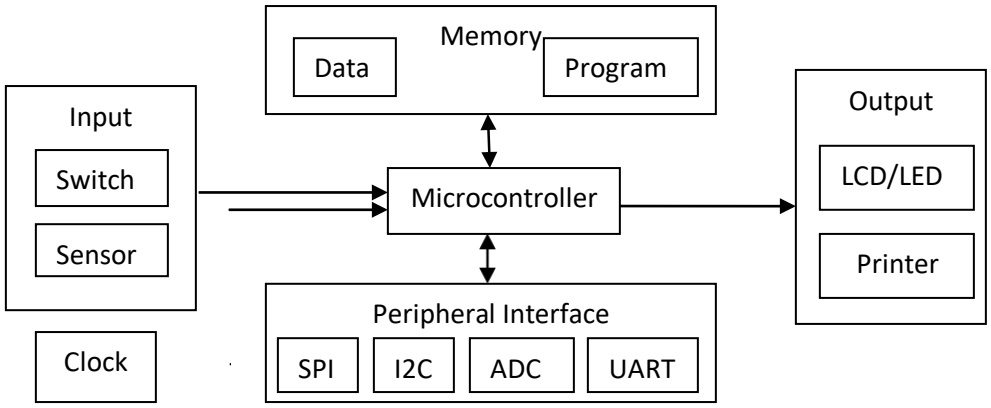


Figure 1.1: Block diagram of Embedded System

"Components of a Computer"

Basic component of an embedded system is its controller which could be a microprocessor unit (MPU) or a microcontroller unit (MCU). MPU needs more peripherals to accomplish a task and hence results in complex circuit and higher power consumption, whereas MCU units mostly have on chip peripherals that includes memory elements like ROM/RAM, basic function elements like Timers/ Counters/ Interrupts and special interfaces like UART/ SPI/ I2C/CAN etc. and thus resulting in lesser component count and lesser power consumption. For more information on difference between MPU and MCU one may visit below mentioned sites.

Re-programmable Embedded System (RES):- In its easiest definition, a re-programmable embedded system is one which can be re programmed a number of times easily while in system or in application and with minimum component requirement i.e. there is no need to pull out MCU every time one wants to program it and hence provide flexibility in programming and operations. It is developed using 8051 compatible microcontrollers manufactured by NXP/ Atmel. In addition to execution of intended program RES also provide debugging facility and chip programming for other users.

The Reprogrammable embedded system consists of:

- Sockets for placing microcontroller- 40 pin
  DC socket for external power supply (DC 5V)
- 1 LED for power on indication and 1 push button for reset
  11.0592 MHz Quartz Crystal Oscillator
- 8 LEDs for output pin state indication at port P0
  1 DIP switch (8 switch) for input pin activation
- Connector and driver for serial communication RS232
  Multiple-pin connectors for direct access to I/O ports
  Connector for SPI programming
- 1 Piezo buzzer for audio/frequency output
  Additional power supply connectors

Selection of component for a given application

Every application circuit is build around some components which should be selected as per the functionality of the application, availability of components, cost of entire system, procurement time for components and most importantly meeting of some critical parameters of intended application.

Selection of Processor:

Selection should be based mainly on architecture, availability, cost, time to prototype and market, testability and debug-ability. As per the requirement a microcontroller will be suitable for this purpose. Intel/Atmel 8051 architecture is suitable for beginners due to its easy understandability, easy

availability of architecture description and instruction set. Some advance controllers of 8051 architecture provide boot-loader, in system programming and in application programming.
NXP's P89V51RD2 and Atmel's AT89S52 are such general purpose controllers, based on 8051 architecture. Re-programmability is achieved using ISP (In-System-Programming) feature provided by NXP P89V51RD2 or by Atmel AT89S52. P89V51RD2 uses ISP by Atmel AT89S52. P89V51RD2 provides ISP feature using UART pins (RxD, TxD, RST, PSEN) while AT89S52 uses SPI pins (MOSI, MISO, SCK, RST) for ISP functionality.

NXP's P89V51RD2 and Atmel's AT89S52 features include;

- 8-bit, 40-pin controller in DIP package
- Operating voltage +5V
- Operating frequency 0 to 40 MHz
- 32-Input / Output pins
- 3-16 bit Timers
- 8- Interrupt levels
- 1-UART
- 1-SPI
- 1 KB of user RAM
- 64 KB of Flash

Selection of other components:

Serial communication interface

UART (Universal Asynchronous Receiver Transmitter) is required for boot-loader/ ISP/IAP programming and also for applications that include PC interfacing.
MAX232 is one such chip which provide serial communication interface between personal computer and microcontroller chip. It is selected due to its easily availability and low cost. Operating voltage requirement is +5V.

Oscillator

Oscillator is used as a clock signal generator. Crystal oscillators are used for their frequency stability and hence should be chosen over other type of oscillators.
Piezo electric crystal oscillator of 11.0592MHz frequency is used here as this frequency is most suitable for generation of precise baud rate and easy interfacing with PC. Besides, it is also possible to select internal RC oscillator during chip programming/Operations.

Connector

DB9 Female PCB Mount:- 3 pins of DB9 connector (pin 2-RD, pin 3-TXD and pin 5-GND) are used for connections between PC and UART IC i.e. MAX232.

Connectors for direct access to Ports

In order to enable microcontroller ports to be directly connected to additional components, each of them is connected to 8 pin, on-board connector.
* Upper Port P1 is also used for providing SPI interface for flash programming.

Input Selection

8-DIP switches are provided on board here for interfacing with any of input port. Inputs from sensors/ADC/PC may also be connected through port connectors.

Output Selection:

LED: 8-LEDs are connected at port0 with 1KOhm resistor network RN1. They may be used for initial configurations and testing as well as to view outputs.
LCD: 16x2, LCD may be connected using I/O port connectors. They may be used for displaying messages/values. LCD supports ASCII display.
Output at PC/DAC/Motors (through drivers) is also supported.

Power Supply

There is a connector on the development board enabling connection to external power supply source (DC-5V). Besides, voltage necessary for device operation can also be obtained from PC via USB cable at connector J7/J8.

Selection of tools

Some tools and editors are required to prepare assembly language program and its compiling i.e. hex file generation, and writing this hex file to flash memory.
Free downloadable Keil µvision version 4, editor is used for writing assembly language program and its compiling.
Free downloadable Flash Magic or USB programmer is used for flash programming. Hyper terminal available with windows is used for debugging purpose.

Schematic Diagram

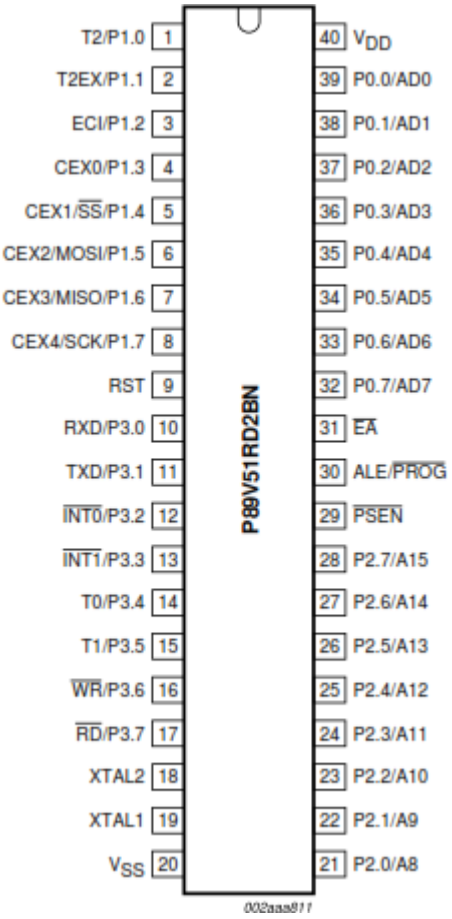
Discussion and explanation: Refer schematic diagram figure 1.6

1. Microcontroller 89V51RD2 is biased with +5V power supply connected at pin 40, GND connected at pin 20. A 0.1MFD ceramic capacitor is connected between pin 40 and GND to suppress supply spikes.
2. Enable Access (EA), pin 31 and PSEN pin 29 are all connected with Vcc. PSEN bar is connected to high logic as only internal flash memory is in use.
3. Cathode of all 8 LEDs are connected at different pins of port0 i.e. from pin 32 to 39 of controller, LED anode will be connected to Vcc through 1KOhm resistance network RN1. These LEDs will be used in program to view outputs or to check proper functioning by blinking them with different delays.
4. A 16 pin DIP switch (8 on/off switches) can be connected through 10KOhm resistance network RN3 at any port for switch inputs. At on condition port will be at low level.
5. A 11.0592 MHz crystal oscillator is connected between pin 18 and 19 of controller, with two 22pf ceramic capacitors connected between pin 18, 19 and GND.
6. As controller requires logic high voltage for short duration to get itself reset, a reset circuit is connected at RST pin i.e. pin 9 of controller. It consists of a push-to-on switch connected between Vcc and pin 9, a 10K resistor connected between pin 9 and GND and an electrolytic capacitor of 10MFD/25V, connected between Vcc and pin9 of controller.
7. For serial UART working, pin 10 of controller i.e. receive pin at port3 (P3.0) and pin 11 of controller i.e. transmit pin at port3 (P3.1) are connected with serial UART IC, MAX232 pin 9

and 10 respectively. Pin 9 of MAX232 is R2OUT i.e. receive out pin, which outputs data received from PC through serial cable via pin 8 i.e. R2IN of MAX232. Pin 10 of MAX232 is T2IN i.e. transmit input, which inputs data from controller. This input data is then sent to PC through serial cable via pin7 i.e. T2OUT of MAX232.

8. IC MAX232 is biased with +5V supply at pin 16, GND at pin 15. Rest of its biasing is done as per recommended circuitry. Four number 10 MFD/63V electrolytic capacitors are connected as recommended.
9. DB9 connector is connected between MAX232 and PC. Refer table 1 for complete list of components.

Figure 1.2: Pin diagram of P89V51RD2/AT89S52



*Note: Some instructions or names of SFRs may be changed in different processors of different manufacturers, e.g. ATMEL NXP for same architecture. Care must be taken here.

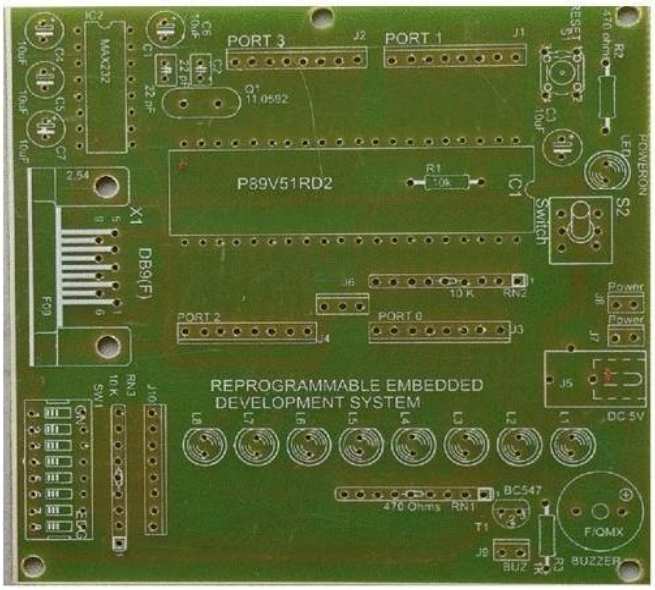


Figure 1.3: Bareboard PCB for Reprogrammable Embedded System

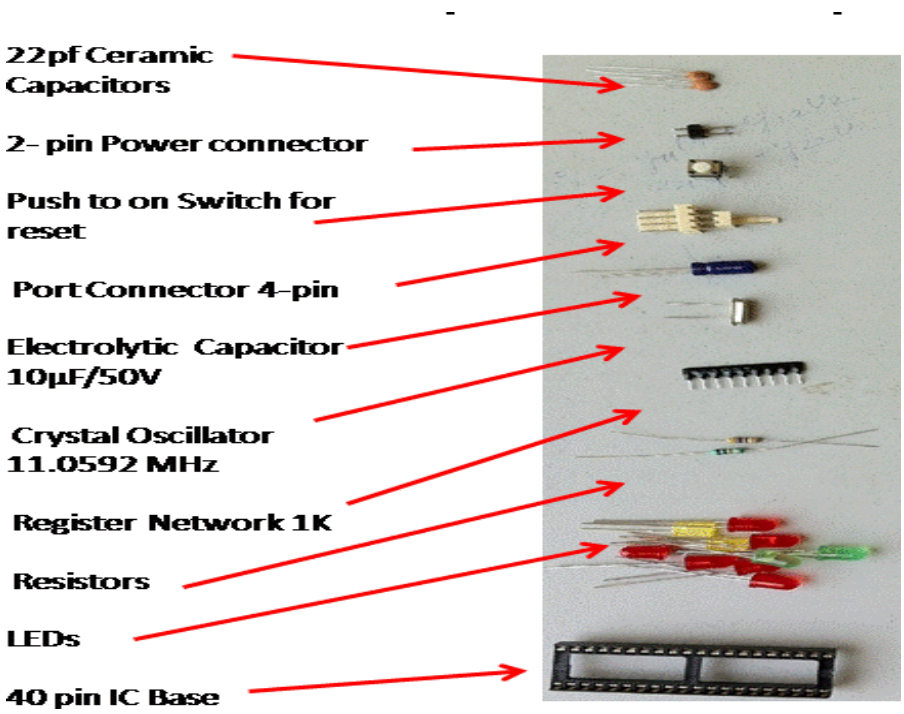


Figure 1.4: Components for Reprogrammable Embedded System

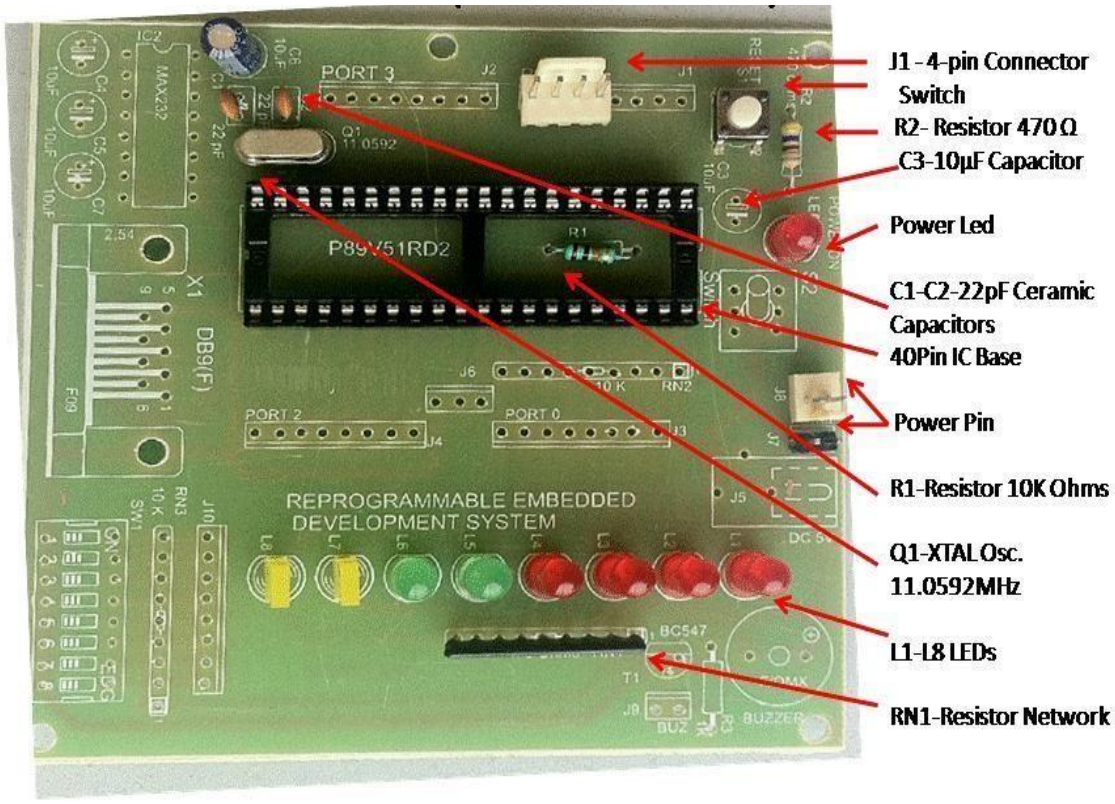


Figure 1.5: Assembled PCB for Reprogrammable Embedded System

EXPERIMENT – 1(b)

Tool Chain of Keil IDE (Embedded Development Tool Chain) with the example of LED Blinking Program

Aim: To understand the procedure of creating source code for reprogrammable embedded system board using IDE such as Keil µVision.

Software Requirement: Editor like Keil µVision Ver 4 or less.

Description:

Understanding any processor or controller needs familiarity with its architecture and instruction set. Any architecture can be best understood using its instruction set through different programs.

One may use assembly language or embedded C for writing programs. Programs written in assembly language are completely processor dependent and need major changes when converting to other processor. While programs written in C are generally independent of processor and needs minor changes during conversion to other processors.

C is thus preferred for programming. But to know and understand a processor better, one must be familiar with assembly language.

All source code written in this document will be written using assembly language for 8051 architecture.

Some development environment is needed to prepare any application. An editor is needed first to provide a platform for writing programs i.e. source code.

A source code written in assembly/C language is needed to be converted to machine language (hex code) before programming into processor. This conversion is done by compiler which converts assembly/C language code to hex code.

IDE i.e. Integrated development Environment, serves both these purposes as well as provide debugging facility.

Assembly language file will be stored by extension **.asm**, C file by extension .**c** and hex file by extension **.hex**.

Procedure:

Many free software are available for educational purpose e.g. Keil, SDCCDown load free tools for IDE from

IDE for 8051 architecture can be downloaded using these links. It's an integrated development environment for creation and compilation of assembly/C source code for any 8051 architecture based target boards. It also provides debugging facility [1].

Steps:

- Click on Keil µVision4 icon for getting started.
- Click on **Project tab**>Make new project> Select target device.
- Click on **File**>New file.
- Prepare a test code in assembly language as shown in editor window. Save it with**.asm**extension.
- Add this created file to project. One may add one or more than one file in a single project.
- Click **Target1** (at left side pane)>Source Group> Right click to add code file.
- Open **Project tab**> Options for target target1> Output tab>**check „create hex file" option.**
- Open **Project tab**> Build target. This will generate compiled **.hex** file from the **.asm** or**.C**

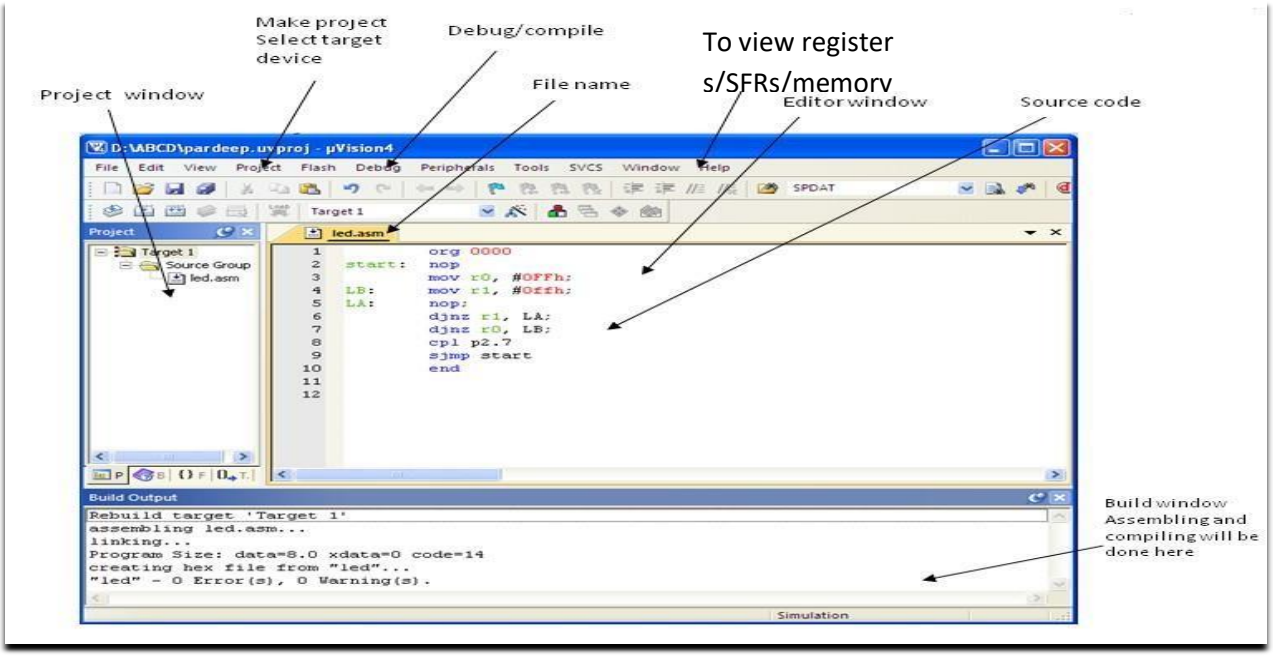


Figure 2.1 IDE- Keil µVision

Result: **Sample program for LED blinking is written, compiled and hex file generated.**

Conclusion:- Different programs can be written, debugged and simulated using IDE.

Remarks:- Different programs should be written and tested using assembly/C language for better understanding of the tool

EXPERIMENT – 2(a)

Aim:
Write a Embedded C Program to toggle all the bits of Port P1 continuously with 250 mS delay led blink with 89V51RD2 microcontroller board

Equipment Requirements:

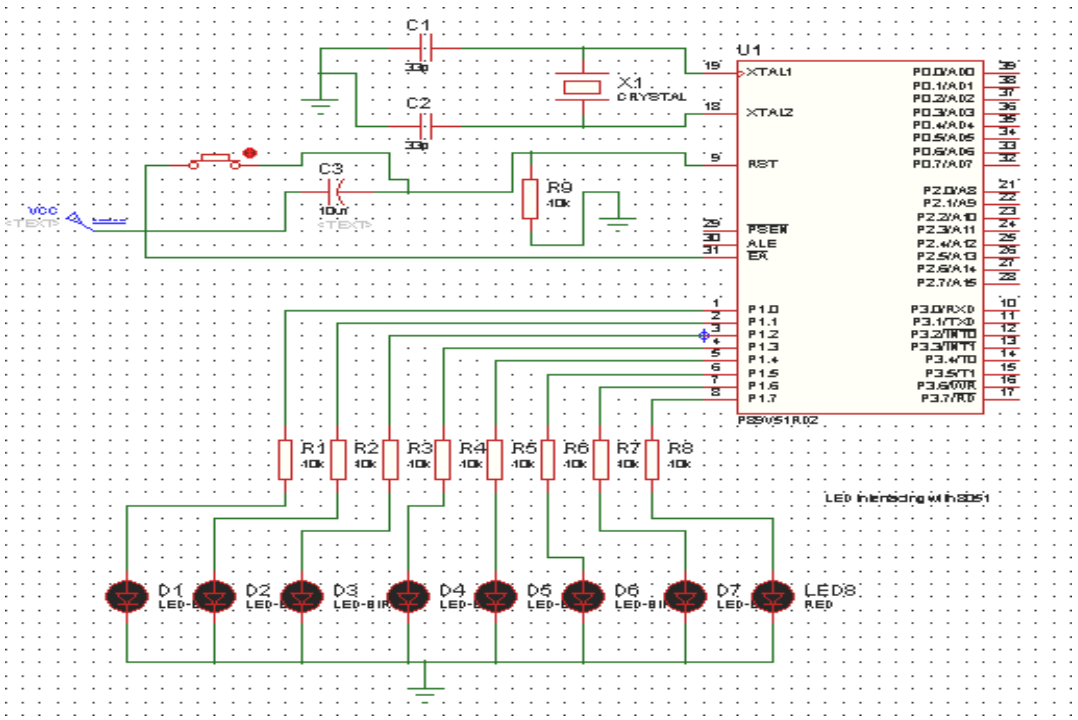
a) Hardware Requirements :

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

b) Software Requirements:

1. Flash Magic tool.
2. Keil evaluation software

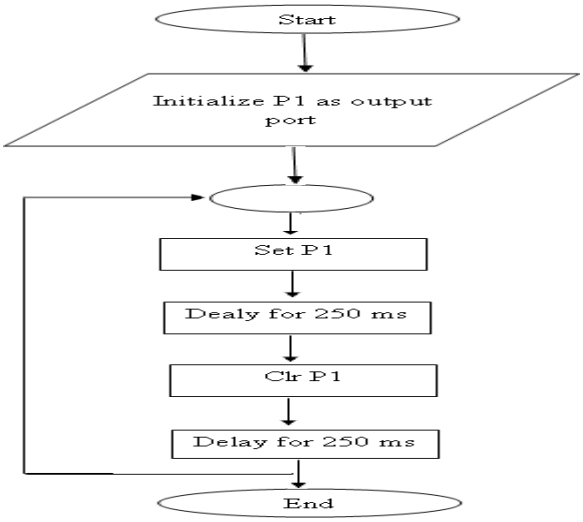
LEDs Interfacing with 8051:



Source code:

```
/* Program to toggle all the bits of Port P1 continuously with 250 mS delay. */

#include<REG51.H>

#define LEDPORT P1

void delay(unsigned int); void
main(void)
{
LEDPORT =0x00;
while(1)
{
LEDPORT = 0X00;
delay(250); LEDPORT = 0x11;
delay(250);
}
}
void delay(unsigned int itime)
{
unsigned int i,j;
for(i=0;i<itime;i++)
{
for(j=0;j<250;j++);
}
}
```

Flow Chart:

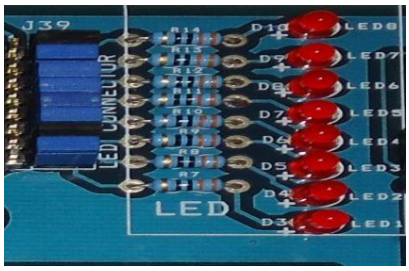


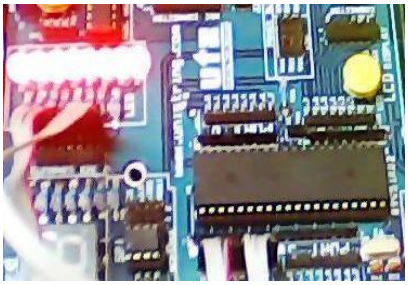
Hardware configuration:

- Connect an 8 pin bus from Port 1 (P1) to the LED pins (No 3 pin strip) or place an 8 pin Jumper connecting No2 and No3 pin strips.
- Turn Off and On the Board or just reset it to view the output.

Results/Output verification:

Now the led program is running on Microcontroller. And the output can be seen in the board. You can see led toggling





EXPERIMENT – 2(b)

Aim:

Write a Embedded C Program to toggle only the bit P1.5 continuously with some delay. Use Timer 0, mode 1 to create delay with 89V51RD2 Microcontroller board.

Equipment Requirements:

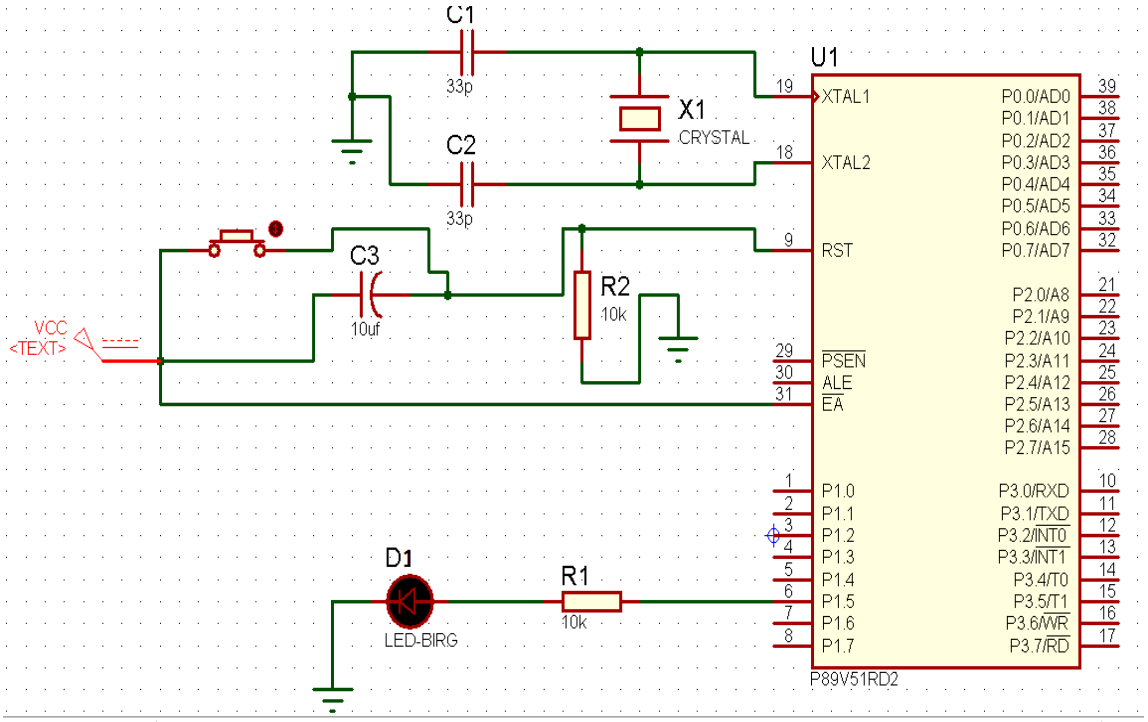
Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1. Flash Magic tool.
2. Keil evaluation software

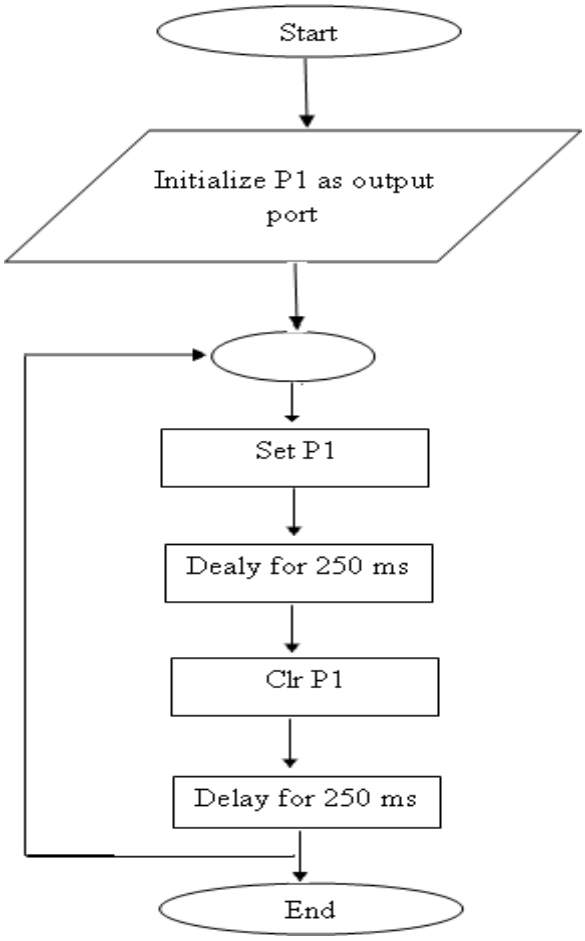
LED Interfacing with 8051:



Source code:

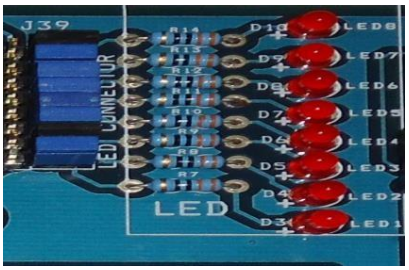
```
/* Program to toggle only the bit P1.5 continuously with some delay. Use Timer 0, mode 1 to create delay.*/

#include <REG51.H>

sbit LEDPIN = P1^5;

void Delay(unsigned int);

void main (void)
{
  LEDPIN = 0;
  while(1)
  {
            LEDPIN = 0x00;
                     Delay(1000);
                     LEDPIN = 0x11;
                     Delay(1000);
  }
}

void Delay(unsigned int itime)
{
  unsigned int i,j;
  for(i=0; i<itime;i++)
  {
            for(j=0;j<500;j++);
  }
  {}
}
```

Flow chart:



Results/Output verification:

Now the led program is running on Microcontroller. And the output can be seen in the board. You can see led toggling



EXPERIMENT – 3

Aim:

Write a Embedded C Program to interface a switch and a buzzer to two different pins of a port such that The buzzer should as long as the switch is pressed

Equipment Requirements:

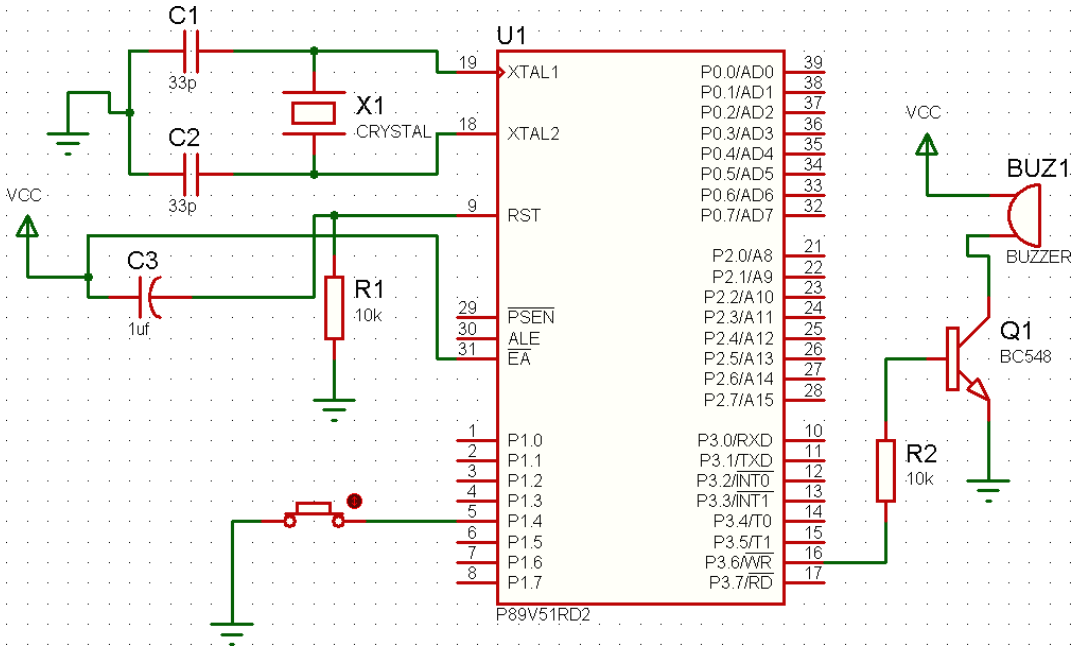
Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Rquirements :

1. Keil evaluation software
2. Flash Magic tool.

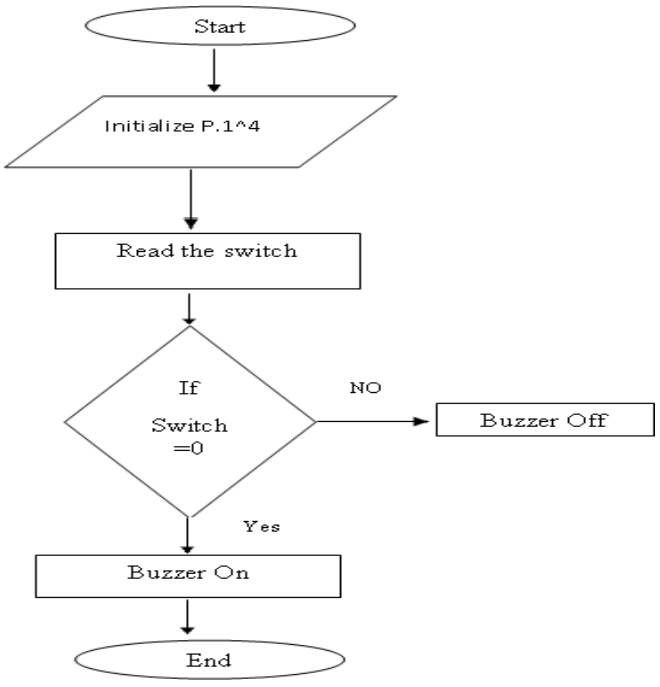
Interfacing Switch & Buzzer with 8051:



Source code:

```
/*Program to interface a switch and a buzzer to two different pins of a Port such that the buzzer
 should sound as long as the switch is pressed.*/

#include <REG51.H> // special function register declarations for the intended 8051
                                derivative

sbit SW1 = P1^4;
sbit BUZZER = P3^6;

void main (void)
{
  BUZZER = 0;
  while(1)
   {
      if(SW1 == 0)
           {
                BUZZER = 1;
      }
           else
                BUZZER = 0;
  }
}
```

Flow Chart:

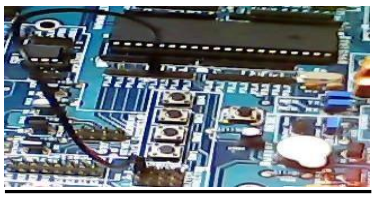


Hardware configuration:

1. Connect a single pin wire from PORT 1.4 to any switch available on board.
2. Place the jumper at jp6 jumper position to connect the buzzer onboard to the controller.
3. Turn ON and OFF or reset the board, to view the output.

Results/Output verification:

After programming the code into the microcontroller just reset the microcontroller. You can listen to the buzzer buzzing.



EXPERIMENT – 4

Aim:

Write a Embedded C Program to interface LCD data pins to port P1 and display a message on it using 89V51RD2

Equipment Requirements:

Hardware Requirements :

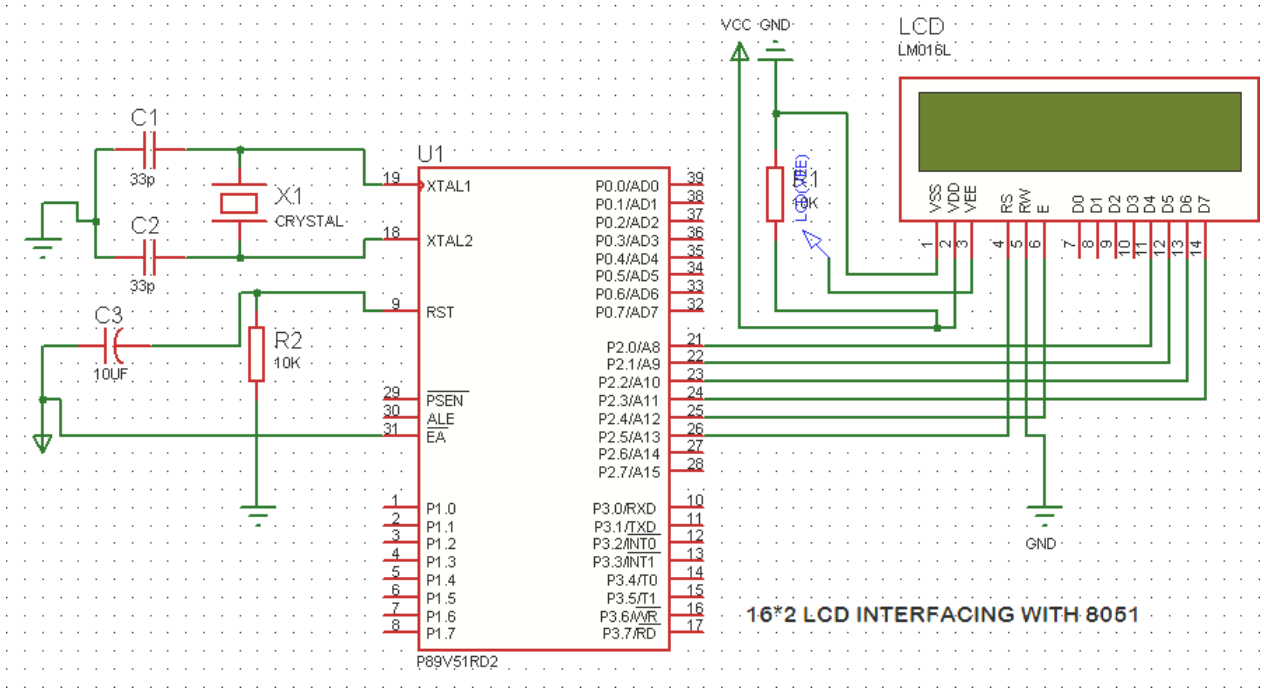
1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements :

1.Keil evaluation software

2. Flash Magic tool.

Interfacing 16*2 LCD with 8051:



Source code:

```
/*Program to interface LCD data pins to port P1 and display a message on it.*/

#include <reg51.h>
#include "lcd.h" // refer LCD.H code for more to about LCD

void Delay_sec(unsigned char s);

main( )
{
   LCD_init();
  while(1)
   {
      LCD_clear();
      Delay_sec(1);
      LCD_row1();
      LCD_puts(" welcome come to embedded lab ");
      LCD_row2();
      LCD_puts(" iare ");
      Delay_sec(5);
      LCD_clear();
      Delay_sec(1);
      LCD_clear();
      LCD_row1();
      LCD_puts("EMEBEDDED SYSTEMS ");
      LCD_row2();
      LCD_puts("AERONAUTICAL ENGG.");
      Delay_sec(5);
   }
}

void Delay_sec(unsigned char s)
{
  unsigned char n;
  for (n=0; n<s; n++)
   {
      LCD_delay(250);
      LCD_delay(250);
  }
}
```

Hardware configuration and Realization:

1. Connect a 6 pin jumper or 6 pin bus from PORT 2 to LCD module available on board.
2. Turn ON and OFF or reset the board, to view the output.

Results/Output verification:

After programming the code into the microcontroller just reset the microcontroller. You can see the text on the LCD.

EXPERIMENT – 5

Aim:

Write a Embedded C Program to 4*4 interface keyboard. Whenever a key is pressed, it should be displayed on LCD using 89V51RD2

Equipment Requirements:

Hardware Requirements:

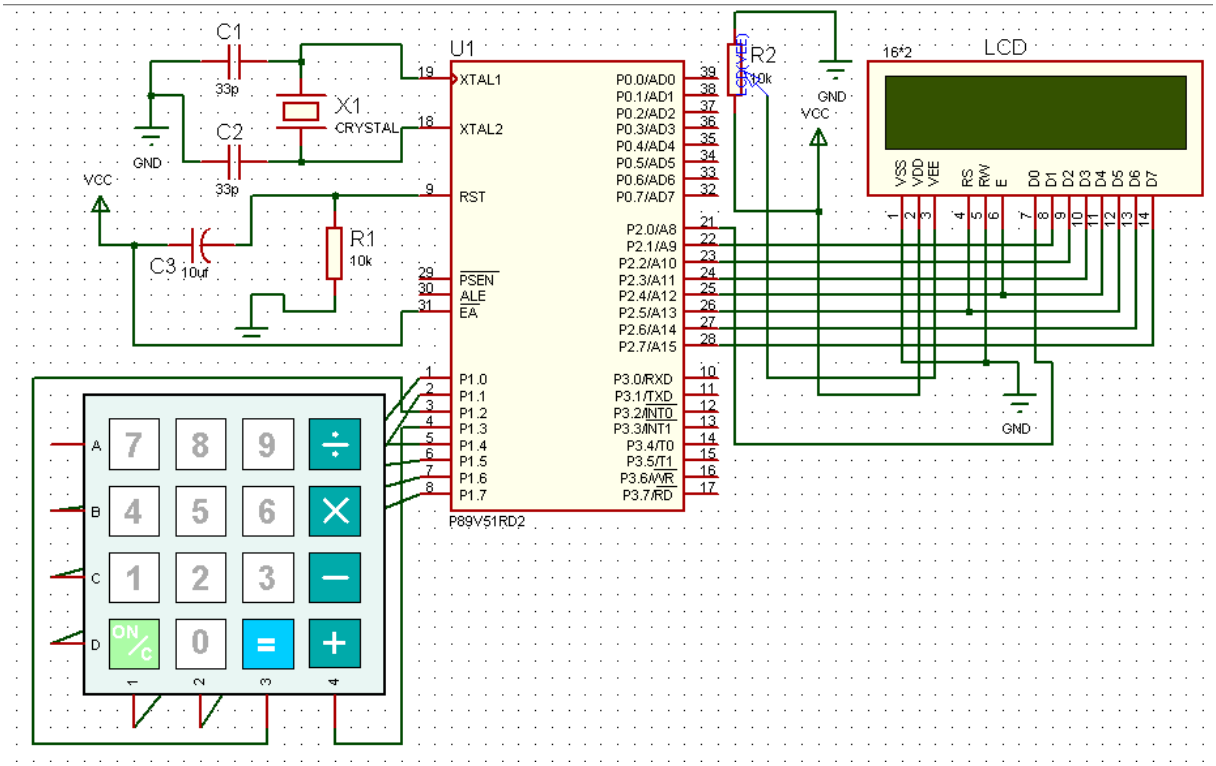
1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1.Keil evaluation software

2. Flash Magic tool.

4*4 Matrix keyboard interfacing with 8051:



Source code:

```
/*Program to interface keypad. Whenever a key is pressed, it should be displayed on LCD.*/

#include <reg51.h>
#include"lcd.h"

sbit C1 = P1^0;
sbit C2 = P1^1;
sbit C3 = P1^2;
sbit C4 = P1^3;
sbit R1 = P1^4;
sbit R2 = P1^5;
sbit R3 = P1^6;
sbit R4 = P1^7;

unsigned char key;

void Delay(unsigned int);

void delay()
{
   unsigned int i;
  for (i=0; i<10; i++);                          /* For 1 ms */
}

unsigned char  READ_SWITCHES (void)              // initialize the port for inputs
{
            // P1.0 to p1.3 are outpot; and P1.4 to P1.7 are inputs
  // the keybad is connected to port 1
  // make all rows = 1
   R4=1;
  R3=1;
  R2=1;
  R1=0;

   //test row 1
  if (C1 == 0)
   {                  // key 1 is presed
      delay();                        //debounce
            while (C1==0);                         //wait until release the key
            return 1;
  }
  if (C2 == 0)
   {                                                //key 2 is pressed
     delay();                                  //debounce
            while (C2==0);                     //wait until release the key
```

```
        return 2;
}
if (C3 == 0)
 {                                          //key 3 is pressed
    delay();                                //debounce
   while (C3==0);                   //wait until release the key
        return 3;
}
if (C4 == 0)
 {                                          //key 4 is pressed
        delay();                    //debounce
        while (C4==0);                //wait until release the key
   return 4;
}
//test row 2

R4=1;
R3=1;
R2=0;
R1=1;

 if (C1 == 0)
 {                          //key 5 is pressed
        delay();                        //debounce
        while (C1==0);                  //wait until release the key
        return 5;
}
if (C2 == 0)
 {                                          //key 6 is pressed
    delay();                                //debounce
        while (C2==0);                  //wait until release the key
        return 6;
}
if (C3 == 0)
 {                                          //key 6 is pressed
        delay();                    //debounce
        while (C3==0);                //wait until release the key
        return 7;
}
if (C4 == 0)
 {                                          //key 7 is pressed
        delay();                      //debounce
        while (C4==0);                  //wait until release the key
        return 8;
}
//test row 3
```

```
 R4=1;
R3=0;
R2=1;
R1=1;

if (C1 == 0)
 {                                          //key 8 is pressed
        delay();                            //debounce
        while (C1==0);                      //wait until release the key
        return 9;
}
if (C2 == 0)
 {                                          //key 9 is pressed
        delay();                            //debounce
        while (C2==0);                      //wait until release the key
   return 10;
}
if (C3 == 0)
 {                          //key A is pressed
    delay();                //depounce
        while (C3==0);                      //wait until release the key
        return 11;
}
if (C4 == 0)
 {                                          //key B is pressed
        delay();                            //depounce
        while (C4==0);                      //wait until release the key
        return 12;
}
 //test row 4

 R1=1;
R2=1;
R3=1;
R4=0;

if (C1 == 0)
 {                                          //key C is pressed
        delay();                            //depounce
        while (C1==0);                      //wait until release the key
        return 13;
}
if (C2 == 0)
 {                                          //key D is pressed
        delay();                            //depounce
        while (C2==0);                      //wait until release the key
        return 14;
```

```
  }
  if (C3 == 0)
   {                                          //key E is pressed
          delay();                            //depounce
          while (C3==0);                      //wait until release the key
          return 15;
  }
  if (C4 == 0)
   {                          //key C is pressed
          delay();                            //depounce
          while (C4==0);                      //wait until release the key
          return 16;
  }
  return 0;                                   // Means no key has been pressed
}



void main (void)
{
   P1 =0x0f;
  P3=0x00;
   LCD_init();
   LCD_row1();
   LCD_puts("< SERIAL KEYPAD >");
   LCD_row2();
   LCD_puts(" INTERFACING ");
   Delay(3);

  while(1)
   {
      key=READ_SWITCHES();
     if(key)
      {
         P3 = key-1;
         LCD_clear();
         LCD_row1();
         LCD_puts("< SERIAL KEYPAD >");
         LCD_row2();
         LCD_puts("KEY : ");

         switch(key)
         {
            case 1:
            {
                                  LCD_putc('0');
                                  break;
```

```
                }

        case 2:
                {
                        LCD_putc('1');
                        break;
                }

        case 3:
                {
                        LCD_putc('2');
                        break;
                }

        case 4:
                {
                        LCD_putc('3');
                        break;
                }
        case 5:
                {
                        LCD_putc('4');
                        break;
                }

        case 6:
                {
                        LCD_putc('5');
                        break;
                }

        case 7:
                {
                        LCD_putc('6');
                        break;
                }

        case 8:
                {
                        LCD_putc('7');
                        break;
                }

        case 9:
                {
                        LCD_putc('8');
                        break;
```

```
        }
case 10:
        {
                LCD_putc('9');
                break;
        }

case 11:
        {
                LCD_putc('A');
                break;
        }

case 12:
        {
                LCD_putc('B');
                break;
        }

case 13:
        {
                LCD_putc('C');
                break;
        }

case 14:
        {
                LCD_putc('D');
                break;
        }

case 15:
        {
                LCD_putc('E');
                break;
        }

case 16:                                        }
        {
```

```
                                LCD_putc('F');
                                break;


            }// switch

    }//if


                    }//while
}//main

void Delay(unsigned int duration)
{
   unsigned int r2;
            for (r2 = 0; r2<= duration;r2++)
   {
            LCD_delay(250);
            LCD_delay(250);
  }
}
```

Hardware configuration and realization:

1. Connect a 6 pin jumper or 6 pin bus from PORT 2 to LCD module available on board.
2. Connect 8 pin jumper to the hex keypad module on the board.
3. Turn ON and OFF or reset the board, to view the output.

Results/Output verification:

After programming the code into the microcontroller just reset the microcontroller. You can listen to the buzzer buzzing.

EXPERIMENT – 6

Aim:

Write a Embedded C Program to interface seven segment display using 89V51RD2

Equipment Requirements:
Hardware Requirements:

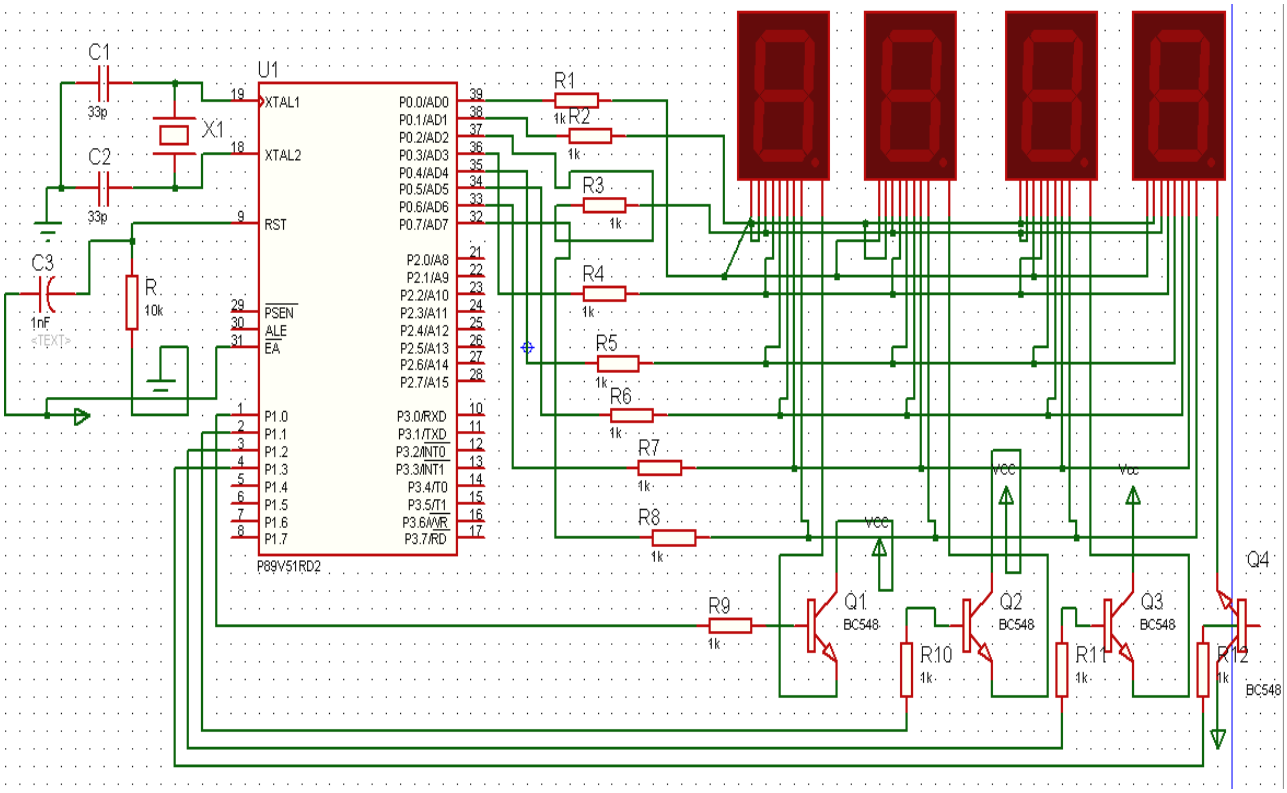
1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements :

1.Keil evaluation software

2. Flash Magic tool.

INTERFCAING SEVEN SEGMENT DISPLAY WITH 8051:



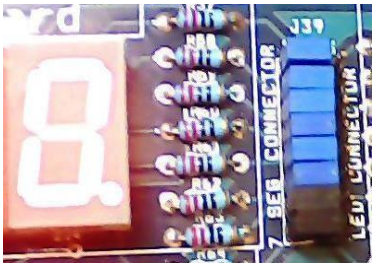
Source code:

```
/*Program to interface seven segment display unit.*/
#include <REG51.H>
#include <stdio.h>

#define LEDPORT      P0

sbit CTRL0 = P1^0;
sbit CTRL1 = P1^1;
sbit CTRL2 = P1^2;
sbit CTRL3 = P1^3;

#define          ZERO          0x02
#define  ONE           0x9E
#define  TWO           0x24
#define  THREE         0x0C
#define  FOUR          0x98
#define  FIVE          0x48
#define  SIX           0x40
#define  SEVEN         0x1E
#define  EIGHT         0x00
#define  NINE          0x18
#define  TEN           0x10
#define  ELEVEN        0xC0
#define  TWELVE        0x62
#define          THIRTEEN      0x84
#define          FOURTEEN      0x60
#define          FIFTEEN       0x70

void Delay(void);

void main (void)
{
  CTRL0 = 1;
  CTRL1 = 1;
  CTRL2 = 1;
  CTRL3 = 1;

  while(1)
  {
          LEDPORT = ZERO;
          Delay();
          LEDPORT = ONE;
          Delay();
          LEDPORT = TWO;
          Delay();
```

```
            LEDPORT = THREE;
            Delay();
            LEDPORT = FOUR;
            Delay();
            LEDPORT = FIVE;
            Delay();
            LEDPORT = SIX;
            Delay();
            LEDPORT = SEVEN;
            Delay();
            LEDPORT = EIGHT;
            Delay();
            LEDPORT = NINE;
            Delay();
                  LEDPORT = TEN;
            Delay();
            LEDPORT = ELEVEN;
            Delay();
            LEDPORT = TWELVE;
            Delay();
            LEDPORT = THIRTEEN;
            Delay();
            LEDPORT = FOURTEEN;
            Delay();
            LEDPORT = FIFTEEN;
            Delay();
  }
}

void Delay(void)
{
  int j;
  int i;
  for(i=0;i<30;i++)
  {
            for(j=0;j<10000;j++)
            {
            }
  }
}
```

HARWARE CONFIGURATION:

To check the output connects the wires as shown and press any key from the keypad that value should be displayed on seven segments.



Result:

Output shown on the seven segment display

EXPERIMENT – 7

Aim:

Write an Embedded C program for serial communication between Microcontroller to PC communication the data should be transfer from microcontroller to PC terminal window using 89V51RD2

Equipment Requirements:

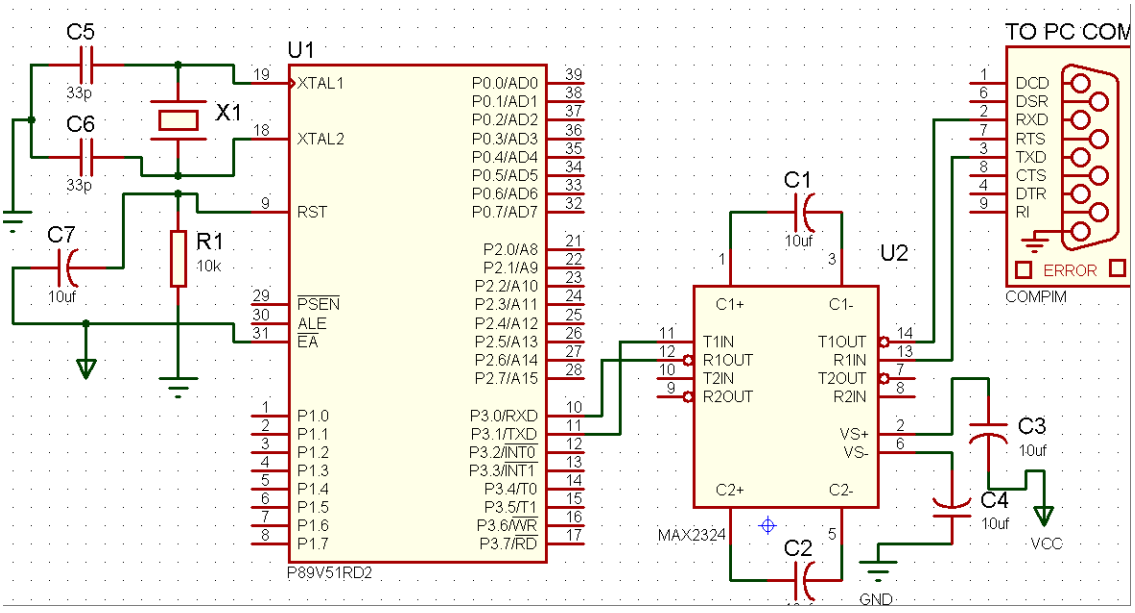
Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1. Keil evaluation software
2. Flash Magic tool.
3. Terminal

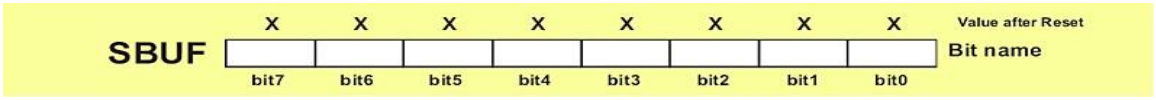
Interfacing Serial communication between MCU to PC:



Basic Theory of 8051 Serial commutations:

UART (Universal Asynchronous Receiver and Transmitter)

One of the microcontroller features making it so powerful is an integrated UART, better known as a serial port. It is a full-duplex port, thus being able to transmit and receive data simultaneously and at different baud rates. Without it, serial data send and receive would be an enormously complicated part of the program in which the pin state is constantly changed and checked at regular intervals. When using UART, all the programmer has to do is to simply select serial port mode and baud rate. When it's done, serial data transmit is nothing but writing to the SBUF register, while data receive represents reading the same register. The microcontroller takes care of not making any error during data transmission.



Serial port must be configured prior to being used. In other words, it is necessary to determine how many bits is contained in one serial “word”, baud rate and synchronization clock source. The whole process is in control of the bits of the SCON register (Serial Control).

SM0 - Serial port mode bit 0 is used for serial port mode selection.

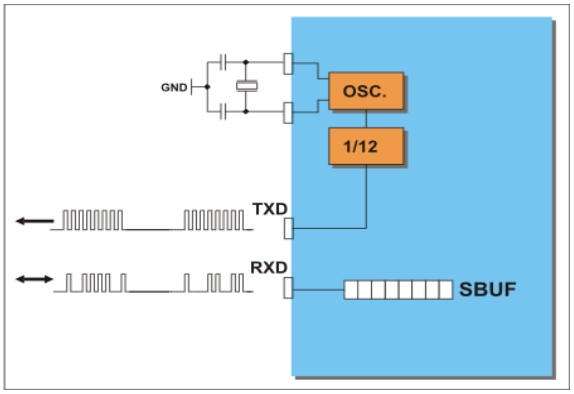
SM1 - Serial port mode bit 1.

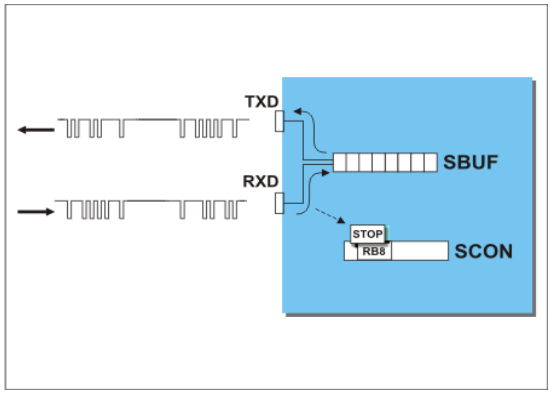
SM2 - Serial port mode 2 bit, also known as multiprocessor communication enable bit.

TI - Transmit Interrupt flag is automatically set at the moment the last bit of one byte is sent. It's a signal to the processor that the line is available for a new byte transmit. It must be cleared from within the software.

RI - Receive Interrupt flag is automatically set upon one byte receive. It signals that byte is received and should be read quickly prior to being replaced by a new data. This bit is also cleared from within the software.

SM0	SM1		Mode Description	Baud Rate
0	0	0	8-bit Shift Register	1/12 the quartz frequency
0	1	1	8-bit UART	Determined by the timer 1
1	0	2	9-bit UART	1/32 the quartz frequency (1/64 the quartz frequency)
1	1	3	9-bit UART	Determined by the timer 1



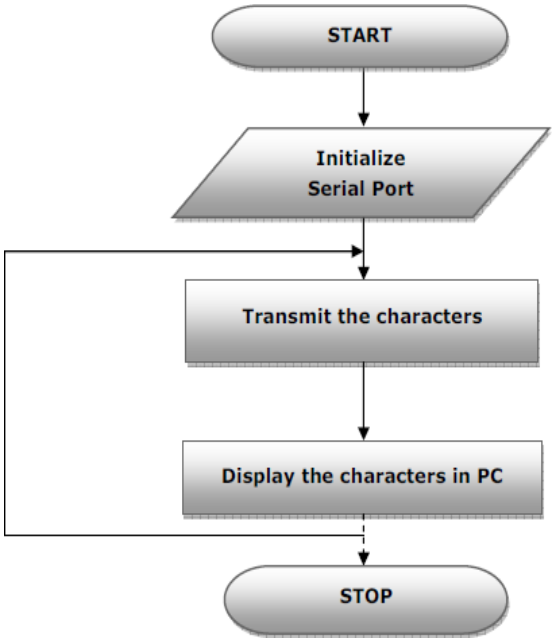


Source code:

```
/*Program to transmit a message from Microcontroller to PC serially using RS232.*/

#include <REG51.h>                      /* define 8051 registers */

void SendChar(unsigned char x);
void DisplayMesPC(unsigned char *);
void serial_init(void);


unsigned char *mes;


void main (void)                        /* main program start */
{
  serial_init();
mes = "\r\nInstitute of Aeronautical engg\r\n\r\nWelcome to Serial
communication Demo \r\n";
  DisplayMesPC(mes);
            mes = "\r\nif above txt visible, then transmission sucess\r\n";
```

```
        DisplayMesPC(mes);
   while(1);
}


void SendChar(unsigned char x)          // transmit function to send character to PC
{
  SBUF =x;                      // wrting the character into the serial buffer
  TI = 0;                       // Clearing the Transmit empty flag
while(!TI);                     // wating for end of trasmission. after transmission
                        the TI flag will set.
}

void DisplayMesPC(unsigned char *mes)
{
  int counter;
  for (counter=0;mes[counter]!='\0';counter++)
  {
                SendChar(mes[counter]);
   }
}

void serial_init()
{
   TMOD = 0x20;                 /* GATE OFF,C/#T = 0, M1 M0 = 10(8 BIT AUTO
RELOAD) TIMER 0 ,TIMER 1 IN MODE 2(AUTO RELOAD MODE)*/
   SCON = 0x50;                 /* SERIAL PORT IN MODE2 8-BIT UART VARIABLE
                        BAUDRATE */
   TH1  = 0xfd;                 /* TIMER 1 FOR BAUD RATE GEN(9.6K)*/
   TR1  = 1;                    /* baud rate timer start*/
}
```

Flow chart:



Results/Output verification:

Now the program is running on Microcontroller. And the output can be seen in the board. You can see terminal device .

EXPERIMENT – 8

Aim:

Write an Embedded C program for serial communication between Microcontroller to PC communication the data should be transfer from microcontroller to PC terminal window using 89V51RD2

Equipment Requirements:

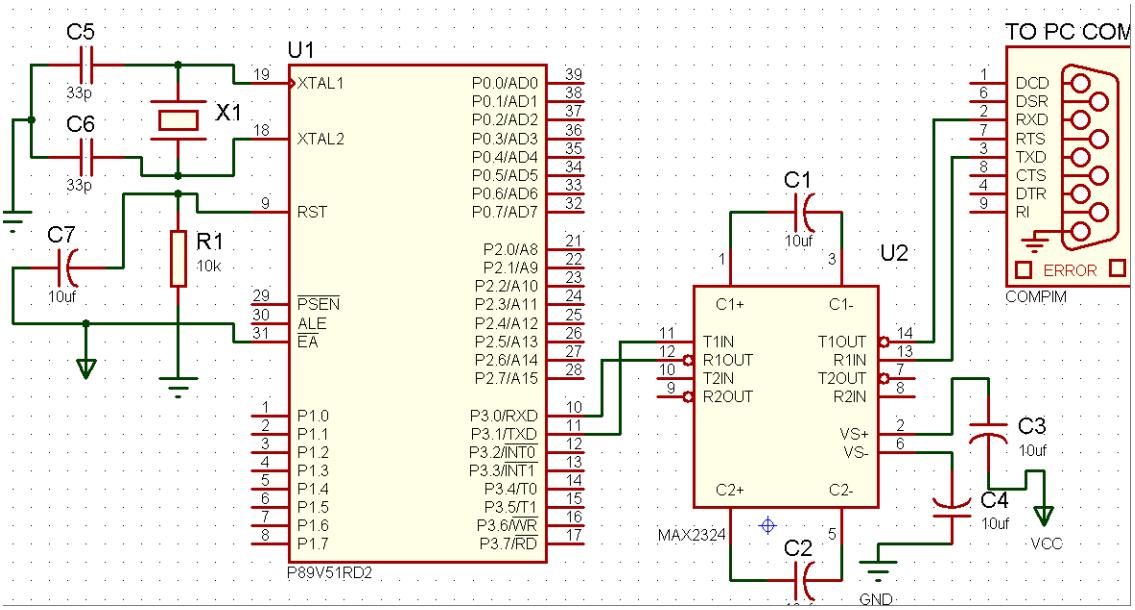
Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1. Keil evaluation software
2. Flash Magic tool.
3. Terminal

Interfacing Serial communication between MCU to PC:



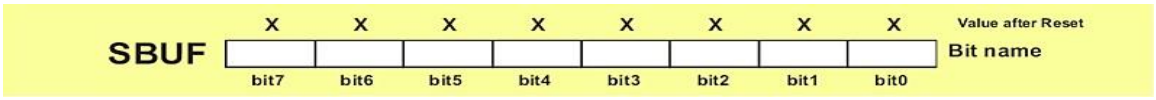
Basic Theory of 8051 Serial commutations:

UART (Universal Asynchronous Receiver and Transmitter)

One of the microcontroller features making it so powerful is an integrated UART, better known as a serial port.

It is a full-duplex port, thus being able to transmit and receive data simultaneously and at different baud rates. Without it, serial data send and receive would be an enormously complicated part of the program in which the pin state is constantly changed and checked at regular intervals. When using UART, all the programmer has to do is to simply select serial port mode and baud rate. When it's done, serial data transmit is nothing but writing to the SBUF register, while data receive represents reading the same register. The microcontroller takes care

of not making any error during data transmission.



Serial port must be configured prior to being used. In other words, it is necessary to
determine how many bits is contained in one serial “word”, baud rate and synchronization clock source. The whole process is in control of the bits of the SCON register (Serial Control).

SM0 - Serial port mode bit 0 is used for serial port mode selection.

SM1 - Serial port mode bit 1.

SM2 - Serial port mode 2 bit, also known as multiprocessor communication enable bit.

TI - Transmit Interrupt flag is automatically set at the moment the last bit of one byte is sent. It's a signal

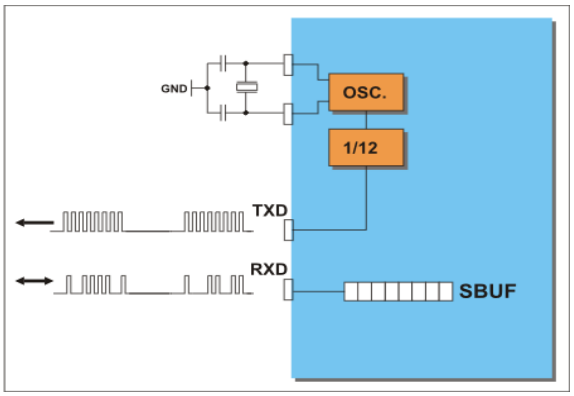
to the processor that the line is available for a new byte transmit. It must be cleared from within the software.

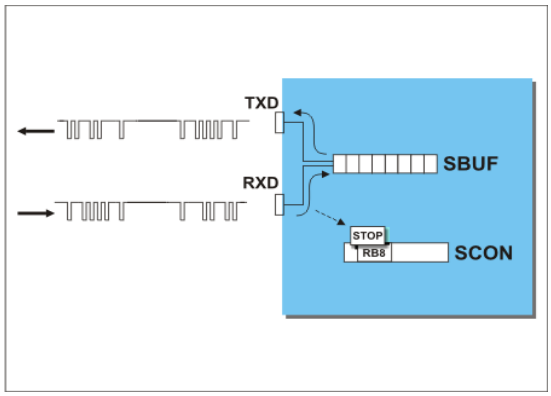
RI - Receive Interrupt flag is automatically set upon one byte receive. It signals that byte is received and

should be read quickly prior to being replaced by a new data. This bit is also cleared from within the software.

SM0	**SM1**	**Mode**	**Description**	**Baud Rate**
0	0	0	8-bit Shift Register	1/12 the quartz frequency

0	1	1	8-bit UART	Determined by the timer 1
0	1	2	9-bit UART	1/32 the quartz frequency
1	1	3	9-bit UART	Determined by the timer 1



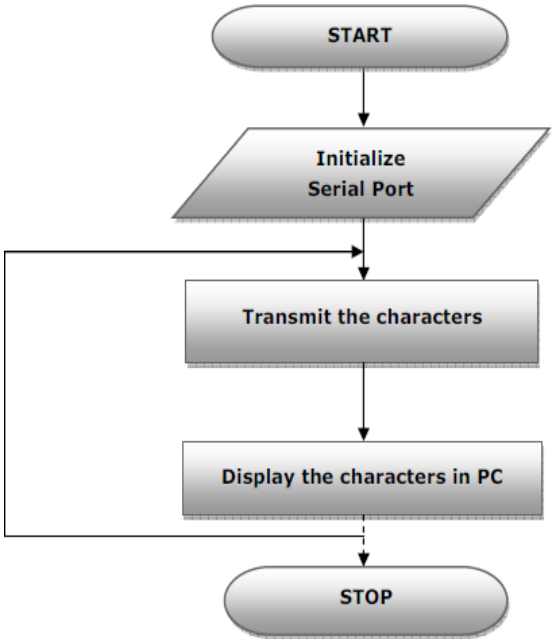


Source code:

```
/*Program to transmit a message from Microcontroller to PC serially using RS232.*/

#include <REG51.h>                    /* define 8051 registers */

void SendChar(unsigned char x);
void DisplayMesPC(unsigned char *);
void serial_init(void);

unsigned char *mes;

void main (void)                      /* main program start */
{
  serial_init();
mes = "\r\nInstitute of Aeronautical engg\r\n\r\nWelcome to Serial
communication Demo \r\n";
  DisplayMesPC(mes);
            mes = "\r\nif above txt visible, then transmission sucess\r\n";
             DisplayMesPC(mes);
   while(1);
 }
```

```
void SendChar(unsigned char x)          // transmit function to send character to PC
{
  SBUF =x;                              // wrting the character into the serial buffer
  TI = 0;                               // Clearing the Transmit empty flag
while(!TI);                             // wating for end of trasmission. after transmission
                                the TI flag will set.
}

void DisplayMesPC(unsigned char *mes)
{
  int counter;
  for (counter=0;mes[counter]!='\0';counter++)
  {
                        SendChar(mes[counter]);
   }
}

void serial_init()
{
   TMOD = 0x20;                         /* GATE OFF,C/#T = 0, M1 M0 = 10(8 BIT AUTO
RELOAD) TIMER 0 ,TIMER 1 IN MODE 2(AUTO RELOAD MODE)*/
  SCON = 0x50;                          /* SERIAL PORT IN MODE2 8-BIT UART VARIABLE
                                BAUDRATE */
   TH1  = 0xfd;                         /* TIMER 1 FOR BAUD RATE GEN(9.6K)*/
   TR1  = 1;                            /* baud rate timer start
```

Flow chart:



Results/Output verification:

Now the program is running on Microcontroller. And the output can be seen in the board.

EXPERIMENT – 9

Write a Program to

Develop necessary interfacing circuit to read data from i) temperature sensor and process using 89c51 sdk, the data has to display terminal window

Aim:

Write an embedded C program to find the temperature sensor using 89V51RD2

Equipment Requirements:

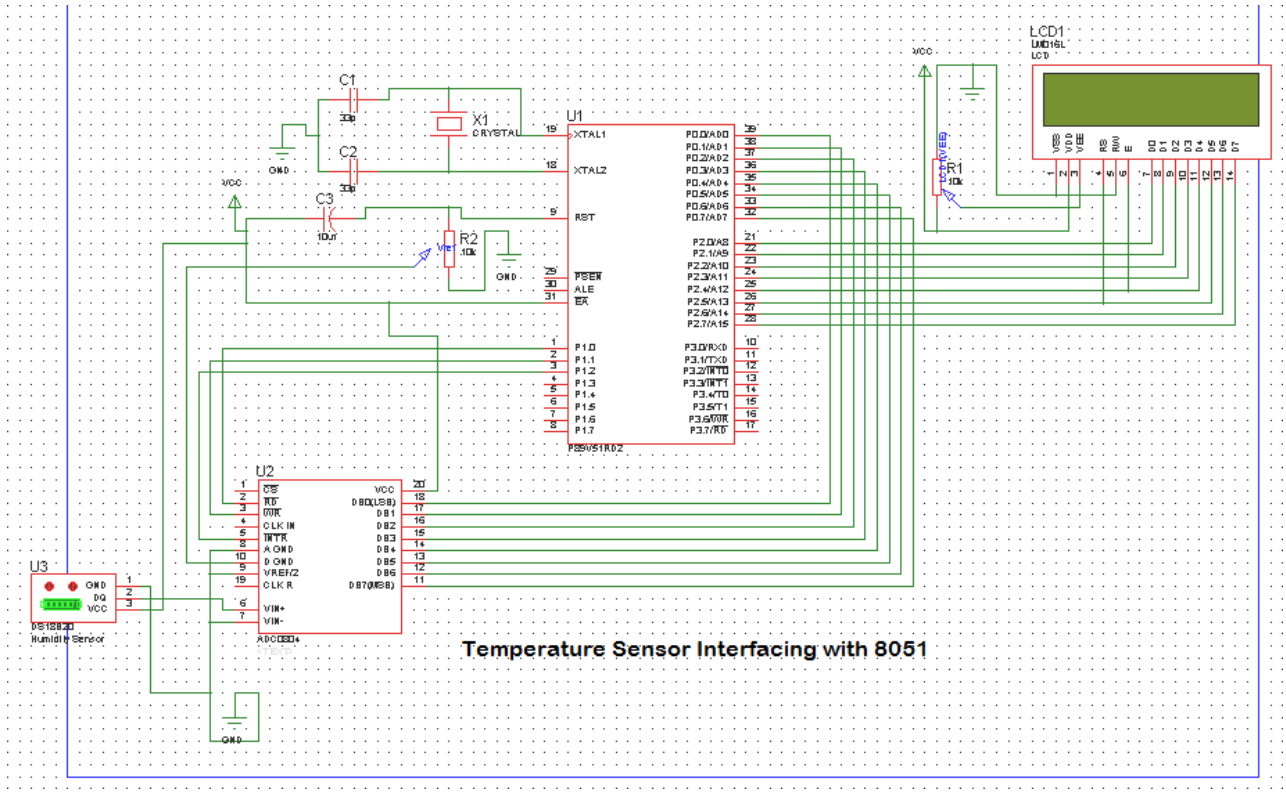
Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1. Keil evaluation software
2. Flash Magic tool.
3. Terminal device

Temperature Sensor Interfacing with 8051:



Source code:

/*Program to get analog input from Temperature sensor and display the temperature value on PC Monitor.*/

```
#include <reg51.h>              /* define 8051 registers */
#include "lcd.h"

sbit rd=P1^0;                  //Read signal P1.0
sbit wr=P1^1;                   //Write signal P1.1
sbit intr=P1^2;                //INTR signal P1.3

void conv();                    //Start of conversion function
void read();                   //Read ADC function
void display();
void Delay(int a);
void SendChar(unsigned char x);
void DisplayMesPC(unsigned char *);

unsigned char *mes;
unsigned char adc_val;
unsigned int value,temp,temp1,temp2,temp3;

void Delay(int a)
```

```
{
   char i;
   for(i=0;i<a;i++)
   {
      LCD_delay(250);
      LCD_delay(250);
   }
}

void serial_init()
{
         = 0x20;          /* GATE OFF,C/#T = 0, M1 M0 = 10(8 BIT AUTO RELOAD)
TIMER 0 ,TIMER 1 IN 2(AUTO RELOAD MODE)*/

SCON = 0x50; /* SERIAL PORT IN MODE2 8-BIT UART VARIABLE
                  BAUDRATE*/

   TH1  = 0xfd;           /* TIMER 1 FOR BAUD RATE GEN(9.6K)*/

   TR1  = 1;              /* baud rate timer start*/
}

void PowerOn( )
{
   unsigned char inner, outer;

   for (outer = 0x00; outer < 0x10; outer++)
   {
      for (inner = 0x00; inner < 0xFF; inner++);
   }

   LCD_init();

   for (inner = 0; inner < 10; inner++)
         LCD_delay(2);
                  serial_init();
}


void main()
{
   P0=0xFF;
   P1=0x04;
   PowerOn();

   while(1)
   {
```

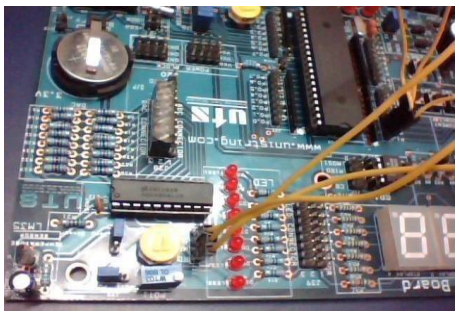
```
      LCD_clear();
      LCD_row1();
      LCD_puts("Temperature sen ");
      DisplayMesPC("\r\nTemparature Value : ");
      conv();                                          //Start conversion
      read();                                          //Read ADC
      display();                                 //Send the read value PC and LCD
      Delay(4);
    }
}

void conv()
{
   wr = 0;                 //Make WR low
   wr = 1;                 //Make WR high
   while(intr);             //Wait for INTR to go low
}

void read()
{
   rd = 0;                //Make RD low
   adc_val = P0;             //Read ADC port
   rd = 1;                //Make RD high
}

void display()
{                            // display the adc vvalue in the form of milli volts
     LCD_row2();
     LCD_puts(" Temp :");
          value=adc_val;
  value=value*196;       //since resolution is 5V/255=19.6mv
  value=value/100;        // 10 division by 196 instead 19.6 another 10 is 1*
                                  corresponds 10mv


  if(value>=1000)
         {
           temp=value/1000;
           adc_val=temp+48;
           LCD_putc(adc_val);
           SendChar(adc_val);
  }

           temp1=value%1000;

           if(temp1>=100&&temp1<=999){
           temp=temp1;
```

```
        temp=temp/100;
        adc_val=temp+48;
        LCD_putc(adc_val);
        SendChar(adc_val);
}
        Else
       {
              LCD_putc('0');
              SendChar('0');
        }

              temp2=temp1%100;
               if(temp2>=10&&temp2<=99)
       {
              temp=temp2;
              temp=temp/10;
              adc_val=temp+48;
              LCD_putc(adc_val);
              SendChar(adc_val);
        }
              else
       {
                    LCD_putc('0');
                    SendChar('0');
              }

              temp3=temp2%10;
              if(temp3>0&&temp3<10){
              temp=temp3;
              adc_val=temp+48;
              LCD_putc(adc_val);
              SendChar(adc_val);
              }
                    else {
                    LCD_putc('0');
                    SendChar('0');
                    }

  LCD_putc(0XDF);
  SendChar('*');
  SendChar(' ');
  SendChar('C');
  LCD_putc('*');
  LCD_putc('C');
}

void SendChar(unsigned char x)          // transmit function to send character to PC
```

```
{
   SBUF =x;              // wrting the character into the serial buffer
   TI = 0;               // Clearing the Transmit empty flag
   while(!TI);    // wating for end of trasmission. after transmission the TI flag will set.
}

void DisplayMesPC(unsigned char *mes)
{
   int counter;
   for(counter=0;mes[counter]!='\0';counter++)
   {
      SendChar(mes[counter]);
   }
}
```

Hardware configuration:

To test the board Power supply cable should be connected to the Board and serial cable must be connected to
the computer. The Data line of the ADC is connected to the P0 of microcontroller. The RD, WR, INTR (J32)
signals are connected to the P1.0, P1.1, P1.2 respectively. The Jumper should be connected at J22. To Connect
Temperature sensor to ADC input Connect J22 1&2 (Temp sensor) with jumper
The temperature is displayed in LCD and same thing displayed on the PC.



RESULTS:

To check the output connect the hardware as shown above diagram, increase the temperature on the
sensor side then we will see the variation on sensor data on both HyperTerminal and lcd.

EXPERIMENT – 10

Write a Program to

Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise directions

Aim:

Write a Embedded C Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise directions

Equipment Requirements:

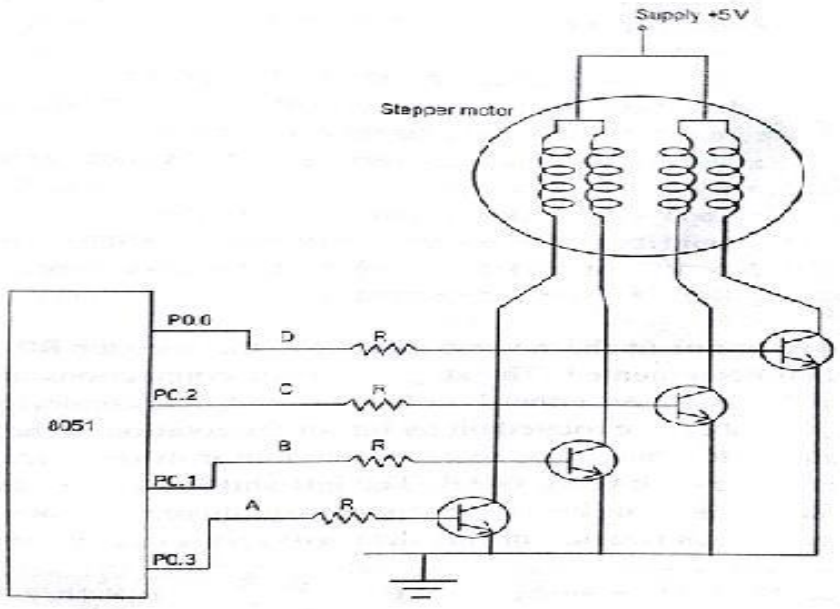
Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.
6. Stepper motor

Software Requirements:

1. Keil evaluation software
2. Flash Magic tool.

Stepper Motor Interfacing with 8051:



Interfacing of stepper motor with 8051

Switching sequence : One Phase excitation (Wave drive)

P0.3	P0.2	P0.1	P0.0	Clock Wise	Anti Clockwise	HEX value
0	0	0	1	1	4	01
0	0	1	0	2	3	02
0	1	0	0	3	2	04
1	0	0	0	4	1	08

Switching sequence: Two phase excitation (High torque excitation)

P0.3	P0.2	P0.1	P0.0	Clock Wise	Anti Clockwise	HEX value
0	0	1	1	1	4	03
0	1	1	0	2	3	06
1	1	0	0	3	2	0C
1	0	0	1	4	1	09

Source code:

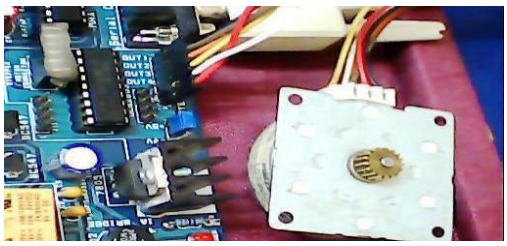
```
/*Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise
directions*/

#include <reg51.h>

sbit SW1 = P1^0;
sbit SW2 = P1^1;

void motor_delay(int sec) ;


void main(void)
{
   P3=0x00;
          SW1 = 0;
  SW2 = 0;
   while(1)
   {
```

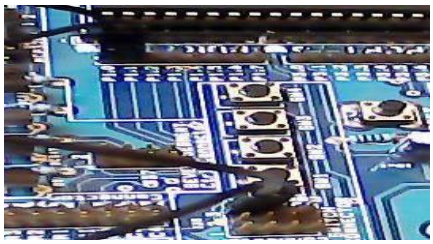
```
        if(SW1 == 0)
        {
           P3 = 0x50;
           motor_delay(2);
           P3 = 0x90;
           motor_delay(2);
           P3 = 0xA0;
           motor_delay(2);
           P3 = 0x60;
           motor_delay(2);
        }
        else if(SW2 == 0)
        {
           P3 = 0x60;
           motor_delay(2);
           P3 = 0xA0;
           motor_delay(2);
           P3 = 0x90;
           motor_delay(2);
           P3 = 0x50;
           motor_delay(2);
        }
    }
}

void motor_delay(int sec)
{
  int i,j,secd;

    for (secd=0;secd<=sec;secd++)
        for(i=0;i<=4;i++)
                for (j= 0;j<=800;j++)
```

```
                    {
                    }
}
```

Result:

1. Connector the jumpers at the stepper motor driver IC.
2. Connect the switch pins to the port pins selected.
3. Connect the Stepper motor to the available pins beside the serial port.





TEXT BOOKS:

1) Computers and Components, Wayne Wolf, Elseveir.
2) The 8051 Microcontroller, Third Edition, Kenneth J. Ayala, Thmson .
3) Embedded systems , lyla B das

REFERENCES:

1) Embedding system building blocks, Labrosse, via CMP publishers.
2) Embedded Systems, Raj Kamal, TMH.
3) Micro Controllers, Ajay V Deshmukhi, TMH.
4) Embedded System Design, Frank Vahid, Tony Givargis, John Wiley.
5) Microcontrollers, Raj Kamal, Pearson Edition.
6) An Embedded Software Primer, David E. Simon, Pearson Edition.
7) 'Embedded/Real-Time Systems', KVKKF Prasad, Dreamtech, Press

EXPERIMENT –11

Write a Program to

Port RTOS on to 89V51 Microcontroller and verify. Run 2 to 3 tasks simultaneously on 89V51 SDK. Use LCD interface, LED interface, Serial communication.

Aim:

Write an Embedded C program to sort RTOS on to 89V51 Microcontroller and verify. Run 2 to 3 tasks simultaneously on P89V51RD2.Use LCD interface, LED interface, Serial communication.

Equipment Requirements:

Hardware Requirements:

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1. Keil evaluation software
2. Flash Magic tool.

RTOS Introduction:

What is a real-time System?

Timeliness is the single most important aspect of a real -time system. These systems respond to a series of external inputs, which arrive in an unpredictable fashion. The real-time systems process these inputs, take appropriate decisions and also generate output necessary to control the peripherals connected to them. As defined by Donald Gillies "A real-time system is one in which the correctness of the computations not only depends upon the logical correctness of the computation but also upon the time in which the result is produced. If the timing constraints are not met, system failure is said to have occurred."

It is essential that the timing constraints of the system are guaranteed to be met. Guaranteeing timing behavior requires that the system be predictable. The design of a real -time system must specify the timing requirements of the system and ensure that the system performance is both correct and timely. There are three types of time constraints:

Hard: A late response is incorrect and implies a system failure. An example of such a system is of medical equipment monitoring vital functions of a human body, where a late response would be considered as a failure.

Soft: Timeliness requirements are defined by using an average response e time. If a single computation is late, it is not usually significant, although repeated late computation can result in system failures. An example of such a system includes airlines reservation systems.

Firm: This is a combination of both hard and soft timeliness requirements. The computation has a shorter soft requirement and a longer hard requirement. For example, a patient ventilator must mechanically ventilate the patient a certain amount in a given time period. A few seconds' delay in the initiation of breath is allowed, but not more than that.

Experimental procedure:

Open the keil IDE and do the same procedure like create new project and build the application. Then open Flash magic and download the hex file. Please refer the above experimental procedure for keil4 IDE. In this RTOS experiment we have to do few more settings for creating new project (if you want to create new project then only do these settings),just follow the settings as below mentioned.

After creating new project file go to target and do these settings: SELECT TARGET and right click on target settings and select RAM size is 0X0000 to 0X1000.Again go to settings and select C51 and select LEVEL 9. And do the below

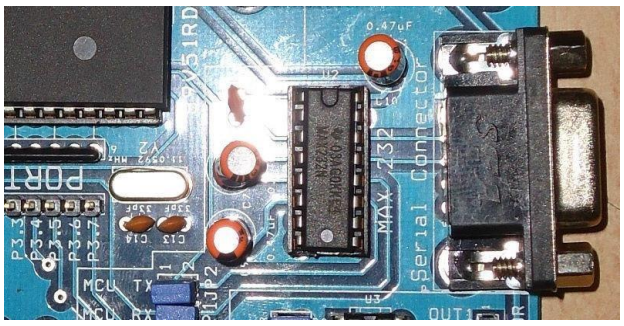
Source code:

```
/*Port RTOS on to 89V51 Microcontroller and verify.
• Run 2 to 3 tasks simultaneously on 89V51 SDK.
• Use LCD interface, LED interface, Serial communication. */


#include "rtos.h"
#include"uart.h"
#include"lcd.h"

unsigned char task_time_counter1=0,task_time_counter2,task_time_counter3=0;
struct generic_sync xdata mut;
sbit            LED1 =      P0^0;
sbit            LED2 =      P0^1;
sbit            LED3 =      P0^2;

void PowerOn()
{
   unsigned char inner, outer;

   for (outer = 0x00; outer < 0x10; outer++)
   {
      for (inner = 0x00; inner < 0xFF; inner++);
   }

    LCD_init();
   for (inner = 0; inner < 10; inner++)
          LCD_delay(2);

  serial_init();
}
```

```
void LED_TASK()
{
  while(1) {
            k_acquire(&mut);
            k_yield();
            if(task_time_counter1==20){
            task_time_counter1=0;
            LED1=LED1 ^ 1;
    DisplayMesPC("\r\nLED Task Running");
            }
            task_time_counter1++;

            k_release(&mut);
            k_yield();
  }
}

void LCD_TASK() {
unsigned char counter=0;
   LCD_clear();
   LCD_row1(); LCD_puts("LCD Task Running");
    LCD_row2();

  while(1) {
            k_acquire(&mut);
            k_yield();

                  if(task_time_counter2==5){
              LCD_putc(counter+48);
              counter++;
                        LED3=LED3 ^ 1;
              task_time_counter2=0;
                    DisplayMesPC("\r\nLCD Task Running");
                                                if(counter>15){
                                    counter=0;
                                       LCD_row2();
                                       LCD_puts("               ");
                                             LCD_row2();
                                      }
             }
            task_time_counter2++;
            k_release(&mut);
            k_yield();
  }
```

```
}

void UART_TASK() {
  while(1) {
            k_acquire(&mut);
            k_yield();
            if(task_time_counter3==10){
            task_time_counter3=0;
            LED2=LED2 ^ 1;
    DisplayMesPC("\r\nUART Task Running");
            }
            task_time_counter3++;

            k_release(&mut);
            k_yield();
  }
}

void main()
{
  P0=0x00;
  PowerOn();
   DisplayMesPC("\r\nRTOS For 8051 Microcontroller");
   k_create_mutex(&mut);
   k_task_create(LED_TASK, "a", 1);
   k_task_create(LCD_TASK, "b", 1);
   k_task_create(UART_TASK, "c", 1);
   k_start();

}
```

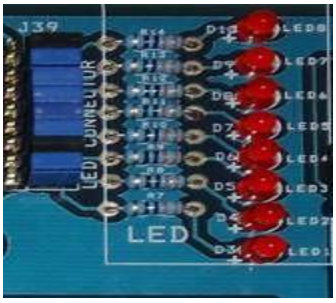
Hardware configuration:

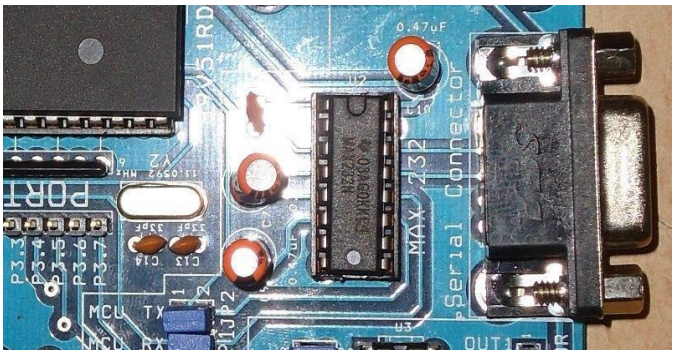


To test the board

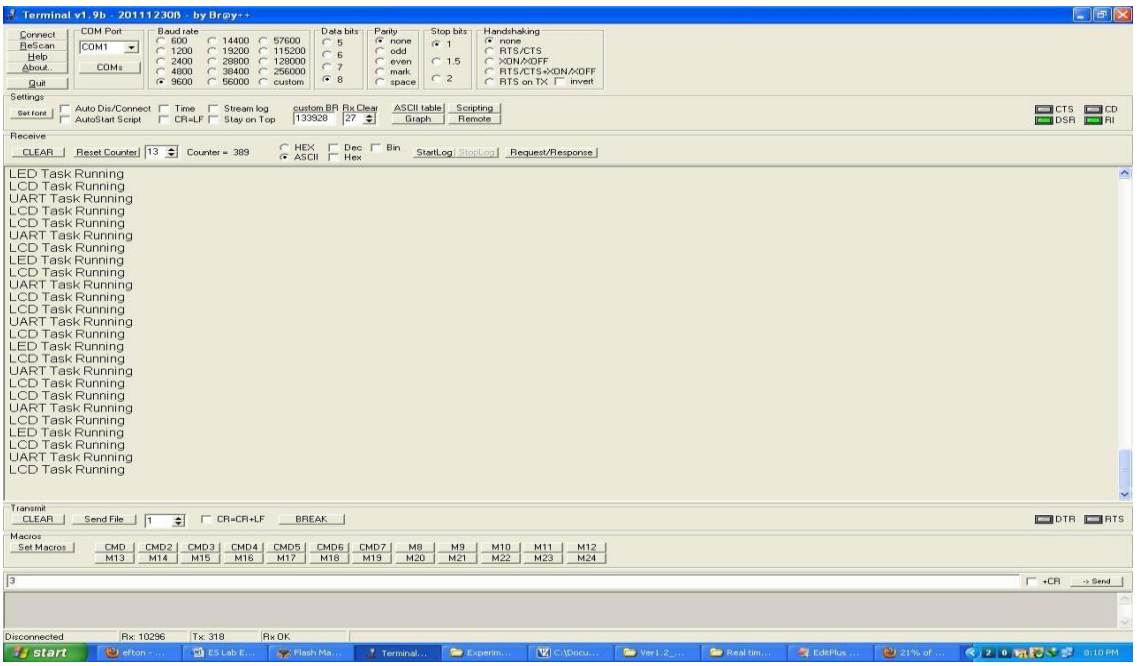
Power supply cable should be connected to the M7 Board and serial cable must be connected to the computer.

Jumpers should be connected to J39[LED's],JP3 and J6[LCD].
To check the output just reset the board and give proper connections and check the output on LCD , LED and on hyperterminal.H ere we are assigned three leds for 3 tasks one led for led,second one for lcd and
third one for UART.There you can observe the the task time on each and every led.





Result
You can fine on LCD display data and led blinks and uart data displayed this terminal like this



Experiment-12

Analog to Digital Converter unit (ADC 0809)

AIM: To write a program and develop analog to digital converter using 89C51 board

Code : Digital to analog (DAC)

```
#include<8051.h>
#define HIGH 01;
#define LOW  00;
__xdata at 0xffc5 unsigned char swt;
__idata unsigned char dat;
__idata unsigned char i;
__bit at(0x94) SCLK;
__bit at(0x95) SDA;
 bit ACK;
 void I2C_Start(void);
 void I2C_Stop(void);
 void I2C_Write(unsigned char j);
 unsigned char I2C_Read(void);
 void Delay_Time();
void I2C_Start(void)              //Start I2C by creating clock by setting and clearing the port pins
 {
   SCLK=LOW;
   SDA=LOW;
   Delay_Time();
   SCLK = HIGH;
   Delay_Time();
   SDA=HIGH;
   Delay_Time();
   SDA = LOW;
   Delay_Time();
   SCLK = LOW;
 }
void I2C_Stop(void)               //Stop I2C operation by clearing the SCLK Pin
 {
   SCLK = LOW;
   Delay_Time();
   SDA = HIGH;
 }
void I2C_Write(unsigned char j) // shifting data bit by bit to MSB and moving through i2c
{
  dat=j;
  for(i=0;i<8;i++)

    {
```

```
      SDA = dat & 0x80;
      dat=dat<<1;
      SCLK = HIGH;
      Delay_Time();
      SCLK = LOW;
    }
  SDA=HIGH;
  Delay_Time();
  SCLK = HIGH;
  Delay_Time();
  ACK = SDA;
  Delay_Time();
  SCLK = LOW;
}
unsigned char I2C_Read(void) //reading from i2c device bit by bit
{
  unsigned char i,j;
  j = 0;
  i = SDA;
  for(i=0;i<8;i++)
    {
      j<<=1;
      SCLK = HIGH;
      j |= SDA;
      Delay_Time();
      SCLK = LOW;
   }
  Delay_Time();
  SDA = LOW;
  Delay_Time();
  SCLK = HIGH;
  Delay_Time();
  SCLK = LOW;
  Delay_Time();
  SDA = HIGH;
  return j;
}
void main()
{
   unsigned int i=0x00;
            I2C_Start();
            I2C_Write(0x9E);    //send device address
            I2C_Write(0x40);        //send device's control register address
            I2C_Start();
            I2C_Write(0x9E);    // send command for read
             while(1)
      {
```

```
            if((swt & 0x1f)== 0x1E)
            {
            i=i+0x0a;
            if(i>0xff)
            i=0x00;
            I2C_Write(i);
            Delay_Time();
            }
    }
}
void Delay_Time()
{
 unsigned int i;
 for(i=0;i<=5000;i++);
}
```

ADC 0809 is an 8-channel 10
Digital form. In ADC section a jumper is provided to select either external analog input from signal conditioning as input source or can select internal 5V generator, which is variable from 0-5V. Th
the any of the port by using the Bus/connector. Reference voltage of 2.5V is given at the reference input so that the analog input span is 5V. In a sample program provided with the module the digital ou
Microcontroller, can be view on the hyper terminal of the PC
Features of ADC0809:

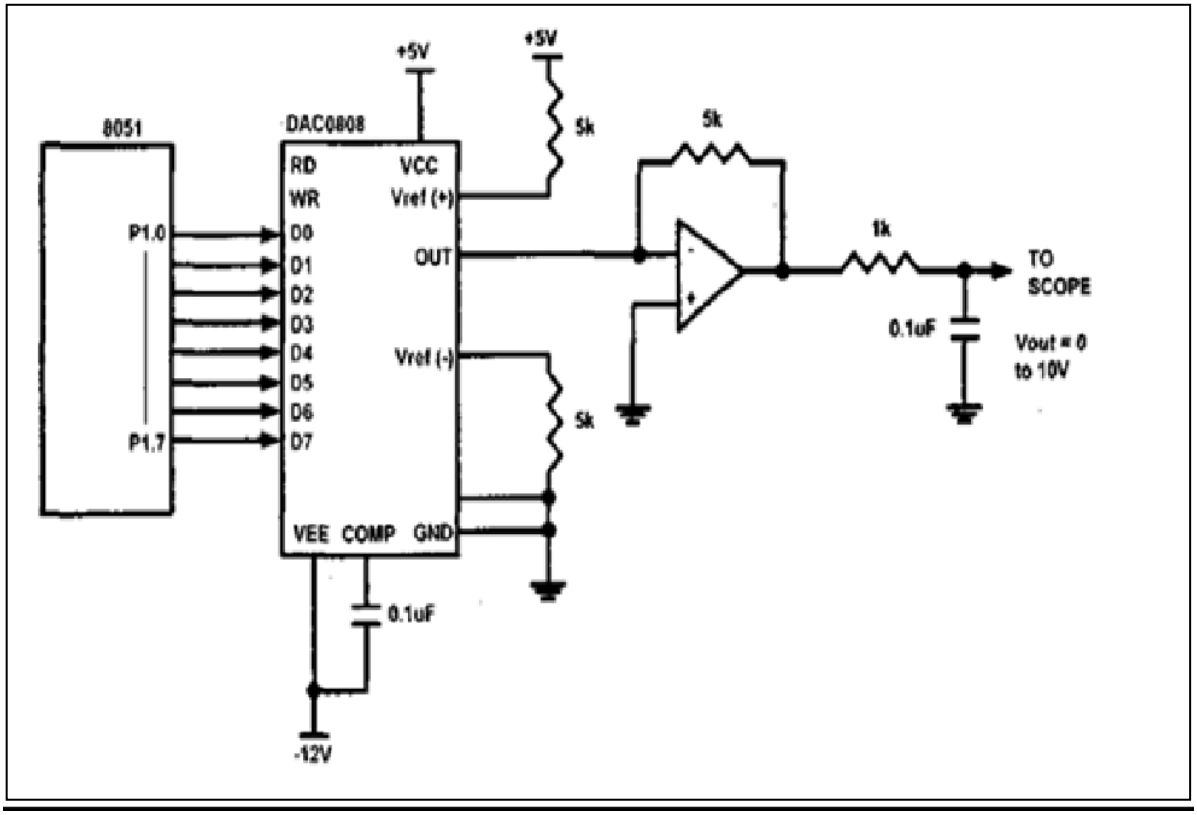
- Resolution: 8 Bits.
- Operates ratio metrically or with 5VDC, 2.5VDC, or analog span adjusted voltage reference.
- Differential analog voltage inputs
- Works with 2.5V voltage reference.
- On-chip clock generator.
- 0V to 5V analog input voltage range with single 5V supply.
- No zero adjusts required.

Experiment-13

Aim:
Program to interface DAC device with P89V51RD2 and observer the analog output in CRO.

Hardware and Software Requirement:

1. Set port 1 as output port.
2. Initialize port 1 as 00
3. Go on incrementing value till max value is reached at port1, for the upward going part of the triangular wave.
4. For 1kHz triangular wave, increase the value by 5 each time.
5. Once max value is reached, decrease the value in same steps till min value is reached.
6. Repeat in infinite loop.



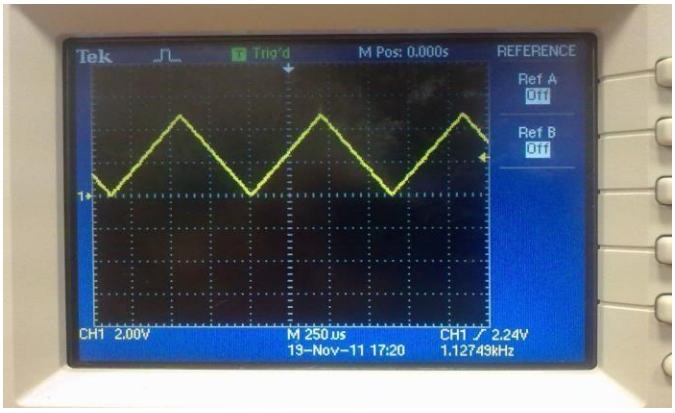
Hardware Connection

Actual Connection

Code

```
#include<reg51.h>                    //Header file for 8051 void main()      // Start of main() function
{
P1 = 0x00;                           // Initialize Port 1 as Output
while(1)                             // Infinite Loop
{
do      // 1st do-while for upward portion of //triangular wave
{
P1 += 0x05;                          // Increment P1 to get upward portion
}
while(P1<0xFF);                      // stop loop after reaching max value do      // 2nd do-while for
downward portion of //triangular wave
{
P1 -= 0x05;                  // Decrement P1to get downward portion
}
while(P1>0x00);                      // stop loop after reaching lowest value
}
}
```

Expected Output



Experiment-14

Program to interface Relay with P89V51RD2 using transistor

Aim: Write a Embedded C Program to interface Relay with P89V51RD2 using transistor

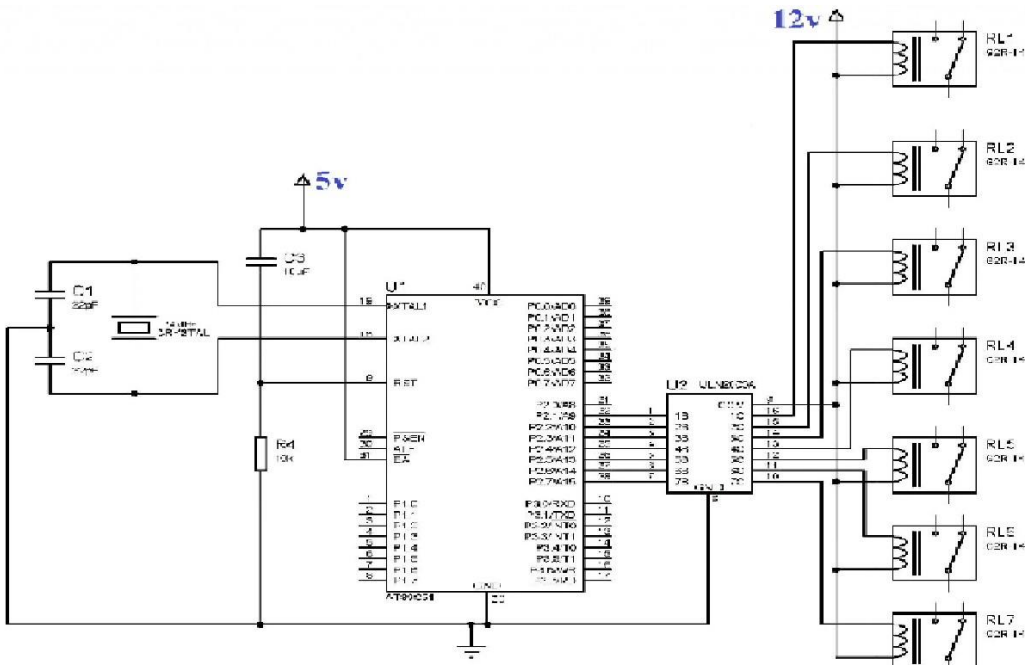
Equipment Requirements:

Hardware Requirements :

1. 89V51RD2 Development board
2. A serial 9 pin cable wired one to one from female connector to male connector
3. PC with serial port
4. 9V adaptor
5. Connecting jumper and Connecting Wires.

Software Requirements:

1. Flash Magic tool.
2. Keil evaluation software



source code:

```
#include<reg52.h>

sbit relay_pin = P2^0;

void Delay_ms(int);

void main()
{
```

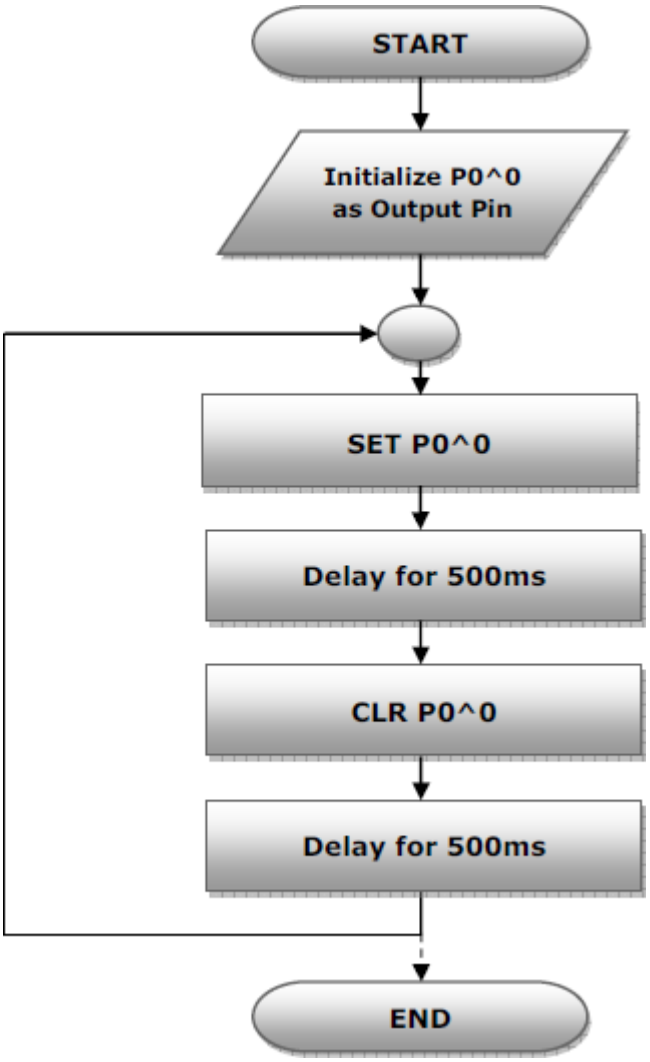
```
  do
  {
    relay_pin = 0; //Relay ON
    Delay_ms(1000);
    relay_pin = 1; //Relay OFF
    Delay_ms(1000);
  }while(1);
}

void Delay_ms(int k)
{
  int j;
  int i;
  for(i=0;i<k;i++)
  {
   for(j=0;j<100;j++)
   {
   }
  }
}
```

Experiment-15

To make LEDs blink

----------*/
Example 1 : Program to Blink LED at P0.0
Description : Connect a LED at a port pin and make it
flash at predefined intervals.
----------*/

Flow Chart



Code:

```
#include<reg51.h> //Define 8051 Registers
void DelayMs(unsigned int a); //Delay function
sbit led =P0^0; //Set bit P0^0 for led

/*-------------------------------------------------------------------------------------------------------*/
// Main Program

void main()
{
P0=0x00; //Port0 as output port
while(1) //Loop forever
{
led = 1; //Set the led to high
DelayMs(500); //Delay for 500ms
led = 0; //Set the led to low
DelayMs(500); //Delay for 500ms
}
}

/*****************************
// Delay for 1 msec
*****************************/

void DelayMs(unsigned int k)
{
unsigned int i,ms;
for(ms=0;ms<=k;ms++)
{
for(i=0;i<=114;i++);
}
}
```

Execution:

Note: After loading corresponding Examples Hex file located in "OUT" Folder to the microcontroller kit, press "RST" Button, user program now executes.

References:

1. https://www.cadsoftusa.com/download-eagle/freeware/
2. http://www.dauniv.ac.in/downloads/EmbsysRevEd_PPTs/Chap01Lesson_1Emsys.pdf
3. http://en.wikipedia.org/wiki/Embedded_system
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