# DATA AND VOICE COMMUNICATION USING OPTICAL FIBER


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WAKNAGHAT

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# CERTIFICATE

This is to certify that the work titled "**DATA AND VOICE COMMUNICATION USING OPTICAL FIBER**" submitted by "**Anuj Thakur (071111) & Vikas Sharma (071107)**" in partial fulfilment for the award of degree of B. Tech, of Jaypee University of Information Technology; Waknaghat 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.

Signature of Supervisor : ……………………..

Name of Supervisor : Mr. Munish Sood

Designation : Lecturer

Date :

# ACKNOWLEDGEMENT

***"The aim of making the major project is to correlate the theoretical course contents with practical applications of the components and to get to know the degree of one's own capabilities when contributing to the conversion of scientific knowledge into practical results."***

Availing the facility of making the final year's major project provide us an outlook towards the practical electronics world. We came to know about the components, their versions, their versatility among their choice to implement in the project help us to a great deal to make this project successful.

We express our heartfelt thanks to Mr. Munish Sood , who through his expert guidance helped us throughout the course of this project. If it were not his motivation and encouragement, we would not have seen through this project in an honest course to the splendor of success.

Finally, we wish to convey our gratitude to all the faculty members of the Electronics department of our college for providing necessary help and encouragement in the course of completion of this project.

Anuj Thakur ……………………..

Vikas Sharma ……………………..

Date:

# ABSTRACT

Before fiber optics came along, the primary of real-time, reliable data communication was electrical in nature. It was accomplished using copper wire or by transmitting electromagnetic (radio) waves through free space. Fiber optics changed that by providing an alternate means of sending information over significant distances- using light energy.

Light, as utilized for communication, has a major advantage because it can be manipulated (modulated) at significantly higher frequencies than electrical signals. For example, a fiber optic cable can carry up to 100 million times more information that a telephone line! The fiber optic cable had lower energy loss and wider bandwidth capabilities than copper wire.

Fiber optic communication is a quite simple technology, closely related to electronics. Fiber optics became reality when several technologies came together at once. This project simply provides practical demonstration of transferring data and voice through optical fiber. In this demonstration, we will generate data of 4 bits with the help of DTMF encoder and voice signals with the microphone. The data and voice signals produced are converted to optical signals and transferred to the receiver end where it is detected by photo-transistor. The output is amplified and can be seen on seven segment decoder.

Anuj Thakur ………………….    Supervisor: Mr. Munish Sood

Vikas Sharma ………………….    Signature …………………….

Date:

# LIST OF FIGURES

# INTRODUCTION

# Chapter 1
# INTRODUCTION

Communication systems have undergone a fast growth during the last few years, giving rise to a huge support infrastructure. Further developments in the domain of wideband systems are expected to sustain the expansion of this segment of the telecommunication and electronic market, linking it more closely to the world of data communication and Internet. In the next future, a substantial amount of skilled personnel will be engaged in running communication systems both at a network level and in the maintenance and organization of field apparatus. At the same time, short time-to-market is becoming a must for companies engaged in the development and design of communication system hardware, which requires advanced skills in terms of analog and digital design, but also a broad vision of all problems related to the world at large.

The enthusiasm is not mere hype; fiber optic technology is real and important. From coast to coast, phone companies are laying fiber in the ground, pulling cable through manholes and stringing it between poles. The military is buying fiber for portable battlefield communications systems, due to its superior performance. Medical fiber optic systems allow physicians to peer inside the human body without surgery. Very few technologies ever realize he fantastic growth rates predicted for them by market analyst. Fiber optics, however, has exceeded predictions.

As we near the year 2050, fiber optics will become more common in your everyday life. It will enter the office environment. In our home, it will provide services that would have been impractical without it: high-definition TV, secondary education classes in the comfort of your home, a paper-less, environmentally clean "newspaper."
A decade ago, fiber optics was tucked away in the back pages of optics books, and optics was options for senior-level physics majors. Even today, few universities have full –fledged optics programs, and even fewer have fiber optics program alone. Most of today's optics specialists were trained in other fields, typically electronics or physics.

But today, you are not alone in your interest in fiber optics. Interest is increasing as technology advances and begins affecting everyone’s life.

The Optical Voice Link is a project-oriented introduction to optical fiber communications. This booklet contains all the information needed to construction this project including component lists, a section on theory of your design and operation, assembly instructions and simple exercises to increase your knowledge. A list of references, fiber optics glossary and additional projects complement the instruction.

Welcome to the fascinating and expanding world of fiber optics. We hope that you will find the field an exciting and interesting one in which to work and play.

So looking at all the latest trends we have tried to develop a system which is able to remove the limitations of a normal communication system. Therefore we have used fiber optics as the communication media. Some of the salient features of this communication technique are :-

- This method of communication is relatively noise free and transmits the signals over a long range without any appreciable attenuation.
- The size of the optical fibers is very small and their diameter is comparable to the human hair. This helps in reducing the congestion of electrical wires.
- Optical fibers are very good electrical insulators and therefore immune to electrical interference.
- Optical fibers are also free from electromagnetic interference and thus immune to crosstalk.
- The optical fiber provides excellent signal security as one can't simply obtain the information by invading the fiber.
- The optical fibers have high strengths and they can be twisted without any damage.
- The optical fibers are reliable and require less maintenance.
- Also the system where on the one hand is very simple to use and is very cheap. On the other hand this gives a very good accuracy for the data and command communication.

# TECHNOLOGIES USED

# Chapter 2
# TECHNOLOGIES USED

## 2.1 FIBER OPTIC TECHNOLOGY

A fiber-optic system is similar to the copper wire system that fiber-optics is replacing. The difference is that fiber-optics use light pulses to transmit information down fiber lines instead of using electronic pulses to transmit information down copper lines. Looking at the components in a fiber-optic chain will give a better understanding of how the system works in conjunction with wire based systems.

At one end of the system is a transmitter. This is the place of origin for information coming on to fiber-optic lines. The transmitter accepts coded electronic pulse information coming from copper wire. It then processes and translates that information into equivalently coded light pulses. A light-emitting diode (LED) can be used for generating the light pulses.

Light pulses move easily down the fiber-optic line because of a principle known as total internal reflection. "This principle of total internal reflection states that when the angle of incidence exceeds a critical value, light cannot get out of the glass; instead, the light bounces back in. When this principle is applied to the construction of the fiber-optic strand, it is possible to transmit information down fiber lines in the form of light pulses.

There are generally five elements that make up the construction of a fiber-optic strand, or cable: the optic core, optic cladding, a buffer material, a strength material and the outer jacket (Fig. 2.1). The optic core is the light carrying element at the center of the optical fiber. It is commonly made from a combination of silica and germanium. Surrounding the core is the optic cladding made of pure silica. It is this combination that makes the principle of total internal reflection possible.

The difference in materials used in the making of the core and the cladding creates an extremely reflective surface at the point in which they interface. Light pulses entering the fiber core reflect off the core/cladding interface and thus remain within the core as they move down the line.

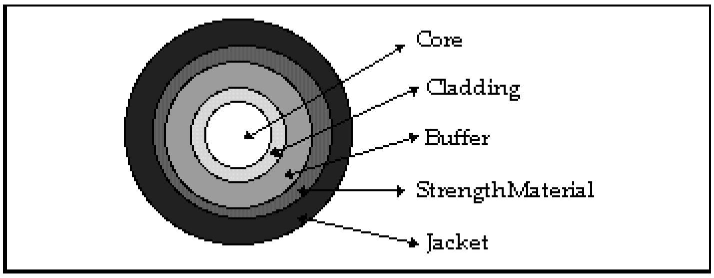


Fig. 2.1 Cut away of a fiber-optic cable.

Surrounding the cladding is a buffer material used to help shield the core and cladding from damage. A strength material surrounds the buffer, preventing stretch problems when the fiber cable is being pulled. The outer jacket is added to protect against abrasion, solvents and other contaminants.

Once the light pulses reach their destination they are channeled into the optical receiver. "The basic purpose of an optical receiver is to detect the received light incident on it and to convert it to an electrical signal containing the information impressed on the light at the transmitting end. The electronic information is then ready for input into electronic based communication devices, such as a computer, telephone or TV.

## 2.1.1 ELEMENTS OF A FIBER OPTIC DATA LINK

Basically, a fiber optic data link contains three main elements: a transmitter, an optical fiber and a receiver. The transmitter takes data previously in electrical form and transforms it into optical (light) energy containing the same information. The optical fiber is the medium which carries the energy to the destination (receiver).At the receiver, light is converted back into electrical form with the same pattern as originally fed to the transmitter by the person who sent the message.

It is important to note that optical energy can be beamed through the air or free space (like a flashlight beam). In fact, there are applications in which communication through air is used when installing optical fiber would be too costly or impractical. The advantages of optical fiber is that is allows light to be routed around corners and transported through obstructions (such as walls in buildings), just as household electrical can telephone wiring do, but with much greater signal-carrying capacity, plus being able to operate at greater distances and on foggy and rainy days.

Also contained kit you have constructed contains all the elements described above with the exception of multiple distribution devices, since it links a single receiver and transmitter. The transmitter and receiver in this kit are analog. This means the sound waves are converted to light to transmit down the fiber and then converted back electrical and acoustic waves at the receiver. We will not digitize the audio sounds and recreate them at the receiver as is done in telephone fiber optic networks.

## 2.1.2 LIGHT: A Review

The operation of an optical fiber depends on the basic principles of optics and the interaction of light with matter. The first step in understanding fiber optics is to review some of the properties of light.

## 2.1.2.1 WAVELENGTH AND PARTICLES

Many of light's properties are explained by thinking of light as an electromagnetic wave. "Light" is a small part of the electromagnetic spectrum . The relationship between light's wavelength and frequency can be seen by Equation 1:

$$\lambda = \frac{C}{f} \qquad \textbf{Eq. 1}$$

Where c is the speed of light and f is frequency.

Light is higher in frequency and shorter in wavelength than the more common AM and FM radio waves. Visible light rages from 380 nanometers, (nm), as far deep violet, to 750 nm, as far deep red. Infrared radiation has longer waves than visible light. Most fiber optic systems operate using infrared light with wavelengths between 750 and 1500nm.

Light also has some particle-like properties similar to electrons. A light particle is called a photon, a discrete unit of energy, but it has no mass. The amount of energy contained by a photon depends on its frequency. The higher the frequency, the higher the energy. The energy, E, in joules, contained by a photon is:

$$E = h \cdot f \qquad \textbf{Eq. 2}$$

Where f is frequency in Hz and h is Planck's constant, which is 6.63 X $10^{-34}$ joule-seconds.

Light's ability to act sometimes as a wave and sometimes as a particle, prompted the famous "wave-particle duality" theory of modern physics. Using both of light's properties is important in fiber optics. For example, many properties of optical fiber vary with wavelength, so the wave description is used. The responsively of optical detectors is best explained by light's particle theory.

### 2.1.2.2 REFRACTIVE INDEX

The most important optical measurement for any optical material is its refractive index (n). Refractive index is the ratio of the speed of light in a vacuum to the speed of light in a material.

$$n = \frac{C_{vacuum}}{C_{material}} \qquad \textbf{Eq. 3}$$

The speed of light through any material is always slower than in a vacuum, so the refractive index is always greater than one. In practice, the refractive index is measured by comparing the speed of light in the material to that in air, rather than in a vacuum. This simplifies the measurements and in most cases does not make any practical difference, since the refractive index of air is very close to that of a vacuum.

## 2.1.3 FIBER MATERIALS

Optical fiber is made from three of materials:

- Glass
- Plastic
- Other

More than 99 percent of all optical fiber used for data communications in the world is made from glass or plastic. The category "other" includes exotic optical materials such as silicon or gallium arsenide, which are used for special ultraviolet or infrared light applications.

Glass has superior optical qualities compared to plastic, but is more expensive, harder to cut and requires special end connections. Glass fiber is typically used for high-data-rate/long-distance transmission and for medical applications because it can be autoclaved and is impervious to body fluids. For lower data rates and distances less than 100 meters, plastic fibers are more economical, easy to terminate and do not require special tools. A very small amount of fiber is a hybrid solution- plastic-cladding glass. The fiber core is high quality glass, with an inexpensive plastic cladding.

## 2.1.4 ATTENUATION

Although fiber has many advantages it is not perfect because a certain amount of light is lost as it travels through the optical fiber. This loss is called ***attenuation***, and it has several causes:

- Absorption by the material.
- Scattering of light out of the fiber core by imperfections.
- Leakage of light form the core caused by environmental factors.

Fiber attenuation is measured by comparing output power with input power. Attenuation of a fiber is most often described in decibels (dB). The decibel is a logarithmic unit, relating the ratio of output power to input power. Loss in decibels is defined as:

$$\text{Loss} = 10 \ \text{Log}_{10} \frac{P_0}{P_1}$$

If the output power from a fiber is 0.001 of the input power, the signal has experienced a 30 dB loss. (The minus sign has been dropped for convenience and is implied on all attenuation measurements.)

A fiber's attenuation is very dependent upon the composition of its core material and the wavelength of light being transmitted. A fiber's attenuation is normalized for a unit length, usually in kilometers. This normalized definition is called a fiber's characteristic attenuation and is accurate for the measured wavelength only.

### 2.1.5 ADVANTAGES OF FIBER OPTICS

Fiber optics has at least eight advantages over conventional copper cables:

- Greater information-carryon capabilities.
- Smaller cable diameter.
- Lighter weight-per-cable length.
- Greater transmission distance.
- Immunity to electrical interference.
- Cables do not radiate energy.
- Greater reliability
- Lower overall cost.

## 2.2 DTMF (Dual Tone Multiple Frequency) TECHNOLOGY

Dual-Tone Multi-Frequency (DTMF) is the generic name for pushbutton telephone signaling equivalent to the Bell System's Touch Tone. DTMF signaling is quickly replacing dial-pulse signaling in telephone networks worldwide. In addition to telephone call signaling, DTMF is becoming popular in interactive control applications, such as telephone banking or electronic mail systems, in which the user can select options from a menu by sending DTMF signals from a telephone. This application note describes a DTMF coding and decoding implementation based on Hyper signal Block Diagram. The DTMF coding is based on two tones used to generate a digit. Two of eight tones can be combined so as to generate sixteen different DTMF digits.

### 2.2.1 DTMF SIGNAL GENERATION

In a DTMF signal generation, a DTMF keypad could be used for digit entry , the resultant DTMF tones are generated mathematically and added together. The values are logarithmically compressed and passed to the receiver. In a DTMF scheme, pairs of tones are used to signal the digits 0 through 9, hash (#), star (*), and the digits A, B, C and D. For each pair, one of the tones is selected from a low group of four frequencies, and the other from a high group of four frequencies. The correct detection of a digit requires both a valid tone pair and the correct timing intervals. The matrix of frequencies used to encode the 16 DTMF symbols is shown in Figure 1. Each symbol is represented by the sum of the two frequencies that intersect the digit.

The row frequencies are in a low band, below 1 kHz, and the column frequencies are in a high band, between 1 kHz and 2 kHz. The digits are displayed as they would appear on a telephone's 4x4 matrix keypad (on standard telephone sets, the fourth column is omitted). The user should note that there are a number of different algorithms possible for generation and detection of DTMF tones; this application note simply describes one manner of doing so.

| | column 1 1209 Hz | column 2 1336 Hz | column 3 1477 Hz | column 4 1633 Hz |
|---|---|---|---|---|
| row 1 697 Hz | 1 | 2 | 3 | A |
| row 2 770 Hz | 4 | 5 | 6 | B |
| row 3 852 Hz | 7 | 8 | 9 | C |
| row 4 941 Hz | * | 0 | # | D |

**Figure 2.2 Row and column frequencies**

## 2.2.2 DECODING

Decoding a DTMF signal involves extracting the two tones in the signal and determining from their value the intended DTMF digit. Tone detection is often done in analog circuits by detecting and counting zero-crossings of the input signal. In digit circuits, tone detection is easier to accomplish by mathematically transforming the input time-domain signal into its frequency-domain equivalent by means of the Fourier transform, or through use of tone-specific digital filters.

The general approach taken by this algorithm for DTMF tone detection is to take the Fourier transform of the observed signal and search for energy at the frequencies of interest. Since the algorithm is implemented by Discrete Fourier Transform (DFT). The analysis frame must be long enough to resolve the DTMF frequencies, but short enough to detect the minimum length tone. A 12.75 ms frame at a sampling rate of 8 kHz is good choice. In calculating the DFT, the Goertzel algorithm, a method for calculating any single coefficient of a DFT, is chosen over a fast Fourier transform (FFT) algorithm. There are two reasons for this.

## 2.2.3 How does it work?

When you press the buttons on the keypad, a connection is made that generates two tones at the same time. A "Row" tone and a "Column" tone. These two tones identify the key you pressed to any equipment you are controlling. If the keypad is on your phone, the telephone company's "Central Office" equipment knows what numbers you are dialing by these tones, and will switch your call accordingly. If you are using a DTMF keypad to remotely control equipment, the tones can identify what unit you want to control, as well as which unique function you want it to perform.

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 697 Hz |
| 4 | 5 | 6 | 770 Hz |
| 7 | 8 | 9 | 852 Hz |
| * | 0 | # | 941 Hz |
| 1209 Hz | 1336 Hz | 1477 Hz | |

When you press the digit 1 on the keypad, you generate the tones 1209 Hz and 697 Hz. Pressing the digit 2 will generate the tones 1336 Hz and 697 Hz.

Sure, the tone 697 is the same for both digits, but it take two tones to make a digit and the equipment knows the difference between the 1209 Hz that would complete the digit 1, and a 1336 Hz that completes a digit 2.

# MODULES OF THE PROJECT

Chapter 3

# MODULES OF THE PROJECT

There are 2 different modules of the project :

1 1. Data Communication

2 2. Voice Communication

## 3.1 DATA COMMUNICATION

The data communication through an optical fiber consists of a switch panel. When the user presses any particular switch (for example :- switch no 5) then the DTMF encoder IC UM 91215B will generate a unique pair of frequencies which will be passed to the optical source as the input and accordingly the signals of different frequencies for different keys, from the transmitter is passed through the fiber . This code sequence will be fed to an LED which will emit the light according to the sequence generated i.e. it will turn on for logic 1 and turn off for logic 0.

Then this light signal is transmitted to the receiver side, where it is reproduced as an electrical signal through a phototransistor or photodiode.

On the receiver side the received signals of different frequencies from the optical sensor is passed to the DTMF decoder IC 8870 which will convert it to BCD signal. These BCD signals are passed to the seven segment driver IC 7447 which will drive the seven segment display.

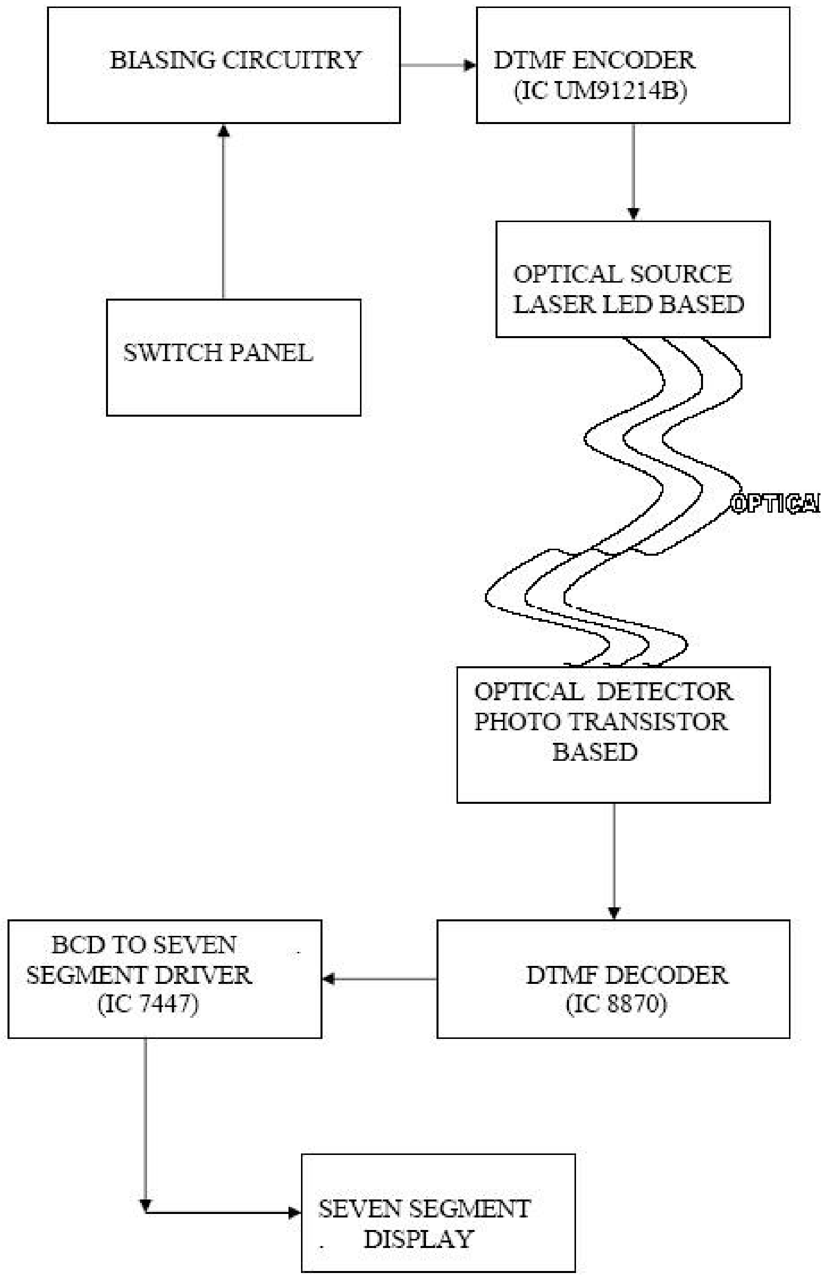


Fig. 3.1 Block diagram of data communication.

Now whenever a person presses a particular key suppose it to be 5 from the keypad then from the transmitter side a signal of particular frequency is generated by UM91215B which is further given to the optical source then this light signal is transmitted to the receiver side, where it is given to seven segment display after decoding from the IC 8870 and then passing through IC 7447, which will then show 5 as its output.

## 3.2 VOICE COMMUNICATION

In the process of voice communication through an optical fiber, on the transmitter side, we use voice as the input signal. This signal is converted to an electrical signal through a condenser MIC. This electrical signal is processed by a modulator circuit and fed to an optical source which is an laser LED .The light signal from the LED varies according to the intensity of the voice signal .The more louder you speak, the glow of the LED will be more. Then the light signal is transmitted over an optical fiber to the receiver side. At this end a photo transistor or photodiode receives the light signal and correspondingly generates an electrical signal proportional to it. This electrical signal is processed by a demodulator circuit, which is then fed to a speaker and it produces the audio signal which was at the input of the transmitter side.

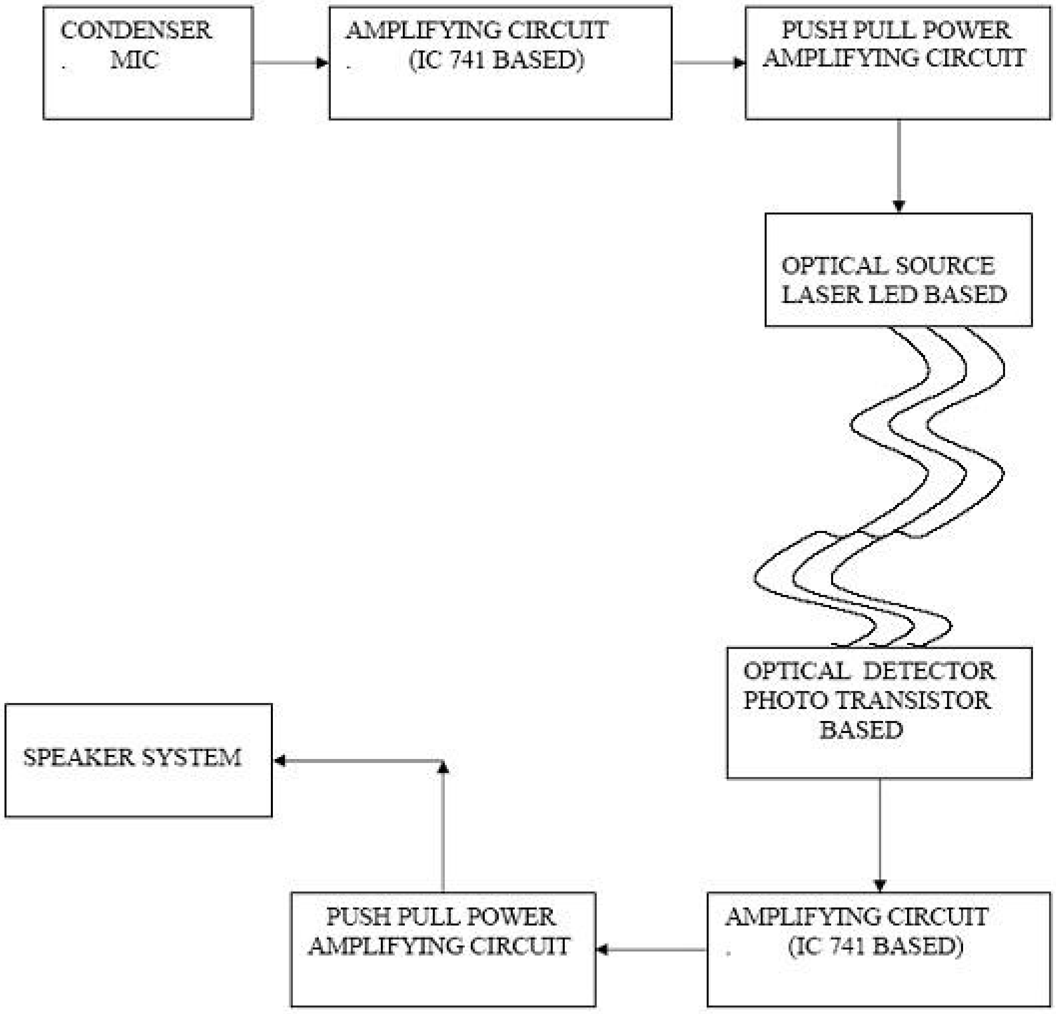


Fig. 3.2 Block diagram of voice communication.

# ***BLOCK DIAGRAM***

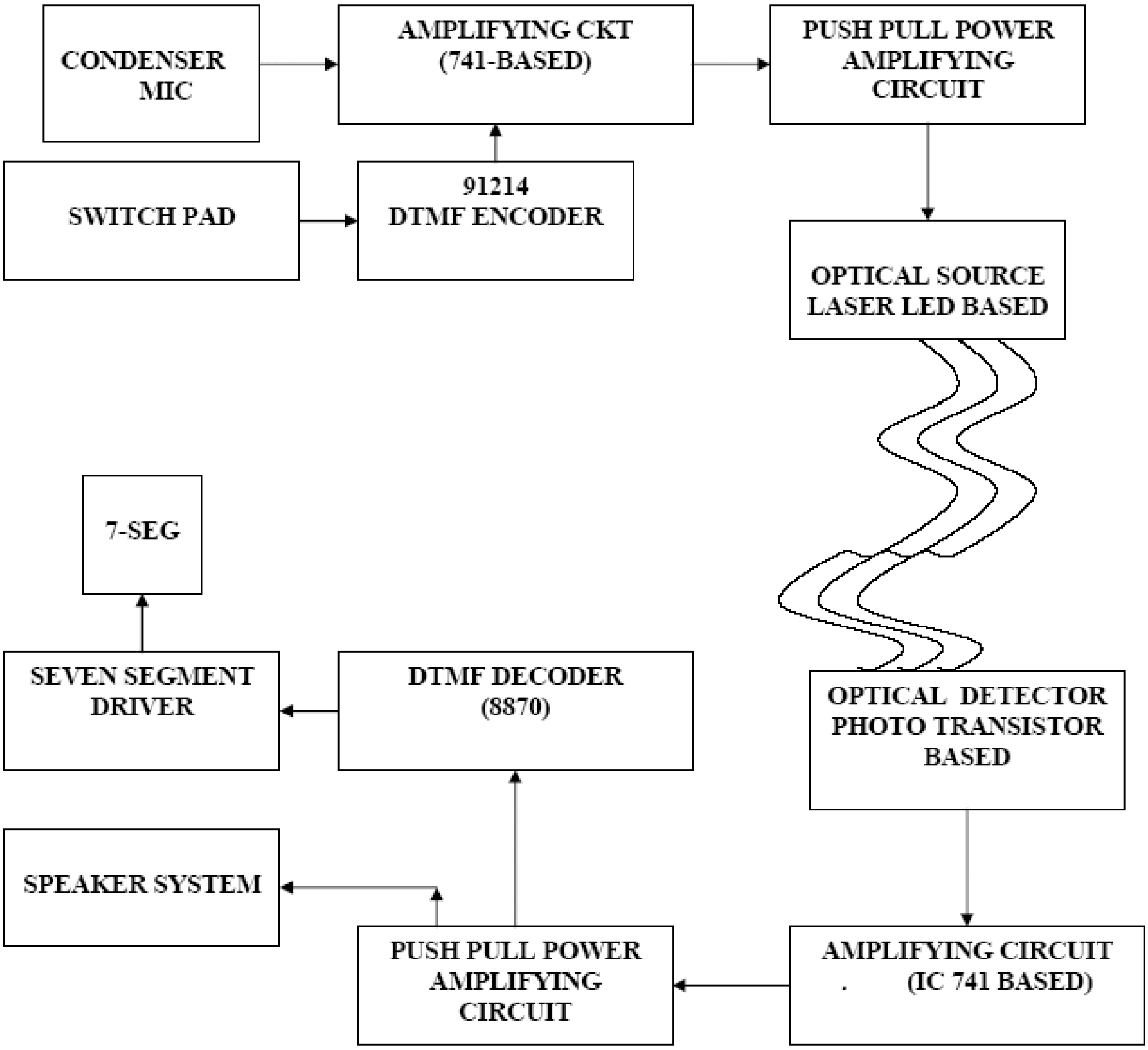


Fig. 3.3 Data and voice communication

# DETAILED EXPLANATION

Chapter 4

# DETAILED EXPLANATION

## 4.1 DATA COMMUNICATION

In this module we show the working of the optical fiber with the help of DTMF encoder (IC-UM91214B), DTMF decoder(IC-8870),Seven segment driver (IC-7447),seven segment display and two amplifier circuits . In this module we transmit the data in analogue form. Firstly we convert the data signal into light signal having different frequencies for different signals. This light signal is coupled to the optical fiber and end of the optical fiber is connected to photodiode. Photodiode convert the light signal into electrical signal and this electrical signal is now reproduced in to data signal with the help of DTMF decoder, seven segment drivers and using seven segment display.
In this project we use IC 741 as a amplifier component. Pin no 7 of the IC is connected to the positive supply. Pin no 4 of the IC is connected to the negative supply. Pin no 6 is output pin. Pin no 2 and 3 is input pin.

Positive and negative voltage is supply to the IC through battery. In this project we use 9-volt dc voltage as a supply voltage. Pin no 3 is act as a reference voltage pin, for this purpose we connect two resistance to pin no 3 via positive terminal and negative terminal. Input signal is applied to the
pin no2 via capacitor and input resistance. Input signal is applied to the DTMF encoder (UM91215B) at its input pins then according to the input given to the encoder the output is generated. The frequency of output signal will be different according to the input given to it. For each key pressed from the keyboard or from the switch panel there will be different frequency signals generated from the output. There are two frequencies for each key pressed.
These frequencies are as follows:-

For key 1 697Hz and 1209Hz
For key 2 697Hz and 1338Hz
For key 3 697Hz and 1477Hz
For key 4 770Hz and 1209Hz
For key 5 770Hz and 1338Hz
For key 6 770Hz and 1477Hz
For key 7 852Hz and 1209Hz
For key 8 852Hz and 1338Hz
For key 9 852Hz and 1477Hz

This output of the DTMF encoder is connected to the pin no 2 of the IC -741.This electrical signal is coupled to the pin no. 2 via capacitor and resistance. Here capacitor works as a DC blocking capacitor and pass only AC signal from the DTMF decoder. This input signal after coupling to the pin no2 is amplified by the IC 741 and available on the pin no 6. Here we connect a one feedback resistance between pin no 6 and pin2. This resistance is work as a feedback resistance. Feedback resistance acts as a very important part in this amplifier. After increasing the value of this resistance we change the level of the input signal. Now output from the pin no 6 is coupled to the two transistor circuit. Here both transistor works as push pull amplifier network circuit.

Output of the transistor is connected to the L.E.D through one resistance. Now sound is converted into light with the help of this L.E.D Variations in the intensity of the light is as per the frequencies generated by the DTMF encoder. We coupled this light of the LED to the optical fiber in proper way. We connect it in optical fiber, so that all the light is passed through the optical fiber to other end.

Now optical fiber is connected to the photodiode in proper way, so that all the light is from optical fiber is connected to the photodiode is not wasted. Photodiode is light sensitive component. Photodiode convert this light into the small voltage. This small electrical signal is coupled to the pin no 2 of the IC. Here again we use one operational amplifier as a amplifier circuit. Pin no 7 of this IC is connected to the positive. Pin no 4 is connected to the negative voltage. Pin no 6 is the output pin. Electrical signal amplify by the IC is available on the pin no 6. Output from the IC is again amplified by the push-pull amplifier circuit.

Output from the push pull amplifier is now connected to the DTMF decoder via capacitor. We use capacitor to block the dc voltage from the IC and pass only AC signal to the DTMF decoder. Now the frequency of signal received from the optical fiber and then amplified by the push pull amplifier depends upon the frequency of the light emitted by the source. Now this frequency is determined by the switch you pressed or the key you pressed from the transmitter. For each key DTMF encoder (UM91214B) will produce a different frequency signal for example if we press '1' from the keyboard then the frequency generated by the DTMF encoder will be 697 Hz and then it will be 1209 Hz and if somebody has pressed the key '2' then the frequency generated by the DTMF encoder will be 770Hz first and then it will be 1336 Hz.
Same are the frequencies of the signals which are the output of the push-pull amplifier now this output is fed to the input pins of the DTMF decoder (IC 8870) which will check the frequency of the input given to it and produce a BCD code as its output from the output pins.

Now the pin no 2 and 3 are the input pins of the decoder where the output from the push pull amplifier is connected now when a person press any key from the transmitter side the corresponding light signal of a particular frequency is transmitted as well as received at the receiver and accordingly the signal input to the DTMF decoder will have a particular frequency signal. Now it will check the input signal frequency fed to it and generate the BCD code accordingly for exp if someone presses the 1 then it will produces "0001" at its output pins. Pin no 11, 12, 13 and 14 are the output pins which are actually the BCD output.

These BCD no are then passed to the seven segment driver (IC-7447) which is then connected to the seven segment display at its output. Seven segment driver IC will produce output according to the BCD input given to it .Pin no 1,2,6 and 7 will act as the input pins and the pin no 9,10,11,12,13,14 and 15 will act as the O/P pins a few of this pins gets high according to the input given to the IC 7447 which will drive only that segments of the seven segment display which are necessary to show the decimal number equivalent to the BCD number passed to it at its I/P.

## 4.2 VOICE COMMUNICATION

In this model we show the working of the optical fiber with the help of two-amplifier circuit. In this model we transmit the data in analogue form. Firstly we convert the sound signal into light signal. This light signal is coupled to the optical fiber and end of the optical fiber is connected to photodiode. Photodiode convert the light signal into electrical signal and this electrical signal is now reproduced in to sound signal with the help of amplifier and speaker.

In this project we use IC 741 as a amplifier component. Pin no 7 of the IC is connected to the positive supply. Pin no 4 of the IC is connected to the negative supply. Pin no 6 is output pin. Pin no 2 and 3 is input pin.

Positive and negative voltage is supply to the IC through battery. In this project we use 9-volt dc voltage as a supply voltage. Pin no 3 is act as a reference voltage pin, for this purpose we connect two resistance to pin no 3 via positive terminal and negative terminal. Input signal is applied to the pin no2 via capacitor and input resistance. Input signal is applied to the pin no2 through condenser mike. Condenser mike converts the sound signal into small electrical signal. This electrical signal is coupled to the pin no 2 via capacitor and resistance. Here capacitor works as a DC blocking capacitor and pass only AC signal from the mike. This input signal after coupling to the pin no2 is amplified by the IC 741 and available on the pin no 6. Here we connect a one feedback resistance between pin no 6 and pin2. This resistance is work as a feedback resistance. Feedback resistance acts as a very important part in this amplifier. After increasing the value of this resistance we change the level of the sound. Now output from the pin no 6 is coupled to the two transistor circuit. Here both transistor works as push pull amplifier network circuit.

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# COMPONENTS REQUIRED AND CIRCUIT DIAGRAM

Chapter 5

# COMPONENTS REQUIRED AND CIRCUIT DIAGRAM

## 5.1 TRANSMITTER

*Semiconductors: -*

IC1 UM91215B

IC2 741

T1 548 NPN

T2 558 PNP

ZD1 3.2V Zener Diode

*Resistors: -*

R1 150K

R2 27K

R3, R4, R6 10K

R5 1K

R7 470K

VR1 10K

*Capacitors: -*

C1 100uF 2.5V

C2 .04

C3 1000uF

*Miscellaneous:-*

Crystal 3.58 MHz

S1 DPDT Switch

Condenser Mic

LED Infrared (Tran.)

## 5.2 RECEIVER

*Semiconductors: -*

IC1 741

IC2 CM 8870

IC3 7447

IC4 7805

T1 548 NPN

T2 558 PNP

FND DIS 542

*Resistors: -*

R1-R5 10K

R6, R7 100k

R8 330K

R9-R16 470K

VR1 100K

*Capacitors: -*

C1 .04

C2 1000uF

C3 470uF

C4 47uF

C5, C6 .1uF

*Miscellaneous:-*

Crystal 3.58 MHz

Speaker

IR LED (Rec.)

## 5.3 Circuit Diagram Of Transmitter

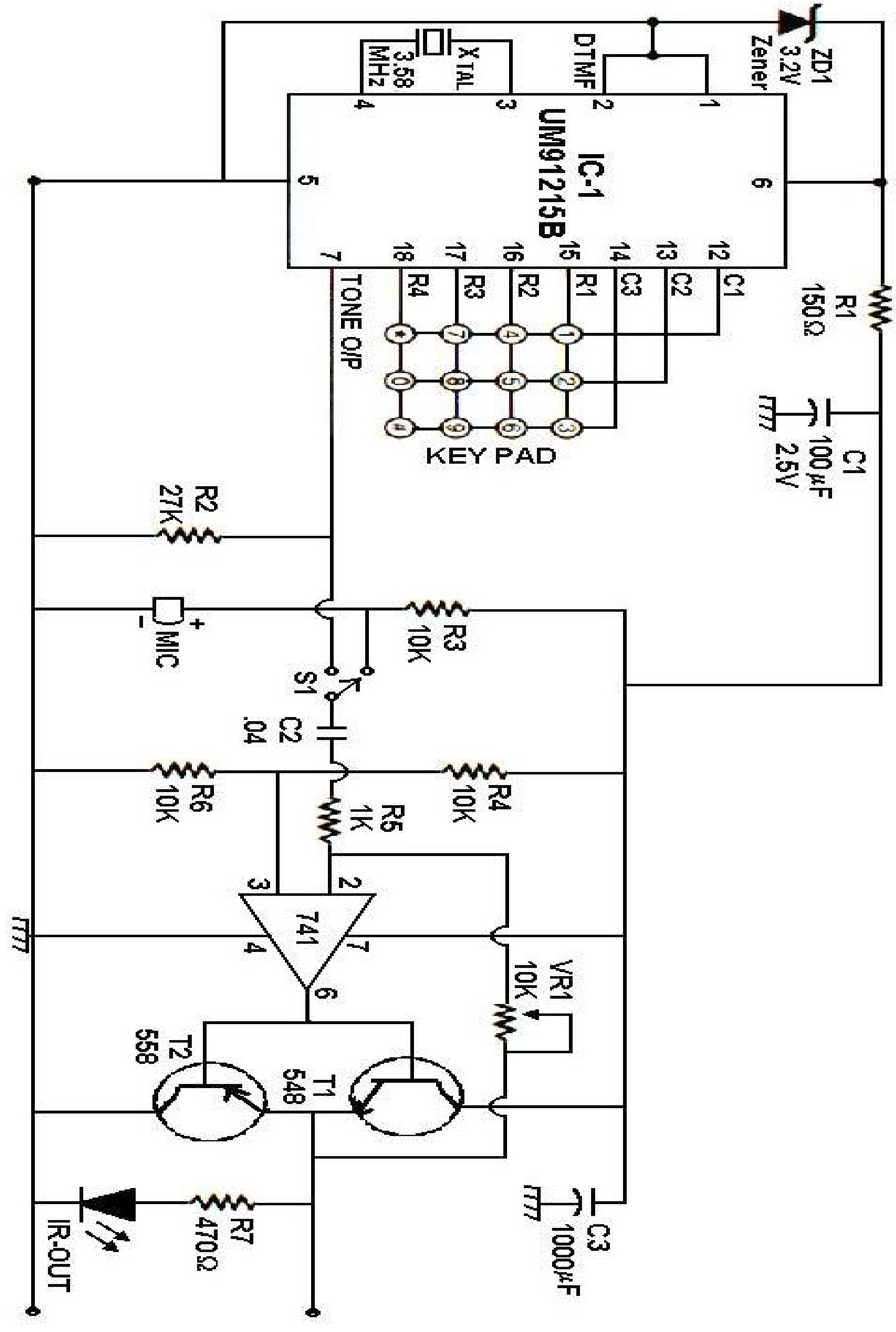



Fig 5.1 Circuit diagram of the transmitter transmitting data and voice (one at a time).

## 5.4 Circuit Diagram Of Receiver

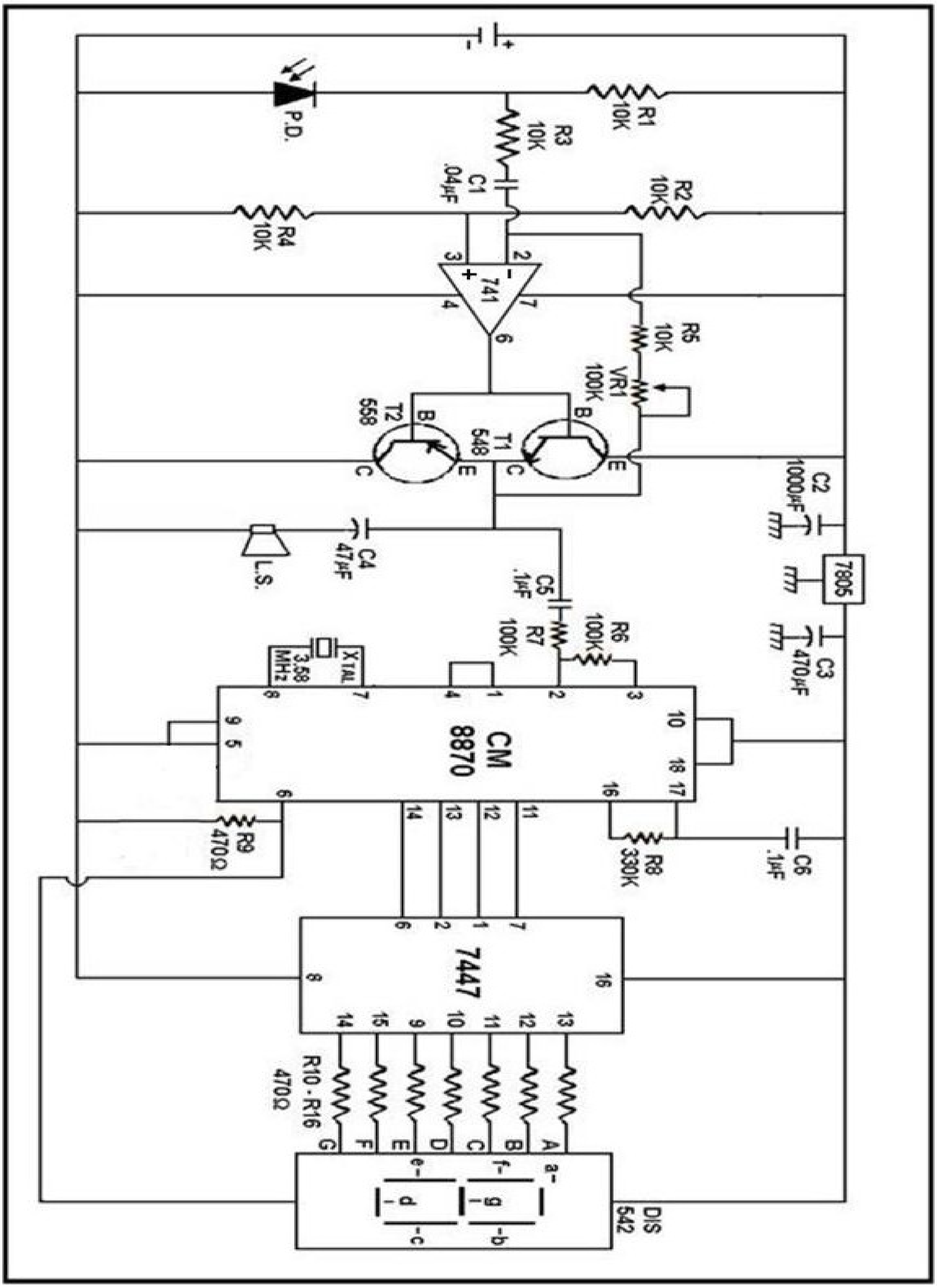



Fig. 5.2 Circuit receiving signals through optical fiber and giving output through loudspeaker and seven segment decoder.

# COMPONENTS USED IN DETAILS

Chapter 6

# COMPONENTS USED IN DETAILS

## 6.1 DUAL TONE MULTIPLE FREQUENCY (DTMF) ENCODER (UM91215B)

Fig.6.1 shows the circuit diagram of the remote control unit. Its main parts are a DTMF dialer IC UM91215B (IC1). For any depressed key, the corresponding DTMF tone output is available at pin 7 of IC1. This tone is given as input signal to the desired circuit (either Infrared remote or FM transmitter).

9V battery is used for the remote control unit. However, the DTMF dialer IC requires only 3V for its operation, which is derived with the help of a zener diode voltage regulator.

The DTMF encoder IC UM91215B is commonly used as a dialer IC in telephones. Its function is to generate the DTMF tones corresponding to the depressed key.

For its time base the UM91215B requires a quartz crystal of 3.58 MHz, which is connected between pin 3 and 4 of the IC to form part of an internal oscillator. The oscillator output is converted into appropriate DTMF signals through frequency division and mixing by control logic.

The keyboard interfacing section interfaces the matrix type keyboard with the control logic. Pins 15 through 18 are row pins and pins 12 through 14 are column pins. Up to 12 switches are possible with this key array. They represent digits 1 through 9, 0, and symbols * and # (used for special functions). To find out the dual tones associated with each digit, you can easily read the low and high group tones associated with each key. The fourth column corresponding to 1633Hz frequency is not applicable to IC UM91215B.

IC UM91215B also incorporates a 20-digit dialed number memory. This feature of the IC is not used in the present remote control system. The memory unit and read/write pointer logic is controlled by the control logic. The DTMF tones are obtained from pin 7 of the IC. The IC also has some control inputs that are not used in its present application.

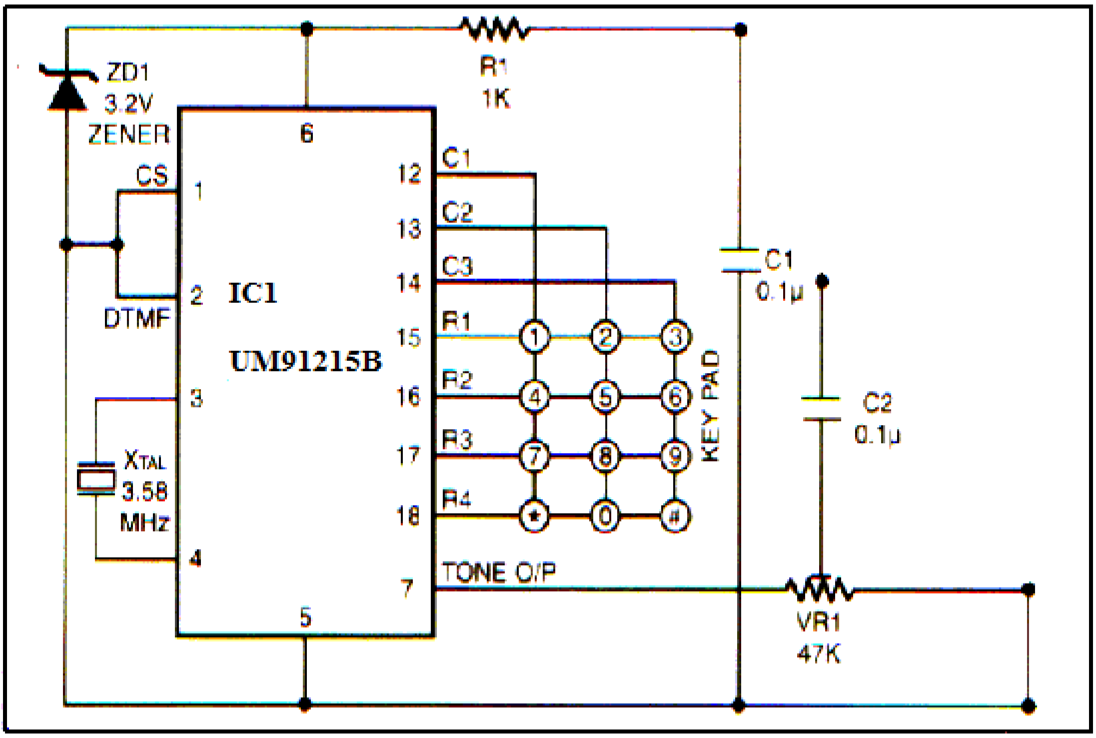



Fig.6.1 Circuit Diagram of DTMF Encoder

## 6.2 DTMF DECODER (MT8870)

The MT8870 is a single-chip DTMF receiver incorporating switched capacitor filter technology and an advanced digital counting/averaging algorithm for period measurement. The functional block diagram of Fig. 4 depicts the internal working of this device.

The DTMF signal is first buffered by an input op-amp that allows adjustment of gain and choice of input configuration. The input stage is followed by a low-pass RC active filter, which performs anti-aliasing function. A third-order switched capacitor notch filter then rejects dial tone at 350 and 440 Hz. The signal is still in its composite form and is split into its individual components by two 6th -order switched capacitor band-pass filters. Each component is smoothed by an output filter and squared by a hard limiting comparator. The two resulting rectangular waveforms are then applied to a digital circuit, where a counting algorithm measures and averages their periods. An accurate reference clock is derived from an inexpensive external 3.58MHz crystal.

The time required to detect a valid tone pair, tDP, is a function of decode algorithm, tone frequency, and the previous state of the decode logic. ESt (early steering output) indicates that two tones of valid frequency have been detected and initiates an RC timing circuit. If both tones are present for a minimum guard time, determined by an external RC network, the DTMF signal is decoded and the resulting data is latched on the output register. The delayed steering output (StD) is raised to indicate that new data is available. The output corresponding to each key pressed is shown in the truth table.

MT8870 OUTPUT TRUTH TABLE

| FLOW | FHIGH | KEY | TOE | Q4 | Q3 | Q2 | Q1 |
|---|---|---|---|---|---|---|---|
| 697 | 1209 | 1 | 1 | 0 | 0 | 0 | 1 |
| 697 | 1336 | 2 | 1 | 0 | 0 | 1 | 0 |
| 697 | 1477 | 3 | 1 | 0 | 0 | 1 | 1 |
| 770 | 1209 | 4 | 1 | 0 | 1 | 0 | 0 |
| 770 | 1336 | 5 | 1 | 0 | 1 | 0 | 1 |
| 770 | 1477 | 6 | 1 | 0 | 1 | 1 | 0 |
| 852 | 1209 | 7 | 1 | 0 | 1 | 1 | 1 |
| 852 | 1336 | 8 | 1 | 1 | 0 | 0 | 0 |
| 852 | 1477 | 9 | 1 | 1 | 0 | 0 | 1 |
| 941 | 1209 | 0 | 1 | 1 | 0 | 1 | 0 |
| 941 | 1336 | * | 1 | 1 | 0 | 1 | 1 |
| 941 | 1477 | # | 1 | 1 | 1 | 0 | 0 |
| 697 | 1633 | A | 1 | 1 | 1 | 0 | 1 |
| 770 | 1633 | B | 1 | 1 | 1 | 1 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 852 | 1633 | C | 1 | 1 | 1 | 1 | 1 |
| 941 | 1633 | D | 1 | 0 | 0 | 0 | 0 |
| ---- | ANY | | 0 | Z | Z | Z | Z |

|---------------------------------------------------|

|TOE is three-state output-enable input at pin 10 of the IC|

|---------------------------------------------------|

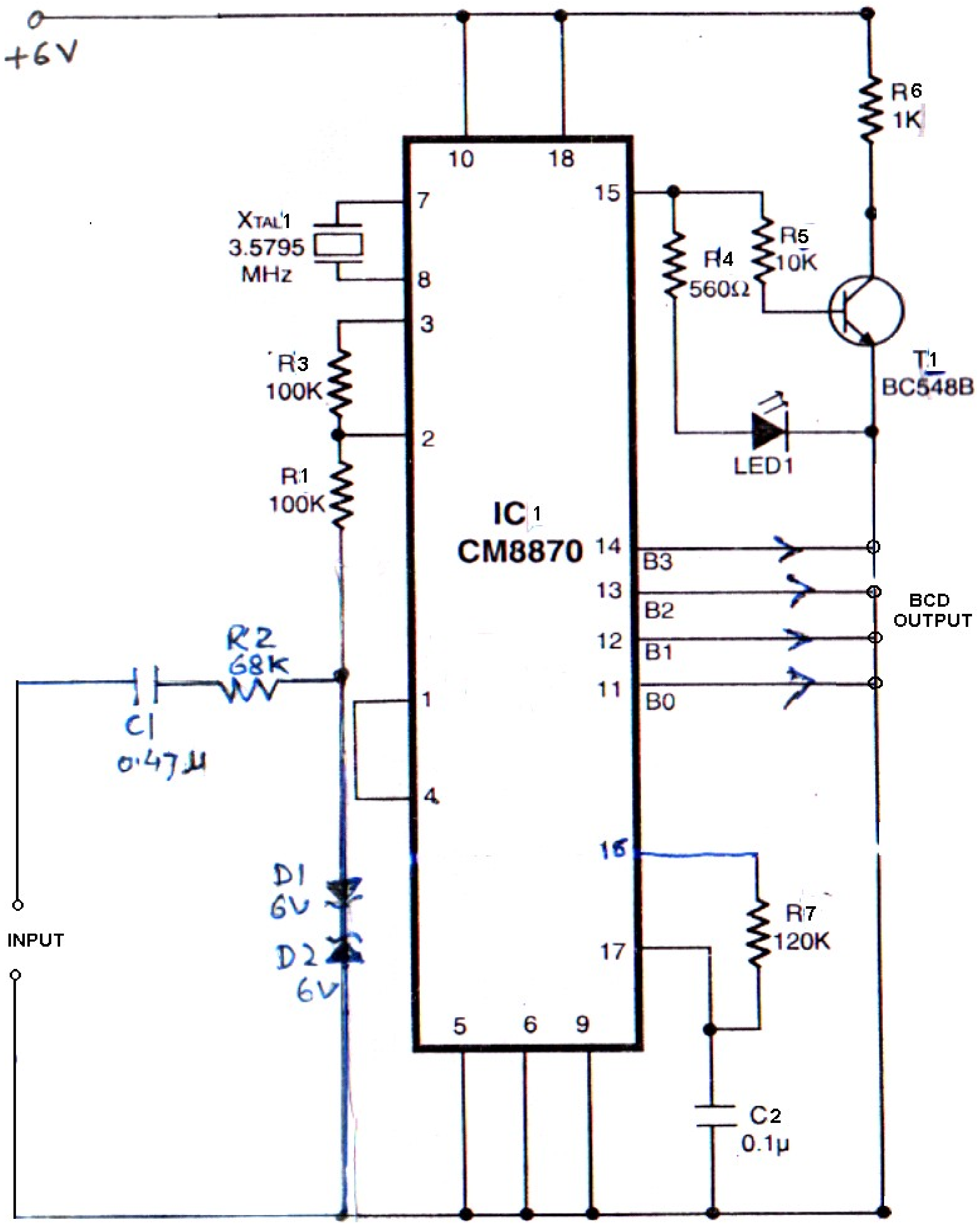


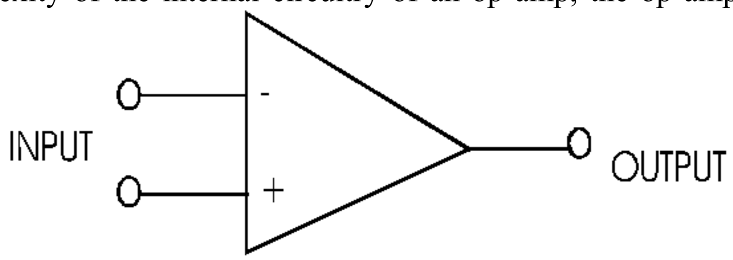

Fig.6.2 Circuit Diagram of DTMF Decoder

## 6.3 OPERATIONAL AMPLIFIER : INTRODUCTION

An op amp is a high-gain, direct-coupled differential linear amplifier whose response characteristics are externally controlled by negative feedback from the output to the input. OP amps, widely used in computers, can perform mathematical operations such as summing, integration, and differentiation. OP amps are also used as video and audio amplifiers, oscillators, etc. in the communication electronics. Because of their versatility op amps are widely used in all branches of electronics both in digital and linear circuits.

OP amps lend themselves readily to IC manufacturing techniques. Improved IC manufacturing techniques, the op amp's adaptability, and extensive use in the design of new equipment have brought the price of IC ops amps from very high to very reasonable levels. These facts ensure a very substantial role for the IC op amp in electronics.

Fig shows the symbol for an op amp. Note that the operational amplifier has two inputs marked (-) and (+). The minus input is the inverting input. A signal applied to the minus terminal will be shifted in phase 180° at the output. The plus input is the non-inverting input. A signal applied to the plus terminal will appear in the same phase at the output as at the input. Because of the complexity of the internal circuitry of an op amp, the op amp symbol is used exclusively in circuit diagrams.




### 6.3.1 IC-741

An operational amplifier often referred to as op Amp, is a very high gain high performance amplifier designed to amplify ac and dc signal voltages. Modern integrated circuit technology and large-scale production techniques have brought down the prices of such amplifiers within reach of all amateurs, experimenters and hobbyists. The Op Amp is now used as a basic gain element, like an elegant transistor, in electronic circuits.

A symbol used to represent an operational amplifier in schematics is shown in fig. The operational amplifier has two inputs and only one output. One input is called the inverting input and is denoted by a minus sign. A signal applied to this input appears as an amplified but phase inverted the signal output. The second input is called a non-inverting input and is denoted by a plus sign. A signal applied to this input appears at the output as an amplified signal, which has the same phase as that of the input signal.

The availability of two input terminals simplifies feedback circuitry and makes the operational amplifier a highly versatile device. If a feedback is applied from the output to the inverting input terminal, the result is a negative feedback, which gives a stable amplifier with precisely controlled gain characteristics. On the other hand, if the feedback is applied to the non-inverting input, the result is positive feedback, which gives oscillators and multi-vibrator. Special effects are obtained by combination of both types of feedback.

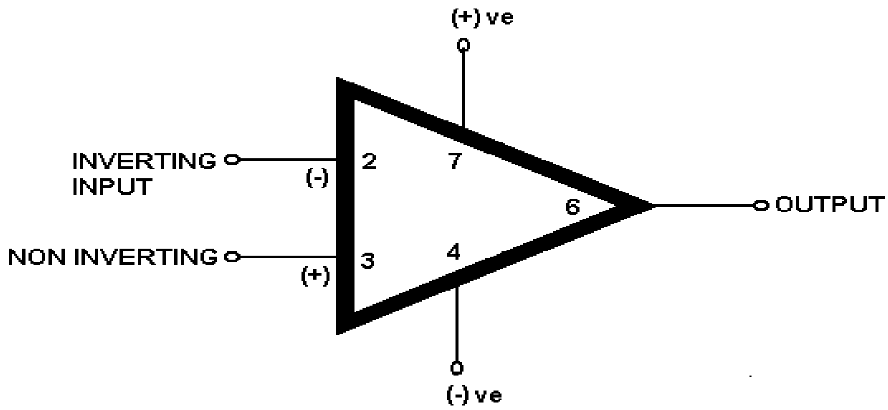



Fig. 6.3 NEGATIVE FEEDBACK CONTROL

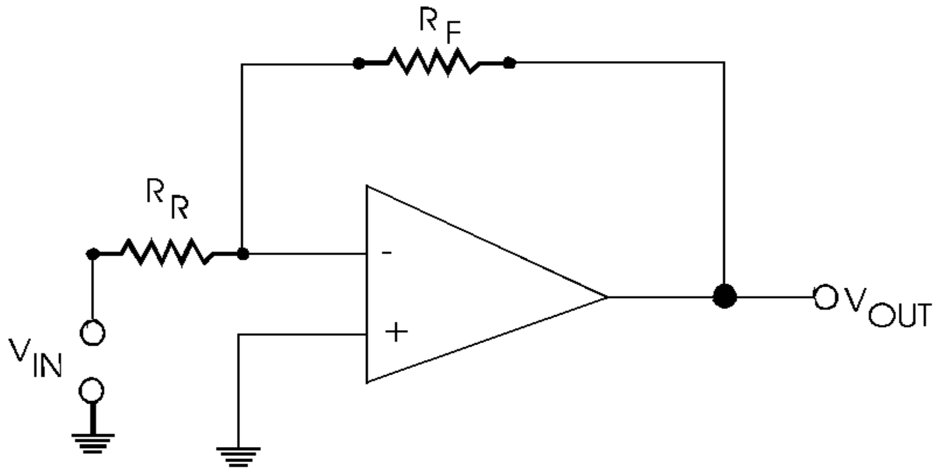



Fig. 6.4 IC 741 connected in inverting mode.

The above figure shows the basic circuit, including the negative feedback loop of an op amp. The output is fed back to the inverting input terminal in order to provide negative feedback for the amplifier. The input signal is applied to the inverting input. As a result, the output will be inverted. It is possible to operate the op amp as a non-inverting amplifier by applying the signal to the plus input. In this circuit the feedback network is still connected to the inverting input.

For the circuit of op amp showing negative feedback loop, the output of the amplifier is defined as

$$V_{out} = \frac{-R_F}{R_R} V_{in}$$

$$\frac{V_{out}}{V_{in}} = +\left(1 + \frac{R_F}{R_R}\right)$$

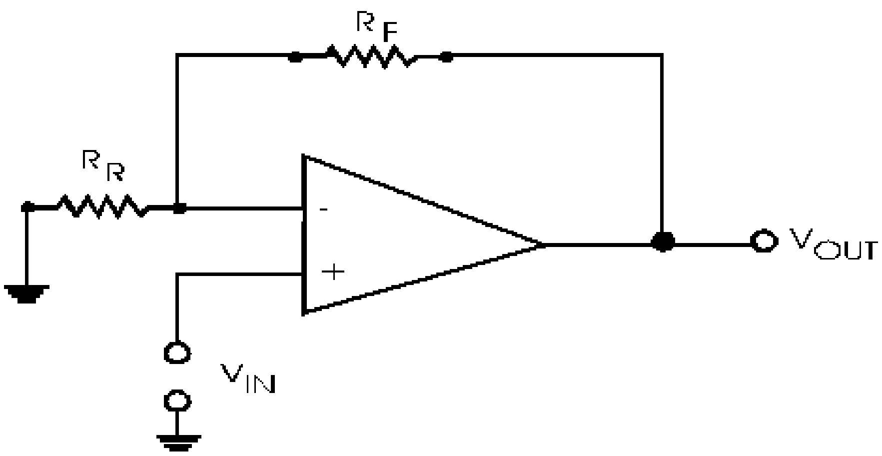



Fig. 6.5 OP AMP OPERATED AS NONINVERTING AMPLIFIER

The minus sign indicates that the sign of the output is inverted as compared to the input. The equation for the gain of this amplifier is

$$Gain = \frac{R_F}{R_R}$$

For the non-inverting amplifier

$$V_{out} = \left(1 + \frac{R_F}{R_R}\right) V_{in}$$

and its gain is

$$1 + \frac{R_F}{R_R}$$

Equations indicate that the output voltage is dependent only on the ratio of the feedback resistors $R_F$ and $R_R$ and that the gain of the op amp is dependent only on these resistors.

## 6.4 CRYSTAL OSCILLATORS

Crystal oscillators are oscillators where the primary frequency determining element is a quartz crystal. Because of the inherent characteristics of the quartz crystal the crystal oscillator may be held to extreme accuracy of frequency stability. Temperature compensation may be applied to crystal oscillators to improve thermal stability of the crystal oscillator.

Crystal oscillators are usually, fixed frequency oscillators where stability and accuracy are the primary considerations. For example it is almost impossible to design a stable and accurate LC oscillator for the upper HF and higher frequencies without resorting to some sort of crystal control.

## 6.5 ZENER DIODE

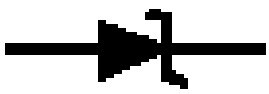
Zener diodes are very important because they are the key to voltage regulation. The chapter also includes optoelectronic diodes, Schottky diodes and other diodes.

A zener diode is specially designed junction diode which can operate continuously without being damaged in the region of reverse breakdown voltage. One of the most important application of zener diode is the design of constant voltage power supply. The zener diode is joined in reverse bias to D.C. through a resistance of suitable value.

Small-signal and rectifier diodes are never intentionally operated in the breakdown region because this may damage them. A zener diode is different; it is a silicon diode hat the manufacturer has optimized for operation in the breakdown region, zener diodes work best in the breakdown region. Sometimes called a breakdown diode, the zener diode is the backbone of voltage regulators, circuits that hold the load voltage almost constant despite large changes in line voltage and load resistance.

Figure shows the schematic symbol of a zener diode; another figure is an alternate symbol. In the either symbol, the lines resemble a “z”, which stands for zener.
By varying the doping level of silicon diodes, a manufacturer can produce zener diodes with breakdown voltage from about 2 to 200V. These diodes can operate in any of three regions: forward, leakage, or breakdown.

Figure shows the I-V graph of a zener diode. In the forward region, it starts conduction around 0.7V, just like an ordinary silicon diode. In the leakage region (between zero and breakdown), it has only a small leakage or reverse current. In a zener diode, the breakdown has a very sharp knee, followed by an almost vertical $V_Z$ over most of breakdown region. Data sheets usually specify the value of $V_Z$ at a particular test current $I_{ZT}$.



ZENER DIODE

## 6.6 CONDENSER MICROPHONE

A microphone is a device which converts the air pressure variations produced by a voice or musical instrument into an electrical variation of the same frequency and corresponding amplitude. Its primary purpose is to convert sound energy into electrical energy. It is based on the basic principle to work in the sequence- air vibration, mechanical vibration , electrical vibration.

The conversation of air vibration into mechanical vibration is effected mostly by means of a diaphragm which in much the same way as the ear drum in the human ear. In capacitor to a certain value. The resistance R is rather large. When diaphragm vibrates as a result of sound waves acting on it, the distance between the plates of the capacitor changes. Therefore the capacitor value also changes and it causes a small a.c. to flow in the circuit. The a.c. develops an alternating voltage across the R. The cond. microphone is of high quality but its voltage output is very low therefore they are built with an amplifier as a compact unit.

## 6.7 PHOTO SEMICONDUCTOR

A Germanium or silicon diode or transistor, which has a transparent encasing, can serve as a photodiode or transistor because the light photons can initiate conduction in the p-n- junction region. Early devices such as the OCP 71 were Ge-devices. Later, silicon types became available with lower leakage current and better light sensitivity. In a phototransistor, the base lead is not used; but, if a resistor is connected form base to emitter it reduced the light sensitivity. Darlington connected photo transistors (two transistors together in one case) such as the 2N5777 are very sensitive with a $h_{FE}$ of 2.5K, a dark current of 100nA and a light current of 0.5-2.0mA for light flux density H=2mW/cm$^2$. The device is rated 200mW and voltage of 25V maximum.

SCRs with a light window are also available, called as LASCR, which are very sensitive and can turn mains power ON and OFF, with light.

The switching speed of phototransistors far exceeds those of LDRs, made of CdS. The rise time for the 2N5777 is 75us and fall time is 50us. Maximum switching speed is 1KHz. Photo devices are useful in optical encoding, intrusion alarms, tape readers, level control, character recognition etc.

Nowadays packing containing an LED and a photodiode, called ‘opto-coupler’ is used for switching on power or control circuits. Because the light source (LED) and photodiode are physically kept separated (with 2mm) in the package, isolation upto 2500V can be had.

## 6.7.1 PHOTO-DIODES

If a conventional silicon diode is connected in the reverse-biased circuit of fig. 6.6, negligible current will flow through the diode and zero voltage will develop across $R_1$. If the diode casing is now carefully removed so that the diode's semiconductor junction is revealed, and the junction is them exposed to visible light in the same circuit, the diode current will rise, possibly to as high as 1 mA, producing a significant output across $R_1$. Further investigation will show that the diode current (and thus the output voltage) is directly proportional to light intensity , and that the diode is therefore photosensitive.

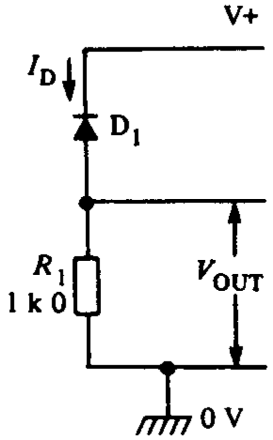
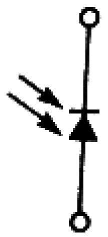


Fig. 6.6 Reverse-biased diode circuit.

In practice, all silicon junctions are photosensitive, and a photodiode can be regarded as a conventional diode housed in a case that lets external light reach its photosensitive semiconductor junction. Fig. 6.7 shows the standard photodiode symbol. In use, the photodiode is reverse biased and the output voltage is taken from across a series-connected load resistor. This resistor may be connected between the diode and ground, as in fig. 6.6, or between the diode and the positive supply line, as in fig. 6.8



***Photodiode symbol***

Fig. 6.7 Photodiode symbol

The human eye is sensitive to a range of light radiation, as shown in fig. 6.9 . It has a peak spectral response to the color green, which has a wave length of about 550 nm, but has a relatively low sensitivity to the color violet (400 nm) at one end of the spectrum and to dark red (700 nm) at the other. Photodiodes also have spectral response characteristics, and these are determined by the chemistry used in the semiconductor junction material. Fig. 6.9 shows typical response curves of a general-purpose photodiode, and infrared (IR) photodiode.

Photodiodes have a far lower light-sensitivity than cadmium-sulphide LDRs, but give a far quicker response to changes in light level. Generally, LDRs are ideal for use in slow-acting direct-coupled light-level sensing applications, while photodiodes are ideal for use in fast-acting AC-coupled signaling applications. Typical photodiode applications include IR remote-control circuits, IR beam switches and alarm circuits, and photographic flash slave circuits, etc.

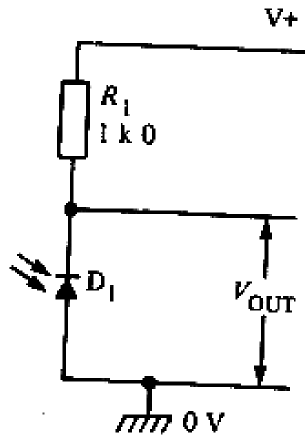



Fig 6.8 Photodiode circuit with $D_1$-to-V + load

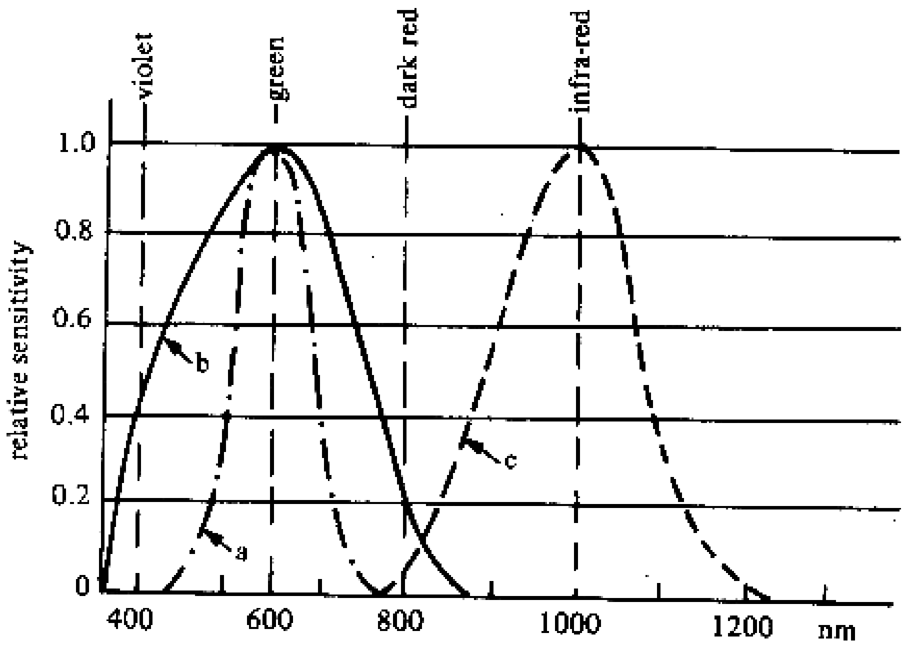



Fig. 6.9 Typical spectral response curves of (a) the human eye, (b) a general-purpose photodiode, and (c) an infra-red photodiode.

### 6.7.2 PHOTOTRANSISTORS

Fig. 6.10 shows the standard symbol of a phototransistor, which can be regarded as a conventional transistor housed in a case that enables its semiconductor junctions to be exposed to external light.

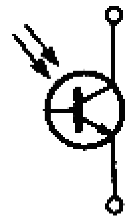


Fig. 6.10 Phototransistor symbol.

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# RESULT AND CONCLUSION

In this project, we are generating data with the help of DTMF encoder and voice with microphone. And both of these components cannot work at the same time, so we have employed DPDT switch to select data or voice communication.

When we select for data communication then DTMF encoder is turned on and the corresponding keys are ready to be pressed. When we press a key at the transmitter then the corresponding row and column frequencies are selected and transmitted. Those frequencies are detected by the DTMF decoder and the number (0-9) corresponding to those frequencies is displayed on the 7-segment decoder. For example, when we press key no. 3 then row frequency 697Hz and column frequency 1477 gets selected and the number 3 can be seen at 7-segment decoder. The dialing tone of the frequency produced can be heard from the speaker.

In case of voice communication, the voice is converted to electrical signals by microphone and those electrical signals are converted to optical signals by photo-diode. The optical signals are passed through optical fiber and it is detected at the receiver end by the photo- transistor. The output of the voice can be heard from the loudspeaker connected at the transmitter.