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Low Cost Transmission Of Voice And DTMF Signals Using LASER Torch

Mohan Kumar P

Assistant Professor, Department of Biomedical Engineering, PSNA College of Engineering and Technology, Dindigul, Tamilnadu, India
Email: mohanpalanichamy23@gmail.com

ABSTRACT: The microprocessor and digital network technologies have fundamentally reinvented the ways in which today's data acquisition systems handle data. Most of the laboratory and manufacturing unit, information is still communicated the old way, via analog electrical signals and a fundamental understanding of how analog signal transmission works. In this work, the low intense LASER beam is used for transmitting low power signals like audio signals and to enable a wireless communication between two nodes for information exchange. Also the same modules were used for transmitting standard signals like DTMF signals.

Keywords : LASER, DTMF, Wireless, Optical communication

1 INTRODUCTION

LASER is being used in number of applications like military, medicines and more. LASER has its own characteristics features like monochromatic, intense beam, and travel in straight line. LASER is nowadays used mainly for cutting heavy metals accurately. For such applications a high intense LASER beam is used. Low intense beam are also available for domestic purposes. These extra ordinary characters of LASER had driven us to implement them for signal transmission. Here such low intense beam was used for signal transmission. The work explains the signal transmission using low cost LASER torch in two modules.

Audio signal Communication module
DTMF signal Communication module

The advantages of wireless communication systems and the uninterruptability of LASER rays laid the foundation for this work. Also the advantages in transmitting audio signals across two ends using LASER will prove a new trend in signal transmission. The world relies on the flow of information or data. With the advent of the internet, this has become extremely convenient and cost-efficient. While the flow of information rests on the internet, the internet in turn lives on beams of light. Computers from which the information is sent consist of a bundle of copper wires/optical cables that actually conduct/transmit data. However, with computers getting faster by the day, the ability of transmission to carry more information is reaching its physical limits. Fibre-optic network is being looked upon as an alternative to increase the computer's ability to carry more data. To power a fibre-optic network, a process called Photonics is employed, which deals with the production and utilization of light and other forms of radiant energy with photon as the quantum unit. Glass fibre as thin as a single hair is capable of carrying as much data as thousands of copper wires. A light signal has higher frequency than an electric signal. This higher frequency helps light transmit many thousand times greater amount of information than an electric signal. But the lasers used in optical communications are made from semiconductors that are not compatible with the established processes for making silicon computer chips. Hence, the advantages of laser have not yet benefited the computer chips. Making silicon emit light can be the right solution to power a fibre-optic network, but this has proved to be a tough challenge owing to the disparity between silicon's electrons and its positively charged electronic vacancies called 'holes'. When an electron encounters a hole, the excess energy is released as vibration and not as light. But a team at the university of california, Los Angeles, became the first to make a laser out of silicon. Subsequently, researchers at Intel reported a silicon laser that emitted a continuous beam instead of a pulsed beam, which is necessary for data communications. In these experiments, the researchers employed the Raman effect. Photons of light that pass through a material gather energy from the natural vibration of its atoms and change to another frequency. When light is emitted from a non-silicon laser into silicon, the photons are emitted as a laser beam at another frequency due to Raman's effect. This laser is a significant scientific discovery. Earlier, Intel also created a silicon modulator, which allows data encoding onto a light beam by rendering it stronger or weaker. It is believed that silicon lasers will be a cost-effective way to raise the computing speed limit. The goal is to enable optical communication between components of the same chip. On-chip optical communication requires a silicon laser powered by electricity, which would be cheaper and less complicated than the one that depends on the external laser. If such a laser is built, it becomes possible right from super-computers to the smallest transistors to talk to each other at the speed of light.

2 EXISTING METHODOLOGIES

The millimeter wave signal transmission using BPSK technique [2] is not power efficient and need optical amplification for successful error-free transmission. Optical amplifiers are expensive components and are not viable for these applications unless used to overcome optical splitting losses in situations where one optical source is used for many remote antenna sites. Optical heterodyning of two laser diodes can generate enough optical power to overcome the need for optical amplification. Successful transmission experiments using optical injection locking (OIL) techniques and, at 9 GHz, optical phase-lock loop (OPLL) techniques have been reported, but need milli-Kelvin precision laser temperature control. The optical injection phase locked loop technique has been shown to be capable of 68Mbit/s BPSK millimeter-wave over fibre transmission over 25 km of standard SMF by direct data modulation. In another study two basic optical communication links [3]was studied. A Laser driver to interface an audio signal to

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each of two infrared sources was proposed. One source was a light-emitting diode (LED) and the other was a laser diode. An audio signal injected through the laser driver modulated the light source. Positioned using fibre positioners and optical translation stages, the fibre captured the signal and transmitted it to a photo detector connected to an audio amplifier and speaker. Operated in the infrared region, this invisible light gave a new experience with sources and detectors beyond that obtained with earlier experiments with the helium-neon laser. The received signal intensity reduced by inserting a translucent card between the fibre outputs face and the photo detector. Future possibilities for new experiments include the use of Wavelength-division multiplexing and study of optical fibres with different index of refraction profiles. The transmission of audio and burst signals through a prototype THz analog communication link [1] employing laser-gated low-temperature-grown GaAs dipole antenna as THz emitter and receiver. The transmission distance is about 100 cm. Noise analysis reveals a 10% power fluctuation in the received signal with on-off extinction ratio of greater than 1000. The transmission of a six-channel analog and burst audio signal with least distortion is also demonstrated. Thus it was concluded that the fidelity of the transmission of a melody through the THz link with and without any amplification. The transmission of video signal should be feasible by improving the electronic interface

3 Materials and Methods

In the first module of this work, audio signal transmission is employed. It consists of an audio signal transmitter circuit and a receiver circuit. In transmitter circuit, the voice signal is received using a condenser mic and it is sampled using NE555 timer. This sampled signal is used to drive the laser torch. The received signal (using LDR) is further processed to reproduce the audio signal. In the second module, DTMF signal transmission is employed. The transmitter circuit is same as first module. In the receiver section, the DTMF is received using a special DTMF receiver. Then the DTMF signal is converted into BCD signal using DTMF to BCD converter. Later the BCD signal is displayed in 7-segment display after decoding using seven-segment decoder

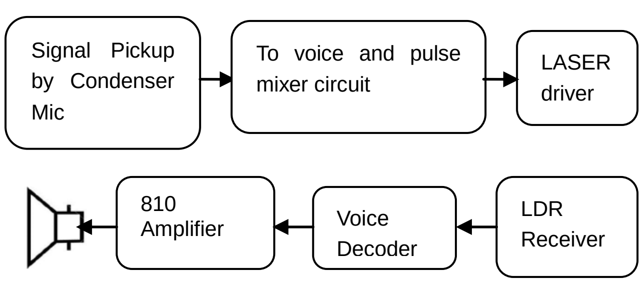

Fig 1: *Block diagram represent the signal flow in the transmitter and receiver circuit*

3.1 Noise & Grounding

While transmitting analog signals across a process plant or factory floor, one of the most critical requirements is the protection of data integrity. However, when a data acquisition system is transmitting low level analog signals over wires, some signal degradation is unavoidable and will occur due to noise and electrical interference. Noise and signal degradation are two basic problems in analog signal transmission. Noise is defined as any unwanted electrical or magnetic phenomena that corrupt a message signal. Noise can be categorized into two broad categories based on the source-internal noise and external noise. While internal noise is generated by components associated with the signal itself, external noise results when natural or man-made electrical or magnetic phenomena influence the signal as it is being transmitted. Noise limits the ability to correctly identify the sent message and therefore limits information transfer. Some of the sources of internal and external noise include:

ElectroMagnetic Interference (EMI)
Radio-Frequency Interference (RFI)
Leakage paths at the input terminals
Turbulent signals from other instruments
High-frequency transients and pulses passing into the equipment
Improper wiring and installation

3.2 Wire & Cable Options

Another important aspect to consider in analog signal transmission is a proper wiring system, which can effectively reduce noise interference. Analog signal transmission typically consists of two-wire signal leads or three-wire signal leads. In systems that require high precision and accuracy, the third signal lead, or shield, is necessary. In the three-wire configuration, the shield is grounded at the signal source to reduce common-mode noise. However, this does not eliminate all of the possibilities of the introduction of noise. It is crucial to prevent the noise pickup by protecting the signal lines. In this scenario, the signal cannot be isolated /filtered from the noise at the receiving device.

3.3 Laser

Laser means Light Amplification by Stimulated Emission of Radiation. Light from laser can be continuous beam of medium power or it can be a short burst of intense light delivering millions watts. It is acting as transmitting module in fibre optic communication. When a photon is incident on a system three transition processes can take place . They are

Absorption
Spontaneous emission
Stimulated emission

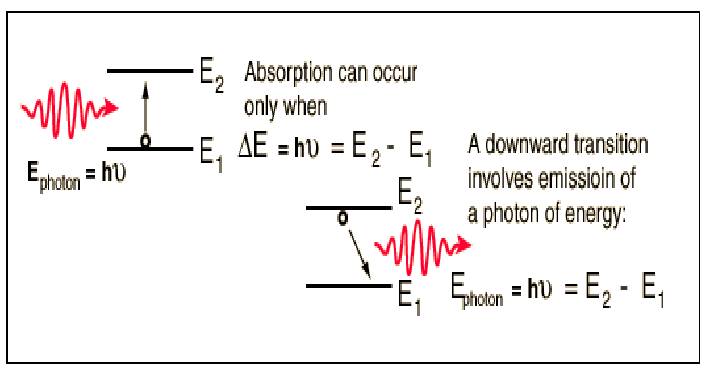

Fig 2: *Represents the process of spontaneous emission*

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Characteristics of LASER
Laser light is sharply mono chromatic. It may have more than one monochromatic frequency can be separated from the others.

The light is coherent.
Laser emit beam in parallel rather than in all directions like a bulb filament. It has low dispersion and it can be accurately directed by lenses and prisms.

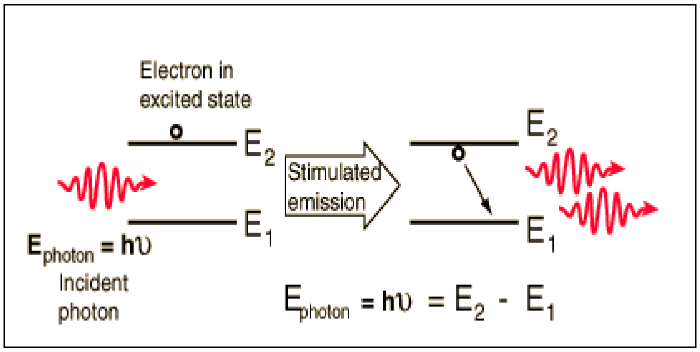


Fig 3: *Represents the process of Stimulated emission*

3.4 The DTMF technique

DTMF stands for Dual Tone Multiple Frequency. It is a tone consisting of two frequencies superimposed. Individual frequencies are chosen such that it is easy to design filters and easy to transmit the tones through a telephone line having bandwidth of approximately 3.5 kHz. DTMF was not intended to be used for data transfer, it was meant to be used for sending the control signals along the telephone line. With standard decoders it is possible to send 10 beeps per second i.e., five bits per second. DTMF standard specifies 50ms tones and 600ms duration between two successive tones.

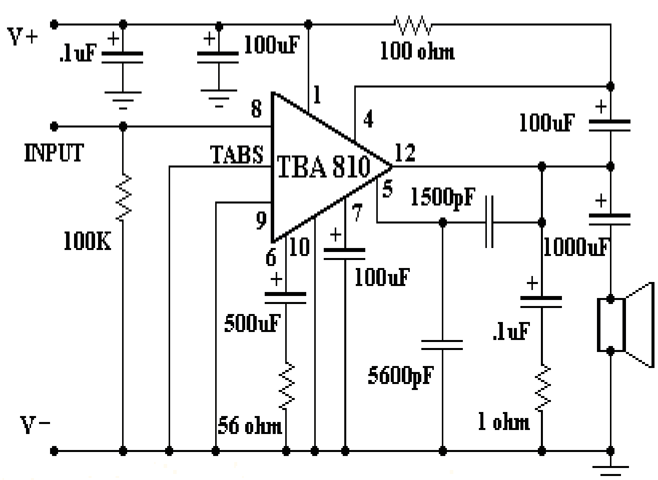
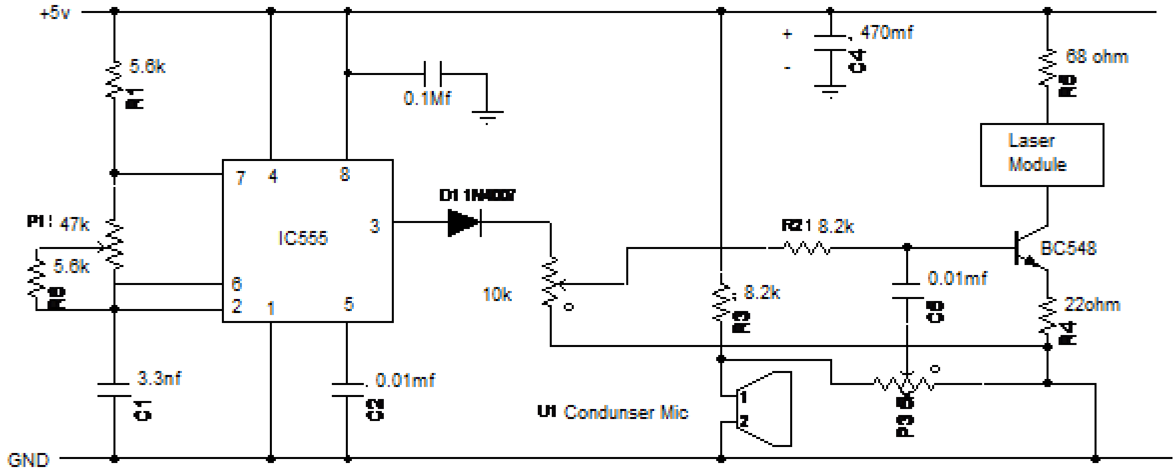


Fig 4: *Schematic used as 810 Amplifier*

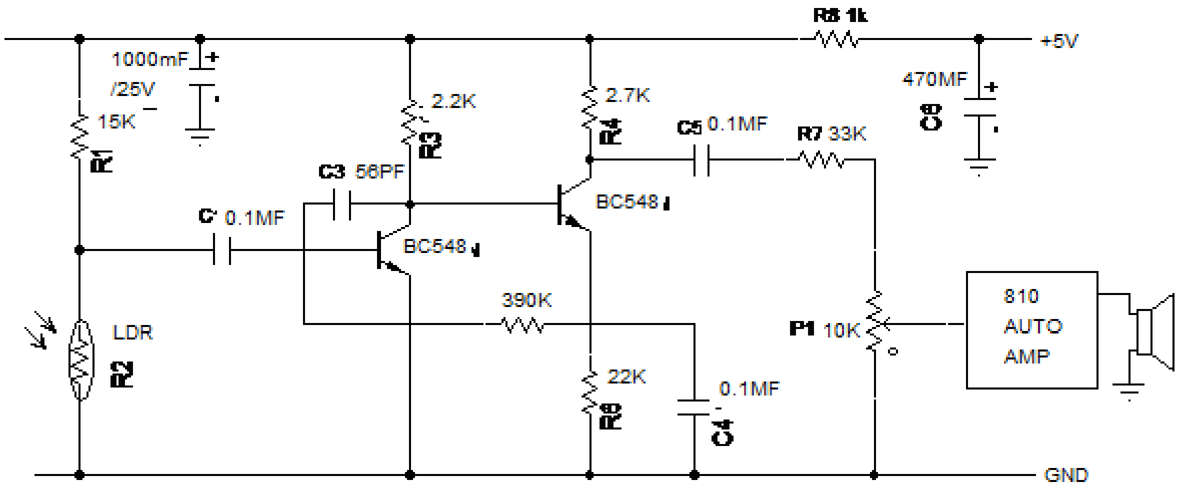
Hz	*1209*	*1336*	*1477*	*1633*
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

Note that the last column is not commonly seen in the telephones that we used, but telephone exchanges use them quite often. Nowadays, DTMF is used for dialing the numbers in telephones, configuring telephone exchanges etc. A CB transceiver of 2.7 MHz is normally used to send floating codes. DTMF was designed to be able to send the codes using microphone. Each beep (or digit you dial on the telephone) is composed of two concurrent frequencies, which are superimposed on amplitude. The higher of the two frequencies is normally aloud by 4dB, and this shift is termed as twist. If the twist is equal to 4dB, the higher frequency is loud by 4dB. If the lower frequency is loud, then the twist is said to be negative.

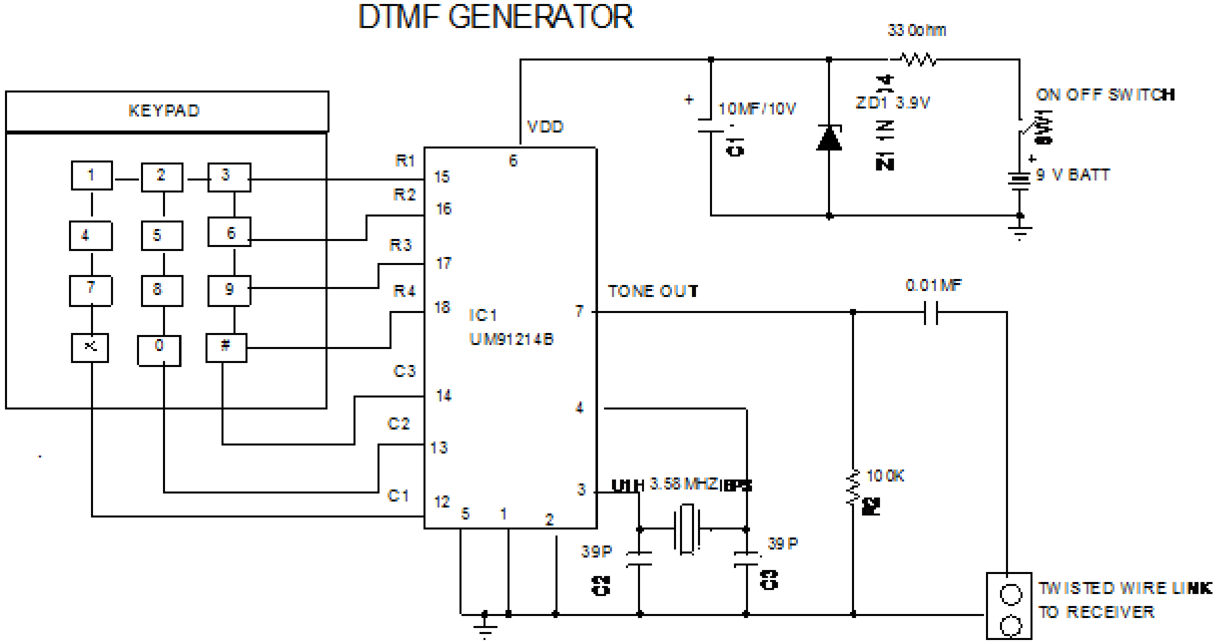
LASER TRANSMITTER



LASER RECEIVER



DTMF GENERATOR



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3.5 Generating DTMF

DTMF signals can be generated through dedicated ICs or by using RC networks connected to a microprocessor. MT8880 is an example of a dedicated IC. But getting the latter method work is a bit difficult if high accuracy is needed. The crystal frequency needs to be sacrificed for a non standard cycle length. Hence this method is used for simple applications. Most often, a PIC micro could be used for the above purpose. The UM 91215 series is used for DTMF encoding .in this PC based wireless system. UM 91215-B is used for encoding purpose.The mode selection pin is checked for tone pulse dialing at each digit key entry .in pulse mode the dialing rate is checked along with the make/ break ratio at the first key.

3.6 DecodingDTMF:

Detecting DTMF with satisfactory precision is a hard thing. Often, a dedicated IC such as MT8870 is used for this purpose. It uses two 6th order band-pass filters using switched capacitor filters and it suppresses any harmonics. Hence they can produce pretty good sine waves from distorted input. Hence it is preferred. Again microprocessors can also be used, but their application is limited.

3.7 LDR

LDR is nothing but a light dependent resistor whose resistance value changes inversely to the variations in the intensity of light that falls over the sensing portion. LDR is chosen as the receiver for LASER signals because of its good frequency response and its ability for withstanding over the specified ranges. LDR is used as receiver for both the signals (audio and DTMF). The output resistance variation is fed to a potential divider circuit and its resistance change is transduced into voltage signal. The transduced voltage signal depends on the intensity of light which falls on the device which is in-turn dependent on the amplitude of the audio signal that is being transmitted.

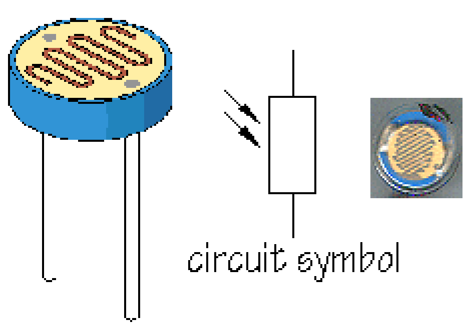

Fig 8: *Schematic of the LDR used in the receiver*

3.8 CD 4511B BCD to 7- Segment decoder

The decoded DTMF signals are to be displayed using a suitable display device. A common 7-segment display can be more suitable for this purpose. The CD4511 is a single chip device that satisfies the requirement of converting the BCD signals into a code required for the display device.

4 Results

The signal that is being transmitted through the LASER is properly received and is decoded. The error in the received signal is observed to be low. Also it is noted that the DTMF signals are also being transmitted and received using the same modules. This proves the effectiveness in the transmission of both types of signals. It is also proved that the signal from an function generator can be transmitted and received using a CRO.

5 Conclusion & Future Scope

This is an innovative idea of using the LASER rays in wireless technology. In the beginning the design of these modules and principles may appear to be fuzzy but if this technique is adapted for industrial signal transmission the cost of wiring will be considerably reduced this proves the worthiness of our work. The is a provision in future that if high power LASER signals are used for signal transmission the range of transmission can be considerably improved and can be used for long distance transmission. Also if high intense beam is employed the LASER rays can penetrate through interruptions and aid better transmission.

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