LASER COMMUNICATION SYSTEM

By

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BONAFIDE CERTIFICATE

Certified that this project report entitled "LASER COMMUNICATION SYSTEM**"** is a bonafide work of **CH. NIKHIL CHAKRAVARTHY (15BEC1184), CH. KRISHNA KALYAN (15BEC1090)** and **K. SATEESH KUMAR RAJU (15BEC1197)** who carried out the Project work under my supervision and guidance.

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ABSTRACT

Laser communication is one of the key area in wireless Communications. This report includes analysis, optimization, design and system level development of signal transformation between any two sources. Which work similarly to fiber optic links, except the beam is transmitted through free space. While the transmitter and receiver must require line-of-sight conditions, they have the benefit of eliminating the need for broadcast rights and buried cables. Laser communications systems can be easily deployed since they are inexpensive, small, low power and do not require any radio interference studies. Students in science and engineering have recently been attracted by the properties and applications of lasers. A project on the application of the laser which has been widely welcomed by students is introduced. The aim of this project is to stimulate the interest of students in applied physics and to demonstrate the interaction between light and ultrasonic waves by building a simple laser communication system. The principle of this system is based on the diffraction of a laser beam by ultrasonic waves.

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CHAPTER 1

INTRODUCTION

Laser Communication is one of the emerging areas of wireless communication system. Due to its low noise ratio makes its one of the well suited communication medium for exchange of information. Currently laser commutation is adopted in satellite communication for space research activities and due to its efficiency on low noise ratio, inexpensive, low power and its flexibility and its resistance to the radio interferences makes laser communication as one of research area in wireless communication. In this process, this report comprises the one such application of laser communication for information exchange between any two devices.

In Laser Communication the transmitter and receiver must require a line-of-sight conditions and Laser communications systems have the benefit of eliminating the need for broadcast rights and buried cables. The carrier used for the transmission signal is typically generated by a laser diode. Two parallel beams are needed, one for transmission and one for reception.

Laser communications systems are wireless connection through the atmosphere. Which is focused on decreasing the noise ratio in optical communication system. Laser communications systems work similarly to fiber optic links, except the beam is transmitted through free space. In Laser Communication the transmitter and receiver must require a line-of-sight conditions and Laser communications systems have the benefit of eliminating the need for broadcast rights and buried cables. Laser Communications systems can be easily deployed since they are inexpensive, small, low power and do not require any radio interference studies. The carrier used for the transmission signal is typically generated by a laser diode. Two parallel beams are needed, one for transmission and one for reception.

Laser communications plays a key role, as solutions for satisfy ever increasing high demand of bandwidth. In Laser communications systems bandwidth could be distributed in neighbourhoods by putting systems on top of homes and pointing them towards a common transceiver with a fast link to the Internet. It supports possible transmit speeds of up to a gigabit per second, Other applications of Laser communications systems technology include temporary connectivity needs (e.g. sporting events, disaster scenes, or conventions), or space based communications.

Laser communication system can be used to transmit sound and data signals through the laser beam of the system. The intensity of the carrier beam changes with the change in amplitude of the sound signal. Variation in the intensity of the laser beam is converted in to a variation in the voltage level by using solar panel. In this mode of communication the transmitter and receiver requires to satisfy the line of sight conditions. The carrier required for transmission of signal in laser communication System is generated by laser diodes.

COMPONENTS REQUIRED

- Laser Pointer
- AA Batteries,1.5V,any size
- Battery Holder for the 1.5V batteries
- Connecting Wires
- Audio Output Transformer, 1kΩ primary coil, 8Ω secondary
- Solar Cell
- Mini Amplifier
- 3.5mm Audio Jack

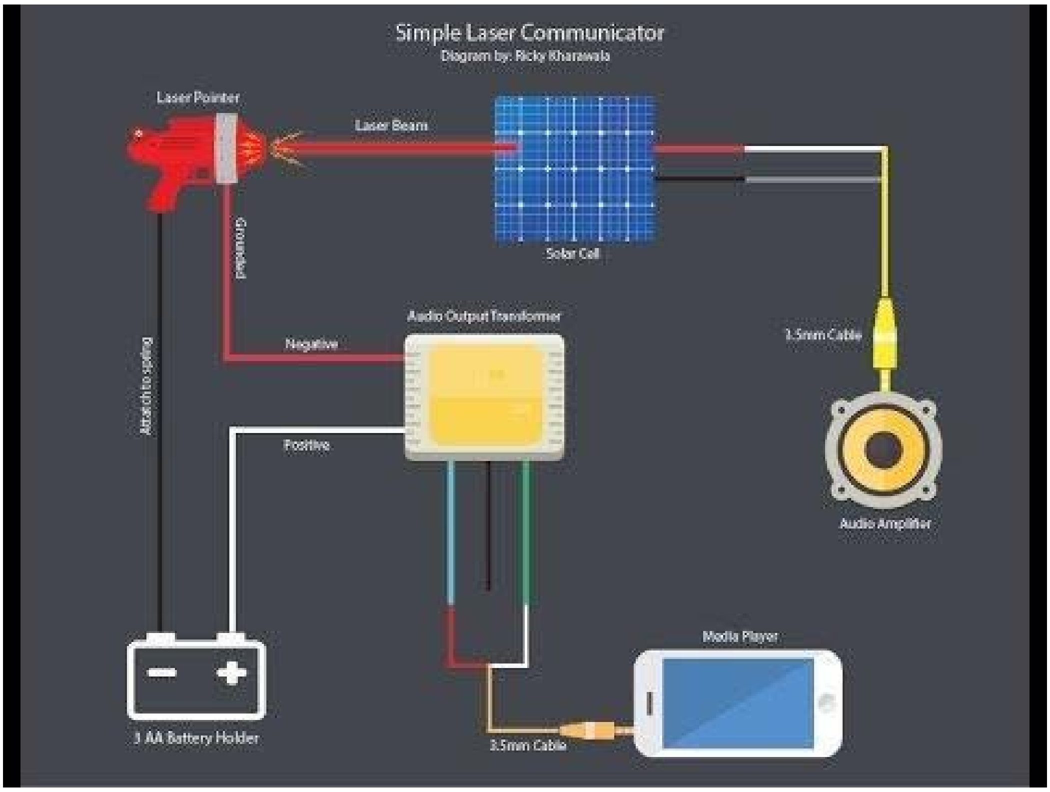
CHAPTER 2
PROJECT DESIGN

2.1 OBJECTIVE:

The main objective of this project is primarily to realize a transmission-reception system to transfer sound via Laser without any guiding medium, using Intensity Modulation with little quality loss.

To demonstrate the fact that the large bandwidth available when we use laser for communication purposes can be utilized to send and receive multiple signals at a time using the concept of FDM.

2.2 BLOCK DIAGRAM:



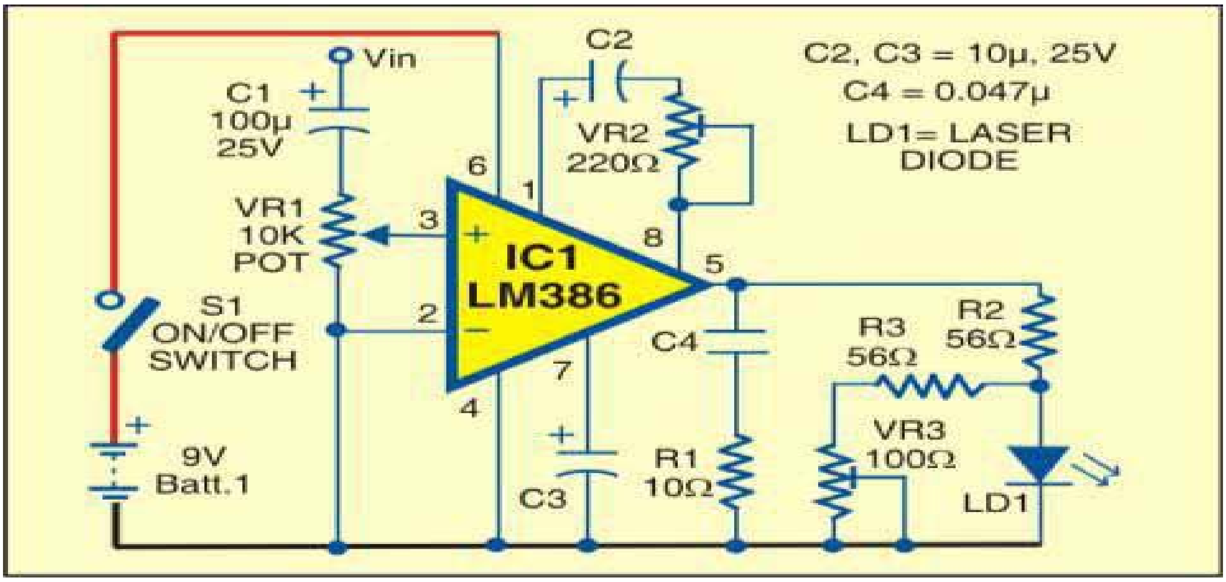
-The transmitter sends the audio data to the transmitting unit using an aux cable.

-The transmitting unit converts the electrical signal into light and transmits to the receiving unit in free space.

-The receiving unit converts this light signal and converts it back into electrical signal.

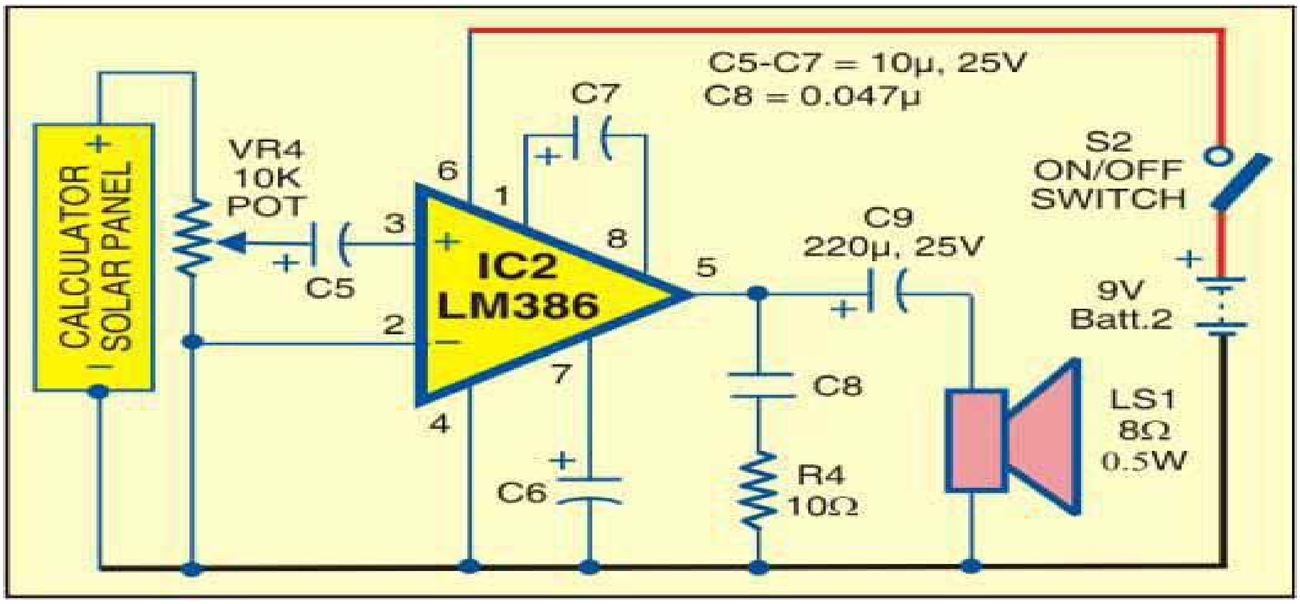
-This signal is fed to the receiver module.

2.3 CIRCUIT DIAGRAM – TRANSMITTER



- A laser diode (LD1) with maximum operating voltage of around 2.6V DC and maximum operating current of 45 mA is used to transmit the audio signal.
- The voltage divider network formed by R2, R3 and VR3 keeps the voltage as well as the current for the laser diode in the safe region.
- Potentiometer VR1 (10-kilo-ohm) is used to change the level of the input audio signal.
- The audio input (Vin) is taken from the preamplifier output of the music system (CD player, mike system, DVD player, etc).
- Capacitor C2 and preset VR2 are used to vary the gain of the LM386.

2.4 CIRCUIT DIAGRAM - RECEIVER



- The audio signal transmitted by the laser diode (LD1) is received by the solar panel and amplified by IC2.
- The gain of the amplifier is fixed by capacitor C7. Preset VR4 is used to change the signal level from the solar panel.
- This signal is fed to input pin 3 of IC2 through coupling capacitor C5 so that the DC value from the solar panel can be eliminated.
- The amplified output from IC2 is fed to the speaker, which plays the music from the CD player connected at the input (Vin) of IC1.

IC LM386:

The LM386 is a power amplifier designed for use in low volt-age consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value from 20 to 200. The quiescent power drain is only 24 mill watts when operating from a 6 volt supply, making the LM386 ideal for battery operation. To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open the 1.35 k ohms resistor sets the gain at 20 (26 dB).

CHAPTER 3

IMPLEMENTATION

The voltage variation on the solar panel is amplified by a low-voltage audio power amplifier LM386 and reproduced by a speaker. The maximum output of audio amplifier LM386 is 1 watt, while its voltage gain is 20 to 200. The circuit consists of a transmitter and a receiver. Both the transmitter and the receiver are built around IC LM386, powered by a 9V battery. The transmitter circuit here a laser diode (LD1) with maximum operating voltage of around 2.6V DC and maximum operating current of 45 m A is used to transmit the audio signal. The voltage divider network formed by R2, R3 and VR3 keeps the voltage as well as the current for the laser diode in the safe region. In place of the laser diode, you can also use a laser pointer. Remove the battery from the laser pointer. Extend two wires from terminals of LD1 and connect them to the battery terminals of laser pointer.

The spring inside the laser pointer is the negative terminal. The output power of the laser pointer is 5 m W. Take care while working with laser, as direct exposure to the laser beam can be hazardous to your eyes. Point the laser beam to the solar panel. Potentiometer VR1 (10-kilo-ohm) is used to change the level of the input audio signal. The audio input (V in) is taken from the preamplifier output of the music system (CD player, DVD player, etc). Capacitor C2 and preset VR2 are used to vary the gain of the LM386. The receiver circuit shows the audio signal transmitted by the laser diode (LD1) is received by the calculator’s solar panel and amplified by IC2. The gain of the amplifier is fixed by capacitor C7. Assemble the transmitter and receiver circuits on separate PCBs and enclose in suitable cabinets. In the transmitter cabinet, fix two terminals for connecting the audio signal. Fix switch S1 on the front panel and the laser diode (LD1 or laser pointer) to the rear side of the cabinet. Keep the 9V battery inside the cabinet. In the receiver cabinet, fix the calculator’s solar panel to the rear side such that the transmitted beam directly falls on it. Fix switch S2 on the front panel and the speaker to the rear side. Keep the 9V battery inside the Cabinet.

CHAPTER 4

WORKING

Microphone Amplifier: The first step in transmitting sound is to digitize sound waves. For this we used an electric microphone. The microphone we had consists of three leads- power, ground, and signal. The signal coming off the mic was far too low to be read (with any degree of precision) by the analog to digital converter. For that we are using the LM386 op-amp to increase the power and signal. Before the signal is put through the amplifier, first put the signal through a capacitor to remove DC, and then through a voltage divider to appropriately bias the signal. The gain is adjusted by the resistors and for the microphone the gain is around 50-100 (depending on how much popping and how much quality you want).

UART (Universal Asynchronous Receiver/Transmitter): It is a piece of computer hardware that translates data between parallel land serial forms. The universal designation indicates that the data format and transmission speeds are configurable and that the actual electric signalling levels and methods typically are handled by a special driver circuit external to the UART.

A UART is usually part of an integrated circuit used for serial communications over a Computer or peripheral device serial port. A dual UART, or DUART, combines two UARTs into a single chip.

Laser Driver:

After the A/D converter translates the mic signal into 8 bits, the MCU generates the appropriate bits to send (including start and stop bits) and applies them to the laser driver circuit a 5V and 0V signals. The BJT in this circuit turns on at 5V and provides the proper current according to the diode.

RECEIVER:

A solar panel detects the laser pulses in a different (distant) location. This signal is put through a comparator in order to generate solid 5V and 0V values which are applied to the receive pin on the microcontroller.

LASER DRIVER:

Once the signal is put through the DAC, it is boosted and low pass filtered (to improve sound quality).

NOISE FACTORS:

The noise in photodiodes the main sources of noise are dark current noise, shot noise and thermal noise in a photodiode. There is one more source of noise due to random nature of the avalanche in an APD. The dark current noise arises due to dark current which flows in the circuit when the photodiode is in un illuminated environment under bias condition. It is equal to the reverse saturation current of the photodiode. The magnitude of this current is strongly dependent on the operating temperature, the bias voltage and the type of detector. In an optical receiver, dark current sets a noise floor for the detectable signal power level. Therefore, it should be minimized by careful device design and fabrication. Dark current in optical telecommunication grade Si PIN photodiodes is typically 100pA, while in Si APDs it is typically 10 pA. In InGaAs based PIN-photodiodes and APDs, the dark current is of the order of 100nA and it could pose a serious problem unless the device is cooled an appropriate temperature.

CHAPTER 5

APPLICATIONS

-In the Laser communications systems bandwidth could be distributed in neighbourhoods by putting laser communication systems on top of homes and pointing them towards a common transceiver with a fast link to the Internet.

-With possible transmit speeds of up to a gigabit per second,

-With the powerful laser, it would even be possible to communicate using satellites to reflect the signals.

-It can be used to reproduce sound in large public meetings on open grounds or for communication between tall buildings. Direct communication between high-rise buildings in a crowded city would become easy.

CHAPTER 6

ADVANTAGES

-The advantages of laser communication is that it allows very fast communication service between two or more devices than other modes of communications

-It can provide speed more than 1GBps.So it overtakes the LAN or wireless LAN comprehensively

-Laser communications systems have the benefit of eliminating the need for broadcast rights and buried cables.

-Laser communications systems can be easily deployed since they are inexpensive, small, low power and do not require any radio interference studies. The carrier used for the transmission signal is typically generated by a laser diode. Two parallel beams are needed, one for transmission and one for reception.

-The transmitting and receiving station are smaller and lighter for given range. Less overall power is required for the given distance and data rate. Higher data rate may be achieved for given distance and power output.

-A tiny light detector may allow for superfast broadband communication over interplanetary distances. This technology advance offers the space laser communication system designer the flexibility to design very lightweight, high bandwidth, low-cost communication payloads for satellites whose launch costs are a very strong function of launch weigh.

-Signals can be reproduced without distortion, even long distances. So the system could be use for communication and cable television transmission.

-A one way laser communications system that is capable of ẋ the transmission of both text and sound.

-Even by a minute fraction of a degree, the laser will miss by thousands of miles. Instead of better and faster pictures, there could be no pictures.

CHAPTER 7

7.1 FUTURE WORK:

-The laser communication system is currently being developed for underwater communication.

-With a suitable laser, long distance communication with very low latency can be achieved.

-The devices themselves will have to be modified to work with fiber optics or some other system that eliminates conventional metal wires and circuits.

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