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LI-FI DESIGN FOR HIGH SPEED DATA TRANSMISSION

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ABSTRACT

Li-Fi represents Light Fidelity. Li-Fi is the future upcoming technology and this can transmit the information through light at high speed as compared to the present wireless technologies. The Li-Fi technology can transfer the data through LEDs. It is a high speed and low cost wireless communication system, compared to Wi-Fi. It can provide high security, large bandwidth, and low cost. While using various color LEDs can get the different bandwidth and speed. This paper describes the design of Li-Fi high speed data transmission system and analyzing its performance.

Keywords: Li-Fi, light emitting diode (LED), photo detector, visible light communication (VLC), universal asynchronous receiver transmitter (UART), field programmable gate array (FPGA).

INTRODUCTION

The term of Li-Fi Technology basically is called Visible Light Communication (VLC). This technology can transmit the data through high illumination LED devices that varied the intensity is very faster than the human eyes can follow[1,4] The LED bulb can cycle OFF and ON millions of times per second. Figure-1 shows the Design of LED Bulb.

Figure-1. Design of LED bulb.

The visible light spectrum is 10,000 faster than the radio frequency spectrum. The data is encoded and send to the light transmitting devices which is driven the high illumination LED. It is feasible to encode the data which the LED bulbs on and off to give different kind of strings of 1s and 0s. The LED bulb intensity is changing very faster that which the human eyes cannot be notice. Figure-2 shows the block diagram of Li-Fi design [6,5,2].

In transmitter section the data input is converting to binary information and LED driver circuit drives the high illumination LED. In receiver section side, the photo detector receives the original information and getting amplified by the inverting amplifier. The binary information is converted to the Original data message and given to the output signal [7, 9].

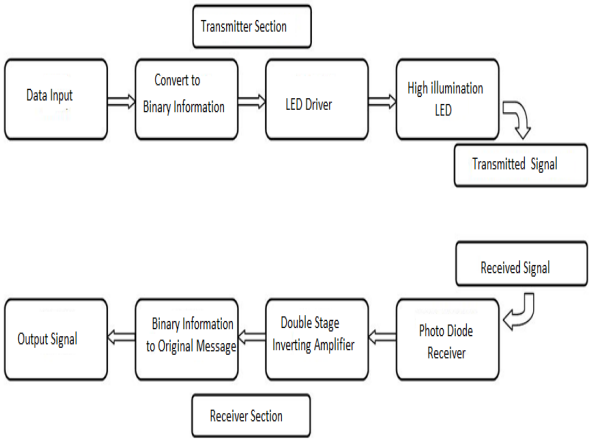

Figure-2. Block diagram of Li-Fi design.

DATA TRANSMISSION

A. Li-Fi data transmission

Figure-3 shows that Block diagram for Li-Fi Data Transmissions. Computer 1 is gives the data input to the LED Driver Circuit. Then LED Driver Circuit drives the high illumination LED. The illumination level is detected by Photo Detector in receiver side. Now signal gets amplified and given to the FPGA Kit. FPGA Kit receives and transmits the serial information to the LED Driver Circuit. Then the LED Driver circuit drives the high Illumination LED. Now the Photo detector detect the information and given to Computer 2 [8, 3].

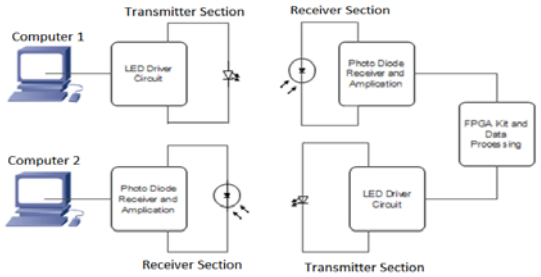

Figure-3. Block diagram for Li-Fi data transmission.

B. LED driver circuit for data transmission

Figure-4 shows that LED Driver circuit for data transmission. In LED Driver circuit, ULN2803 is used for the driver IC. The eight NPN Darlington transistors are connected in this IC. It is directly compatible to TTL families. The absolute maximum rating of output voltage is 50volt. The IC can handle the output current is 500mA. The data input is directly given to ULN2803 IC. LED Anode terminal is directly connected to positive power supply. LED cathode terminal is connected to output of the ULN2803 IC [14].

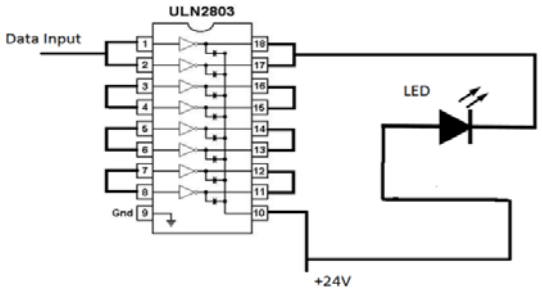

Figure-4.LED driver circuit for data transmission.

Figure-5 shows that hardware model of Li-Fi Data Transmitter.

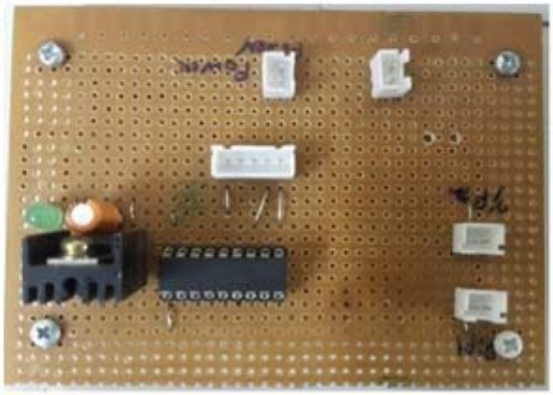

Figure-5. Hardware model of the Li-Fi data transmitter.

C. Photo diode receiver circuit for data transmission

Figure-6 shows that Photo diode receiver circuit for data transmission. In Photo Diode Receiver circuit, LM339 is used as a comparator. LM339 had high gain and wide bandwidth. It is an open collector comparator. So it can be compatible t to all logic levels like TTL, DTL, ECL, and CMOS Logic. If the light illumination varies photo diode current also changes. In receiver have two stages. First stage photo detector current converts to voltage level. In second stage inverting amplifier inverts once to get original information [16].

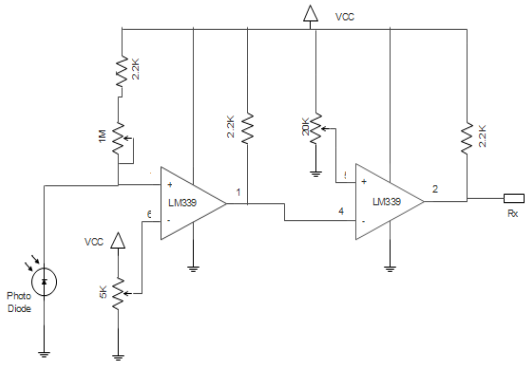

Figure-6. Photo diode receiver circuit for Li-Fi data transmission.

Figure-7 shows that hardware model of Li-Fi Data Receiver.

Figure-7. Hardware model of the Li-Fi data receiver.

Figure-8 shows that Real Time Implementation of Li-Fi Data Transmissions.

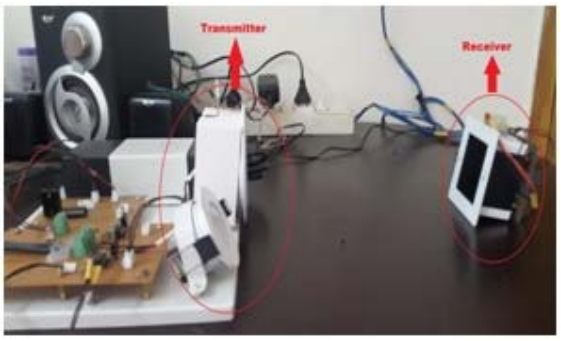

Figure-8. Real Time implementation of Li-Fi data transmission.

D. UART

UART stands for universal asynchronous receiver/transmitter. The operations of the UART are controlled by a clock which can runs the multiple data rates. Mostly 8 times the bit rate are used in the UART. Initially start bit at high. While start bit going low the UART process will start. After the 8 bits received the stop bit will be a high. Figure-9 shows the waveform representation of the UART.

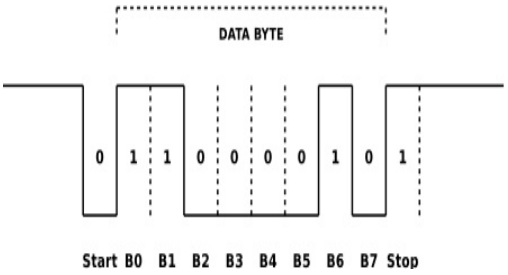

Figure-9.UART waveform presentation.

The SPARTAN 3 FPGA received the information and transfer to the LED Driver circuit. The UART process was done by SPARTAN 3 FPGA. Figure-10 shows the Hardware model for SPARTAN 3 FPGA.

Figure-10. Hardware model for SPARTAN 3 FPGA.

RESULTS AND DISCUSSIONS

A. UART output simulation

The universal asynchronous receiver transmitter (UART) takes the bytes of data. It transmits the individual bits at a sequential logic. Each UART consists of shift register, which is the basic method of serial conversion. The digital information transferred through a single wire by the Serial transmission. Figure-12 shows that UART simulation result of UART.

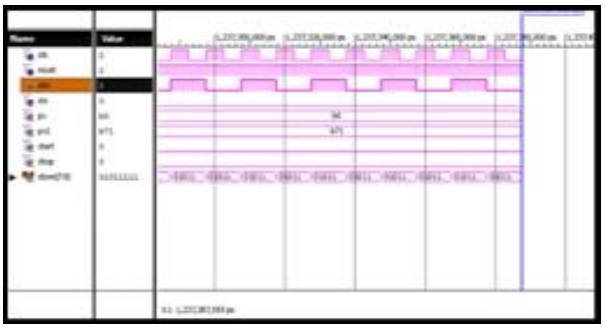

Figure-11. Simulation results of UART.

B. Simulation output for transmitter circuit

By using the CRO probe locate the 18 pin of the ULN2803 IC. This IC voltage level is around 24V. Computer 1 sends the information through the hyper terminal. It converts the text value to ASCII (American Standard Code for Information Interchange) Value. Hyper terminal serially transfer data to UART. The Baud Rate of the hyper terminal should be 9600. Figure-12 shows the Simulation result for data transmitter.

Figure-12. Simulation results for data transmitter.

C. Simulation output for receiver circuit

Figure-13 shows that simulation output for the data Receiver. In Receiver circuit side have to do the two stages of amplification process. One is photo diode current is converted to voltage signal which is by inverting amplifier. For getting the original information again one more time have to invert by LM339 operational amplifier. When the light illumination varies means photo diode current also changes.

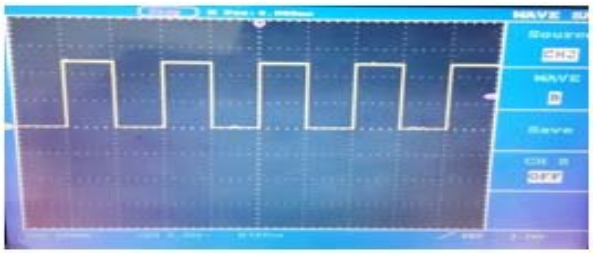

Figure-13. Simulation output for data Receiver.

CONCLUSIONS

Li-Fi has great potential in the field of wireless data transmission. It is a promising replacement to conventional methods of wireless communications. It can also use for the high speed Internet access. If this technology is put into full-fledged practical use, every LED can be used like a Wi-Fi hotspot to transmit wireless data. The Li-Fi technology can be leading us a greener and safer future. The Idea of Li-Fi technology attracting us a great deal of interest because it's latest and very efficient alternative to radio-based wireless technology. If the Li-Fi technology can put into practical use, every LED bulb can be used something like a Wi-Fi hotspot to transmit the wireless data. This Li-Fi technology can solve issues such the radio frequency bandwidth and also allow internet where the traditional radio based wireless is not allowed such as aircraft or hospitals. One of the upcoming however is that it only work in direct line of sight.

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