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Laser Communication System

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***Abstract*: This paper presents design of the circuit, using this circuit we can communicate with our neighbors wirelessly. Instead of RF signals, light from a laser torch is used as the carrier in the circuit. The laser torch can transmit light up to a distance of about 500 meters when IR sensor is accurately oriented towards the laser beam from the torch. If there is any obstacle in the path of the laser beam, no sound will be there from the receiver. The transmitter circuit consists of a condenser microphone transistor amplifier BC548 followed by an op-amp stage built around µA741. The value of gain of op-amp can be varied with** the help of 1-mega-ohm pot meter VR1.The AF output from IC1 is coupled to the base of transistor BD139 **(T2), which modulates the laser beam. The power supply is firstly stepped down through a step down transformer which is further rectified through a rectifier and 9V power supply is given to the transmitter circuit. However, the 3-volt laser torch is directly connected to the circuit with the emitter of BD139. The receiver circuit uses an IR sensor that is followed by a two-stage transistor pre-amplifier and LM386 audio Power amplifier. The receiver does not require any complicated alignment. Just keep the IR sensor oriented towards transmitter's laser point and adjust the volume for a clear sound. While using circuit keep the IR sensor away from AC light sources such as bulbs. The reflected sunlight, however, does not cause any problem. But the sensor should not directly face the sun.**

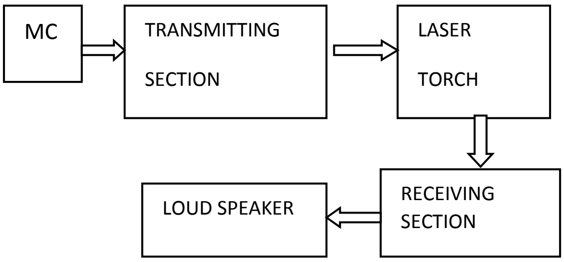
***Keywords:* Laser, LST, RF, LM386, Wireless.**

1. INTRODUCTION

Laser communication system can be a better substitute for the present day communication systems as the problem faced due to interference in case of electromagnetic waves is not there and high secrecy can be achieved. It can easily provide communication between distance of hundred meters, and with a parabolic light reflector, up to several kilometers. The laser-induced lubricant pockets generates high local pressure and thus causes a thicker lubricant film, allowing an optimal separation of the contact surfaces. It transmits very high quality audio and the link is virtually impossible for anyone else to tap into without knowing. Privacy is an another important feature of laser communication system. If someone interrupts the beam, the link is broken. Fiber-optic cables also have high security, as it is very difficult to get into the cable without breaking the link. However, it is theoretically possible; so for the high security, we probably cannot compete with a line-of-sight laser beam. It cannot be even detected by the use of spectrum analyzers and RF meters and hence can be used for various applications which includes financial, medical and military streams. Laser Surface Texturing (LST) is probably the most advanced till now. LST produces a large number of micro-dimples on the surface and each of these can serve either as a micro-hydrodynamic bearing in case of full or mixed lubrication, a micro reservoir for lubricant in case of starved lubrication conditions, or a micro-trap for wear debris in either lubricated or dry sliding. Laser can also be transmitted through glass, but we need to consider the physical properties of the glass. By rotating the medium under the focused pulsed-laser beam, a row of crater shaped dimples are produced in the landing zone. Laser transmitter and receiver units ensure easy, straight forward systems alignment and long-term stable, service free operation, especially in unapproachable environment. Over the last 10 years, laser intensity is increased by more than fourth order of magnitude to reach tremendous intensities of 1020 W /cm2.The laser can also be mandated in satellites for communication, as laser radar requires small aperture as compared to microwave radar. As we cannot see the laser beam without special IR sensitive equipment, it also makes alignment more difficult. Further, potential bandwidth of radar using laser can be translated to a very precise range measurement. Due to these reasons, it can be used as an alternative to present modes of communication. Laser communication is both wide-band and high-speed.

2. DESIGN OF WORKING PRINCIPLE

The block diagram of working principle of the system:



A. Condenser Microphone:

Condenser microphones require power from a battery or external source. Condenser also tends to be more sensitive and responsive than dynamic, making them well suited to capturing subtle nuances in a sound. The diaphragm vibrates when struck by sound waves, changing the distance between the two plates and therefore changing the capacitance. Specifically when the plates are closer together capacitance increases and a charge current occurs and this current will be used to trigger the transmitting section.

B. Transmitting Section:

The transmitter section comprises condenser microphone, transistor amplifier BC548 followed by an op-amp stage built around IC1. The gain of the op-amp can be controlled with the help of 1-mega ohm pot meter VR1. The AF output from IC1 is coupled to the base of transistor Bd139, which in turn, modulates the laser beam. The transmitter uses 9V power supply. However, the 3-volt laser torch (after the removal of its battery) can be directly connected to the circuit with the body of the torch connected to the emitter of BD139 and the spring loaded lead protruding from inside the torch to circuit ground.

C. Laser Torch:

Here we use the light rays coming from laser torch as the medium for transmission. Laser had potential for the transfer of data at extremely high rates, specific advancements were needed in component performance and systems engineering, particularly for space-qualified hardware. Free space laser communications systems are wireless connections through the atmosphere. They have worked similar to fiber optic cable systems except the beam is transmitted through open space. The laser systems operate in the near infrared region of the spectrum. The laser light across the link is at a wavelength of between 780 - 920 nm. Two parallel beams are used, one for transmission and one for reception.

D. Receiving Section:

The receiver circuit uses an NPN phototransistor as the light sensor that is followed by a two stage transistor preamplifier and LM386-based audio power amplifier. The receiver doesn't need any complicated alignment. Just keep the IR sensor oriented towards the remote transmitter's laser point and adjust the volume control for a clear sound.

E. Loud Speaker:

A loudspeaker (or "speaker") is an electro acoustic transducer that converts an electrical signal into sound. The speaker moves in accordance with the variations of an electrical signal and causes sound waves to propagate through a medium such as air or water.

3. CIRCUIT DESIGN OF SYSTEM

There the transmission distance is no more than meters of so, a LED (or two for increased power) can be substituted for the laser diode. For instance, there the link is being used for educational purposes, such as demonstrating fiber-optic coupling, or the concept of communication over a light beam. Obviously the security of the transmission is much lower as LEDs transmit light in all directions. While, that laser link can be adapted for use as a perimeter protector. Now to a description of how it all works. As we shall see, it's really very simple.

A) Transmitter:

A laser diode needs a certain value of current, called the threshold current, before it emits laser light. A further increase in this current produces a greater light output. The relationship between output power and current in a laser diode is very linear, once the current is above the threshold, giving a low distortion when the beam is amplitude modulated. The circuit is based upon the principle of LIGHT MODULATION where instead of radio frequency signals; light from a laser torch is used as the carrier in the circuit.

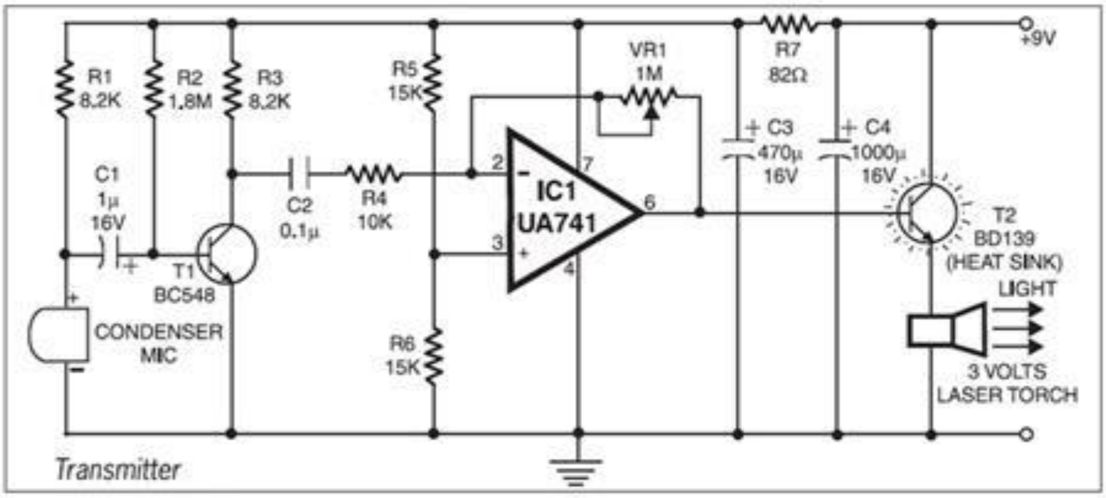


Fig . Laser Based Voice Transmitter

Here, the transmitter uses 9V power supply. Audio signal or voice is taken as input from the condenser mic, which is, followed transistor amplifier BC548 along with op-amp stage built around UA741.The gain of the op-amp can be controlled with the help of 1 mega ohms pot meter. The AF output from op-amp UA741 is coupled to the base of the power transistor BD139, which in turn, modulates the laser. However, the three volts laser torch can be directly connected to the emitter of BD139 and the spring loaded lead protruding from inside the torch to the ground. In the transmitter circuit, audio signal of the non-sinusoidal waveform and having a few mV of amplitude is taken as input from condenser mic. Condenser mic is directly followed by the transistor amplifier stage consist of BC548. Transistor BC548 is connected in common emitter configuration. Resistor R1 is the source resistor, which is directly connected to the power-supply.R2, R3 and capacitor C1 are acting as self-biasing circuits, which is used for the biasing transistor. These circuit arrangements provide or establish a stable operating point. The biasing voltage is obtaining by R2 and R3 resistors network. Self-bias is used for obtaining entire audio signal as input.Capacitor C1 is the coupling capacitor, since audio input signal is having a non-sinusoidal waveform of different amplitude and frequency, coupling capacitor is used to reject some of the dc noise/line as well as level from audio input signal. The self-biased circuit is connected with the BC548 in CE configuration. It is transistor amplifier stage, where the low amplitude audio signal is amplified to the desired voltage. The output is taken from the collector terminal; so inverted audio input signal is obtained. Transistor pre-amplifier stage is coupled with op-amp stage built by ua741. C2 is the blocking capacitor while R4 is the op-amp stage resistor. Op-amp ua741 is easily available general-purpose operational amplifier. Pin configuration of UA741 is shown in the glossary. Here pin no. 1 and 5 are not connected in order to nullify input-offset voltage. Pin no. 7 and 4 are VCC as well as –VEE supply voltage. Pin no. 3 is non-inverting input while pin no. 2 is inverting input. Between pin no. 2 and 6, 1 mega-ohm pot meter is connected as voltage series negative feedback, which controls the infinite gain of the op-amp. Resistors R5 and R6 of its value acts as a voltage-divider network, thus it gives a fixed voltage at the non-inverting pin. Input inverted audio signal is applied to the inverting pin. Op-amp works on the differences into the applied two input voltage and provide an output at pin no. 6. Since, input is applied to the inverting pin the output is also an inverting one. Thus, again we get in phase high power and high amplitude level audio signal. Capacitors C3, C4 and resistor R7 are acting as diffusion capacitors and feedback resistor respectively. These diffusion capacitors stored the carriers like holes and electrons in the base and thus provide self-biasing of the transistor. Power dissipation rate of UA741 is very high, which is not practical for driving other electronics devices, so heat sink power transistor BD139 is used. Power transistor BD139 absorbs most of the power and supplies the suitable power to drive the laser torch. This in turns modulates the laser beam, since laser torch acts like a balanced modulator, where two signals – one is message signal (audio signal) and carrier laser signal, superimposed. So, laser beam modulates and transmits the signals to large distances.

B) Receiver:

The receiver circuit uses an IR sensor as the light sensor. Here, the IR sensor receives the audio signal of low power and low amplitude that is followed by a two-stage transistor pre-amplifier.

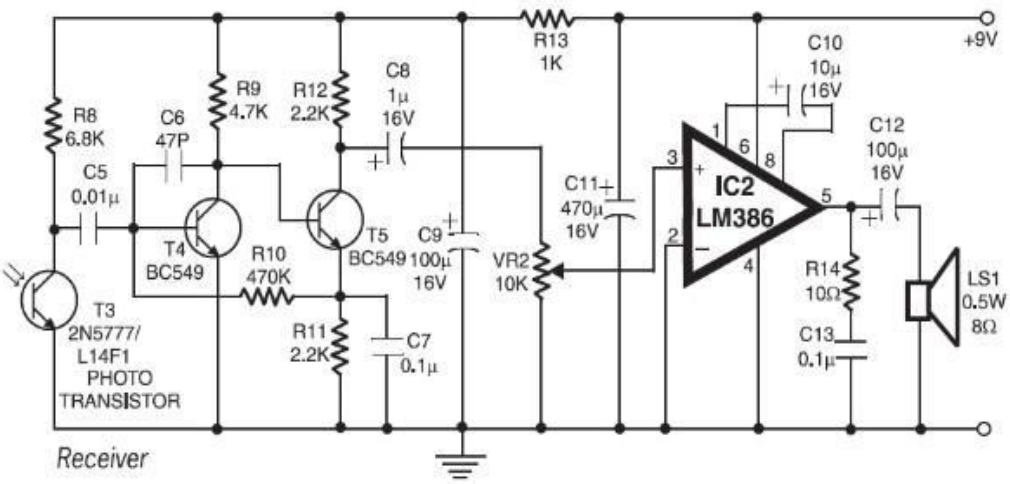


Fig 2: Laser Based Voice Receiver

In the pre-amplifier stage R8 is a source resistor, which is directly connected to the power supply. The pre amplifier stage is RC coupled amplifier in CE configuration.C5, C6 are the junction capacitances, which are taken in to the account when we consider high frequency response, which is limited by their presence. Resistors R9 and R12 are used to establish the biasing of the transistor BC549.R11 is self-bias resistor, which is used to avoid degeneration.C7 is a bypass capacitor, which acts as to prevent loss of amplification due to negative feedback arrangement.

Transistors BC549 are the amplifier transistors, which amplifies the signal because the signal obtained by the IR sensor is of few mV.C8 is the blocking capacitor, which is connected to the variable resistor VR2, which in turn followed by audio power amplifier IC LM386. Pin configuration of LM386 is shown in the glossary. Pin no. 1 and 10 is followed by C10, which is an external capacitor, used to compensate internal error amplifier and thus avoid instability. Volume control can be adjusted from variable resistor VR2 of 10 kilo- ohms. LM386 provides suitable power output useful for drive the loudspeaker of 0.5W.From the pin no. 5, the high power as well as suitable amplitude received audio signal is taken as output.R14 and C13 are bypass arrangement used to prevent loss of amplificationC12 capacitor is used for preventing the noise as well as the hum produced by the ac sources. From the loudspeaker, the audio output is heard.

4. CONCLUSION

Using this laser communication system we can communicate with our neighbors wirelessly. It can be also used in inapproachable areas, conference halls and in satellite for communication. Instead of the short range laser, high range lasers can be used which range a few hundred meters, provided there should be no heavy traffic.

REFERENCES

[1] Etsion, I. and Burstein, L., “A Model for Mechanical Seals with Regular Micro surface Structure,” Tribology Transactions, Vol. 39, pp. 677–683, 1996.

[2] Geiger, M., Roth, S., and Becker, W., “Influence of Laser-Produced Microstructures on the tribological Behavior of Ceramics,” Elsevier, Surface and Coatings Technology, Vol. 101, pp. 17–22, 1998.

[3] Etsion, I., “State of the Art in Laser Surface Texturing,” J. of Tribology Trans. ASME, Vol.127, pp. 248–253,2005.

[4] Ranjan, R., Lambeth, D.N., Tromel, M., Goglia, P., and Li, Y., “Laser Texturing for LowFlying-Height Media,” J. of Applied Physics, Vol. 69, pp. 5745–5747, 1991.

[5] Geiger, M., Popp, U., and Engel, U., “Eximer Laser Micro Texturing of Cold Forging Tool Surface-Influence on Tool Life,” , Elsevier Annals of the CIRP, Vol. 51, pp. 231–234, 2002.

[6] A.Braun, G. Kern, X. Liu, D. Du, J. Squier, and G. Mourou, “ Ultrahigh-intensity laser: physics of the extreme on a tabletop “ , Springer, Berlin, Vol. 60, p. 248-265, 1994.

[7] C. V. Shank. Kaiser,” Ultrashorf Laser Pulses and Applications”, Springer-Verlag, Berlin, Vol. 60, pp. 5-34, 1988.

[8] A. Pukhov and J. Meyer-ter-Vehn, “Relativistic Magnetic Self-Channeling of Light in Near-Critical Plasma: Three-Dimensional Particle-in-Cell Simulation” Phys. Rev. Left., Vol. 76, pp. 3975-3978, 1996.