# 8051 MICROCONTROLLER INTERFACED WITH PHONE LINE FOR CONTROLLING ELECTRONICS DEVICES


**By**

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**MAY-2007**

**Submitted in partial fulfillment of the Degree of Bachelor of Technology**


**DEPARTMENT OF ELECTRONICS AND COMMUNICATION**

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## CERTIFICATE

This is to certify that the work entitled, "8051 Micro controller Interfaced With Phone Line for Controlling Electronic Devices " submitted by Amit Jain, Neeraj Shah, Sachin Garg and Sumit Gupta in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering Department of Jaypee University of Information Technology has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Vivek

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# Acknowledgments

This project would not have been completed without the guidance of our teachers and encouragement from our friends and parents. They have been on our side during high and low phases of our project. We thank each and every one of them to have coaxed us into completing the project in time.

Above all, our deepest and sincere gratitude goes to **Respected Sir Vivek Kumar Sehgal** who provided the desired expert guidance and endless support through out the preparation of this complex project.

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# Abstract

The objective of this project was to design, construct, and test hardware and software to create a phone (Land line or mobile) controlled robot. Four tires were chosen for this project as a reasonable compromise between the hardware complexity where in many tires/legs are used and the software complexity required for stability when fewer tires/legs are used. A four-wheel design was chosen for easier maneuvering and stability. At the time of the writing of this paper, the robot is capable of moving forward, backward, turn left and turn right over level surfaces (as dc motor is used).

This project is basically a demo version , which shows how to control various electronic devices which are miles away and that to from a universal remote such as a mobile phones.

## Introduction

We choose to build a (8051 based) motorized robot that can be controlled and operated by user sitting far away from it. It has ability to move forward, backward and turn right, left according to the command given by the user from his telephone. We have implemented this robot by keeping in the mind the various further enhancements that can be added to it like robotic arm, controlling the operation of certain electronic device by the user sitting at distant place.

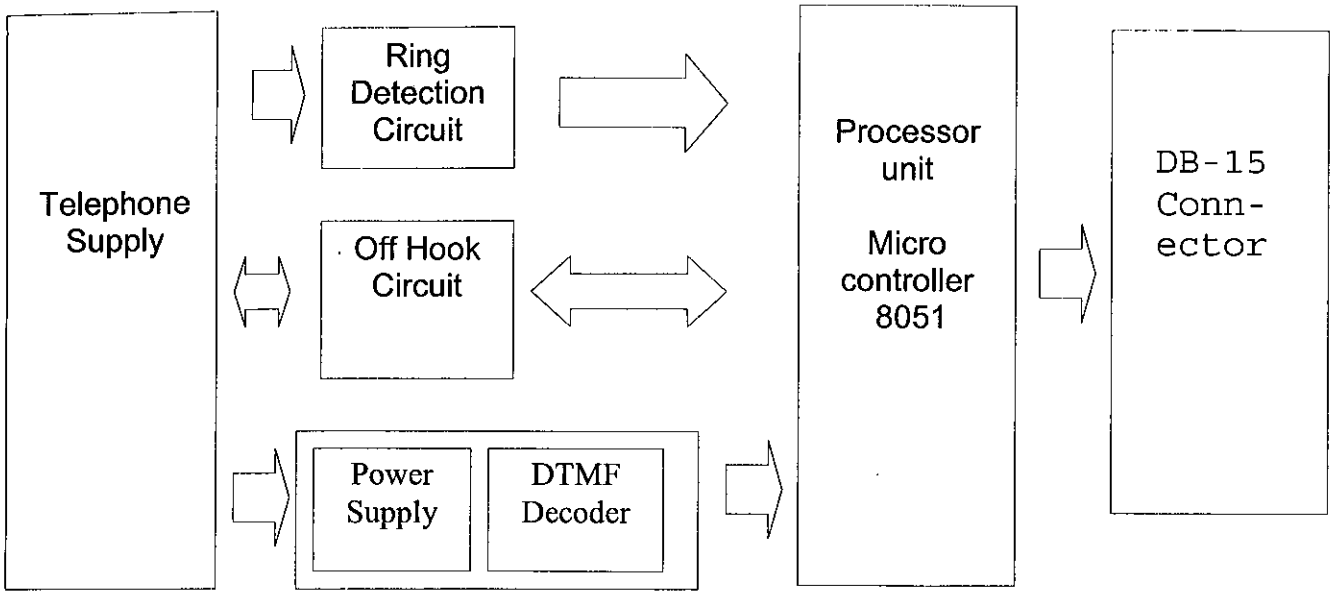
Due to the complexity of the project the project was divided into modules, which were built over time and then assembled together to build the whole system. Each System was built independently and tested before being put to use.

In this project we have use a DTMF decoder(8870)which converts the analog signal from the land line to the digital signal , which is fed into microcontroller(8051) for further working.

## Salient Features

★ Outputs - Relays x 8
★ Fully micro controller based interface using 8051 MCU (AT89C51, 52, S51, S52)
★ Auto line pick up
★ Auto line hang-up line
★ Acknowledgement tone out put for the user.
★ Connects to standard single telephone line.
★ On board line Ring, power, and relay status LEDs
★ Operating voltage 12V AC / DC (nominal).
★ Operating current 100mA with no relays operated (aprox.)
★ Connections RJ-11 for telephone line.

## Modules




1.) ***RING DETERCTOR CIRCUIT (RDC)***: When ever a phone (Landline or mobile) calls robot, RDC will convert this audio signal to the appropriate signal (by removing ac component using opto-isolator) as required by 8051 microcontroller.

2.) ***OFF HOOK CIRCUIT (OHC)***: After getting authentic signal (as detected by RDC)the OHC is activated by making PIN NO:15(of 8051)high, and thus the robot gets connected to the phone line.

3.) ***DTMF DECODER:*** Since the robot has been connected to the phone line, so now whenever user presses any digit from his phone its binary equivalent is send into the microcontroller.

RST

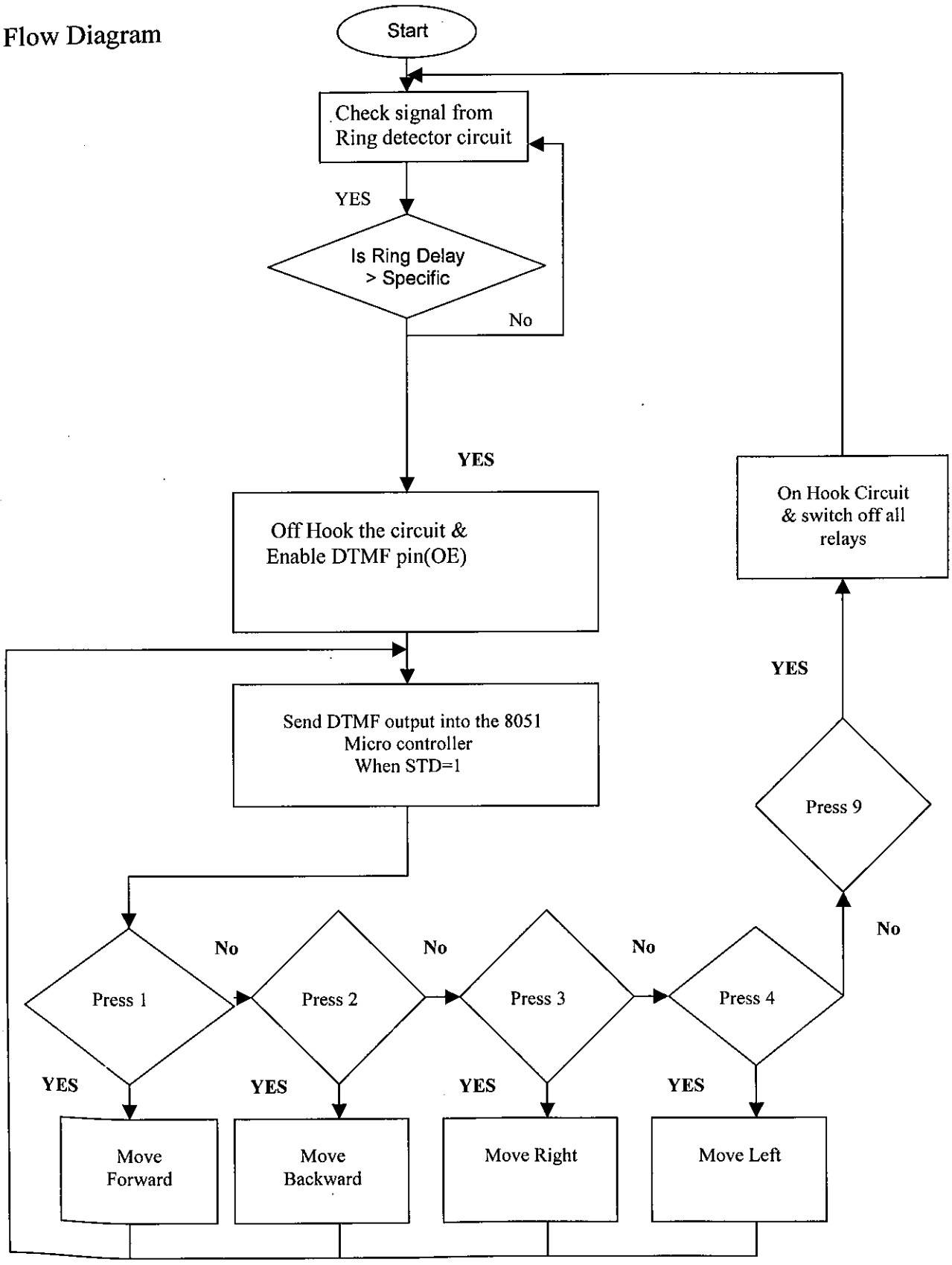
## Objectives

The primary design criteria for this robot were as follows:
- minimal cost
- incorporate already-owned components
- use cheap and easily-worked materials for platform
- minimize weight to make use of cheaper servos
- robustness
- solid design and construction
- able to be implemented in stages
- modular design
- room for expansion

The objectives for this project were:
- design and construct the platform
- implement a simple, maneuvering robot
- if time allows, implementing this technique to connect daily use electronic devices to this microcontroller.

# Software Consideration

Flow Diagram



Ring detector circuit being the first module detects the incoming signal (ringing voltage of around 100 volts) whenever the user calls.

If the ring delay is greater than the specified delay (as mentioned in the software) then the micro controller will send a signal to the off-hook circuit and this is how a call is established.

Now whenever caller presses any key its equivalent digital data is sent to the micro controller using the four output pins (Q0 to Q3) of the DTMF decoder. This transfer of data takes place after enabling output-enabling pin (OE), which is done by the micro controller; also STD pin of DTMF decoder initially gets enabled whenever the first response from the caller comes.

In our program we have specified four keys for the movement of the car in all the four directions. The car moves in the forward, backward, right and in left direction whenever user presses 1,2,3 and 4 respectively. By pressing 9 the micro controller will be reset and will on hook the circuit.

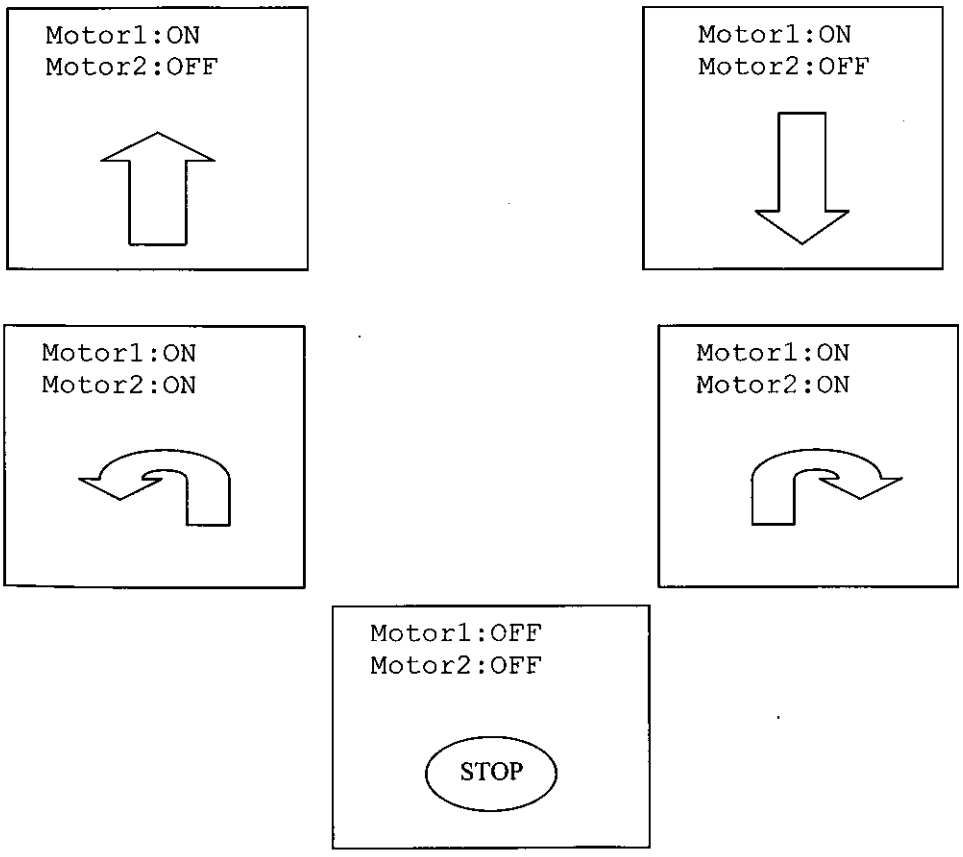
# Mathematical Explanation

The relationship between the input and the motors can be described in the following table (where +1 means move motor in clockwise direction, -1 means move motor in anticlockwise direction and 0 means motor off). If input is detected then motors perform accordingly to the given command.

The tabular form can be represented as:

| Command | Motor1 | Motor2 |
|---|---|---|
| **Forward** | +1 | 0 |
| **Backward** | -1 | 0 |
| **Right** | +1 | +1 |
| **Left** | +1 | -1 |

These are the following action that the robot would result on the requisite motor status..



Here we are using AT89C51 microcontroller having frequency of11.0592 MHz. Since 8051 design use 12 clock periods per machine cycles hence the delay provided by 1 machine cycle:

11.0592 MHz/12 = 921.6 kHz

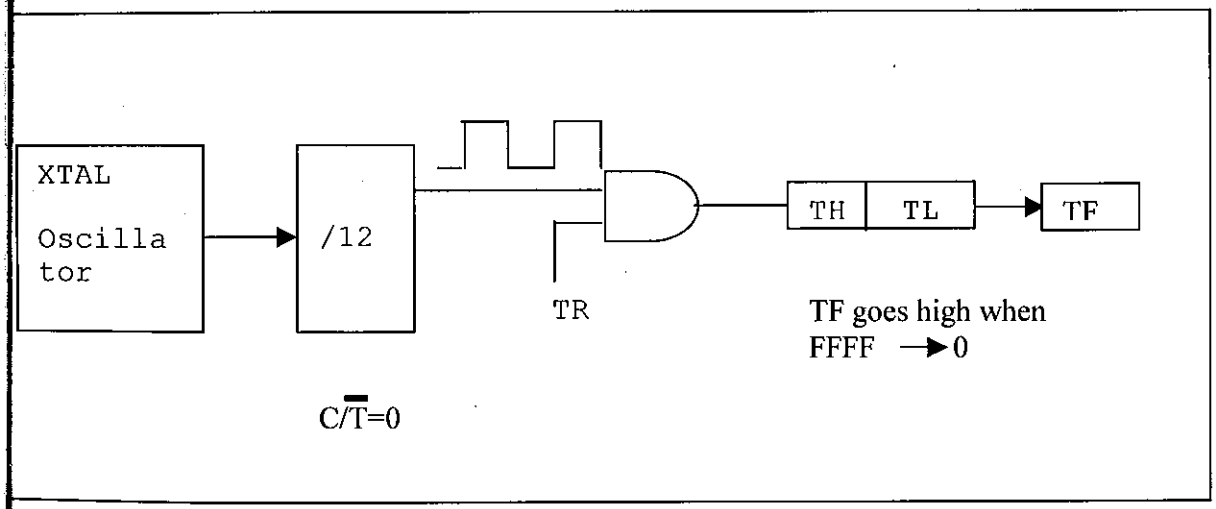
MC is 1/921.6 kHz = 1.085 micro seconds = 1085 nano seconds.

## Generation of Required Time Delay:

1. Selection of Timer 0/Timer 1 using TMOD register.
2. Load registers TL & TH with initial count values.
3. Start the timer.
4. Keep monitoring the timer flag (TF) to see if it is raised or not, get out of this loop when TF=1.
5. Stop the timer.

## Calculation of TH &TL values:

YYXX=initial values of TH &TL respectively.
So delay =(FFFF - YYXX +1)*1.085 micro seconds.




TF = overflow flag
**For e.g.:**

**YYXX** = FE0C

So delay = (FFFF-FE0C+1)*1.085 micro seconds

= (1F3 +1)*1.085

= 500*1.085
= 0.54 mili seconds.

# Hardware Consideration

## 8-Bit Microcontroller With 4K Bytes Flash

## Features:

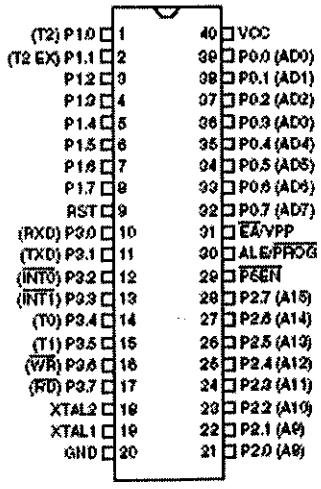
- ★ Compatible with MCS-51™ Products
- ★ 4K Bytes of In-System Reprogrammable Flash Memory
- ★ Fully Static Operation: 0 Hz to 24 MHz
- ★ Three-level Program Memory Lock
- ★ 128 * 8-bit Internal RAM
- ★ 32 Programmable I/O Lines
- ★ Three 16-bit Timer/Counters
- ★ Eight Interrupt Sources
- ★ Programmable Serial Channel
- ★ Low-power Idle and Power-down Modes

## Description:

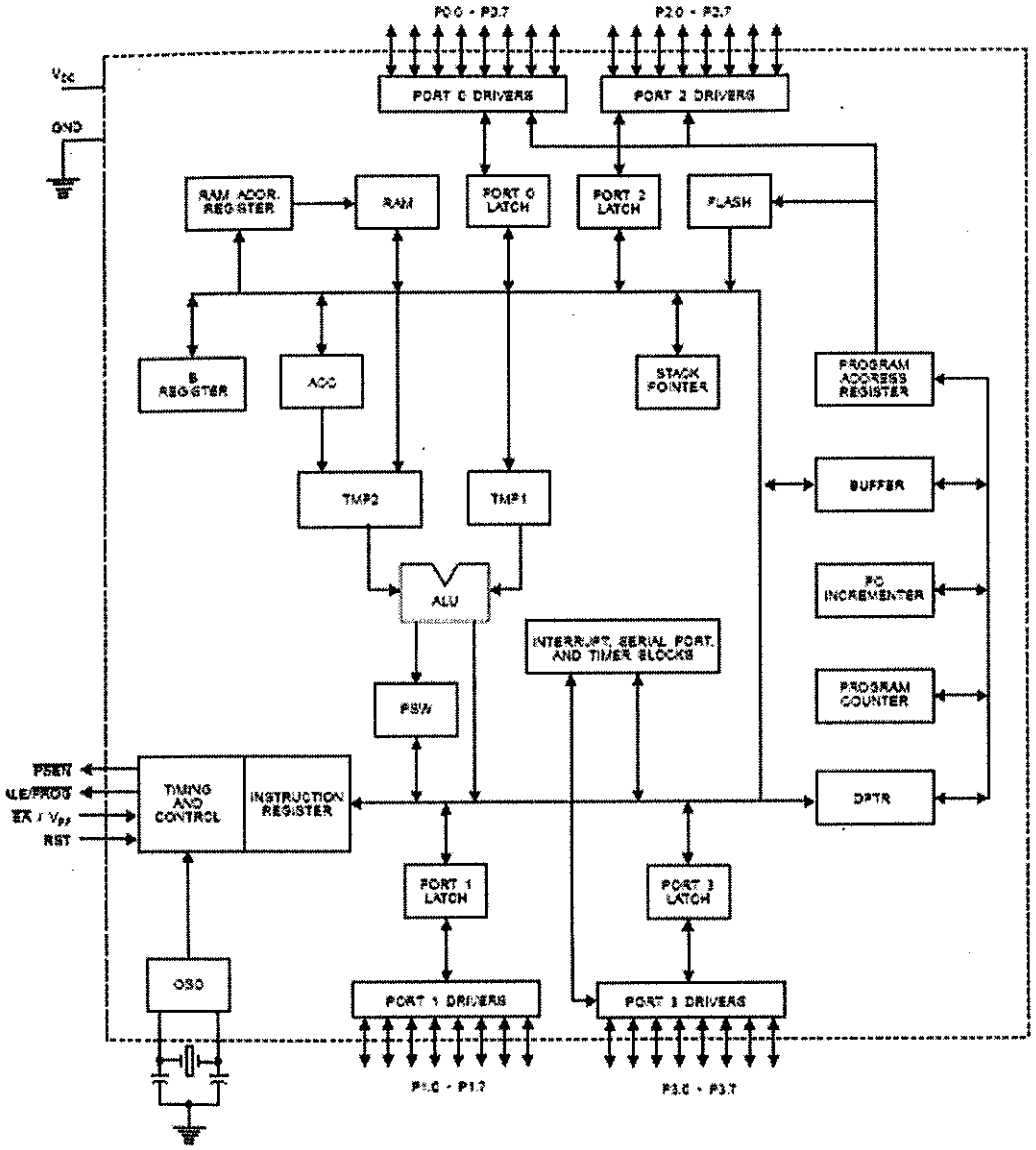
The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 and 80C52 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

## Pin Configurations:

PDIP



# Block diagram 8051




The AT89C52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full-duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next hardware reset.

## Pin Description

### VCC

Supply voltage.

### GND

Ground.

### Port 0

Port 0 is an 8-bit open-drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs.

### Port 1

Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups.

### Port 2

Port 2 is an 8-bit bi-directional I/O port with internal pullups.The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pullups.

### Port 3

Port 3 is an 8-bit bi-directional I/O port with internal pullups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups.

**RST**

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

**ALE/PROG**

Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory.

**PSEN**

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

**EA/VPP**

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH.
Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset.

**XTAL1**

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

**XTAL2**

Output from the inverting oscillator amplifier.

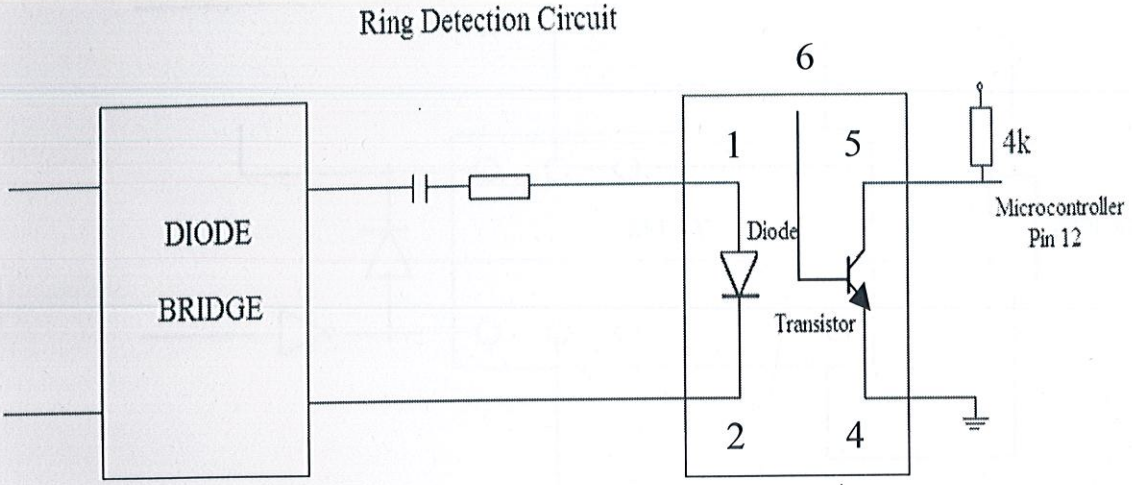
XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven .

## Idle Mode

In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset.

# Modules Description

## Module 1

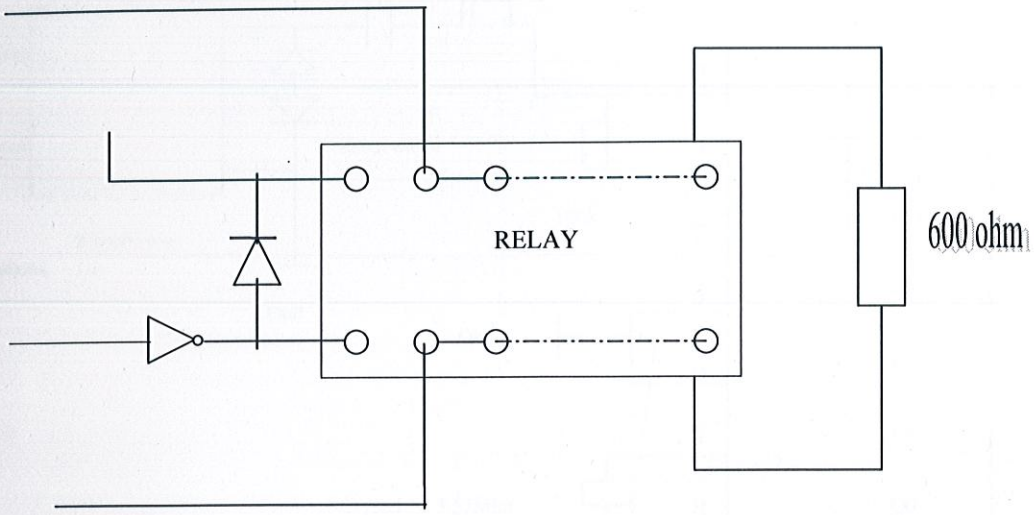



### Ring Detection Circuit (RDC) -

The basic function of this circuit is to detect an incoming call. This circuit consists of an optoisolator (IC 4N35), which is used for isolation of input from the output signal. Since the Micro controller cannot handle the high voltages of the ringing signal therefore an optoisolator is used to convert this high voltage into a signal appropriate for the micro controller. Optoisolator is a 6 pin IC having a photodiode and phototransistor pair. The photodiode, which is at its input, is used to convert an incoming electrical voltage into an optical signal, which is sensed by the phototransistor, which in turn sends an appropriate voltage to the microcontroller pin 17. This pin is initially high and after getting a signal it changes its state from high to low and this is how micro controller detects the ring.

## Module 2

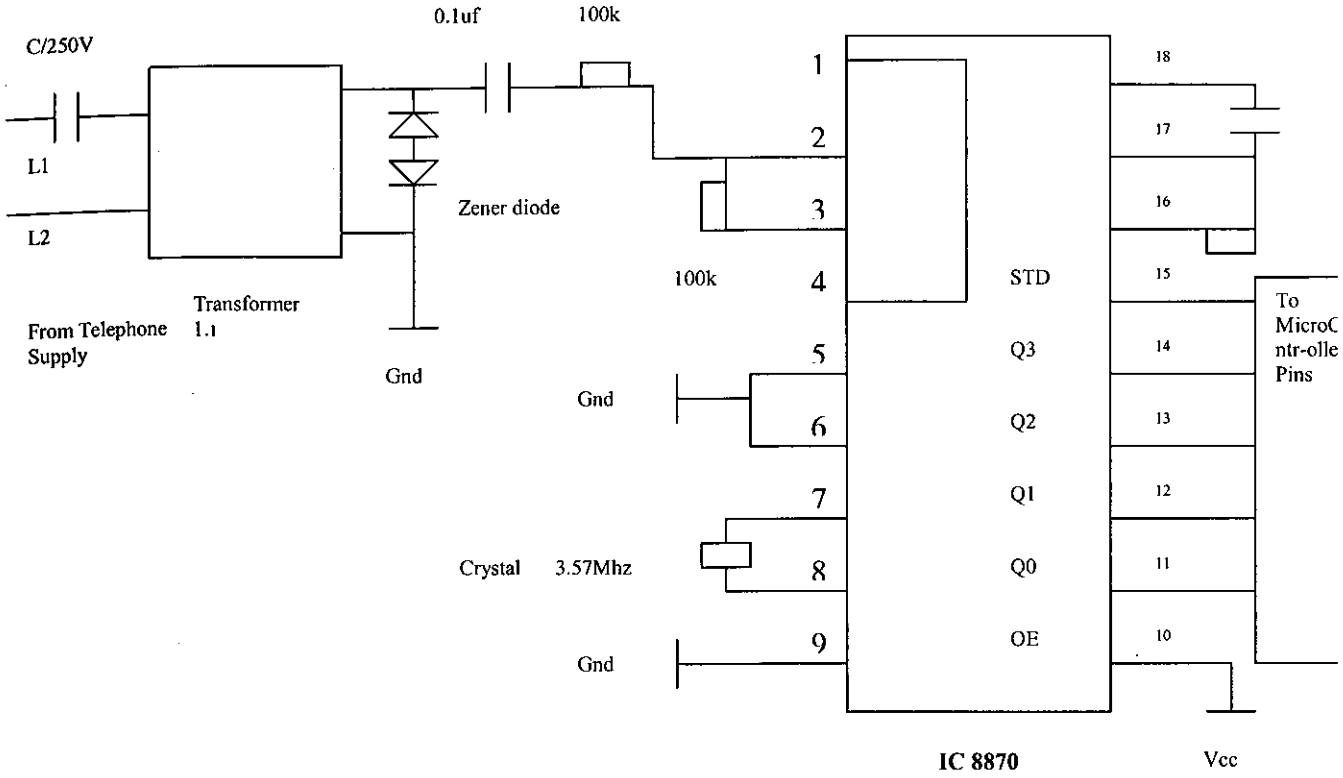





### Off-Hook Circuit:

OFF-Hook Circuit is connected to microcontroller from Pin 15. Basic Function of this is to connect the robo to the phone line after a certain specified delay when user calls. On detection of the incoming signal micro controller activates the off-hook circuit after a specified delay, which provides 600-ohm resistance across the phone line so that the phone line can be engaged and hence no further call can interrupt in between. This 600-ohm resistance is connected across one end of the 8-pin relay and the phone line is connected on the other. Once the relay gets activated after getting a signal from the micro controller via the buffer it provides this resistance across the phone line to engage the line

# DTMF(Dual Tone Multiple Frequency)

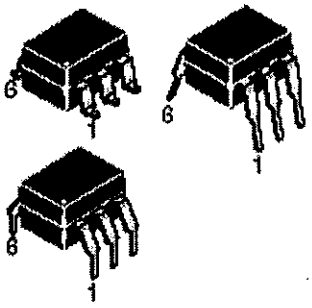


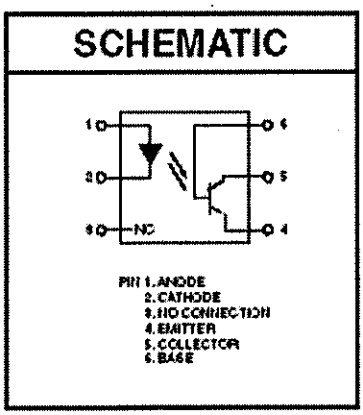

## DTMF Decoder & Power Supply :

DTMF circuit converts the user given analog command to digital signal, so that when ever user presses any key from his device, we can get the digital data corresponding to that signal. IC 8870 has four output pins, which gives the digital output. When user presses any key it will make STD pin high of the DTMF decoder, after that all the output pins, which give digital data, be monitored. DTMF decoder has OE pin, which remain high so that all the output pins remain enabled. This digital output is fed into 8051 micro controllers, which gives the corresponding output at its other port. Zener diode is used to convert 12V of output from the transformer to 5V, which is used as Vcc for the DTMF.

# Important Components

## 6-Pin Phototransistor Optocouplers






### Features:

- ★ Also available in white package by specifying -M suffix, e.g. 4N25-M
- ★ UL recognized (File # E90700)
- ★ VDE recognized (File # 94766)
- ★ Add option V for white package (e.g., 4N25V-M)
- ★ Add option 300 for black package (e.g., 4N25.300)

### Description:

The general purpose optocoupler consist of a gallium arsenide infrared emitting diode driving a silicon phototransistor in a 6-pin dual in-line package.

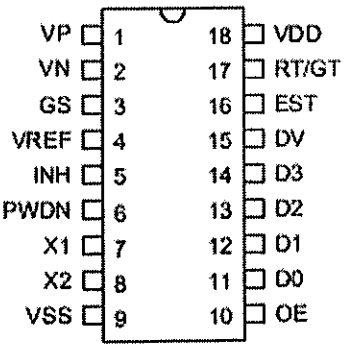
### Applications:

- ★ Power supply regulators
- ★ Digital logic inputs
- ★ Microprocessor inputs

# IC 8870 DTMF Decoder

## Features:

- ★ Operating voltage: 2.5V~5.5V
- ★ Minimal external components
- ★ No external filter is required
- ★ Low standby current (on powerdown mode)
- ★ Excellent performance
- ★ Tristate data output for MCU interface
- ★ 3.58MHz crystal or ceramic resonator
- ★ 1633Hz can be inhibited by the INH pin
- ★ IC 8870: 18-pin DIP package

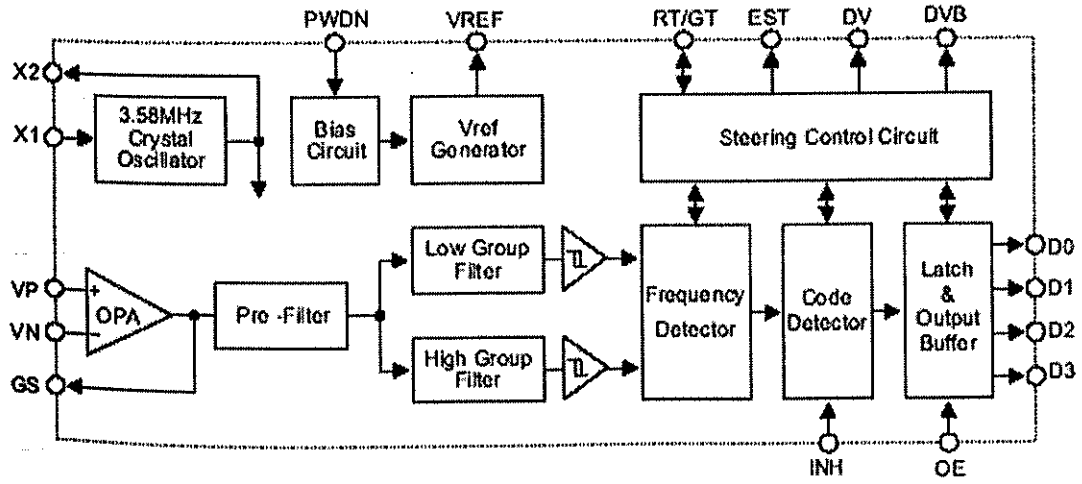



**IC 8870**

## Description:

The HT9170B/D are Dual Tone Multi Frequency (DTMF) receivers integrated with digital decoder and band split filter functions as well as power-down mode and inhibit mode operations. Such devices use digital counting techniques to detect and decode all the 16 DTMF tone pairs into a 4-bit code output. Highly accurate switched capacitor filters are implemented to divide tone signals into low and high group signals. A built-in dial tone rejection circuit is provided to eliminate the need for pre-filtering.

## Block Diagram:



# Relay

## Electrostatic Relay:

An electrostatic relay comprises: a torsional elasticity portion supported on a substrate such that a gap is maintained from the substrate and arranged to have a beam shape; a movable structure portion which can be rotated by dint of elastic support of the torsional elasticity portion; at least one movable contact provided for at least an end of the movable structure portion; a movable electrode disposed between a fulcrum P of rotation of the movable structure portion and the movable contact; at least one fixed contact formed on the substrate at a position opposite to the movable contact such that contact is permitted; and a fixed electrode formed on the substrate at a position opposite to the movable electrode, wherein at least a portion between the fulcrum P of rotation of the movable structure portion and the movable contact is formed into an elastic connection portion.

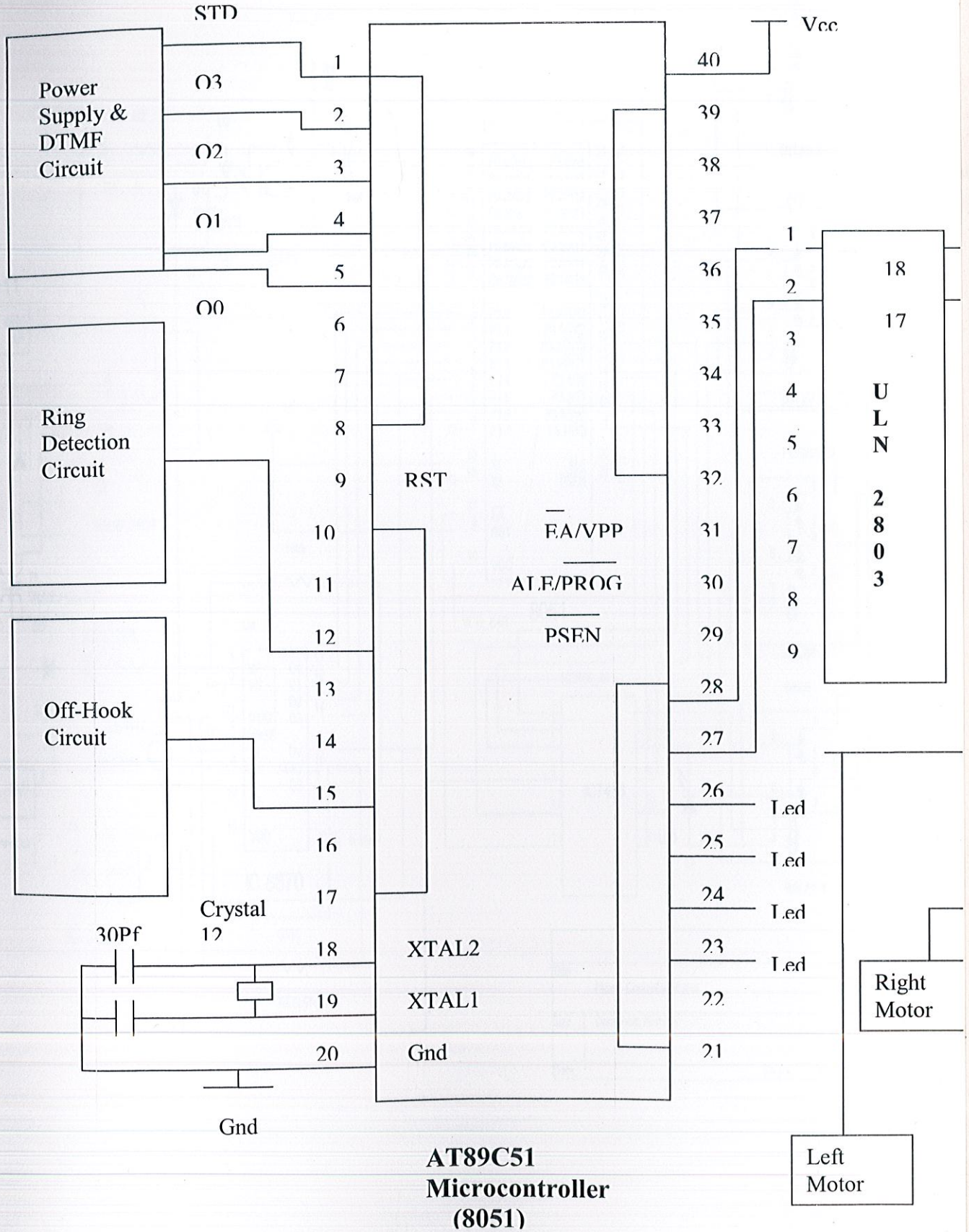
## Relay Application:

In general, the point of a relay is to use a small amount of power in the electromagnet -- coming, say, from a small dashboard switch or a low-power electronic circuit -- to move an armature that is able to switch a much larger amount of power. For example, you might want the electromagnet to energize using 5 volts and 50 milliamps (250 milliwatts), while the armature can support 120V AC at 2 amps (240 watts).

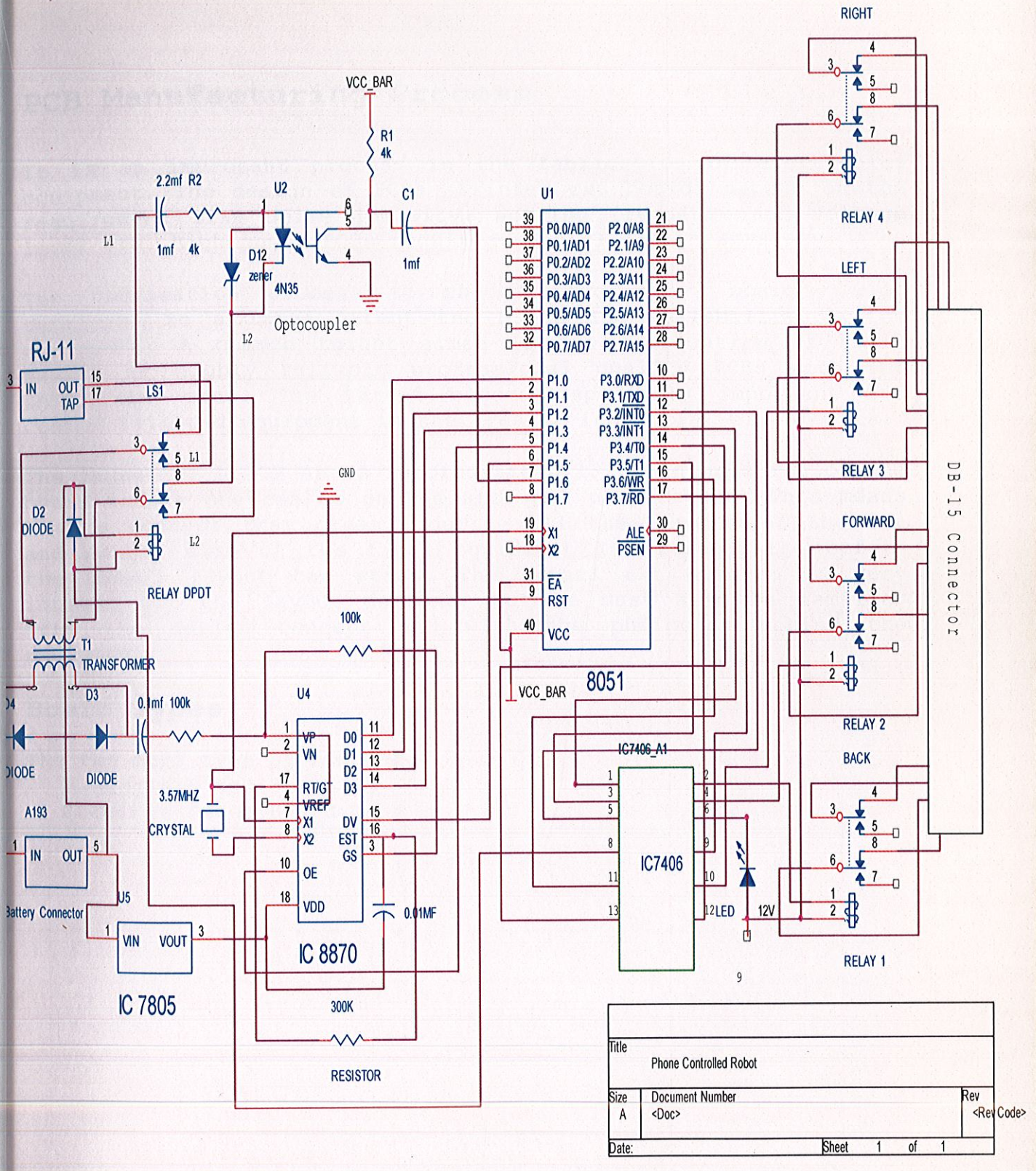
Relays are quite common in home appliances where there is an electronic control turning on something like a motor or a light. They are also common in cars, where the 12V supply voltage means that just about everything needs a large amount of current. In later model cars, manufacturers have started combining relay panels into the fuse box to make maintenance easier.

In places where a large amount of power needs to be switched, relays are often cascaded. In this case, a small relay switches the power needed to drive a much larger relay, and that second relay switches the power to drive the load.

## Complete Circuit



# Schematic Design (Software: Orcad 10.5)



# PCB Manufacturing Process

It is an improtant process in the fabrication of electronics equipment. The design of PCBs (Printed ckt board) depend on the requirement like noise immunity, working frequency and voltage level etc. high power PCBs requir a special design strategy.

The fabrication process to the printed ckt board will determine to a large extent the price and reliability to the equipment. A common target aimed is the fabrication of small series of highly reliable professional quality PCBs with low investment cost. The target become especially important for costom tailored equipment in the area of industrial electronics.

The layout of a PCB as to incorporate all the information of the board before one can go on the art work preperation. This means that a concept that clearly define all the details of the ckt and partly also of the final equipment is prerequisite before the actual layout can start. The detail ckt diagram is very impront for the layout designer but he must also be familiar with the design concept and with the philosopy behind the equipment.

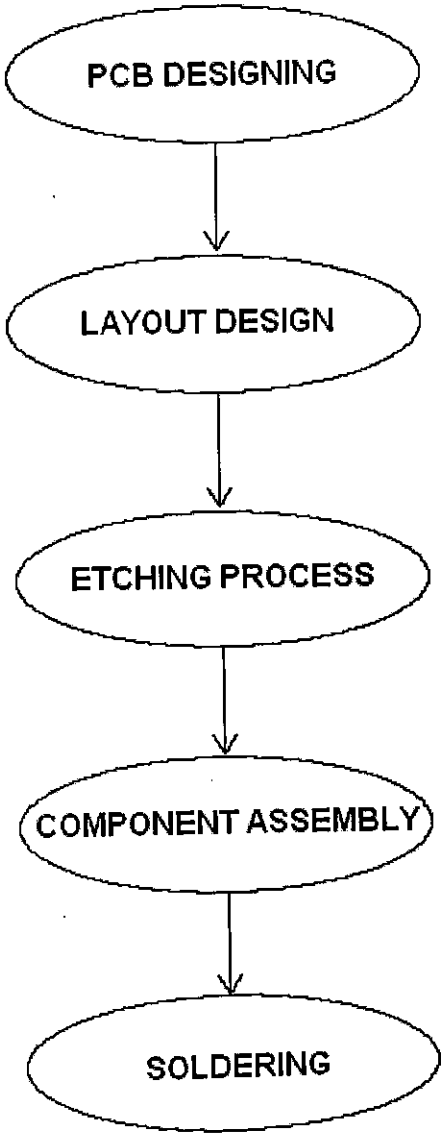
## Board Types:

The two most type of PCBs are

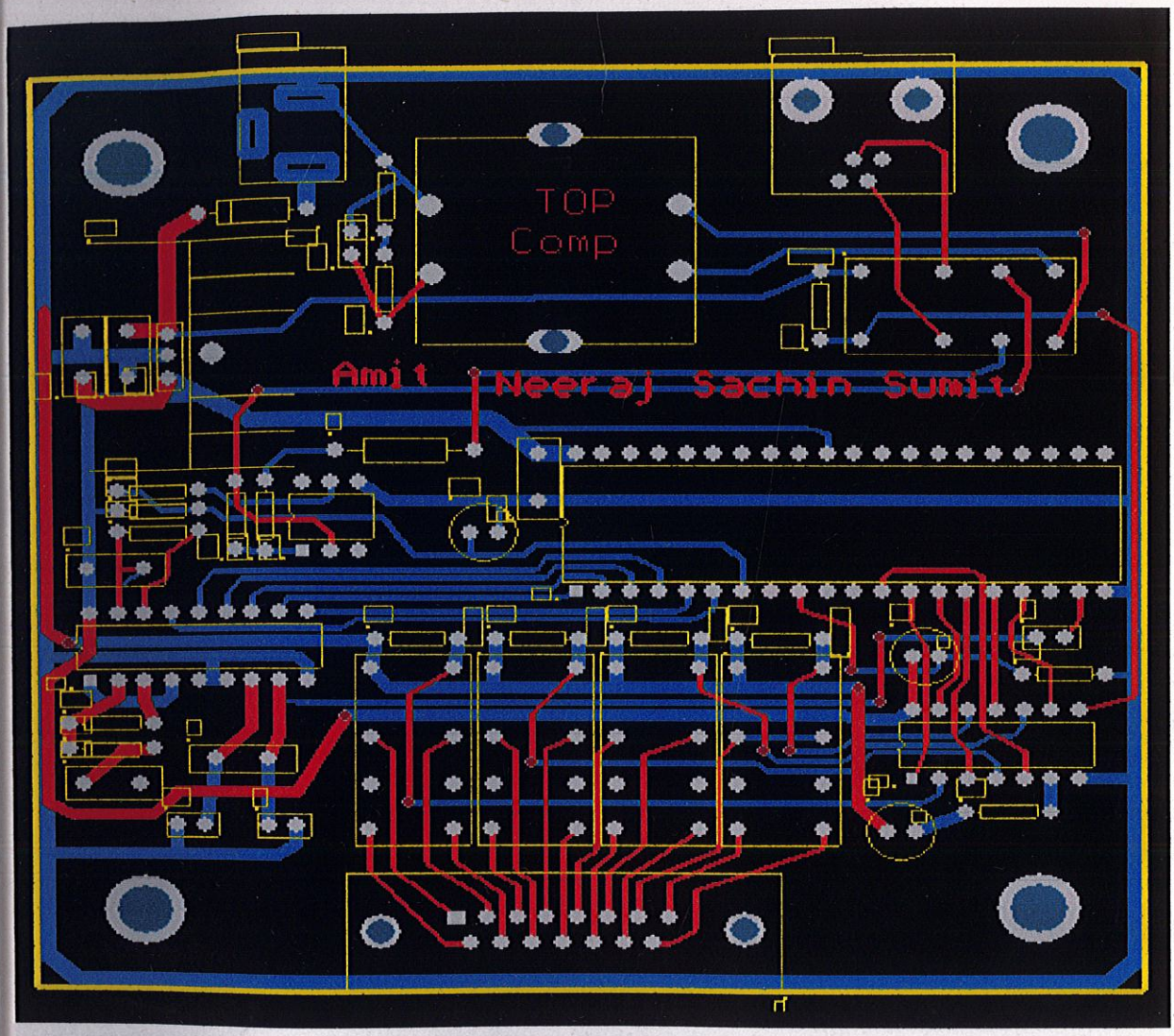
1. Single Sided Board.
2. Double Sided Board.

## Design Specifications

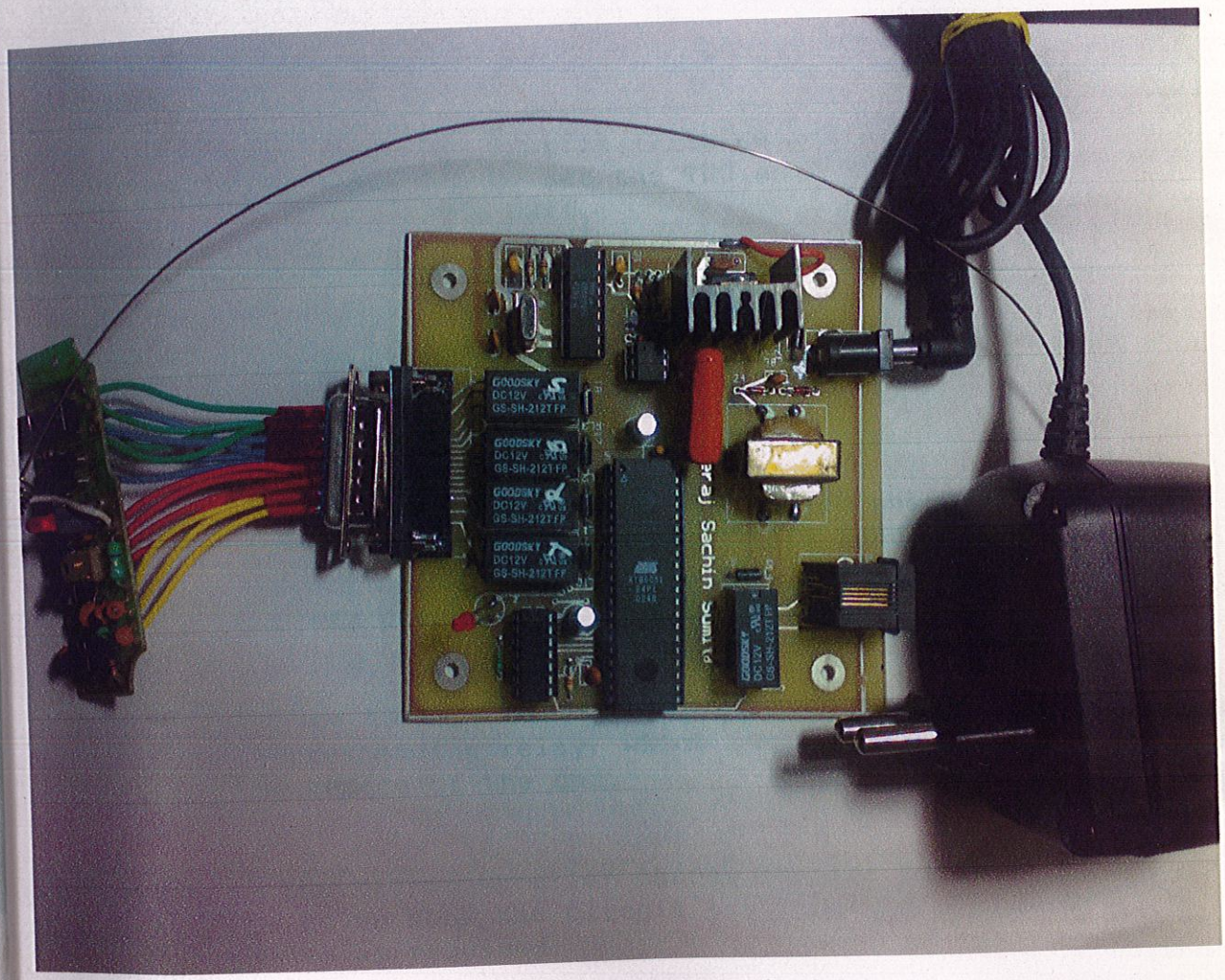
### Board Types:



PCB Layout (Software: Protel Design System)



# Pratical Implementation



# Algorithm For The Source Code

**STEP1:** The function Initialize () is called to set allports (P0-P3) of the microcontroller as input pins, to set TMOD register as 0x11 for using both timers in 16 bit mode and for enabling all interrupts as well as for starting timer0.

**STEP 2:** Then the function TimeTik () is called to set flag (TF0) of timer 0 & to set the TH0 as 0xfa so that counter moves from 0xfa to 0xff.

**STEP 3:** The function ConnectSystem () is called to check for the incoming signal and if that signal is greater than the specified delay then the circuit is off-hook as per the instruction of microcontroller.

**STEP 4:** Then the function GetDtmf () is called whenever STD pin of DTMF decode goes low and this function returns the equivalent binary data of incoming signal Corresponding to the key pressed by the user.

**STEP 5:** According to this binary data microcontroller activates the corresponding relay, which further passes the signal to the remote of the car.

**STEP 6:** Then the microcontroller checks for the particular key (10 ) to on hook the circuit and then whole process repeats as required.

## Source Code

```
#include "at89x51.h"
#define BOOL bit
#define BYTE unsigned char

bit Tm0Flg;
sbit STD = 0x95;
sbit TOE = 0x94;
sbit RDS = 0x96;

sbit Relay1 = 0xb3;
sbit Relay2 = 0xb6;
sbit Relay3 = 0xb5;
sbit Relay4 = 0xb4;
sbit Telephone = 0xb7;
sbit Led = 0xb2;

BOOL TimeOut;
BYTE BlinkTimer;
int TimeOutTimer;

void Timer0(void) interrupt 1
{
   Tm0Flg = 1;
   TH0 = 0xfa;
}

void TimeTik()
{
   while (!Tm0Flg);
   Tm0Flg=0;
}

void TimeDelay(int cnt)
{
  while(cnt--)TimeTik();
}

BYTE GetDtmf()
{
BYTE pp;
    Led = 1;
    while(!STD)TimeTik();
     pp = P1 & 0x0f;
     while (STD);
     Led = 0;
     return pp;
}
```

```
void Initialize()
{
    P0 = 0xff;
    P1 = 0xef;
    P2 = 0xff;
    P3 = 0x00;
    TMOD = 0x11;
    ET0 = 1;
    TR0 = 1;
    EA = 1;
}

void IfTimeOut()
{
    if (TimeOutTimer++ < 5000)return;
    TimeOut = 1;
}

void BlinkLed()
{
    BlinkTimer++;
    BlinkTimer &= 0x7f;
    if (BlinkTimer == 0)Led = ~Led;
}

void ConnectSystem()
{
     TimeOut = 0;              // No Time out
      Telephone = 1;           // Telephone ofhook
     Led = 0;
     while(TimeOut == 0){          // Loop Till it timed out
          TimeTik();           // 5ms secs
         IfTimeOut();         // test for time out
           if (STD){            // Any Dtmf code recvd
              TimeOutTimer = 0;
            TOE = 1;
              switch(GetDtmf()){
                  case 1:
                          Relay1 = ~Relay1; // Toggles switch 1
                          break;
                  case 2:
                          Relay2 = ~Relay2; // Toggles switch 2
                          break;
                  case 3:
                          Relay3 = ~Relay3; // Toggles switch 3
                          break;
                  case 4:
                          Relay4 = ~Relay4; // Toggles switch 4
                          break;
                  case 10:
```

```
                        Relay1 = Relay2 = Relay3 = Relay4 = 0;
                        break;  // clear all switch

                }
                TOE = 0;
            }
        }
        Relay1 = Relay2 = Relay3 = Relay4 = 0;
        Telephone = 0;
        Led = 0;
}

void main()
{
   Initialize();               // Initialize the system
   while (1){
     TimeTik();
     ConnectSystem();
   }
      BlinkLed();          // Blink Led if not connected
     if (!RDS){               // if it is ringing
          TimeDelay(400);      // wait 2 Secs
           Telephone = 1;       // Telephone
           Led = 1;             // Led on
           TimeDelay(200);      //
           ConnectSystem();
     }
   }
}
```

## Application

1. Telephone answering machine.
2. Interactive voice response system (IVRS).
3. DTMF remote controlling by cell phone or telephone.
4. Home Automation system (Mobile as universal remote for controlling various Devices).

## Future Advancements

Though this project has great utilizations, it has certain drawback which requires further improvements. These improvements are:

1. Presently the system doesn't have mechanism for directly turning ON and OFF the various devices. It is just operating with the help of phone. Thus the system requires a mechanism which would work on Automatic & manual mode simultaneously, so that if the user is in the home he can use it to turn ON and OFF the various devices without using his phone.
2. The no of devices can be increased by using the microcontroller IC in cascade or by using some other ICs.
3. Voice ICs can be used to make the system more interactive & user friendly.

# Conclusion

The necessary code has been made and uploaded in microcontroller by using appropriate software. Data is transferred using DB-15 pin . Analog to digital conv- -ersion & instruction given by user is easily decoded by the device .successful application has been achieved

With the steady increase in demand for the useful home based automation systems in the world, our project gives direction to this need.

# Bibliography

The following are the major influences for this project: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