DESIGN, CONSTRUCTION AND TESTING OF LASER TORCH-BASED VOICE TRANSMITTER AND RECEIVER

BY

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NOVEMBER 2010

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DEPARTMENT OF ELECTRICAL, ELECTRONICS ENGINEERING AND TECHNOLOGY NUHU BAMALLI POLYTECHNIC ZARIA., IN PARTICIPIAL FULFILLMENT FOR THE AWARD OF HIGHER NATIONAL DIPLOMA.

NOVEMBER, 2010.

DECLARATION

I Basher Suleiman sincerely declare this project is wholly sole output of my work and to the best of my knowledge it has not been submitted ever, in this polytechnic for the award of the award of any Higher National Diploma (H.N.D) or other wise. Under the supervision of Mallam Mohammad Abubakar Garba head of Department of Electrical, Electronics Engineering technology Nuhu Bamalli Polytechnic Zaria. As part of the requirement for the award of higher national diploma in Electrical Engineering (H.N.D).

	06/12/2010
Sign	Date

CERTIFICATION

I certify that this thesis has been read and found worthy of approval having met the requirement of the Department of Electrical, Electronics Engineering and Technology Nuhu Bamalli Polytechnic Zaria for the award of higher national diploma in electrical, electronics engineering technology

6/12/10

Mal. Mohammad Abubakar Garba
(Project supervisor)

Date

Mal. Mahmud Panti
(Project coordinator)

Date

6/12/10

Mal. Mohammad Abubakar Garba
(Head of department)

Date

DEDICATION

This is dedicated to the one and only true sole administration of this world Allah (S.W.T). The lord of the world and to my beloved, caring and understanding parents, Alhaji Suleiman Abdulazeez and Malama Rahilatu Usman.

ACKNOWLEDGEMENT

In the name of Allah the beneficent the merciful. Most of all I am grateful to almighty Allah most gracious most merciful who teaches man that which he knows not. I am sincerely gratitude to my supervisor Mallam Mohammad Garba who took most of his time to provide me with all the necessary materials, guidance and with all necessary materials support, suggestion and article review of this book. I am also indebted to my lecturers Mallam Rabiu Al-Tanko Umaisha, Mallam Bello Atiku, Mallam Umar Garba, Mal. Ibrahim Bashir also to Mal Abubakar Maude. I also appreciate the effort of Bashir Al-Hassan, Nuradeen Aliyu and Mallam Ya'u Muktar for their technical contribution.

My most profound gratitude and appreciation go to my parents, Alhaji Suleiman Abdulazeez and Malama Rahilatu Usman, who made provision from my early education and wished me great success.

I will not forget to express my thank to my friends Mohammed Bashir Abdulrazak who help me day in day out on my academic pursue and who welcomes me at all time when ever I have problem with some course, especially for coaching me the easiest way to solve problem and also my thanks goes to Isma'il Hamisu for guiding me through the Islamic injunction.

The list is inexhaustible but for time and space constraint those that have not been mention does not imply not reorganizations or non appreciation of your quota to this

moral being. To you all. I say jazakumullah khayran and may Allah (S.A.W) join us in Al-jannatul Firdausi amin. I am indebted to you all.

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ABSTRACT

This project present the design and construction of laser torch based voice transmitter and receiver is aim at providing a means of communication between two people located within the same area not more than 50 meters. The transmitter section is designed using a condenser microphone, which detect the voice and convert it into an electrical signal. The output of the microphone is given first amplification by driver transistor T_1 and it output is modulated by an oscillator signal design using a comparator IC. The modulated output is further amplified by a power transistor T_2 and the signal is transmitted inform of light by a laser torch. The receiver circuit on the other hand, a phototransistor T_3 which received the light transmitted by the laser torch, and changes it back to electrical signal. The signal is demodulated by a demodulator build around transistor T_4 and T_5. The demodulated signal is amplified by an audio amplifier IC LM 386 and finally the output is taken by the speaker.

CHAPTER ONE

INTRODUCTION

1.1 PREAMBLE

The field of Telecommunication has evolved from stage when signs, drum beats and semaphones were used for long distance communication to a stage when electrical; radio and electro-optical signals are being used. Optical signals produced by laser sources and carried by ultra-pure glass fibres are recent addition to the field (Thiagarajan viswanathan.Telecommunication switching system and networking.)

In order to communicate, it is necessary to transfer information from one person to another, speech or voice is the most convenient form of human communication and development of electronics and telephonic system. To achieve this objective leads the development of laser-torch based voice transmitter and receiver.

This is a two communication link over a limited distance of 50 meters. for example from house to house, from one office to another office, from one battalion to the other that is in the military aspect especially during war e.t.c it is against this background that the objective of this project is not only worthwhile but gainfull venture in the future because it has become indispensable communication facility in many ways especially in home due to the fact that most modern homes and other related buildings now appear in complex structure.

1.2 AIMS AND OBJECTIVES

The aims and objectives of this project is to design and construct a laser torch-based transmitter and receiver that can facilitate communication within a comon environment.

.3 PROJECT MOTIVATION

The increasing demand for high band within communication has lead to the rise in use of optical communication system for transmitting voice, video and audio. Optical communication can be either guided as fiber optics wave guided or unguided as in free space. Optical system is the must reliable means of providing optical communication. What really motivates me from writing this project is the problems that constrain with must of our telecommunication provider or companies.

1.4 SCOPE AND LIMITATION

The main scope and limitation of this project is to design and construct a laser torch base voice transmitter and receiver.

The limitation of this project is that it can only provide a unidirectional communication that is a monochractic which is one of the characteristic of the laser and also canbe use trasmit an audio signal for a distance up to 50 meter provided the rays of light from the laser is pointing the direction of the sensitive phototransistor of the receiver.

1.5 PROJECT OUTLINE

The entire project comprises of five chapters. Chapter one will be project overview and chapter two will contain theoretical background of the project. Chapter three will be the design procedure which is the analysis and calculations. Chapter four will contain the construction and testing procedure while chapter five will be the conclusion and recommendations.

CHAPTER TWO

LITRITURE REVIEW

1 INTRODUCTION

his chapter will contain the litriture review of the project.

For effective communication (transmission and reception of signal), the need for reliable fficient method with low cost (affordability) arises. Fiber optics system offer high bandwidth ansmission. In Australia through the G.K.D design engineering website, in October, 1997. ublished and article on laser transceiver and transmitter circuits.

In 1994 Akintude Oluwasdun design and construct a two-way intercom system for domestic pplication. The completed intercom consists of two units;

The house holder and the caller units which can be separated by a considerable distance.

Development was made by Martins Christopher in 2006 who construct a RS – 232 laser transceiver as an optical free space communication system. Until the development of solid state laser, laser based project used to be expensive. People always buy laser pointer to display with, but could never find practical uses for one. The laser transceiver circuitry is one of such practical circuit that utilized laser pointer.

In 2008 Jatau Kendima improve another way to communicate with you neighbour. He design and construct a 2-way transceiver. His research is based on how the voice we speak or sound called the baseband signal (usually 4kHz) is been transduced by a microphone, amplified and modulated. The modulated R.F power is radiated by a transmitter antenna into surrounding space. A receiver antenna must capture sufficient amount of the radiated power and pass it into he receiver. This is heard into a handset or speaker. An input voltage 9V and 1.5V are used for he receiver and transmitter. It carries power of 4.4mw and expected range of about 50meters. The objective of this project is to improve our means of communication. Using laser torch-based voice transmitter and receive, using the circuit you can communicate with your neighbours wirelessly insisted RF signals. The laser torch can transmit light up to a distance of 50meters.

.2 TRANSDUCERS

A transducers is an electrical device that convert one form of energy into another, for example, a loudspeaker convert electrical energy from an electronic amplifier into mechanical energy, moving the loudspeakers cone, which compress the air creating sound wave into human electrical signal interpreted by the brain as sound. In order to achieve electrical communication, it is essential to have a means of converting the input information into electrical energy and also converting the electrical energy into its original form.

There are different types of audio transducers used as the input or output devices of communication net work system. The following are the different types of transducers.

1. Carbon granue microphone
2. Crystal microphone
3. Moving coil microphone
4. Condenser microphone

4. Condenser microphone

2.2.1 CONDENSER MICROPHONE

A condenser microphone incorporates a stretched metal diaphragm that forms one plate of a capacitor. A back metal disk places close to the diaphragm act as a back plane. When sound field excited. The diaphragm, the capacitance between the two plates varies according to the variation of the sound pressure. A stable DC voltage is applied to the plate through a high resistance to keep electrical charges on the plate. The change in the plate capacitance generate an AC output proportional to the sound pressure in figure 2.1 represent a condenser microphone.

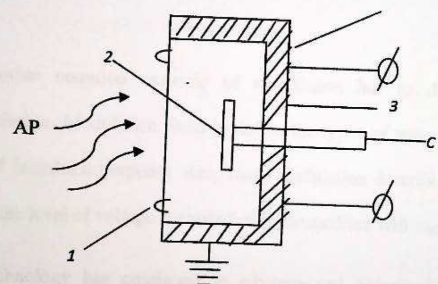


Fig. 2.1 Condenser microphone

AP= acoustic pressure

C= variable capacitor

1= metal diaphragm

2= metal disk

3= insulator

4= case

2.3 MODULATION

Modulation is a means by which a signal of some type entered into and carried by an electronic signal carrier within the scope of modulation, The type of signal of information that is introduced into and carried by the electrical or optical signal may varied depending on the configuration of the carrier and the source of modulation. Different types of modulation are used with various types of broadcast and communication media today.

Another common example of modulation has to do with reception of radio transmission. Modulation help to define the types of transmissions that are in used for general broadcast purposes. Amplitude modulation describing a broadcast situations in which the level of voltage is carried over the medium will vary noticeably overtime.

As technology has continued to advance and communications have become more expensive and varied, other constructs of modulation have appeared. Wireless communication and the use of internet have resulted in such important signaling tools as multiplexing and modern modulation. Along withy more common forms of modulation that are represented by AM and FM broadcast. The general equation of an amplitude modulation wave who carrier signal is given in the next page.

$Vc(t) = VcCoswct$

is transformed by the amplitude of a modulating signal given as

$Vm(t) = Vm\ Coswmt$

And combination of the carrier and modulating signal yield

$Y(t) = (Vc + VmCoswmt)\ Coswct$

Using trigonometry this is expanded and yield

$Y(t) = VcCoswct + \frac{1}{2} VmCos(wc+wm) + \frac{1}{2} Vmcos\ (wc-wm)t$

The depth of modulation, modulation index or modulation factor defined as the ratio of the amplitude of the modulating signal to that of the carrier. m = (Vm/Vc) is also discussed within the text =

Carrier power $= \frac{Pc}{R}$

Total power $Pt = p_{c(1+\frac{m^2}{2})}$

Single sideband power $= m^2 \frac{Pc}{4}$

Double sideband power $= m^2 \frac{Pc}{2}$

Efficiency $\eta = \frac{m^2}{2+m^2} \times 100$ =carrier power/ DC power supply

For complex modulation $m(t) = \sqrt{m_1^2 + m_2^2}$

Total side band power $p_{sb} = (\frac{m_1^2+m_2^2}{2})p_c$

2.3.1 AMPLITUDE MODULATION

In this case, the amplitude of the carrier wave is varied in proportion to the instantaneous amplitude of the information signal or AF signal. Obviously the amplitude (and hence the intensity) of the carrier wave is changed but not its frequency. The greater the amplification of the AF signals the greater the fluctuation in the amplitude of the carrier wave. The process of amplitude modulation shown graphically in fig 2.2. The AF signal has been assumed to be sinusoidal.fig 2.2 (a) is the carrier wave by which is desired to transmit the AF signal as shown in fig 2.2 b .The resultant is called modulated wave as shown in fig 2.2(c).The function of modulation is to mix these two waves in such away that fig2.2 (a) is transmitted along with fig2.2 (b)

2.4 DEMODULATION OR DETECTION

When the RF modulated waves, radiated out from the transmitter antenna, after travelling through space it strike the receiving aerials ,The induced very weak RF current and voltage in them. If these high-frequency currents are passed through headphones or loudspeakers, they produce no effect on them because all such sound-producing devices are unable to respond to such high frequencies due to Large inertia of their vibrating disc etc.neither will such RF currents produce any effect on human ear because their frequencies are much beyond the audible frequencies (20 to 20000Hz approximately). Hence, it is necessary to demodulate them first in order that the sound –producing devices may be activated by audio- frequency current similar to that used for modulating the carrier wave at the broad casting station.

This process of recovering AF signal from the modulated carrier wave is known as demodulation or detection.

The demodulation of an AM wave involves two operation.

I. Rectification of modulated wave

II. Elimination of the RF component of the modulated wave

2.5 AMPLIFICATION

Simply speaking, Amplification means making things bigger or enlarged. For many applications, an amplifier may be required to deliver a substantial amount of power, for example to a loudspeaker or to produce a large peak to peak voltage serving. For example the drive to a CRT. In such a case, small signal equivalent circuit can not be used for design and analysis and it is customary to establish the operating principles of power amplifiers. The usual term for large signal amplifiers is by using transistors characteristics. An important aspect of power amplifier design is electrical efficiency not because we are considering the waste of electrical power.

2.5.1 OPERATIONAL AMPLIFIER

It is a very high-gain, high-in directly-coupled negative-feed back amplifier which can amplify signals having frequency ranging from 0Hz to a little beyond 1MHz. They are made with different internal configuration in linear ICs. An OP-AMP is so named because it is originally designed to performed mathematical operations like summation, subtraction, multiplication, differentiation and integration e.t.c in analog computers. Present day's usage is much wider in the scope but popular name OP-AMP continue.

Typically, uses of OP-AMP are: scale changing analog computers operations. In instrumentation, control systems, and great variety of phase-shift and oscillator circuits.

The OP-AMP is available in three different packages (i) standard dual-in-line packages (DIL) (ii) To-5 ease and (iii) the flat-pack.

Although an OP-AMP is a complete amplifier, it is so designed that external components (resistance, capacitors) e.t.c can be connect to its terminals to change its external characteristics. Hence, it is relatively easy to tailor this amplifier to fit a particular application and it is, in fact due to this versatility that OP-AMPs have become so popular in industries. An OPAMP IC may contain two dozen of transistors and one or two capacitors. Example of OP-AMP symbol

1. μA709

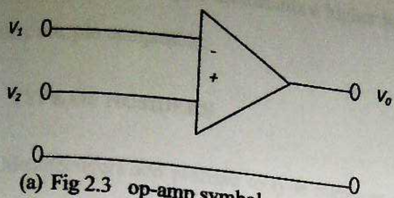
2. LM 108 – LM 208

3 LM 741

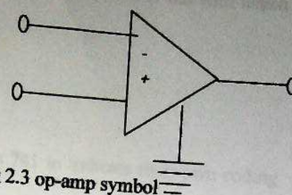
2.5.2 OP-AMP SYMBOL

Standard triangular symbol for an OP-AMP is show in fig 2.3 through the one shown in fiq.2.3 (a) is also used in fig2.3 (b) the common ground line has been omitted. It does not show other necessary connections such as dc power and feedback.

The OP-AMP's input can be a single ended or double ended (or differential input) depending on whether input voltage is applied to one input terminal only or both. Similarly amplifiers output can also be either single-ended or double ended.



(a) Fig 2.3 op-amp symbol



(b)Fig 2.3 op-amp symbol

2.5.3 GENERAL FEATURES OF OP-AMP'S

i. Infinite Input resistance R_i

ii. Zero output resistance R_o

iii. Infinite CMR R

It is also dc coupled. In practice op amps do not, of course have ideal properties, but common types nevertheless have impressive specifications. For the 741, typical values are quoted as

$A_{vol} = 200\ 000$

$R_i = 2m\Omega$

$R_o = 75\Omega$

Where typical values are given. They are quoted from 741 specifications unless a different type is given for comparison. More recent types such as the 3140 have FET input stages, which give the circuits a higher input resistance than the 741 but with which they are, pin compatible.

TYPE OF NUMBERS

Manufacturers add prefixes to type numbers such as 741 to indicate their own coding even though the specifications are similar e.g

1. µA.741 Fairchild

2. LM 741 National semiconductors

An extra letter is sometimes added to indicate a temperature specification e.g

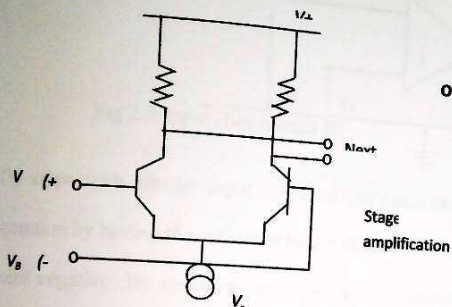
µA 741 A- Military specification for guaranteed operation between -55_oc and $+125_o$c

µA 741C – Commercial specification for temperature range 0 c to 70c

2.5.4 DC SUPPLIES

The input stage of an OP-AMP is usually a differential amplifier of the type describe. In fiq.2.4 for a dc coupled amplifier requiring an output which can swing positively and negatively with respect to ground. It is evident that the circuit requires negative and positive dc supplies. V+ and V-, referenced to some intermediate voltage level which will usually be ground. These voltage will have specified maximum and for the µA741C they are±18 V.

Fig2.4b shows the pin layout for the dual in line version of a 741 op- amp with pin numbers corresponding to the terminal in fig2.4b pin 1 and 5 are usual for offset purposes to be explained op amps are available to operate with a single supply referenced to ground, e.g µA 124, but clearly the output voltages e.g if the supply rails is positive then the output cannot swing below ground level.



Basic differential amplifier input stage for OP AMP

Fig.2.4 (a)

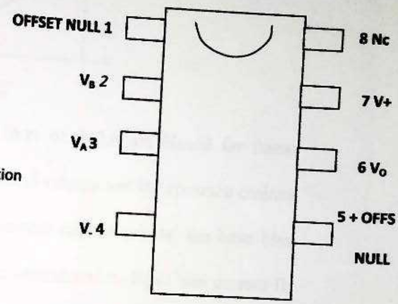


fig 2.4(b) Pin Out For Dual In Line Version Of 741 OP Amp

2.5.5 PRACTICAL PROPERTIES

Open-loop voltage Gain A_{vol}

As with the differential amplifier of fiq2.5 the op -amp amplifies the difference Vd between the voltage on the non inverting (+) and inverting (-) terminals in fig2.5.The term open-loop signifies that there is no external feed back connection between the output and either of the inputs.

A_{vol} is defined as the ratio of the change in the output voltage to the change in differential input voltage, usually for load resistance of not less than 2kΩ. As noted 20000 is typical for A_{vol}. Input resistance is the open-loop incremental resistance looking into the two input.

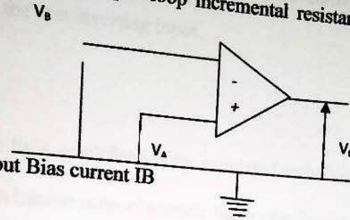


Fig 2.5 Input Bias current IB

Op amps with bipolar input stages of the basic form of fiq2.6 are biased for linear operation by having the quiescent base voltage at ground voltage and the common emitter point negative .By operating at extremely low quiescent current values, the base bias currents will be low but they do have to be taken into consideration. Input bias current Ib for an OP amp is define as the average of the two input currents with the inputs grounded.

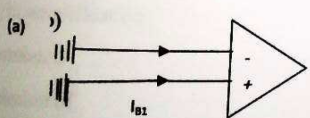


Fig 2.6 (a) Bias current in Op Amp

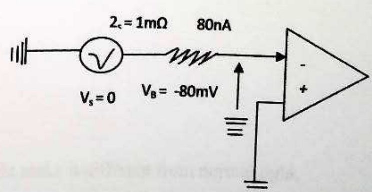


Fig 2.6 (b) Illustrating the bias current generates cut input voltage

I. In contrast to normal light which radiates in all direction, laser light is almost completely unidirectional, which means the laser light travels almost completely in one direction. A beam of this sort i.e one which does not expand is referred to as a collimated beam

II. Laser light is highly monochromatic, being basically of one color of frequency (this is in contrast to most lights which are combination of many different colors)

III. All rays of light in a laser beam are in phase, which means they all inter[illegible] constructively at all times. As there is no destructive interference, this lea[illegible] intense beams of light.

Laser light which is monochromatic and in phase is called coherent light [illegible] is coherent and usually collimated. Semiconductor diode lasers d[illegible] light but the light can easily be collimated using lens.

Another special feature is the time taken to turn the beam [illegible] very small, allowing high precision pulse light to be gener[illegible] than the time it takes to turn an ordinary bulb on or off.

2.6.2 Laser diode

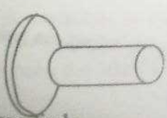


Fig 2.7. Laser diode.

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II. Laser light is highly monochromatic, being basically of one color of frequency. (this is in contrast to most lights which are combination of many different colors)

III. All rays of light in a laser beam are in phase, which means they all interfere constructively at all times. As there is no destructive interference, this lead to very intense beams of light.

Laser light which is monochromatic and in phase is called coherent light. Thus, laser light is coherent and usually collimated. Semiconductor diode lasers do not emit collimated light but the light can easily be collimated using lens.

Another special feature is the time taken to turn the beam off or on. And can be made very small, allowing high precision pulse light to be generated. This time is much smaller than the time it takes to turn an ordinary bulb on or off.

2.6.2 Laser diode

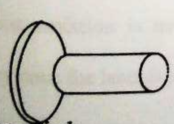

Fig 2.7. Laser diode.

A laser diode is a laser where the active medium is a semiconductor similar to that found in a light emitting diode. The most common and practical type of laser diode is formed from a p-n junction and powered by injected electrical current. These devices are some times referred to as an injection laser diode to distinguish them from optically pumped laser diodes which are more easily produced in the laboratory.

2.6.3 Principle of operation

A laser diode like many other semi conductors device is formed by dropping a very thin layer on the surface of a crystal wafer. The crystal is doped to produce an n-type region and a p-type region, one above the other resulting in p-n junction or diode. As in other diodes, when this structure is forward biased, holes from the p-region are injected into the n-region, where electrons are the dominant carriers. Similarly, electrons from the n-regions are injected into p-regions, where holes are the majority carrier. When an electron and hole are present in the same region, they may recombine by spontaneous emission that is the electron may re-occupy the energy state of the hole, emitting a proton with energy equal to the differences between the electron and the holes state involved. These injected electron and holes represent the injection current of the diode and spontaneous emission give the laser diode lasing threshold similar properties to lead. Spontaneous emission is necessary to initiate laser oscillation but it is a source of inefficiency once the laser is oscillating.

Under suitable conditions, the electron and the hole may co-exit in the area for quite sometimes (in the order of micro seconds) before the recombine. Then a nearby photon with energy equal to the recombination energy can cause recombination by stimulated emission. This generates another photon of the same frequency, travelling in the same direction with the same polarization and phase as the first photon.

This means that stimulated emission causes gain in an optical wave (of the same wavelength) in the injection region, and the gain increases as the number of electrons and holes injected across the junction increases. The Spontaneous and stimulated emission processes are vastly more efficient indirect band gap semi conductors than in indirect band gap semiconductors, thus silicon is not a common material for laser diode.

As in other lasers, the gain region is surrounded with an optical cavity to form a laser. In the simplest form of laser diode, an optical waveguide is made on that crystal surface, such that the light is confined to a relatively narrow line. The two ends of the crystal are cleared to form perfectly smooth, parallel edges. Photons emitted into a mode of the wave guide will travel along the wave guide and will be reflected several times from each end and face before they are emitted. As a light wave passes through the cavity, it is amplified by stimulated emission, but light is also lost due to absorption and by incomplete reflection from the end facets, finally if there is more amplification than loss the diode begin to “laze”

Some important properties of laser diode are determined by the geometry of the optical cavity. Generally in the vertical direction, light is contained in a very thin layer, and the structure supports only a single optical mode in the direction perpendicular to the layers. In the lateral direction, if the waveguide is wide compared to the wavelength of light, then the wave guide can support multilateral optical modes; and the laser is known as "multi-mode" these laterally multi-mode laser are adequate in cases where one needs a very large amount of power, but not a small diffraction limited beam; for example in printing, activating chemicals or pumping other types of lasers.

In applications where a small focused beam is needed, the wave guide must be made narrow on the optical wavelength. This way, only a single lateral mode is supported and one ends up with a diffraction limited beam. Such single spatial mode devices are used for optical storage, laser pointers and fibred optics. Note that these lasers may still support multiple longitudinal modes and thus can laze at multiple wavelengths simultaneously.

The wavelength emitted is a function of the band-gap of the semiconductor and mode of optically cavity. In general, the maximum gain will occur for photons with energy slightly above the band-gap energy and modes nearest the gain peak will laze most strongly. If the diode is driven strongly enough, additional side modes may also laze. Some laser diodes such as most visible lasers operate at single wavelength, but that wavelength is unstable and changes due to fluctuations in current or temperature. Due to

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2.7 PHOTOTRANSISTOR

Phototransistor is a light-sensitive transistor and similar to an ordinary bipolar junction transistor (BJT) except that it has no connection to the base terminal. Its operation is based on the photodiode that exit at the CB junction. Instead of the base current, the input to the transistor is provided in the form of light as shown in the schematic symbol of Fig.2.8.The device is usually packed in a TO-type can with lens on top although it is sometime encapsulated in clear plastic. When there is no incident light on the CB junction, there is small thermally-generated collector-to-emitter leakage current. Ice which is called dark current and is in the range of nA.

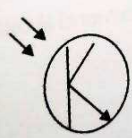
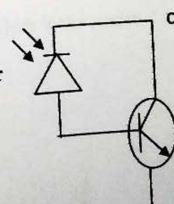


Fig2.8 phototransistor

Fig 2.8 phototransistor



CHAPTER THREE

SYSTEM DESIGN

3.1 Introduction

The objective of this project is to design a low cost wireless communication. Which consists of two modules the transmitter and the receiver. In order to achieve this aim, the design principle were taking into consideration.

The design and selection of various components used in the construction of the transmitter and receiver is as follows

3.2 General Circuit Diagram

The general circuit diagram circuits consist of two modules transmitter and receiver circuit as shown in the figure 3.1

The transmitter circuit fig 3.1 (a) comprises of condenser microphone, transistor, amplifier T1 BC548. The next stage is followed by an OP - amp stage built around μA741 (IC1). The gain of the OP- amp can controlled with the help of 1-mega-ohms potentiometer VR1. The audio frequency signal output from IC1 is coupled to the base of the transistor BD139 (T2) which is in turn modulates the laser beam. Which is the carrier of the signal for propagation.

The transmitter uses 9V power supply. However the 3-volt laser-torch (after removal of its battery is connected to the circuit) which is connected to the emitter of the transistor BD139 (T2) and spring-loaded lead protruding from inside the touch to the circuit ground.

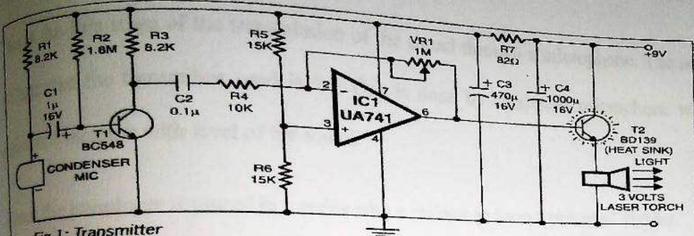


Fig.1: Transmitter

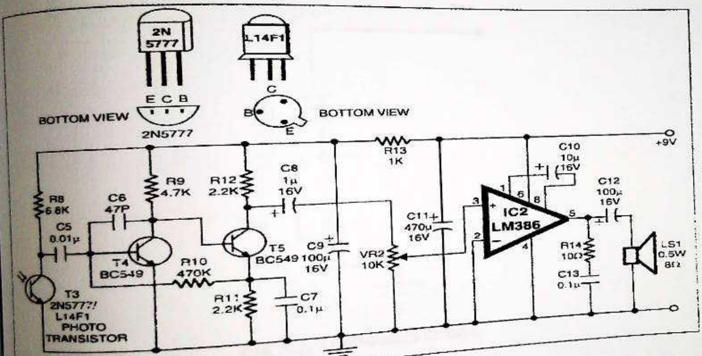


Fig.2: Receiver

fig 3.1 a and fig 3.1 b

The transmitter circuit of fig 3.1 (b) uses an npn phototransistor as light sensor which dictate the modulating signal and the signal is demodulated by this photo transistor and it is followed by a two stage transistor preamplifier and LM386 base audio power amplifier. Just by keeping the phototransistor oriented towards the remote transmitters laser point and adjust the volume control for clear sound.

3.3 Design of the Transmitter

This is the first stage of the transmission of the sound through a microphone. The actual voltage that the transmitter used is 9v. This is done by condenser microphone whose resistance increase with level of the sound.

Hence the transducer is placed in a series with a resistor to form a potential divider.

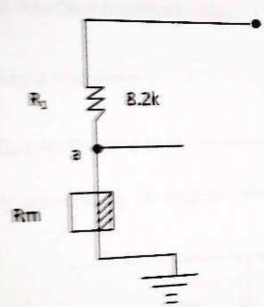


Fig 3.2. Transducers circuit.

Rm is the resistance of the microphone which approximately 1.7kΩ when no sound is received and about 8.2kΩ when receive sound. To have a quiescent value of Dc voltage at a point near ½ Vcc, R1 was chosen to be 8.2kΩ such that the potential difference at a.

$$Vrd = \frac{R_1}{R_1+R_n} \times V_{cc}$$

$$= \frac{9\times 8.2}{8.2+1.7} = 7.45V$$

The condenser mic need to put it on operation after obtaining its characteristics from a datasheet book it has a maximum current of 1.2 mA. Therefore we need a resistor to limit the current to this value. The value of this resistor is calculated as follows

$$R_1 = \frac{V_{cc}}{I_m}$$

$$= \frac{9}{1.2\times 10^{-3}} = 7.5k\Omega$$

But since 7.5 kΩ can not be found in the market. 8.2 kΩ is choosen for this designed because to reduce the current less than maximum value.

3.3.1 The pre-amplifier using a transistor

The signal is pre-amplified by T1 BC 548 the transistor needs a base current of about 5μA to be in active region by considering the diagram below in fig 3.

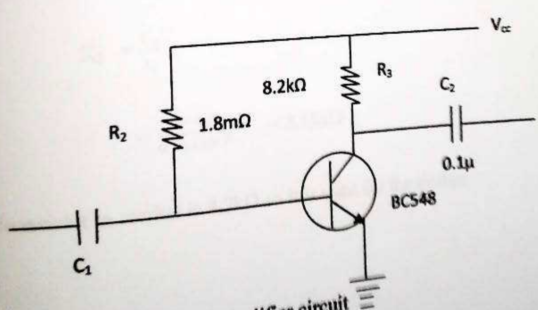


Fig 3.3 pre amplifier circuit

The resistor that delivered this current is calculated as follows

$$R_2 = \frac{V_{cc}}{I_b}$$

$$= \frac{9}{5\times10^{-3}} = 1.8M\Omega$$

To calculated the collector resistor we used the relation

$$R_3 = \frac{V_{cc}-V_{ce}}{I_c} \quad \text{Where } V_{CC} = 9V$$

$$V_{CE} = \frac{1}{2} \times V_{cc} = 4.5V$$

Our Q point is at the middle of the load line that is were we come about 4.5V

Also I obtained that, the collector current as 0.5mA from datasheet book. The value of the collector resistance can be calculated from the relation or equation

$$R_3 = \frac{V_{cc}}{I_c}$$

$$= \frac{9-4.5}{0.55\times10^{-3}} = 8.18k\Omega$$

But the available resistor in market is 8.2kΩ so it is used for the design

3.3.2 Design of Operational Amplifier Amplification

The amplification is made using an op-amp on essential component for this purpose was an amplifier with high voltage gain by considering the diagram below. Fig 3.4 the non-inverting terminal is given a reference voltage while the inverting terminal it receive the output of the potential divider from resistor R_5 and R_6

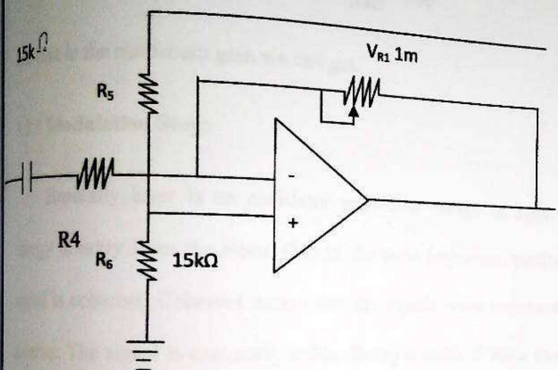


Fig 3.4 op-amp circuit

The value of the resistor R5and R6 were chosen to be 15kΩ to initially drop the supply voltage by ½ Vcc at the positive input of the op-amp and each value is evaluated as follows

$$Vre_f = \frac{R_6}{R_{5}+R_6} \times V_{cc} = \frac{15\times10^3}{(15+15)\times10^3} \times 9 = 4.5\text{ v}$$

Reference voltage is made half of the supply voltage. The gain of the op-amp is control using a feed back resistor Vr_1 which is variable were the gain is

$$Gain = \frac{V_{out}}{V_{in}} = \frac{R_{out}}{R_{in}}$$

Where $R_{out} = V_{R1} = 1m\Omega$ $V_{in} = R4 = 10\ k\Omega$

$$Gain = \frac{1M\Omega}{10k\Omega} = 100$$

but that is the maximum gain we can get.

3.3.3 Modulation Stage

Basically laser is an oscillator providing energy at light frequencies it takes it energy directly from the atom. One of the most important quality of the laser is that its signal is coherent. Coherent means that the signals wave generated are in phase with one another. The signal is extremely stable. Being it stable it has a modulation capability and consequently is detectable; it is capable of taking or carry intelligent information from the IC UA741 which is coupled to the base of the transistor BD139 which in turns modulate the laser beam. This well-aimed directivity of the signal propagation make it very efficient transmitter. It is very high frequency as well as stable, the coherent signal is pure. The visible light spectrum is in order of 10^{15}Hz which allows the beam to carry very wide band width information is modulated bandwidth of modulation in gigahertz.

3.4 Design of the Receiver

The receiver is one of the responsible for detection, demodulation, pre-amplification, and amplification and sound as shown in the block diagram below.

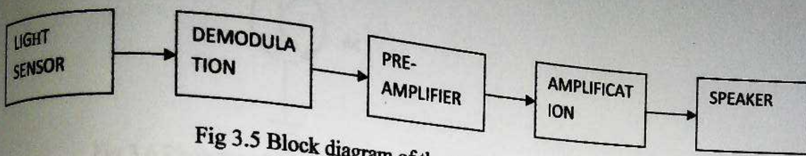


Fig 3.5 Block diagram of the receiver

3.4.1 Design of the Detector Phototransistor

The detector is a light sensitive transistor (phototransistor) similar to an ordinary bipolar junction transistor BJT except that it as no base connection to the base terminal. Its operation is based on the photodiode and has application of demodulation. The photo-transistor instead of the base current. The input to the phototransistor is provided in the form of light.

When there is no incident light on the CB junction there is small thermally generated collector to emitter leakage current I_{EO} which is called dark current and is in nA range collector current $Ic = \beta I\lambda$. The photo transistor circuit diagram is shown in fig 3.6

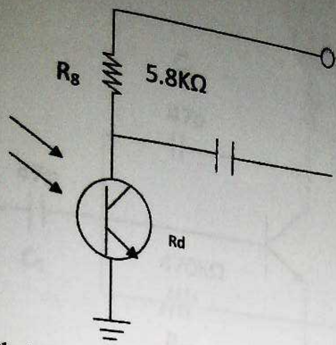


Fig 3.6 Phototransistor dictator circuit

R_d= darkness resistance of the cell which is approximately 1mΩ

After obtaining it characteristics from the datasheet Im = 1.6mA maximum current we can obtained the value of R_8 by the relation

$$R_8 = \frac{V_{cc}}{I_{max}} = \frac{9}{1.6\times10^{-3}} = 5.62\ k\Omega$$

But in the absent of that 5.8kΩ is used for the design also the voltage drop across the phototransistor can be determined by the equivalent circuit equation

$$V_{RD} = \frac{R_d}{R_8+R_d} \times V_{cc}$$

3.4.2 Design of the Preamplifier First Stage

The signal pre-amplified by T4 BC549 the transistors need a base current of about 0.0193 mA to be in active region by considering the diagram below in fig 3.7

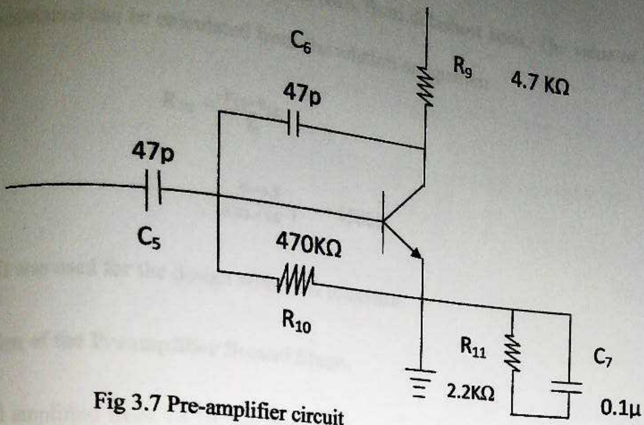


Fig 3.7 Pre-amplifier circuit

The resistor that delivers this current is calculated as follows

$$R_{10} = \frac{V_{cc}}{I_b}$$

$$= \frac{9}{0.019\times10^{-3}} = 466.32\text{k}\Omega$$

But in the absent of the calculated value 470kΩ was used for the design.

Also to calculate the collector resistance the relation is used

$$R_9 = \frac{V_{cc}-V_{ce}}{I_c} \qquad \text{Where } V_{ce}=\frac{1}{2}V_{cc} = 4.5\text{V}$$

Our Q point is at the middle of the load line that is where we come about Vce to be 4.5v

Also I obtained the collector current of 0.01mA from datasheet book. The value of the collector resistance can be calculated from the relation or equation

$$R_{10} = \frac{V_{cc}-V_{ce}}{I_c}$$

$$= \frac{9-4.5}{0.01\times10^{-3}} = 450k\Omega$$

But 470kΩ was used for the design with +5% tolerance.

3.4.3 Design of the Preamplifier Second Stage.

The signal amplified from T4 BC549,the collector current is feed to the base of the T5 BC549 which has already gotten from datasheet book that Ic = 0.01mA

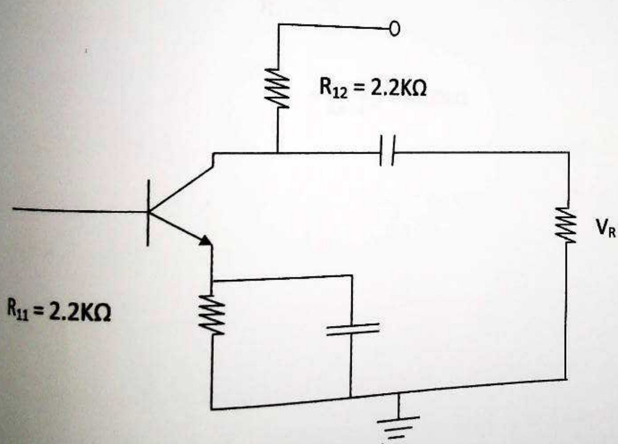


Fig 3.8 Pre-amplifier design circuiT

The resistance R_{12} is calculated from the relation

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 Introduction

This chapter gives the practical actualization of the project specification. The construction, testing and packaging are also discussed and deals with the various experiments carried out on constructed circuits to test its performance and correlate the result and obtained with the designed specification. In order to evaluate the overall design success. The construction is carried out in two stages, the transmitter and the receiver circuit.

The first channel is the transmitter with microphone as input source and laser torch-based as the output of the transmitter.

The same procedure was also used to construct the second channel of the wireless communication (that is the receiver) where the photo transistor act as the input to the circuit and output as loudspeaker.

4.2 Temporary Construction

The circuits of the transmitter and the receiver were first constructed temporarily on the bread board to confirm the workability of the circuit and to have chance for making possible adjustment in order to improve the operating of the circuits suit the design goal.

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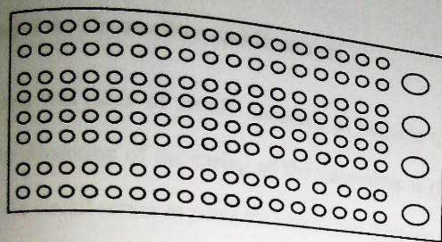

Fig 4.1 breadboard

The figure above shown the practical breadboard used for the temporary building of the circuit to verify its ability to work within the range of accuracy.

4.3 Permanent Construction

After testing the circuit on the breadboard, the components are then build permanently on a veroboard. The components were assembled on the board and then later soldering to the board using a soldering iron and lead. Fig 4.2 below shows typically the nature of the veroboard used for building project permanently after testing.

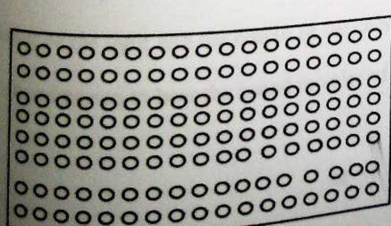

Fig 4.2 veroboard

4.4 Casing of the Transmitter and Receiver

The casing was made of plastic materials as possible to allow the device to be seen easily. The dimension of the casing of the transmitter is (8.7 by 7.2 by 3.7) cm and the output of the circuit serves as ports for interaction with the user by considering fig 4.3 the power switch and the microphone where the first stage where the communication started and on the other side of the case is the out put where the laser base-torch is fixed.

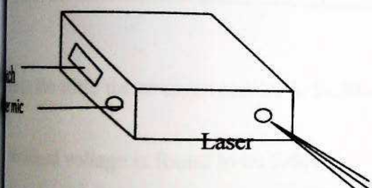

Fig 4.3(a)Transmitter casing

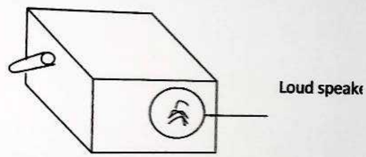

fig 4.3 (b)Receiver casing

The casing of fig 4.3(b) is that of the receiver were the dimension is (15.3 by 7.9 by 3.6) cm with an input from the wave path from the laser through phototransistor which is the detector of the light and the output of the circuit is a loudspeaker which is also fixed for the second person to hear the sound or voice of the first person.

4.5 MEASUREMENT

The amount of current flowing in the circuit was measured for three different values in line to get the average current also the supply voltage is measured and it was recorded as5.46V.The table 4.2 give us the result obtained for three different values and is measured in milli-ampere

TABLE 4.1 VALUES OF CURRENT IN MILLIAMPERE

S/no	I(mA)	I(mA)	I(mA)
1.	54.30	54.00	52.00
2.	53.60	54.43	54.30
3.	48.90	55.01	56.20

From the table the average current is 54.30mA

Measured voltage is found to be 5.46V

Power used by the circuit =average current ×voltage

$$P = IV$$

$$P = 54.30 \times 10^{-3} \times 5.46$$

$$P = 0.3W$$

4.6 Cost Implication

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The aim of this project which is the design and construction of laser torch- base transmitter and receiver for domestic application is practically achieved as demonstrated by the result of the test carried out in chapter four.

The output of the two units gives a reliable result with minimum distortion. It is observed that when the two boxes of the transmitter and the receiver were positioned very close to each other. There was a noisy sound due to feedback as a result of sensitivity of the microphone. The laser torch-base voice transmitter and receiver was tested within the range of 500m and it was able to transmit voice and receive the voice from the receiver without much errors. After the construction it is observed that the optical laser system face some problems especially from atmospheric disturbance as the signal travel trough the path. Rain and snow attenuate the signal and hence decrease the range of reliable communication for being composed of water droplets can completely hinder the passage of light as result of the effects of absorption, scattering and reflection.

5.2 Recommendations

Any project carried out in any place has it own limitation either in the area of it application or in terms of its operations. Where the recommendation are always given in

Fig4.6 Transmitter

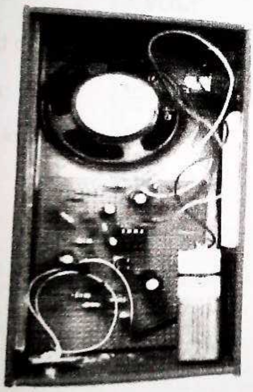

Fig 4.7 Receiver

...e cost implication of the project of laser torch-base transmitter and receiver is ...ulated in the table below

...ABLE 4.2 COST IMPLICATION

COMPONENT	DESCRIPTION	QUANTITY	NAIRA
Fixed resistor	R_1, R_2, R_3 ..... R_{14}	14	140
Variable resistor	$V_{R1} V_{R2}$	2	60
Capacitor	C_1, C_2, C_3 ......C_{13}	13	570
Transistor	T_1, T_2, T_3, T_4 and T_5	5	510
Laser torch	3 VOLT	1	250
I.e. integrated circuit	C_1 & C_2	2	200
Loud speaker	LS1	1	80
Condenser mic	Mic	1	50
D.C Battery	Dry cell	2	160
Casing		2	400
		TOTAL	2420.00

...TESTING

...inary testing has been performed during construction where by the output of each ...ge was monitored and ascertained that necessary gain was achieved using ...meter, ammeter and oscillescope.

This scope makes it possible to observed two times relative wave form at different points. The fig 4.4 represent the output of the wave form.when the transmitter and receiver are powerd with a 9V DC battery,when the phototransistor of the reciever is accurately oriented toward the lasser beam.

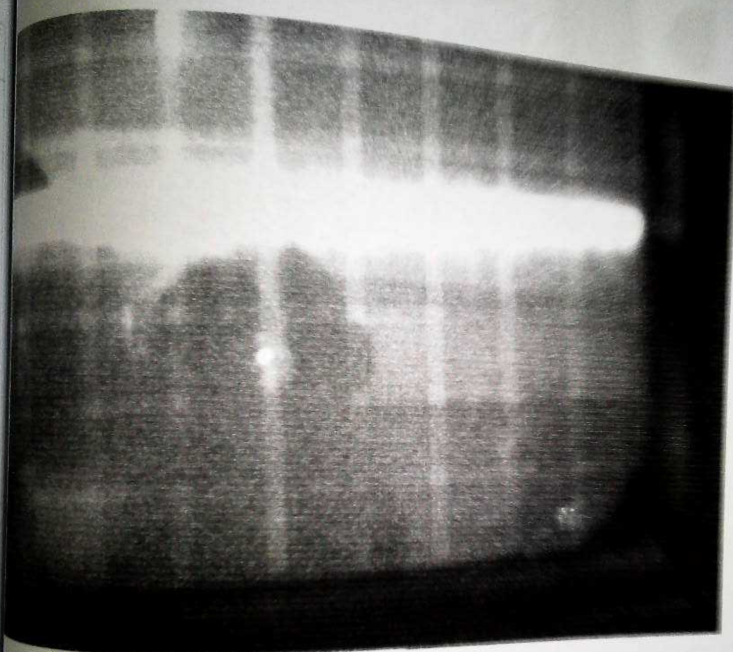

Fig 4.4 The output frequency response when the phototransistor is oriented towards the laser beam.

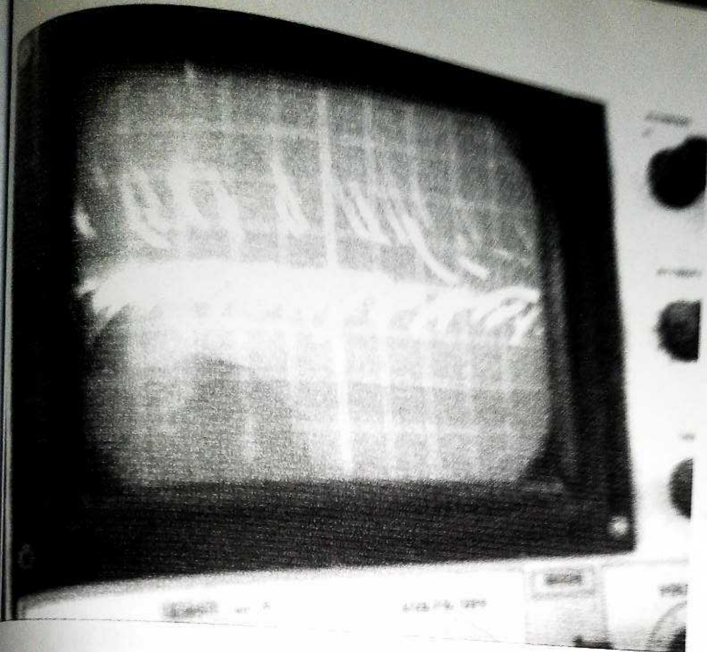

fig4.5 The output frequency response when voice strike the microphone.

Also in fig4.5 represent the output wave form ,from the receiver connect at the output of the receiver in the loudspeaker terminal.The pictorial view of the transmiter and receiver are shown in fig4.6 and fig4.7

References

1. Theraja, B.L and Theraja A.K, "Electrical Technology" 24th edition, S. chan and company Ltd, New Delhi, 2005.

2. Williams K .Pratt "Laser communication system"

3. D.B. Gambo "Telecommunication principle and system"

4. Stephene F. Adam 'Microwave theory and application"

5. M. Kabir Ahmad, "Electronics Engineering 2" (EEEN540) Lecture Note, Dept of Electrical Engineering.ABU Zaria, 2009.

6. Professor B.G. Bajoga "Antenna and Satellite Communication" (EEEN542).Lecture Note, Dept of Electrical Engineering, ABU Zaria. 2009.