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# Design and Implementation of Audio Transceiver using Infrared Laser for Audio Signal Detection[1]

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## Abstract:

In this work, an electronic device capable of receiving vibration modulated laser signals was designed, the idea is to convert these vibrations through the device to a hearable sound with high quality. The transmitter is composed of an infrared laser diode, and the receiver consists of photo-transistor, an integrated circuit of LM358, first order filter, TDA2002 integrated circuit and speaker. The vibrations made by the source will cause a resonant frequency with the window, so the incident infrared laser beam will have this frequency, and then by reflection from the window the reflected laser beam will have vibrations as it's modulated inside the beam.

The transceiver will make sure that these vibrations will be directed to the receiver through the photo-transistor head and then, the signal will be converted from optical to electronic domain.

The audio signal will pass through the receiver components which will eliminate the noise by the filters and amplify the signal with the TDA2002 large audio signal amplifier, then the signal will be converted to audio domain throughout the speaker.

Experimental results proved that this device is able to function properly through 20 m, with good sound quality, this was because the use of 1 W laser diode of 808 nm.

## Keywords:

Laser modulation, Audio amplifier, Sound quality, Threshold frequency, LM358, TDA2002, Diode laser, IREDs.

[1] **This work was part of my B.Sc. degree project and not all the details of the work is included in this articles, it was done in 2013.**

## Introduction:

The technique of using a light beam to remotely record sound was probably originated by Léon Theremin in the Soviet Union at or before 1947, when he developed and used the Buran eavesdropping system. This is done by using a low power infrared beam (not a laser) from a distance to detect the sound vibrations in the glass windows as shown in **fig. (1)** **[1]**.

**Fig. (1):** The Buran eavesdropping system made by Léon Theremin **[1]**

Lavrentiy Beria, had used this Buran device to spy on the U.S., British, and French embassies in Moscow. It has been reported that the National Security Agency (NSA) makes use of laser microphones **[2]**.

In 2009, U.S. patent was issued for a device that uses a laser beam and smoke or vapor to detect sound vibrations in free air ("Particulate Flow Detection microphone based on a laser-photocell pair with a moving stream of smoke or vapor in the laser beam's path"). Sound pressure waves cause disturbances in the smoke that in turn causes variations in the amount of laser light reaching the photo detector. A prototype of the device was demonstrated at the 127th Audio Engineering Society convention in 2009 **[3]**. Recently, many approaches have been made to demonstrate the detection of audio signal from abroad distance, the laser techniques are considered as the most precise techniques **[4, 5]**.

## Experimental work:

The transmitter is the infrared laser diode of wavelength 808nm and the receiver is completely an electronic circuit, it was designed accurately to receive reflected laser beam signal, which is then filtered and amplified again to reach the speaker terminals, as shown in **fig. (2)**. The device was built and used practically in the laboratory with the help of other electronic components like mounting optics, oscilloscope, ammeter, voltmeter, and a mobile device for audio generation.

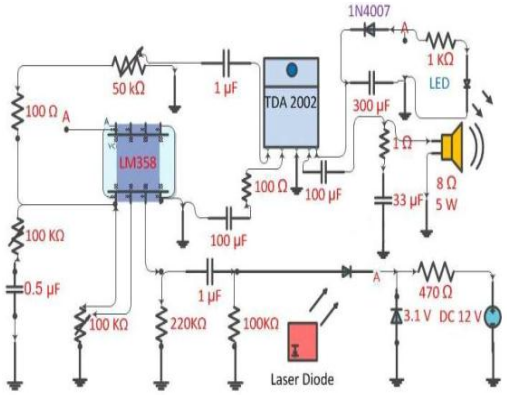


**Fig. (2):** The schematic diagram of the audio transceiver.

## Results and Discussion:

The results were obtained using an oscilloscope at Peak-To-Peak 2 Volts and 10 m-Sec per division. A MATLAB program was designed and executed to evaluate perfect values of the sound absorption coefficient and the allowable distance that the device works in it perfectly.

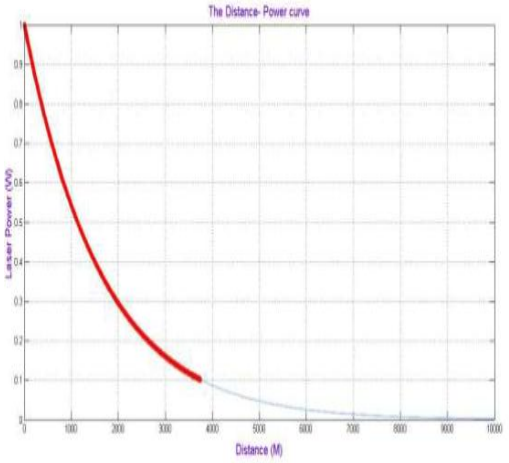


**Fig. (3):** The distance power curve (the bold line is the limit for the good signal quality).

The MATLAB results showed that the absorption coefficient of sound is 0.061 $cm^{-1}$, after calculation of the sound absorption coefficient, a curve was plotted to show the maximum allowable distance as shown in **fig. (3)**.

## Conclusions:

The sound quality is affected by laser power. Minimum losses requires perpendicular incidence of the laser on the window. The deviation angle is proportional to the noise.

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