DEVICE AUTOMATION USING DTMF

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CERTIFICATE

This is to certify that the work entitled, "Device Automation using DTMF" submitted by Gaurav Joshi and Abhishek Chaudhary in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering in 2007 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.

Mr. Davinder Singh Saini

ACKNOWLEDGEMENT

"TELL ME AND I WILL FORGET
TEACH ME AND I WILL REMEMBER
INVOLVE ME AND I WILL LEARN"

No research endeavor is a sole exercise; various individuals in their own capacity at some point or other contributed in bringing of fruition of the research endeavor, in acknowledging their guidance, support and assistance, we humbly thank them.

We would like to express our sincere thanks and gratitude to **Mr. Davinder Singh Saini**, Department of Electronics and Communication Engineering, under whose able guidance we managed to give our endeavor the desired shape, his help, stimulating suggestions and constant encouragement helped us at every phase of the project. His enthusiasm and the view of producing quality substance has casted a deep and a long lasting impression on us.

Finally, we thank all our colleagues for their constant support and encouragement. Their unobtrusive support and suggestions bolstered our confidence as usual. Their inspiring words will be a guiding force in all our endeavors to attain greater heights.

Gaurav Joshi

Abhishek Chaudhary

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LIST OF ABBREVIATIONS

DTMF:	Dual Tone Multi Frequency
RLY:	Relay
PCB:	Printed Circuit Board
DPDT:	Double pole, double throw
DIP:	Dual in line Package
OrCAD:	Oregon + Computer Aided Design
PBEX:	Private Branch Exchange

ABSTRACT

The project "Device Automation using DTMF" is a part of our B. Tech curriculum at Jaypee University of Information Technology, Solan. Our aim by the means of this project is to design a system that is capable of handling the devices that are far away from you, may be thousands of kilometers away, through a mobile phone. We have made use of the DTMF signaling technique in order to control the devices. We have divided the complex circuit into modules so as to make our presentation simple and easy to understand. This effort of ours has taken us into a position where we can think of numerous applications of the technology around us.

We hope this effort of ours will encourage people to find simple applications of the complex technology around us that affects our daily lives. This document is an aid to the future engineers to understand the application, features and the future derivatives of this project.

CHAPTER 1
OVERVIEW

1.1 Introduction

It has been an old pastime of man to dream the impossible, try to formulate it and give it a shape and then finally bring it into existence with the vision of giving the world something new and unique. The history itself is an example of how the things have evolved through the ages. By the means of this project, we have not actually made something new and unique, but our effort aims towards an easy, efficient and economical way of handling your devices from any part of the world. Some technologies like IR remote control are used for controlling short distance applications. We here introduce a system which does not require any radiations or which is not harmful as a long remote control switch or which does not use any laser beam which has a limitation of range. We propose to control devices connected to our land line from a distance ranging from meters to thousands of kilometers. We have designed a device automation system using "DTMF" wherein your landline phone (with some extra circuitry) or your mobile phone is capable of handling electrical and electronic devices as per your requirements. We will discuss each and every aspect of this application as we move further with this idea.

1.2 Features of The project

1. We can control up to 10 devices. But due to complexity of the project we are controlling 4 devices. These may be any electric or electronic appliances or devices with simple to heavy appliances. Each device is given a unique code.
2. It makes accurate switching, any false switching of device are not done.
3. There is no risk for false switching.
4. Our local phone (i.e., home phone or office phone) can be used for normal use by using a DPDT switch. So we need not use a separate telephone line for this device controlling.

5. To control any device our mobile phone, the user needs to dial to the local telephone (to which the interfacing circuit is connected) then the respective code of the device is dialed.
6. This circuit does not require any complex IC, so any one with little knowledge of electronics can construct this circuit, because it does not need any programmable IC's or programming.
7. This system detects the ringing signal from your exchange with the help of ring detector and automatically switches ON.
8. This device saves money. This circuit switches OFF after a time of 5 seconds (The ON-Time can be changed as discussed in detail in coming section).
9. Before changing the state of the device we can confirm the present status of the device.
10. This circuit gives an acknowledgement tone after switching ON the devices to confirm the status of the device.

1.3 Basics of the project

This system uses Dual Tone Multi Frequency (DTMF) technology of our mobile phone. Every mobile will have this facility. The DTMF mode is shortly called as tone dialing mode.

The project is divided into two sections: Remote Section and Local Control Section.

1) Remote Section: It is nothing but a mobile which is present in the remote place. Signals are sent through this mobile set.
2) Local section: This is a control system through which you can control your appliances. This contains one telephone line and a control unit. The appliances to be controlled must be connected to telephone line through control unit. Control unit is kept with a sufficient backup.

CHAPTER 2
ELEMENTARY CONCEPTS

2.1 What is DTMF?

2.1.1 History

DTMF was developed at Bell Labs in order to allow dialing signals to dial long-distance numbers, potentially over non wire links such as microwave radio relay links or satellites. For a few non crossbar offices, encoder/decoders were added that would convert the older pulse signals into DTMF tones and play them down the line to the remote end office. At the remote site another encoder/decoder could decode the tones and perform pulse dialing, for example for Strowger switches. It was as if you were connected directly to that end office, yet the signaling would work over any sort of link. This idea of using the existing network for signaling as well as the message is known as in-band signaling.

It was clear even in the late 1950s when DTMF was being developed that the future of switching lay in electronic switches, as opposed to the electromechanical crossbar systems then in use. Either switching system could use either dial system, but DTMF promised shorter holding times, which was more important in the larger and more complex registers used in crossbar systems. In this case pulse dialing made no sense at any point in the circuit, and plans were made to roll DTMF out to end users as soon as possible. Tests of the system occurred in the early 1960s, where DTMF became known as Touch Tone. Though Touch Tone phones were already in use in a few places, they were vigorously promoted at the 1964 New York World's Fair.

2.2 How DTMF works?

When you press a button in the telephone set keypad, a connection is made that generates a resultant signal of two tones at the same time. These two tones are taken from a row frequency and a column frequency. The resultant frequency signal is called "*Dual Tone Multiple Frequency*". These tones are identical and unique.

A *DTMF* signal is the algebraic sum of two different audio frequencies, and can be expressed as follows:

$f(t) = A_0\sin(2*\Pi*f_a*t) + B_0\sin(2*\Pi*f_b*t) + ...$

Where f_a and f_b are two different audio frequencies with A and B as their peak amplitudes and f as the resultant DTMF signal. f_a belongs to the low frequency group and f_b belongs to the high frequency group.

Each of the low and high frequency groups comprise four frequencies from the various keys present on the telephone keypad; two different frequencies, one from the high frequency group and another from the low frequency group are used to produce a DTMF signal to represent the pressed key.

The frequencies are chosen such that they are not the harmonics of each other. The frequencies associated with various keys on the keypad are shown in figure 1

		HIGH FREQUENCY GROUP		
		1200Hz	1336Hz	1447Hz
LOW	697Hz	1	2	3
FREQUENCY	770Hz	4	5	6
GROUP	852Hz	7	8	9
	941Hz	*	0	#

Figure 1: DTMF table

When you send these DTMF signals to the telephone exchange through cables, the servers in the telephone exchange identifies these signals and makes the connection to the person you are calling.

When we press the digit 5 in the keypad it generates a resultant tone signal which is made up of frequencies 770Hz and 1336Hz. Pressing digit 8 will produce the tone taken from tones 852Hz and 1336Hz. In both the cases, the column frequency 1336 Hz is the same. These signals are digital signals which are symmetrical with the sinusoidal wave.

A Typical frequency is shown in the figure below:

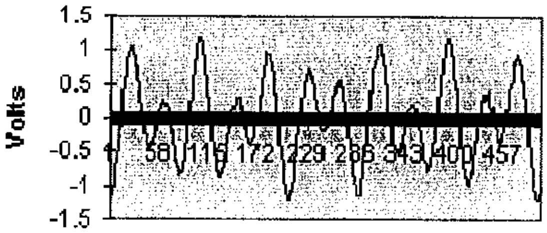

Figure 2: DTMF signal for key 1

Along with these DTMF generator in our telephone set provides a set of special purpose groups of tones, which is normally not used in our keypad. These tones are identified as 'A', 'B', 'C', 'D'. These frequencies have the same column frequency but uses row frequencies given in the table in figure (A). These tones are used for communication signaling.

Due to its accuracy and uniqueness, these DTMF signals are used in controlling systems using telephones. By using some DTMF generating IC's (UM91214, UM91214, etc) we can generate DTMF tones independent on the telephone set.

CHAPTER 3

INTRODUCTION TO COMPONENTS

Aim of our project is to use the cheapest of the components that are easily available in the market and could be purchased at a nominal cost.

For our simplicity we are using a mobile phone at the remote section so as to remove hardware complexity as almost every mobile has a facility of sending a DTMF signal during the call.

The components that were used at the local control section are listed and described below:

3.1 IC MT 8870 DTMF Decoder

IC MT8870 serves as DTMF decoder. This IC takes DTMF signal coming via telephone line and converts that signal into respective BCD number.

3.1.1 Working of IC MT8870:

The MT-8870 is a full DTMF Receiver that integrates both band split filter and decoder functions into a single 18-pin DIP. Its filter section uses switched capacitor technology for both the high and low group filters and for dial tone rejection. Its decoder uses digital counting techniques to detect and decode all 16 DTMF tone pairs into a 4-bit code.. Minimal external components required include a low-cost 3.579545 MHz crystal, a timing resistor, and a timing capacitor.

MT-8870 operating functions include a band split filter that separates the high and low tones of the received pair, and a digital decoder that verifies both the frequency and duration of the received tones before passing the resulting 4-bit code to the output bus. The low and high group tones are separated by applying the dual-tone signal to the inputs of two 6^{th} order switched capacitor band pass filters with bandwidths that correspond to the bands enclosing the low and high group tones.

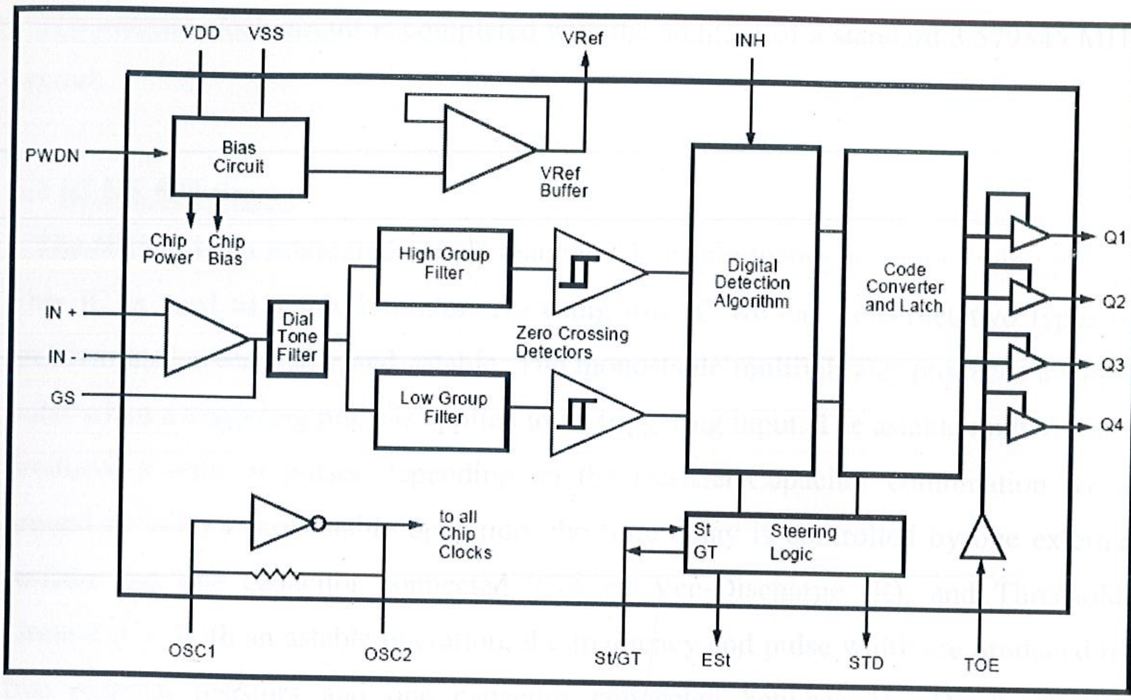

Figure 3: Block diagram of IC MT8870

Each filter output is followed by a single-order switched capacitor section that smoothes the signals prior to limiting. Signal limiting is performed by high gain comparators provided with hysteresis to prevent detection of unwanted low-level signals and noise. The MT-8870 decoder uses a digital counting technique to determine the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies. When the detector recognizes the simultaneous presence of two valid tones (known as signal condition), it raises the Early Steering flag (ESt). Any subsequent loss of signal condition will cause ESt to fall. Before a decoded tone pair is registered, the receiver checks for valid signal duration (referred to as character-recognition-condition). This check is performed by an external RC time constant driven by ESt. A short delay to allow the output latch to settle, the delayed steering output flag (StD) goes high, signaling that a received tone pair has been registered. The contents of the output latch are made available on the 4-bit output bus by raising the three state control input (OE) to logic high. Inhibit mode is enabled by a logic high input to pin 5 (INH). It inhibits the detection of 1633 Hz. The output code will remain the same as the previous detected code. On the M- 8870 models, this pin is tied to ground (logic low).

The internal clock circuit is completed with the addition of a standard 3.579545 MHz crystal.

3.2 IC NE 555 timer:

The NE555 is an integrated circuit that capable of producing accurate timing pulses. This IC is used as a multivibrator. By using this IC we can construct two types of multivibrater, monostable and astable. The monostable multivibrater produces a single pulse when a triggering pulse is applied to its triggering input. The astable multivibrater produces a train of pulses depending on the Resister-Capacitor combination wired around it. With a monostable operation, the time delay is controlled by one external resistor and one capacitor connected between Vcc-Discharge (R), and Threshold-Ground (C). With an astable operation, the frequency and pulse width are produced by two external resistors and one capacitor connected between Vcc-Discharge (R), Discharge-Threshold (R), and Threshold-Ground (C).

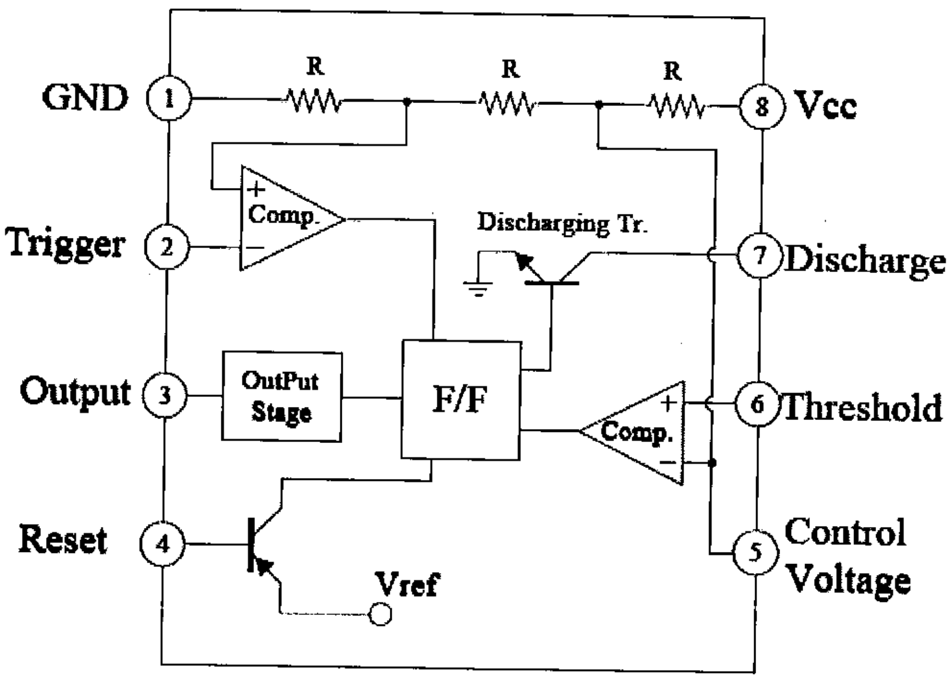

Figure 4 : IC NE 555

3.3 74154 4-16 line decoder/demultiplexer:

IC 74154 is a 4-16 line decoder, it takes the 4 line BCD input and selects respective output one among the 16 output lines It is an active low output IC so when any output line is selected it is indicated by active low signal, rest of the output lines will remain active high.

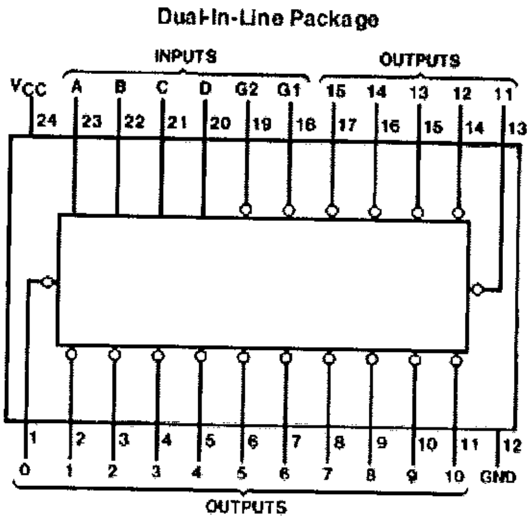

Figure 5: IC 74154 4-16 line decoder

Inputs						Outputs															
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
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L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = High Level, L = Low Level, X = Don't Care

Figure 6: Truth Table of 4-16 line decoder

This 4-line-to-16-line decoder utilizes TTL circuitry to decode four binary-coded inputs into one of sixteen mutually exclusive outputs when both the strobe inputs, G1 and G2, are low.

The demultiplexing function is performed using the 4 input lines to address the output line, passing data from one of the strobe inputs with the other strobe input low. When either strobe input is high, all outputs are high. This demultiplexer is ideally suited for implementing high-performance memory decoders.

All inputs are buffered and input clamping diodes are provided to minimize transmission-line effects and thereby simplify system design.

3.4 <u>74126 Tri - State Buffer:</u>

This IC is a tri state buffer contains four independent gates each of which performs a non-inverting buffer function. The outputs have the 3-STATE. When control signal is at high state, the outputs are nothing but the data present at its input terminals. When control signal is at low state, the outputs are held at high impedance state. So no output will be available at the output terminal.

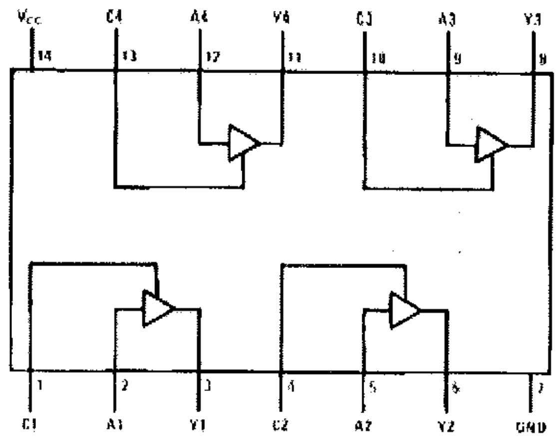

Figure 7: IC 74126 (tri state buffer)

3.5 IC 7474 D-flip-flop:

IC 7474 is a conventional D-flip-flop IC. It consists of two D flip-flops. These flip-flops are used to latch the data that present at its input terminal. Each flip-flop has one data, one clock, one clear, one preset input terminals.

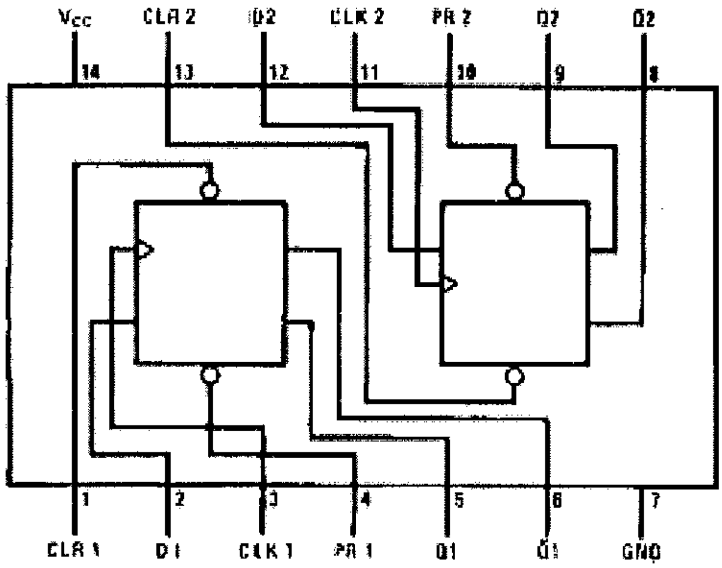

Figure 8: IC 7474 D flip flop

3.6 IC 7447 BCD - seven segment decoder:

The DM74LS47 accepts four lines of BCD (8421) input data, generates their complements internally and decodes the data with seven AND/OR gates having open-collector outputs to drive indicator segments directly. Each segment output is guaranteed to sink 24mA in the ON (LOW) state and withstand 15V in the OFF (HIGH) state with a maximum leakage current of 250 mA. Auxiliary inputs provided blanking, lamp test and cascadable zero-suppression functions.

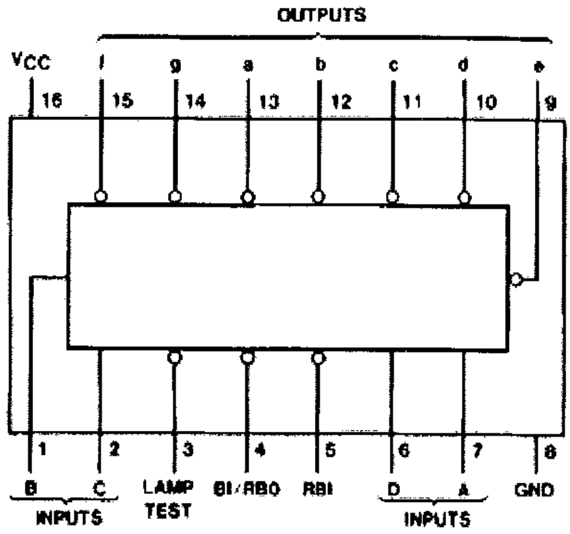

Figure 9: IC 7447 BCD - seven segment decoder

3.7 Seven Segment Display

A seven-segment display, less commonly known as a seven-segment indicator, is a form of display device that is an alternative to the more complex dot-matrix displays. Seven-segment displays are commonly used in electronics as a method of displaying decimal numeric feedback on the internal operations of devices.

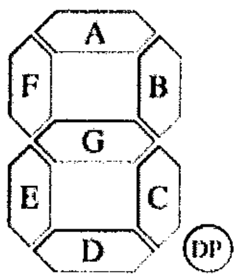

Figure 10: A Seven Segment Display

A seven segment display, as its name indicates, is composed of seven elements. Individually on or off, they can be combined to produce simplified representations of all the numerals. Each of the numbers 0, 6, 7 and 9 may be represented by two or more different glyphs on seven-segment displays.

The seven segments are arranged as a rectangle of two vertical segments on each side with one horizontal segment on the top and bottom. Additionally, the seventh segment bisects the rectangle horizontally. Often the seven segments are arranged in an *oblique*, or *italic*, arrangement, which aids readability.

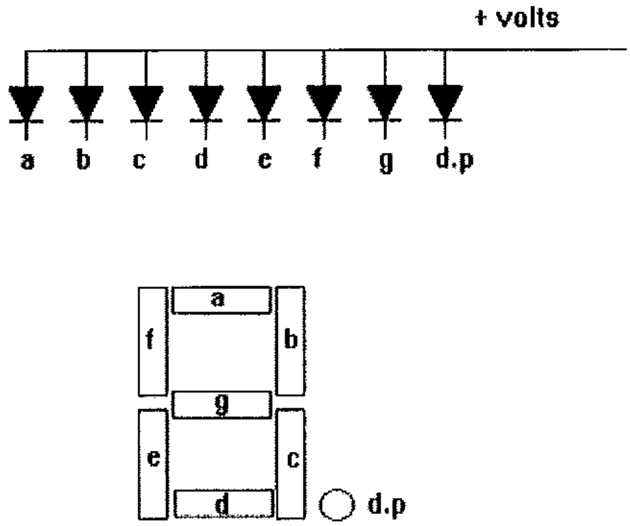

Figure 11: LED configuration of seven segment display

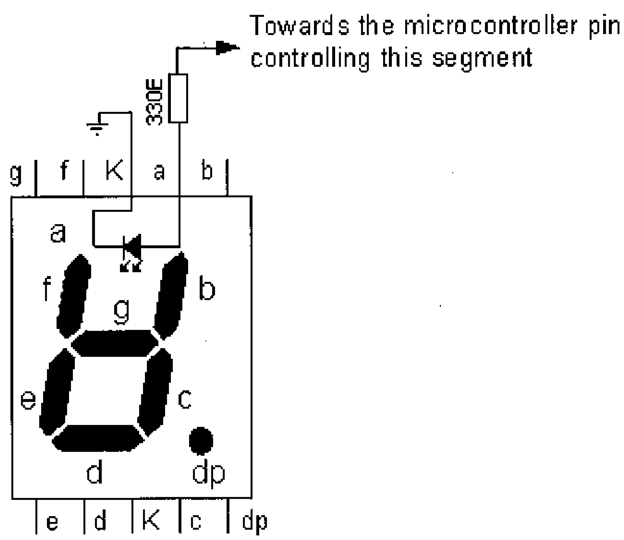

Figure 12: Pin configuration of seven segment display

CHAPTER 4

THE CIRCUIT (PHASES AND MODULES)

4.1 Phases of the circuit

In order to become well versed with the application, we had to divide the circuit into phases for complete understanding. We finally subdivide the process into five phases:

4.1.1 Identification phase

The first step towards any goal is to identify the problem and then come across a solution. The identification phase deals with knowing the function of each and every component in the circuit.

4.1.2 Analyzing phase

The question is perhaps the biggest hurdle to overcome. What happens when one module is connected to another module? For answering such question we had to answer based upon our prior knowledge of electronics. Each and every part of the circuit was analyzed and a rough model was prepared according to the inferences.

4.1.3 Simulation phase

OrCAD was used as a software tool to test the working of our circuit. The snapshot of the circuit on OrCAD is shown in the next chapter. This software has really helped us to analyze the circuit with a different viewpoint.

4.1.4 Implementation phase

Implementation was the toughest of all the parts that we incorporated in this project. Implementation phase was divided into two parts: the first one was implementing small parts of the circuit on the bread board and finally putting the circuit onto the printed circuit board wherein the practical problems related to soldering and re-soldering were faced. We divided our circuit into modules to simplify the process and possibly try to eradicate any error that could have crept into.

4.1.5 Testing and Troubleshooting

Besides all care that we took, we were not able to eliminate all errors completely. Human errors and other factors contributed to a system that could not properly work according to our requirements. We virtually had to redesign the complete systems in order to remove all the errors. The help of software was great in this regard.

4.2 Modules of the circuit

To learn the system in such a way that it follows all out requirements, we had to break the circuit in a way that the purpose of every part becomes clearly visible. The policy of "Divide and Rule" follows when the thing to be dealt with is quite complex and cumbersome. A general system can be divided into three basic modules: input, processing and output. But we have divided the circuit into modules according to our plan of action. The modules were:

1) Power Supply Module
2) Input Identification module
3) Processing module
4) Output and relay driving module

All these things are the part of the local control section.

But before we actually start working on the modules lets have a look upon how the system model looks like. The next page shows the block diagram as a whole.

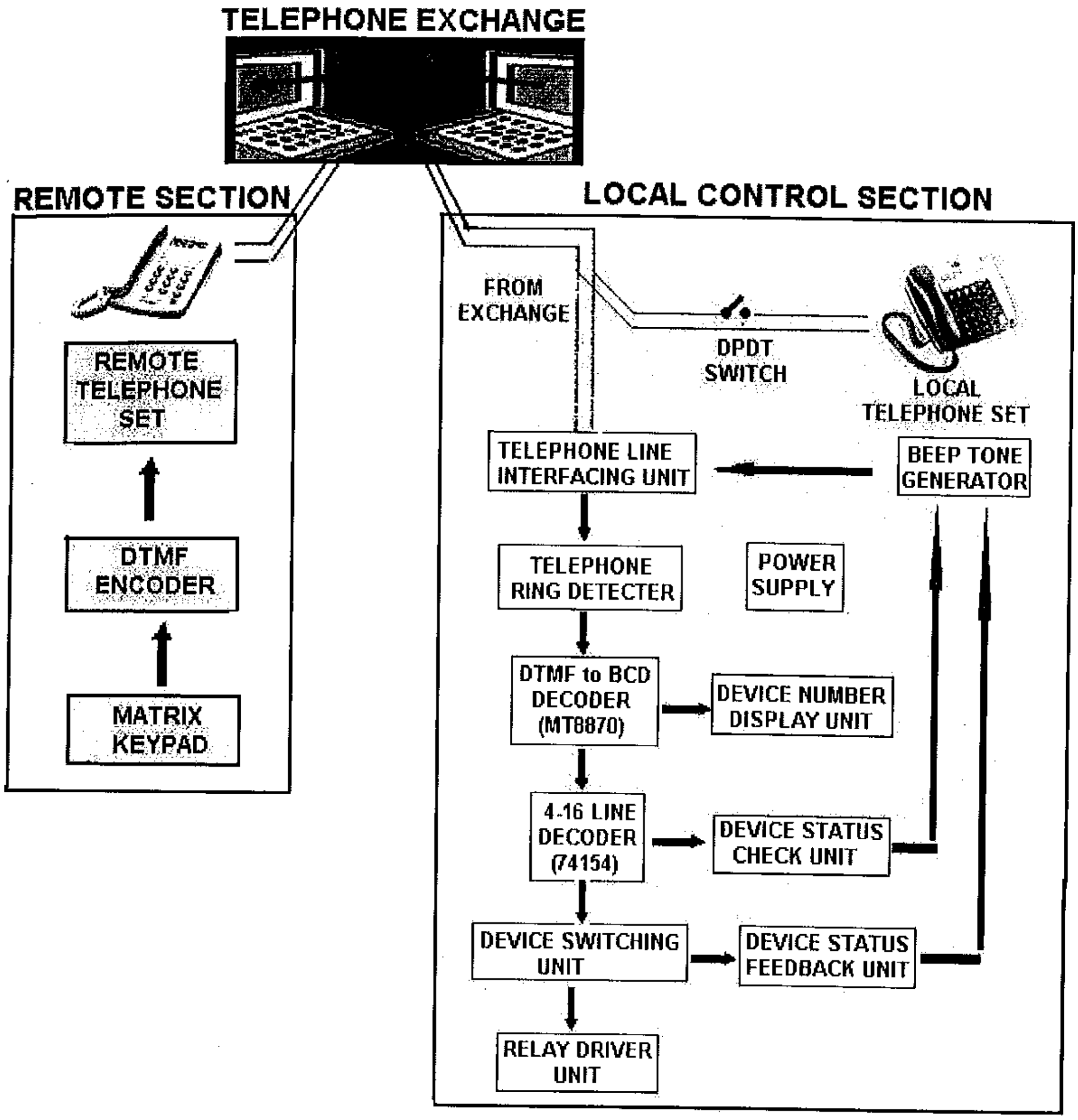

Figure 13: Block Diagram of the system

Now lets have a look upon the circuit diagram of the local control section :

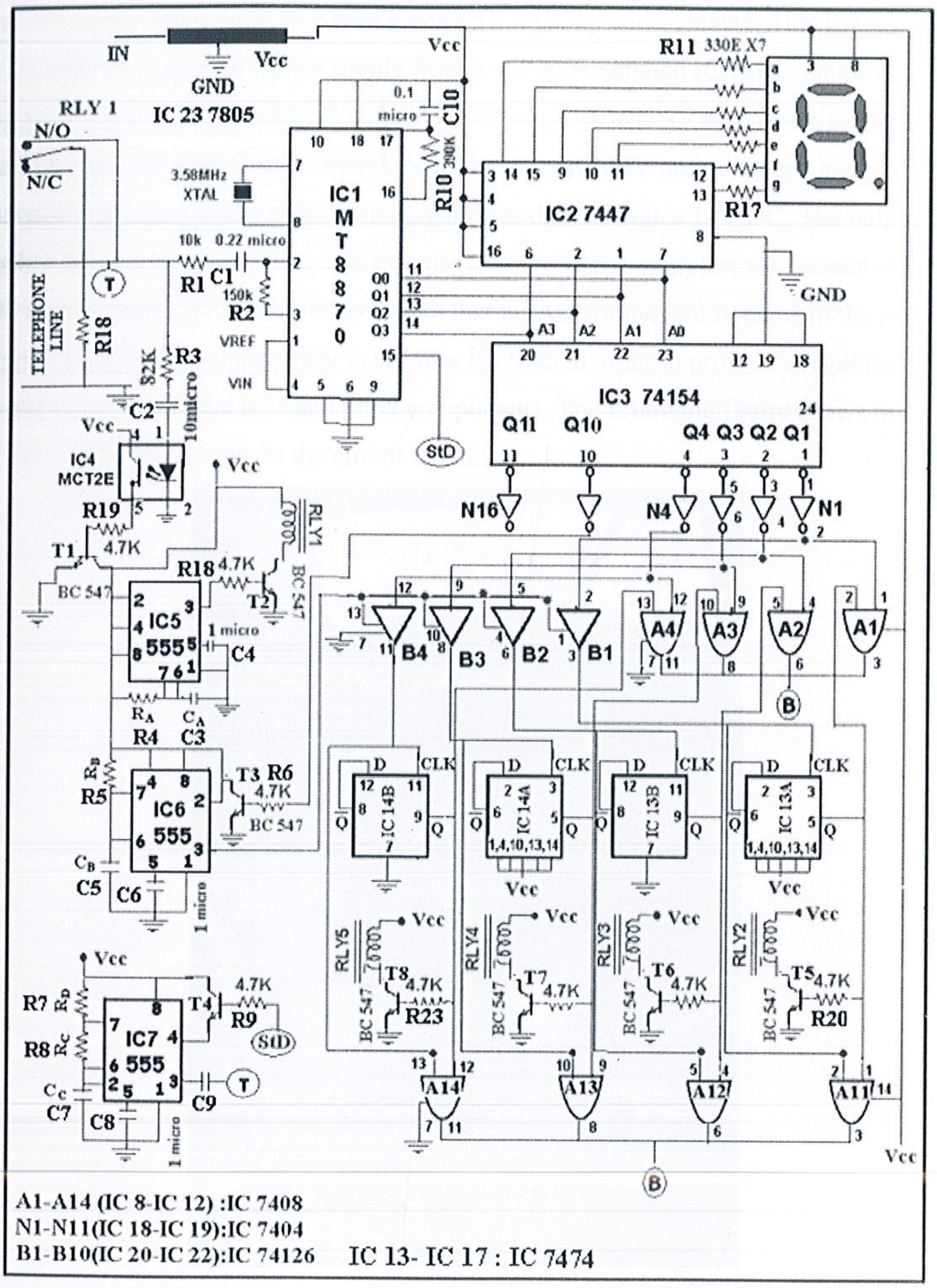

Figure 14 Circuit Diagram of the local control section

4.2.1 Power Supply Module

For the proper working of this local control section except the local telephone set it needs a permanent back up which gives a 5V back up continuously. This is achieved by using a 5V regulated power supply from a voltage regulated IC 7805. This 5V source is connected to all ICs. We could have used a 9V battery as a power source but our relay specification is 12V, therefore we have used 220V mains instead and connected the supply to a step down transformer that generates 12V DC. The output is further fed to a bridge rectifier and in order to smoothen the ripples; we connected a 200 microF capacitor in parallel to ensure that no AC component remains in the power supply. Finally the output power is fed into IC 7805 in order to provide a regulated power supply to all the IC's and other components. The following figure shows the power supply module as on the circuit board.

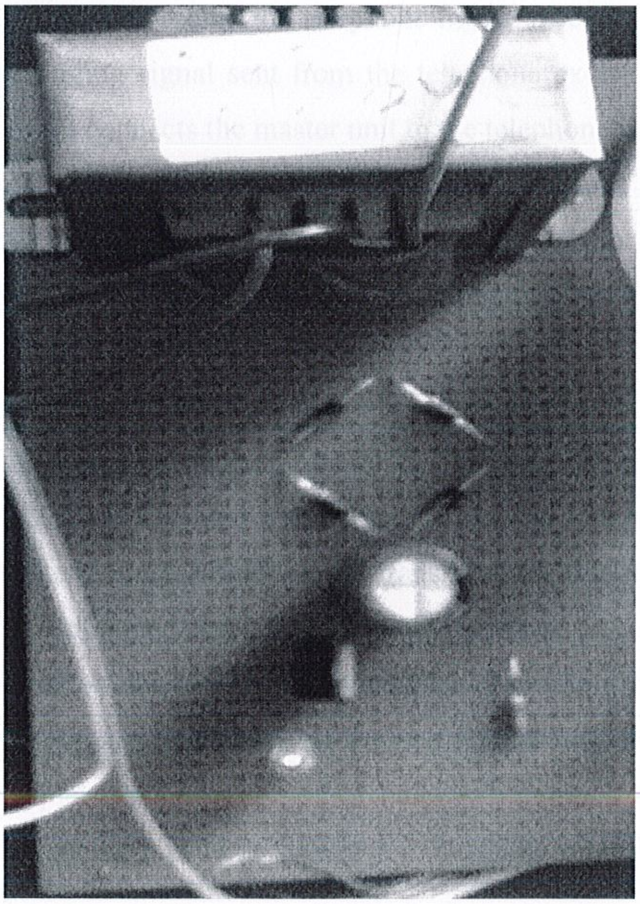

Figure 15 A view of power supply module on the circuit board

4.2.2 Input Identification Module

The DTMF signal sent by mobile phone in our case is a combination of two frequencies that belong to high and low frequency groups respectively. On pressing a particular key the remote section generates two frequencies that are identified by IC MT8870 on the whole. The description of the circuit is as follows:

Telephone interface circuit:

When a signal is sent from the remote telephone, the telephone interface circuit comes to receive the signal. This circuit is directly connected to the telephone line. This circuit consists of some passive components like resisters, capacitors.

Ring detector circuit:

This circuit is useful to receive the telephone in the absence of the person. This circuit identifies the ringing signal sent from the telephone exchange. On getting the ringing signal this circuit connects the master unit to the telephone line.

When some one calls another person through telephone by dialing second persons number, on getting this number of the second person the system in the telephone exchange sends a short duration ringing signal, this signal is sent at 25-30 Hz pulse of 70-90 rms.

This AC signal is bypassed by resister RE and capacitor CE and applied to the optocoupler MCT2E. This optocoupler is 6 pin IC. This is made up of internally built one Light Emitting Diode (LED) and a transistor. When the internal LED glows, the light falls on the emitter-collector junction the transistor. By this transistor is forward biased and the output is obtained at the emitter of the transistor.

On applying the signal to anode of the optocoupler, grounding the cathode, on the positive cycle of the signal LED glows as a result +5volt output is obtained at the emitter of the optocoupler at pin no 4.

The ring detector circuit is built around a monostable multivibrater constructed around timer IC 555.

When a negative going pulse is applied to its triggering input at pin 2, the output of the IC goes high. This output is available at pin 3 of this IC. This will remain high for the time period designed by the RC combination depending on values of resister R_A and capacitor C_A.

High on the pin 3 of this timer IC biases the transistor T2 in the relay driver circuit which in tern switches ON the relay. This relay puts a resistance loop of 220Ω across the telephone line. By this resistance loop the line voltage in the telephone line drops from 50v to 12v. This is same as lifting the receiver of telephone handset (hook-off state).

Here this circuit is designed for a period of 5.2 seconds. This period is calculated by the formula,

$t_d = 1.1\ R_A\ C_A$ ($R_A = 4.7k$, $C_A = 1000microF$)

After this period the output of this IC goes low which intern switches OFF the transistor T2. By varying the values of the R_A and C_A the ON period of the monostable multivibrator is changed according to the formula given above. In the relay driver circuit resister is used to provide the necessary base current to the transistor so that it can bias properly.

Now our circuit is ready to receive any coded signal of the devices connected to the local control section from the remote control section.

Signal Decoding Unit:

This is the main unit of this system. This unit consists of a DTMF to BCD decoder IC MT 8870, 4 to 16 line decoder IC 74154 and hex inverter gate IC 7404. The working of all the above IC's are mentioned here before.

The DTMF to BCD decoder IC MT8870 takes a valid tone signal from the telephone line. Then the tone signal is converted in to 4 bit BCD number output obtained at pins from 11 to 14. This output is fed to the 4-16 line decoder IC74154. This IC takes the BCD number and decodes. According to that BCD number it selects the active low output line from 1 to 16 which is decimal equivalent of the BCD number present at its input pins. Since the low output of this IC the output is inverted to get logic high output. This inversion is carried out by hex inverter IC 7404-built on TTL logic. This IC inverts the data on its input terminal and gives inverted output.

Number display unit:

This unit displays the received device code from the telephone line dialed from remote section. This unit consists of a BCD to seven segment decoder IC7447 and a seven segment display.

A seven segment display has seven LEDs connected in a sequence to give a regular shape and a LED to display the dot for decimal point.

It has 10 pins. Out of this two pins are common for all LEDs and remaining are another polarity terminals of the LED. When common anode seven segment display is used, two common terminal pins are connected to +5v or logic high state and another terminal are kept at logic low state. Then respective LED glows.

Here common anode seven segment display is used. Because of this here we need a BCD to seven segment decoder which gives logic low output for the respective BCD input. Therefore I used a TTL IC 7447.

The device selected from the Remote Section for control purpose, its code is displayed in this seven segment display.Next we discuss about the device control unit .This is an important unit in this project.

Device control unit consist of device status check unit, device switching unit, device status feedback unit, relay driver circuit and beep tone generator unit.

Beep tone generator unit:

Beep tone generator unit produces a beep tone of audible frequency. This unit is constructed using a 555 timer chip. Here it is wired as an astable multivibrater with a few external components like resister and capacitor are required along with the timer 555 chip set.

This frequency should come in the audible range between 40Hz to 650Hz. It should be less than 650Hz otherwise it will mix up with the DTMF tone. Here we generated 480 Hz frequency using $f=1.44/[(Ra+2Rb)C]$ keeping Ra = Rb = 1K and C = 1 uf. When this is less than 650Hz frequency it causes the false triggering of the IC MT8870.

The following figure shows what the circuit looks like on the circuit board

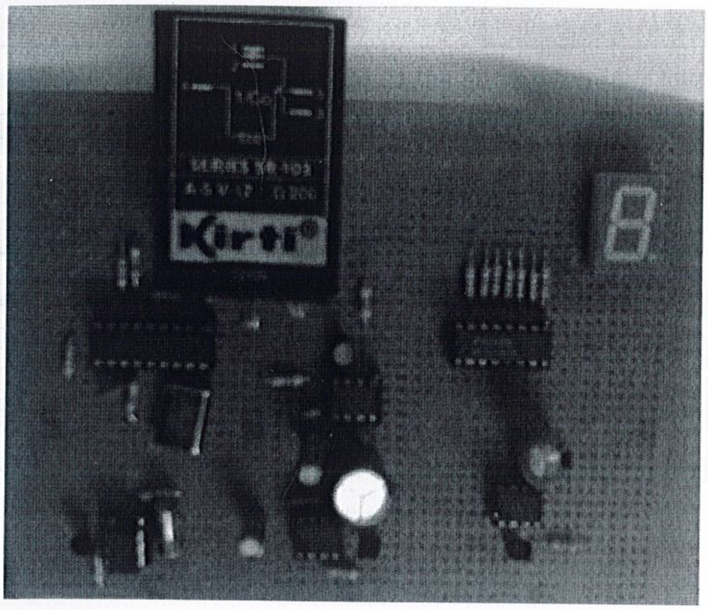

Figure 16 A view of input identification module

4.2.3 Processing module

This unit consists of a tri state buffer and a D flip flop. After making confirmation of current status of the device to alter the status of that device, we have to change the mode of the tri state buffer by making the control input high. This is done by pressing the '#' key. When this key is pressed the output of the 4-16 line decoder goes low. This gives a triggering pulse to monostable multivibrater which is build around the IC 6. This will keeps the output high for a 5seconds. Working of the monostable multivibrater already discussed. In this time interval the output of the tri state buffer will be the signal at its input terminal.

So now the device code of the respective device is again pressed whose status is to be altered.

The output of tri state buffer is latched by using a D flip-flop. Here this D flip flop is used in the toggle mode. For each positive going edge of the clock pulse will trigger the flip flop.

After a period of 5 seconds the output of the IC 6 goes low and puts the tri state buffer in the high impedance state. Therefore to change the status of any other device is to be done after the output of IC 6 goes low, again '#' key is pressed to make the tri state buffer act as input –output state and the respective code of the device is pressed.

After changing the present status of the device confirm the operation you did, here comes the unit which gives the feedback tone after switching ON any device. This device status feedback unit uses a dual input AND gate, the output of the flip flop and the tri state buffer are to as the input. When the both inputs are high that indicates that device is switched ON, then the output of the AND gate goes logic high state. This output is fed to the beep generator unit through switching a transistor. Until you press the key the feedback tone is heard

This feedback tone is heard only when the device is switched ON. While switching OFF the device, this tone is not heard.

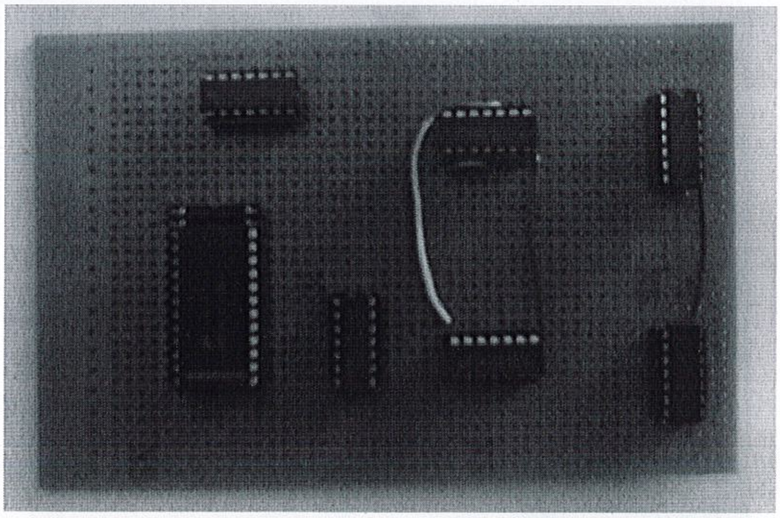

Figure 17 View of Processing module showing various IC's

4.2.4 Output and Relay Driver Module

To carry out the switching of any appliances or devices we commonly use the relays. Since the output of the D flip flop is normally +5V or it is the voltage of logic high state. So we cannot use this output to run the device or appliances. Therefore here we use relays which can handle a high voltage of 230V or more, and a high current in the rate of 10Amps to energize the electromagnetic coil of the relays +5V is sufficient. Here we use the transistors to energize the relay coil. The output of the D flip-flop is applied to the base of the transistor via a resister. When the base voltage of the transistor is above 0.7V the emitter-base (EB) junction of the transistor forward biased as a result transistor goes to saturation region it is nothing but the switching ON the transistor. This intern switches on the relay. By this the device is switches ON. When the output of D flip-flop goes low the base voltage drops below 0.7V as a result the device also switches OFF.

The following figure shows how the Relay driver module looks like on a printed circuit board:

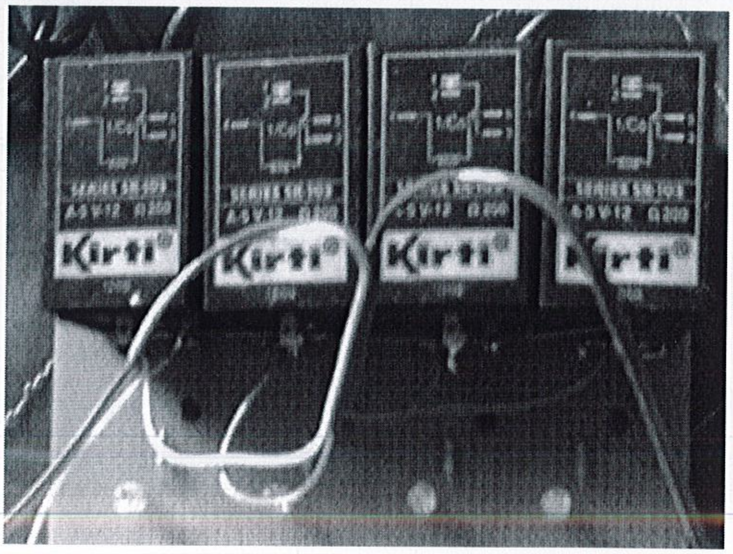

Figure 18 View of Relay driver module

The following figure shows the view of the total circuit mounted on the circuit board and different modules assembled together:

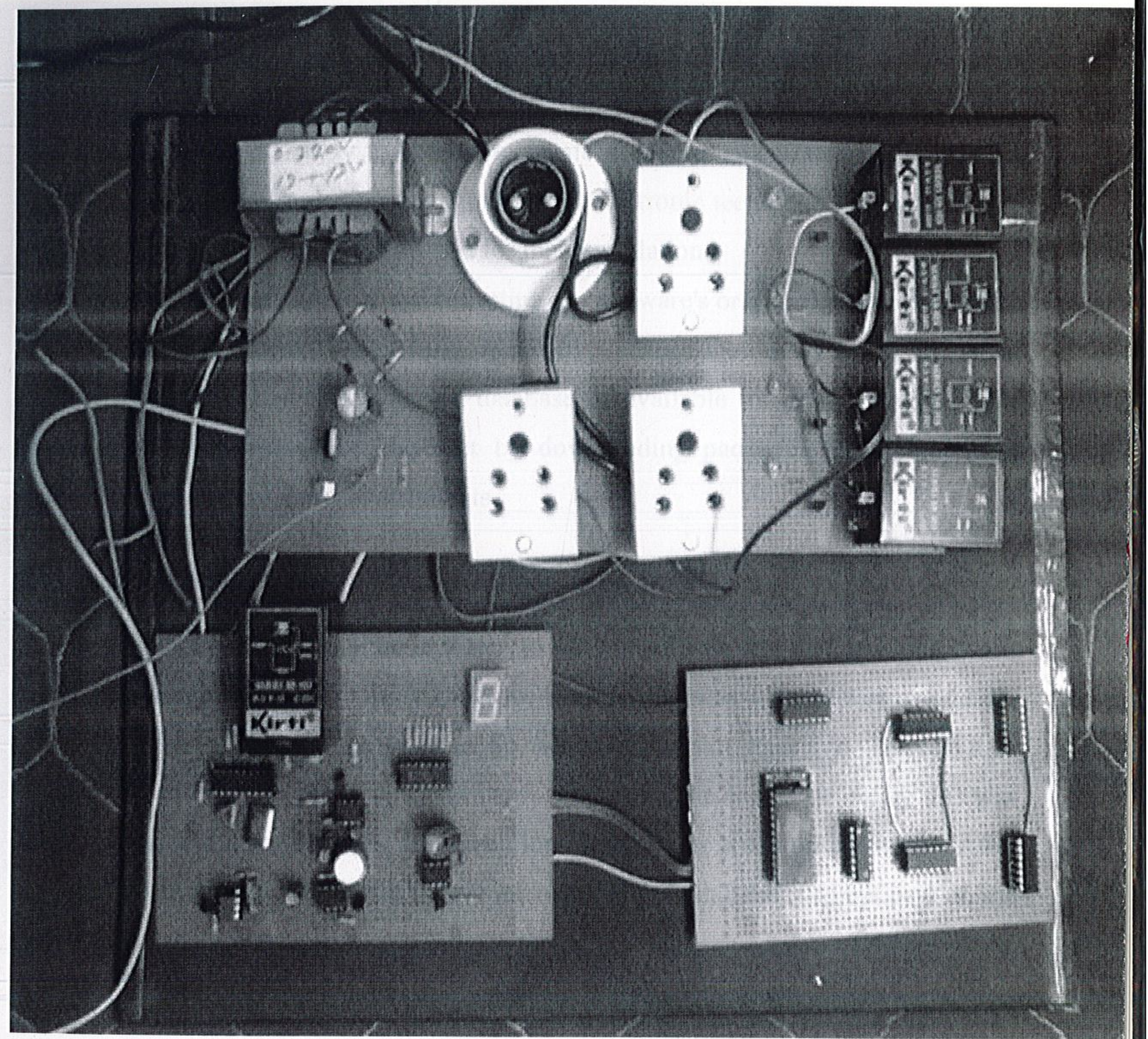

Figure 19 The Complete assembled circuit

CHAPTER 5
SOFTWARE SIMULATION

5.1 Introduction to OrCAD

OrCAD is a software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics and diagrams, and for their simulation.

The name OrCAD is a portmanteau, reflecting the software's origins: **Oregon + CAD**.

The OrCAD product line is fully owned by Cadence Design Systems. The latest iteration has the ability to maintain a database of available integrated circuits. This database may be updated by the user by downloading packages from component manufacturers, such as Texas Instruments.

5.2 Challenges

Software simulation is the best tool to analyze the circuit when it is not on the circuit board. The version of OrCAD that we were having was a demo version and did not supported more than 60 components. So, we had to break circuit into parts and then see how the circuit behaves in different input situations. The challenge before this was to understand and learn the software which took around one week on the whole. After we had a command on the software we implemented each and every component on the software.

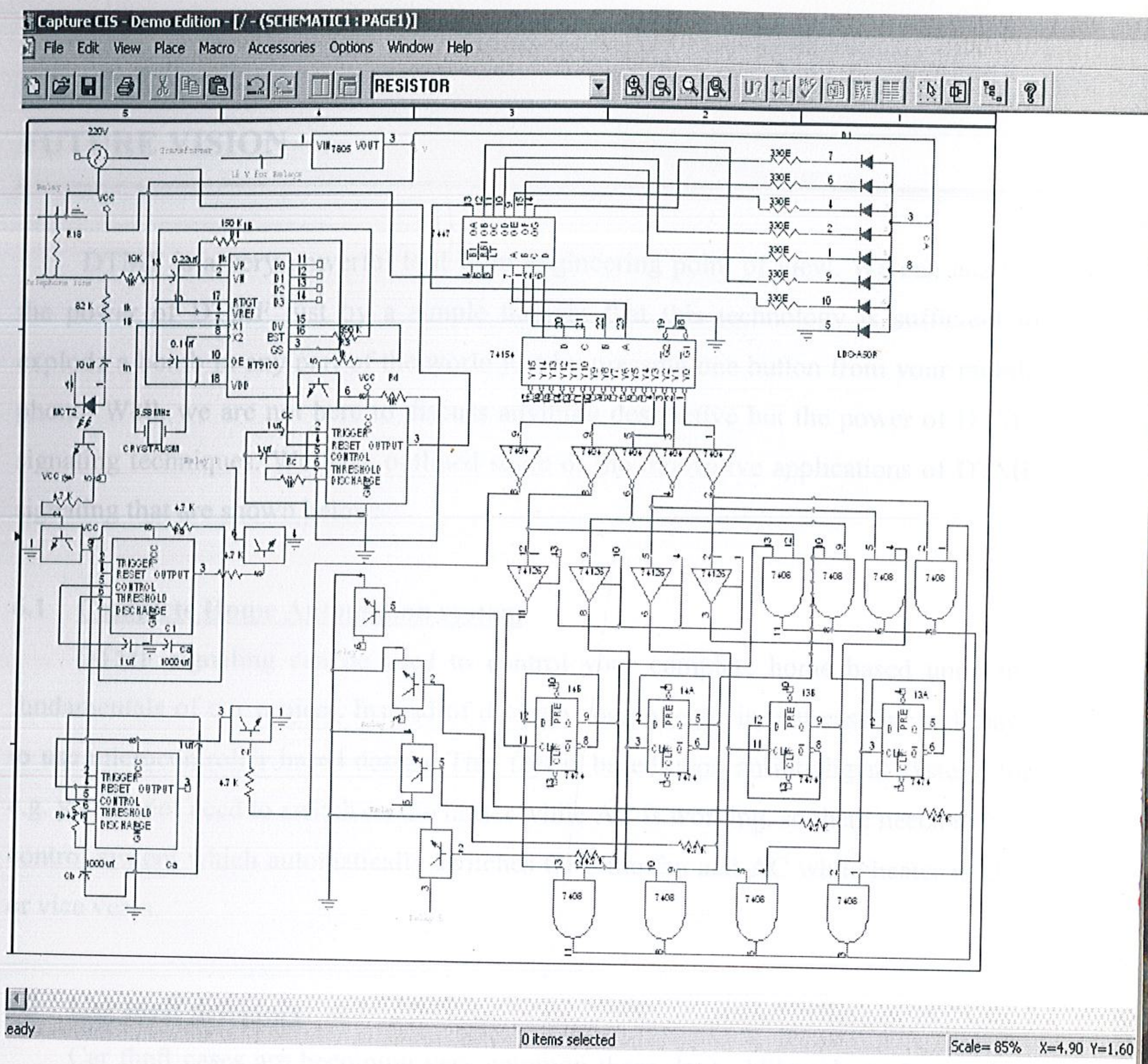

Figure 20 The Circuit on OrCAD

CHAPTER 6
FUTURE VISION

DTMF is a very powerful tool from engineering point of view. We can analyze the power of DTMF just by a simple thought that this technology is sufficient to explode a bomb in any part of the world just by pressing one button from your mobile phone. Well, we are not here to discuss anything destructive but the power of DTMF signaling techniques. We have outlined some of the innovative applications of DTMF signaling that are shown below:

6.1 Complete Home Automation system

DTMF signaling can be used to control your complete home based upon the fundamentals of our project. Instead of discrete components, in that case we will have to use microcontroller based design. This fact is based upon an intelligent system, for e.g. you do not need to switch on the heater while AC is working, so there needs to be a control system which automatically switches OFF the fan and AC while heater is ON, or vice versa.

6.2 Car theft detectors

Car theft cases are becoming very common these days. Although we have other tracking systems like GPS, but they are expensive and currently not very famous in India. DTMF offers a cheap system to ensure the security of your car. This system requires two mobile phones, one in the car and other with the user. Whenever some unauthorized person is trying to open the car illegally, the mobile phone in the car sends a DTMF signal to your mobile phone and you get to know that your car is in danger. This way you can save your car from theft, but it requires some extra circuitry with the mobile phone in the car.

6.3 Speech Recognition Systems

DTMF can be used to identify the choices among the given choices. This has paved a way to IVRS (Interactive Voice Response System). The system reacts on your orders, the way you want it to act.

Speech has transformed this passive DTMF menu structure into a more interactive and natural experience for the caller. Instead of simply listing off the menu items, it asks the caller questions. While this caller managed to remember which number to press for which option, it is very possible that a caller would get confused, need to repeat the options a second time, and start to get frustrated. In general, long and complex menus make it difficult and cumbersome for any caller to a DTMF system to navigate.

6.4 PBEX

By using this project we can construct the personally branched telephone exchange. In many of the PBEX we seen in the offices require one operator to divert the incoming calls to the respective internal telephone line. Here it does not require any such operator to operate this exchange. The person from a remote section is only to press the extension number to get connected to the respective number. In this type of PBEX only 12 extensions can be used.

CONCLUSION

In general conclusion is said to be the end of ideas, but we don't want to put our conclusion in that way. Our idea behind this project was to make use of a very simple and little known technology. By the means of this project we have designed a cheap and economical system by the virtue of which we can make the devices at our home, or any place to work only when we want them to work, even if we are far away from the destination. In order to make the project work efficiently, we divided it into modules (the concept of division of labor). Different modules were tested on the circuit board and on the software as well.

The project serves the basis for even bigger applications such as automatic car theft detector, total home automation system, speech recognition systems and PBEX local exchange. The aim of our effort is to portray that how small and very little known technologies like DTMF can be efficiently utilized for the applications that were never thought of Technology is all about application of science around us and we hope after the completion of this project, the future engineers will find new innovations of the very little known technologies that will pave the way to all new world around us.

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