

Secured Transmission of Data through Laser Using Li-Fi Technology

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Abstract: In today's world where Wireless based communication is become very popular and it became very common between person to person for sending messages containing data and media to each other. The major purpose is transferring data with the help of laser from one side to another side using laser light. The data is sent in a secure manner by making it password protected. When the data is received authenticated password is entered and if the password is accessed successfully then data is displayed on the LCD automatically. Data is to be transfer between two circuits, one as a transmitter and second as a receiver. Here it is simplex communication. In the transmitter side the data is inserted and on the receiver end only receive the data. Transmitting a data using some specific technology is not much easier than processing without technology and also authentication is much necessary while transmitting the data.

Keywords: Li-Fi, Laser, LCD, Microcontroller, Photodiode, MAX2323 IC, LED

I. INTRODUCTION

Lasers¹ have been considered for space communications since their realization in 1960. Specific advancements were needed in component performance and system engineering particularly for space qualified hardware. Advances in system architecture, data formatting and component technology over the past three decades have made laser communications in space not only viable but also an attractive approach into inter satellite link applications.

The word LASER stands for acronym of "light amplification" by the stimulated emission of radiation. They work similar to fibre optics links, except beam is transmitted through free space. In recent years laser light is used to transmit data over longer distances. Laser will allow point to point communication over vast distances, through air, space without any loss. Information transfer is driving the requirements to higher data rates, laser cross-link technology explosions, global development activity, increased hardware, and design maturity. Most important in laser communications has been the development of a reliable, high power, single mode laser diode as a directly modulable laser source. This technology advance offers the 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. Transmitting a data using some specific technology is not much easier than processing without technology and also authentication is much necessary while transmitting the data.

Generally hackers or enemies are playing vital role in tampering the respective data where confidential are being leaked to the public and other countries in order to lower the specific features of a country like economy, damaging the people's welfare, misguiding among public etc. There are also some disturbances in the country due to some external threat where countries reputation is been damaged and also wireless technologies to implement such source to transmit the data from one station to another station. Though this is just a small scale demonstration, it is a very promising point to point communication technology.

The phototransistor³ is a device that is able to sense light levels and alter the current flowing between emitter and collector according to the level of light it receives. Visible light communication⁷ is a data communications variant which uses visible light between 400 and 800 THz. VLC is a subset of optical wireless communications technologies. The technology uses fluorescent lamps to transmit signals at 10 k/bit/s, or LEDs for up to 500 Mbit/s over short distances.

II. BLOCK DIAGRAM

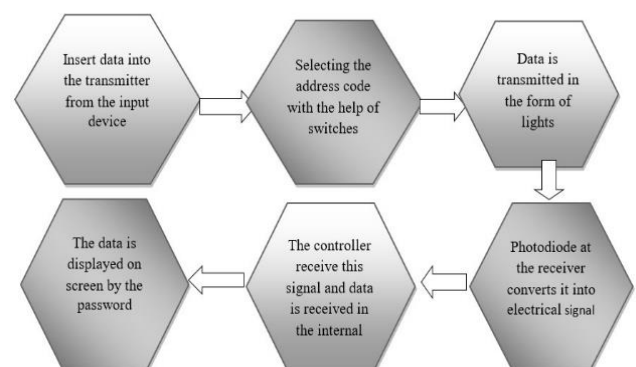


Fig 1: Block Diagram of Authenticated Data Transfer

III. WORKING

Firstly the data which is to be transmitted should be loaded into the microcontroller using dumper through embedded C program. Microcontroller which is placed at transmitter side act as an input device in order to transmit the data to another section. Secondly Address codes are been mentioned itself in the microcontroller using switches i.e. transistors which are used in transmitter section. The data which is loaded can be transmitted using laser light from one section where the levels of the voltage are TTL. On the other hand the data reception can be done with the help of photodiode⁴ where MAX2323 IC can be used to convert TTL logic levels to RS232 logic levels. The reception of the data can be done only when authenticated passkey is accessed. The photodiode on the other hand convert the signal into electrical signal in to display the data on LCD. Incorrect of password may lead to access denied of data where garbage value can be displayed on screen. It is a point to point communication where disruptions can be easily detected. A general-purpose input/output (GPIO)⁸ is an uncommitted digital signal pin on an integrated circuit or electronic circuit board whose behaviour including whether it acts an input or output—is controllable by the user at run time.

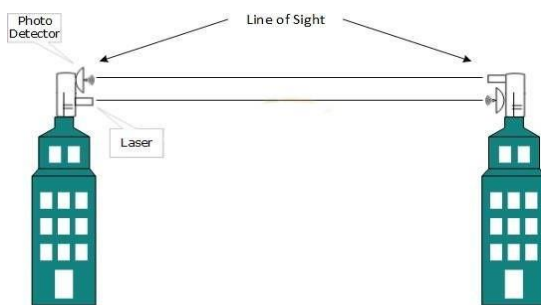


Fig 2: Point to Point Transmission

IV. HARDWARE DESCRIPTION

Transmitter Section: In this the required operating voltage for 8051 microcontroller is 9V. Hence the 9V DC power supply is needed for the microcontroller board. 9v battery is connected across the diode and shorted by 10k resistor and LED. The basic purpose of shorting these two elements is in order to check whether LED is blinking or not when 9v adapter is connected.

On the other section, the decoupling capacitor is connected parallel to it. The main function of connecting these two elements is prohibition of damage to the microcontroller. Resistors are generally used to reduce or control the current flow, adjust signal levels, to avoid voltages, bias active elements.

Capacitors are used to store the energy flow in the circuit in the generation of higher voltages than the input voltage. From the fig.3 it can be observed that the 5533 diode is placed on reverse pattern, the voltage and current flown through the circuit never crosses this section, in addition it rotates inside the node which will not cause damage to microcontroller.

Next, the alternate section consists of two decoupling capacitors (10uf, 220uf) which consists the function of producing the

required voltage to the regulator and by default some energy is stored in the capacitors which will function as to give the appropriate energy to the current coming from section 2 and suppress the high frequency noise in power supply signals.

They intake tiny voltage ripples, which could otherwise be harmful to delicate IC'S out of the voltage supply. It also functions, if the input voltage suddenly drops, and the capacitor provides the energy to keep the voltage stable. Similarly, if there is a voltage spike, the capacitor absorbs the excess energy.

5v regulator is connected (AMS1117) which consists of three pins (input, output, ground) which function is to provide only 5v AC supply. From the output, 5v is taken and given to 40th pin of microcontroller as Vcc. The ground (GND) of the regulator is given to the 20pin of microcontroller.

8051 Microcontroller²: pin 1 is connected to the LASER diode and the GND of LASER diode, emitter of transistor is ground.

The transistor used here acts as switch where base is connected to 10k resistor to pin 1 and collector is grounded to LASER diode.

When logic 1 is (Boolean formula) is given, the transistor closes switch and voltage passes through LASER diode and glows where inappropriate current across pin 1 is reduced or cut by the resistor which is placed.

Reset switch is connected at pin 9 where capacitor (10uf) is placed i.e., shorted to pin 9 of reset switch. The purpose of reset switch is to correct the configuration at the initialization stage of transmitter.

In order to explain in brief when we enter a wrong passkey the buzzer will activate a sound delay of 1ms and acquired data is not been sent. In order to send the data again, toggling the switch brings to initial stage by removing error/corrupted data.

Crystal oscillator plays a major role in microcontroller where pin 18 & 19 is been used, the functioning is to produce clock pulses to microcontroller. The clock is used to carry all the function that microcontroller provides. There is no need of giving any separate voltage because the microcontroller has dedicated pin which excites crystal oscillator.

The key pad consists of 12 keys in order to activate the code, generally 12 pins are required but to reduce the technique of constructing 12 pins, only 7 pins are been shorted by rows and columns (21-27).

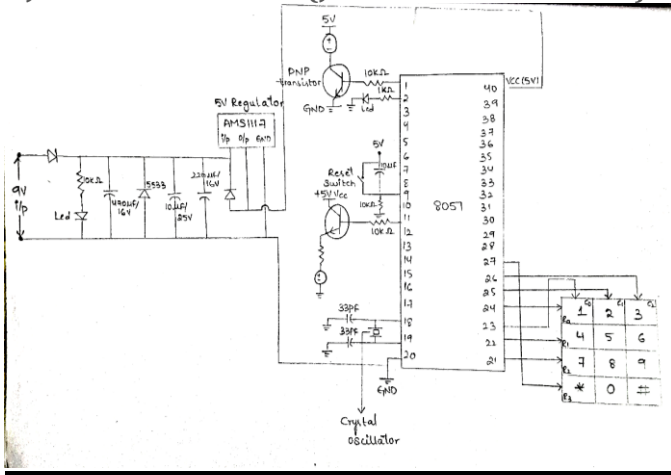


Fig 3: Schematic circuit diagram of transmitter

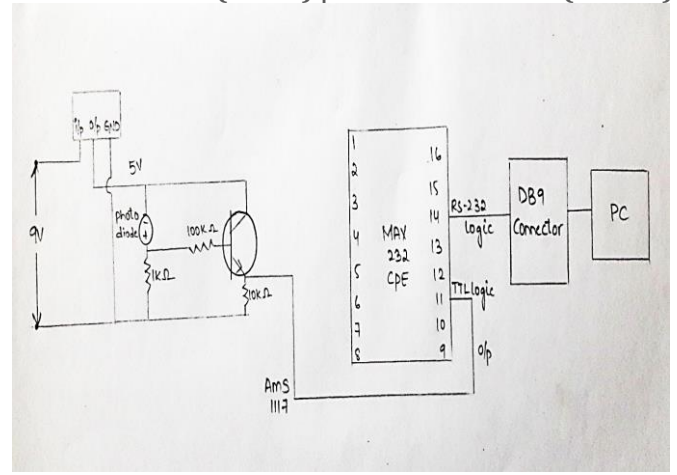


Fig 4: schematic circuit diagram of receiver

Receiver Section: From the fig it can be observed that a 9v power supply is given at this section and in between a regulator of 5v is kept in order to block the bulk amount and sends only required amount given at input.

From the output, it is connected to photo diode which is shorted with 10k and 1k resistors which is connected to base and emitter with 10k resistor is grounded.

The photodiode is PN junction diode that consumes light energy to produce electric current. Sometimes it is called as photo detector, light detector.

Working of photodiode is, when a photon of ample energy strikes the diode, it makes a couple of an electron hole. Therefore, holes in the region move towards the anode, and electrons move towards the cathode, and a photon current can be generated.

Logic levels are designed according to voltage levels before for logic 1-5v is designed and for logic 0.

Then after if the voltage acquired is close to 0v i.e., 0.78, 0.56 etc., rounded off fig is accomplished to which is eliminated by electrical engineering community [EEC]. Finally the hardware level has been designed- for logic 1 is represented by negative voltage (-) from -3 to -25v while a logic low '0' transmits a positive voltage +3 to +25v.

The output is given to pin 11 of MAX 232 IC (16 pins-functions, uses, applications, TTL logic- detail information, pin 14 is connected to DB9 connector [female port], male port is connected to pc/laptop which R_XD).

V. DIFFERENT MODULES

Photodiode

A semiconductor device which converts the light into electrical current is called as a photodiode. Photodiode absorbs the photons and thus the current is generated. Photodiodes may contain optical filters, built-in lenses, and may have large or small surface areas. Photodiodes usually have a slower response time as their surface area increases. The common, traditional solar cell used to generate electric solar power is a large area photodiode. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical fibre connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a photodiode use a PN junction rather than a p-n junction, to increase the speed of response. A photodiode is designed to operate in reverse bias.



Fig 5: VTB100AH photodiode

Numerical Keypad

A keypad is a set of buttons or keys bearing digits, symbols and/or alphabetical letters placed in order on a pad, which can be used as an efficient input device. The keypad is designed in a four- row by three- column matrix. Each dial row is

represented by a low tone frequency and each column by a high tone frequency. The frequencies used are 697 Hz, 770 Hz, 852 Hz, 941 Hz, 1209 Hz, 1336 Hz, 1477 Hz, and 1477Hz.

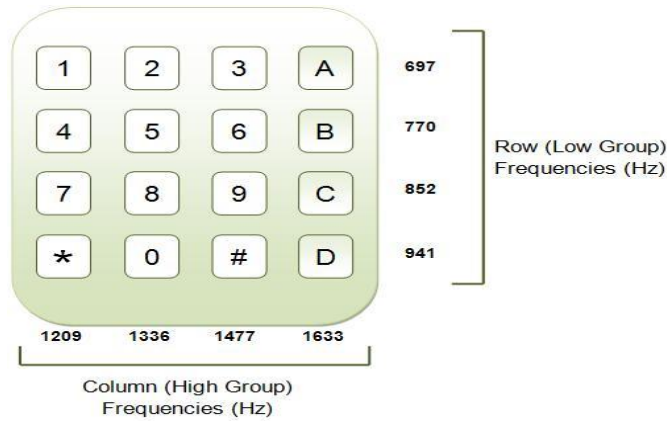


Fig 6: Numerical Keypad with DTMF

RS-232

RS-232 is a standard communication protocol for linking computer and its peripheral devices to allow serial data exchange. In simple terms RS232 defines the voltage for the path used for data exchange between the devices. It specifies common voltage and signal level, common pin wire configuration and minimum, amount of control signals.

Table 1: Logic Levels of RS232

RS232 Line Type & Logic Level	RS232 Voltage	TTL Voltage to/from MAX232
Data Transmission (Rx/Tx) Logic 0	+3 V to +15 V	0 V
Data Transmission (Rx/Tx) Logic 1	-3 V to -15 V	5 V
Control Signals (RTS/CTS/DTR/DSR) Logic 0	-3 V to -15 V	5 V
Control Signals (RTS/CTS/DTR/DSR) Logic 1	+3 V to +15 V	0 V

The RS-232 standard had been commonly used in computer serial ports. The standard defines the electrical characteristics and timing of signals, the meaning of signals, and the physical size and pin out of connectors. An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies, and other peripheral devices.

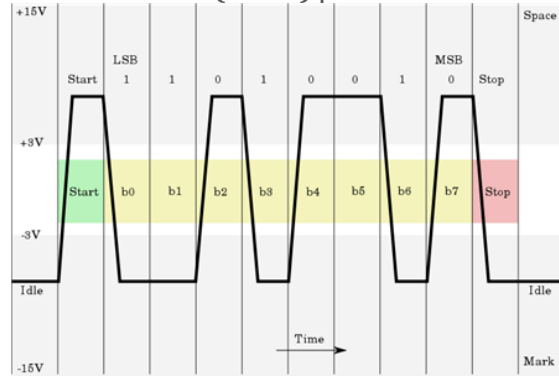


Fig 7: Acquisition of voltage levels at different baud rates

MAX-232 IC

MAX232 is an integrated circuit (embedded in a single chip) designed by Maxim Integrated Products and act as a Voltage Logic Converter i.e. it is used to convert TTL Logic level into TIA/EIA-232-F level (Laptop Serial Port RS-232) and vice versa. It is used for the communication between Microcontroller and PC or laptop. 9 Pin Serial Port on our Laptop works on RS232 Voltage Logic while our Microcontroller’s Serial Port i.e. Tx, Rx pins work on TTL Logic. Suppose you are working on PIC16F877A Microcontroller and you want to connect to Serial Pin of your Laptop, then you have to place MAX232 in between. It has several different applications e.g. computer, modem, battery powered systems etc.

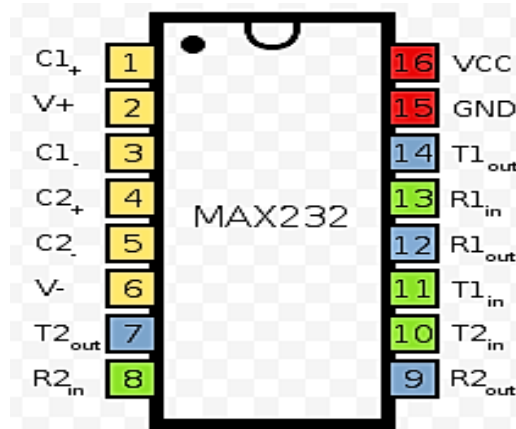


Fig 8: pin configuration of MAX232

LASER

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. Lasers are key components of many of the products that we use every day. Lasers are also used in many surgical procedures such as LASIK eye surgery. In manufacturing, lasers are used for cutting, engraving, drilling and marking a broad range of materials. The letters in the word laser stand for Light Amplification by Stimulated Emission of Radiation. A laser is an unusual light source. It is quite different from a light bulb or a flash light. Lasers produce a very narrow beam of light. This type of light is useful for lots of technologies and instruments—even some that you might use at

home! Light travels in waves, and the distance between the peaks of a wave is called the wavelength.

Each colour of light has a different wavelength. For example, blue light has a shorter wavelength than red light. Sunlight—and the typical light from a light bulb—is made up of light with many different wavelengths.

Our eyes see this mixture of wavelengths as white light. A laser is different. Lasers do not occur in nature. However, we have figured ways to artificially create this special type of light. Lasers produce a narrow beam of light in which all of the light waves have very similar wavelengths. The laser's light waves travel together with their peaks all lined up, or in phase. This is why laser beams are very narrow, very bright, and can be focused into a very tiny spot. Because laser light stays focused and does not spread out much (like a flashlight would), laser beams can travel very long distances. They can also concentrate a lot of energy on a very small area. A Laser Diode is a semiconductor device similar to a light-emitting diode (LED). It uses p-n junction to emit coherent light in which all the waves are at the same frequency and phase.

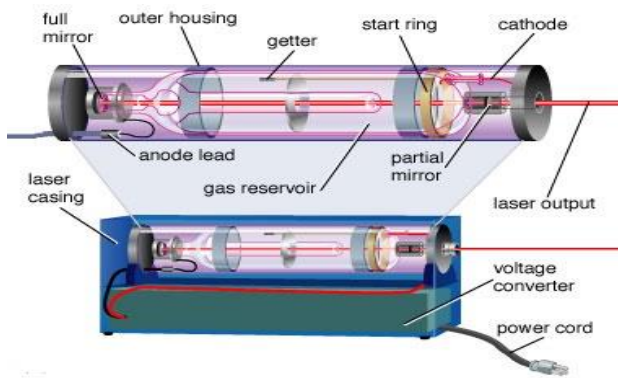


Fig 9: Internal Structure of LASER

UART (Universal Asynchronous Receiver/ Transmitter)

A UART⁵ (Universal Asynchronous Receiver/Transmitter) is the microchip with programming that controls a computer's interface to its attached serial devices. Specifically, it provides the computer with the RS-232C Data Terminal Equipment (DTE) interface so that it can "talk" to and exchange data with modems and other serial devices. As part of this interface, the UART also:

Converts the bytes it receives from the computer along parallel circuits into a single serial bit stream for outbound transmission. On inbound transmission, converts the serial bit stream into the bytes that the computer handles. Adds a parity bit (if it's been selected) on outbound transmissions and checks the parity of incoming bytes (if selected) and discards the parity bit. Adds start and stop delineators on outbound and strips them from inbound transmissions.

Handles interrupt s from the keyboard and mouse (which are serial devices with special port s).May handle other kinds of interrupt and device management that require coordinating the computer's speed of operation with device speeds. It's not a

communication protocol like SPI and I2C, but a physical circuit in a microcontroller, or a stand-alone IC.

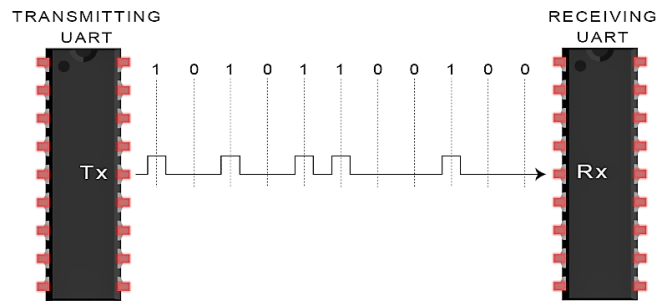


Fig 10: UART operation

Li-Fi (Light Fidelity)

Li-Fi stands for Light Fidelity. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses light as medium to deliver high-speed communication in a manner similar to Wi-Fi and complies with the IEEE standard IEEE 802.15.7. The IEEE 802.15.7 is a high-speed, bidirectional and fully networked wireless communication technology based standard similar to Wi-Fi's IEEE 802.11. Wi-Fi is of major use for general wireless coverage within building, whereas Li-Fi is ideal for high density wireless data coverage in confined area and especially useful for applications in areas where radio interference issues are of concern, so the two technologies can be considered complimentary. Li-Fi provides better bandwidth, efficiency, connectivity and security than Wi-Fi and has already achieved high speeds larger than 1 Gbps under the laboratory conditions. By leveraging the low-cost nature of LEDs and lighting units, there are lots of opportunities to exploit this medium. Li-Fi is the transfer of data through light by taking fibre out of fibre optics and sending data through LED light bulb. Li-Fi has got a much broader spectrum for transmission compared to conventional methods of wireless communications that rely on radio waves. Li-Fi which can be the future of data communication appears to be a fast and cheap optical version of Wi-Fi. Being a Visible Light Communication (VLC), Li-Fi uses visible light of electromagnetic spectrum between 400 THz and 800 THz as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information in wireless medium. The principle of Li-Fi is based on sending data by amplitude modulation of the light source in a well-defined and standardized way. These factors cause an attenuated receiver signal and lead to higher bit error rates.

VI. SOFTWARE DESCRIPTION

HyperTerminal is an application that connects a computer to other remote systems. These systems include other computers, bulletin board systems, servers, Telnet sites, and online services. However, a modem, an Ethernet connection, or a null modem cable is needed before HyperTerminal can be used. IT professionals and users can work with HyperTerminal to set up a dial-up connection to another computer through the

internal modem using Telnet or to access a bulletin board system in another computer. They can use HyperTerminal to set up a connection for data transfers between two computers, such as a desktop computer and a portable computer, using the serial ports. HyperTerminal can also allow IT to take serial-port control of external devices or systems such as scientific instruments, robots or radio communications stations. They also use HyperTerminal to troubleshoot any issues when setting up and using a modem. IT can send commands through HyperTerminal to make sure the modem is properly connected.



Fig 11: Settings of Hyper Terminal on PC

VII. ADVANTAGES

Its chief advantages over RF (radio frequency) communication and Fibre Optics are:

- Quick link setup.
- No regulatory issues.
- High transmission security.
- High bit rates.
- Low bit error rate.
- No interference.

Compared to a microwave link, the advantages are:

- It can support higher bitrates
- Its dispersion is lower.
- No need of expensive Optical Fibres.

VIII. CONCLUSION

The paper “SECURED TRANSMISSION OF DATA THROUGH LASER USING PASSKEY” has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit.

There by transferring the data which is highly secured is completely disables the unauthorized users to access the data present in microcontroller. There is no chance of tampering the respective information from the industry. This increases the probability of maintaining information at any army stations or Government remote areas in a secured manner.

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