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Audio Transmitter and receiver System using Fiber Optic Cable

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Abstract –. Limitations of copper wires, electrical wires result in dispersion and distortion of the message signal or source of any signal for long distances communication. As the data rate required by different applications increases optical fiber networks are becoming the dominant transmission medium then other communication system .Optical signals can be easily sent directionally using a variety of sources such as LED (light emitting diodes) with lenses or collimated lasers. Our goal is to create a short range one-way audio communication system as a proof of concept that such a audio communication system is both feasible and practical to us.

Index Terms – Fiber,POF,Communication system,Transmitting section, Fiber receiver system.

1. INTRODUCTION

A categorization of optical links is shown in figure for short distance communication this classified as machine to machine (a few meters to 100s of meters), or possibly on large boards (a few cm to a few meters), chip-to-chip (a few cm) and on-chip(up to a few cm) .It is important to understand the limitations and issues of electrical interconnects to realize the benefits of optics. The Aspect ratio limit, Frequency dependent loss and equalization and Signal integrity [1]. With the increase of the demand for more bandwidth and cheaper components, plastic optical fiber (POF) has emerged as the most feasible choice for local area network (LAN) applications[1].The demand for ever increasing transmission rates, a high horizon of expectations, and the expansion of networks led to a boom in glass fiber technologies. [2]. Electrical implementation of gigabyte Ethernet over twisted pairs is limited in distance to 100 m, the optical solutions based on 850 nm, 1300nm and 1500 nm [3].

2. FIBER COMMUNICATION

The optical fiber communication is established as the main communication system because the requirements for more bandwidth are over passing the copper capacity. Optical fiber offers low loss over a high bandwidth, low levels of undesirable transmission impairments, immunity to electromagnetic interference, and long life-span. We can think of optical fiber and wireless communications as quite complementary. However, wireless networks still face obstacles at both levels to achieving high, end-to-end performance data delivery, particularly at gigabit per second rates [4]. The comparison between twisted, copper and fiber communication is shown in table 1 and possible different interconnects shown in figure 1. Optical fibers have a variety of applications like communications, sensors and lighting purposes [5]. The light is guided through the center of the fiber called the ”core”. The core is surrounded by a layer called the ”cladding”that traps the light in the core using total internal reflection (TIR). Fiber is coated with a protective plastic covering called the ”primary buffer coating” that protects it from moisture and other damage [6]. More protection is provided by the outer covering called a ”jacket”. The signal (short pulses of light) disperses when it travels through the length of the fiber, as shown in figure 8. The figure of merit (FOM) for the fiber would be as given in equation (1) [7]

$$FOM = sensitivity / FWHM = sensitivity \times DA \quad (1)$$

where DA proportional to 1/FWHM where DA is detection accuracy and FWHM is full width at half minimum.

2.1. Single and Multimode fiber

Single mode fiber has a smaller core, so that the light travels in only one ray but it’s practically limited to about 100,000 gigahertz. Usually it is used when dealt with long haul telecom or submarine cables. Single mode multi core fiber (SM-MCF)have been support to high spectral efficiency [8]. Multimode fiber has light traveling in the core in many rays, called modes. It has a bigger core as compare to single mode fiber and is used with LED sources at wavelengths of 850 and 1300 nml for slower local area networks (LANs) and lasers at 850 and 1310 nm for networks running at gigabits per second or more [9]. Step index multimode was the first Fiber design but is too slow for most uses, due to the dispersion caused by the different path lengths of the various modes [10]. Step index fiber is rare in design today. Graded index multimode fiber uses variations in the composition of the core to compensate for the different path lengths of the modes. It offers hundreds of times more bandwidth than step index fiber.

2.2. Plastic Optical fiber

POFs are advantageous for home networks as well as storage interconnections [11].Core materials The materials for POF core can be divided in three groups: first is Compounds containing Hydrogen , second is Compounds with partial substitution of Hydrogen and last one is Compounds with complete substitution of Hydrogen. Material used these fibers serve as a complement for glass fibers in short haul communications links, because they are easy to handle, flexible, and economical [12]. When people mention optical fiber, most of them think of silica fibers even though plastic fibers are fabricated as early as the silica fibers [2]. The reason is that because of high losses the plastic fiber could not keep up with silica fiber. Said this is clear that, the reduction of optical loss of POFs is a major challenge for materials scientists. It has been shown that the main losses in POF are due to vibrational absorption in the CH-bindings of the PMMA molecule[13]. The factors that contribute in optical loss for POF are intrinsic and extrinsic. Although the various mechanisms contributing to losses in POFs are basically similar to those in GOFs, their relative magnitudes differ [11]. In the intrinsic factors absorption (higher harmonics of C-H absorption and electronic transitions), and Rayleigh scattering (refractive index fluctuations, orientation and composite fluctuations) are included. Extrinsic losses are because of absorption (transition metals, absorbed water) and from scattering (dust, fractures, core-cladding boundary imperfections etc.). The W-shaped POF is used to increase the bandwidth through model dispersion compensation. Each mode propagates having its own group delay, which means a small mode coupling in the W-shaped POF as well. The group delay difference between the highest and lowest order modes is much smaller than that in the GI POF. This delay time contraction is caused not by the mode coupling but by the modal dispersion compensation effect of the refractive index valley. W-shaped POF has a valley of the refractive index at the boundary of the core and cladding of the conventional GI POF. W-shaped index of refraction profile influences the group delay of higher order modes more and therefore gives better compensation for the modal dispersion that GI POF.

2.3. Application of POF

Consequently, electromagnetic disturbance is not a disadvantage for copper wires when properly installed. Plastic optical fiber (POF) biosensors consist in a viable alternative for rapid and inexpensive scheme for detection [14]. However optical fibers offer more speed and bandwidth for LAN applications. Applications like the digitalization of diverse entertainment media (music, video, TV) are requiring more and more bandwidth and speed that copper so far has offered; this would leave optical fiber the only choice for communication medium.

3. COMMUNICATION SYSTEM

The optical fiber communication is established as the main communication system because the requirements for more bandwidth are over passing the copper capacity. Optical fibers have often been considered to offer effectively infinite capacity to support the rapid traffic growth essential to our information society [15]. Optical fiber offers low loss over a high bandwidth, low levels of undesirable transmission impairments, immunity to electromagnetic interference, and long life-spans compare to Cu-based systems . We can think of optical fiber and wireless communications as quite complementary. Wireless goes almost everywhere, but provides a highly bandwidth constrained transmission channel, susceptible to a variety of impairments [9]. Optical fiber, on the other hand, doesn’t go everywhere, but where it does go, it provides a huge amount of available bandwidth. Optical fiber can be silica or plastic fiber. Even though the perfection in performance of silica fibers is not achievable (to date) from plastic ones, the main disadvantages of the silica fiber such as connector cost, skilled labor, fragility-microfractures/microbends and the steadily growth demand for cheaper LAN components, have offered interesting opportunities for plastic optical fiber. POF compete with copper wires, coaxial cables, glass optical fibers, and wireless. The plastic optical fiber originally developed by DuPont in 1968 had a step index profile, and this technology is the most mature [10]. Manufacturers form POFs out of plastic materials such as polystyrene, polycarbonates, and poly methyl methacrylate (PMMA). Due to incomplete purification of the source materials used, attenuation was in the beginning in the range of 1000dB/km. During the seventies it became possible to reduce losses near to 125dB/km at 650nm wavelength. The high loss problem is being addressed constantly and researchers have brought losses down to potentially 10 dB/km [12] . In 1997, Asahi Glass Co. [11] successfully developed a perfluorinated (PF) GI POF, which has less than one-third of attenuation of conventional PMMA.

Figure 3 shows the attenuation spectrum of PF GI-POF. Gigabit Ethernet transmission experiments using PF GI-POF over record distances in the order of 1 km and at wavelengths in the 850 and 1300 nm area are reported [16]. Polymer optical fibers are cheaper than silica fibers and can meet many of the requirements for digital transmission systems that are developing for short range application. Therefore they have become the choice for short range optical networks today.

Choices	Advantages	Disadvantages
Twisted pair wire	Low installation cost	speed =56kbps
Coaxial cable	Ground is shielded	speed =2.5Mbps
Fiber optic cable	Immune to cross talk, high security, high bandwidth capacity over Cu wire,	Connector cost

Table 1 Different types communication

3.1. Transmitter

Fiber based transmitter is suitable for high power, eye safe free space optical communication. It has the transmitter and the receiver. In digital circuits, binary data in the form of voltage are transmitted. Data in the form of these voltage

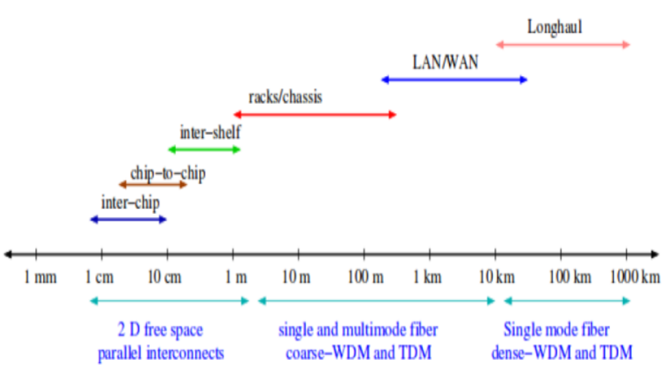

Figure 1 Possibility of optical interconnects at different levels [1]

levels is fed to a transmitter driver, which converts these levels into the voltage or current signal required to drive the optical transmitter device. Optical transmitter acts as the interface between the electrical and optical domains by converting electrical signals to optical signals. Semiconductor lasers are few hundred microns long more coupled light generated by them into an optical fiber.

3.2. LED

LEDs are forwarded biased positive-negative junctions, where carrier recombination results in spontaneous emission at a wavelength corresponding to the energy gap. The internal efficiency of LED can be as high as 60LEDs are often glued to the layer package face down on the metal carrier. The substrate is transparent so it does not effect the radiation. From a high radiance LED several milliwatts may be radiated, however the radiation is over a wide angular range making coupling loss a problem. LED radiation has a large spectral width, determined by thermal effects. At 8:50nm, LED-s tend to be intra-modal dispersion limited [17] . Coupling light is done usually by having a lens because of the large angle of radiation for LED. Some of the commercial available LED's today are LEDs that enhance emission efficiency via a high output power LED chip mounted in a reflector (mirror) at the package base with peak emission wavelengths that range from 660 nm to 940 nm and 1300 nm to 1650 nm are commercially available. Green LEDs at a wavelength of Single mode fiber has a smaller core, so that the light travels in only 520nm are reported to have been used successfully in POF transmission for about 100m [17].

3.3. LASER

The first semiconductor laser diode to radiate continuously at room temperature was achieved in 1970 [18] Laser-s evolution continued in the 1990 with the advent of optical amplifiers. Population inversion between the ground and excited states in a laser results in stimulated emission. In edge emitting laser the radiation is guided within the active region of the laser and is reflected back at the faces; in vertical surface emitting lasers (VCSEL) reflection is from internal mirrors grown within the semiconductor structure.

3.4. Receiver

A receiver consists of a photodiode, TIA and limiting amplifier consisting of electrical circuits. Transmission devices can be LED, laser or VCSEL. VCSEL are strong candidate as transmitter devices .Various optical transmitter technologies are explained and compared in literature [18] .From different light sources that can be used for POF transceiver, VCSEL operating at 850nm actually represent the majority of commercialization With the increasing demand for data communications through cheaper optical networks, the cost effective POF transceivers have become increasingly of interest. Transmitting model ckt is shown in figure 2 and 3.

4. CIRCUITS CONNECTION OF DESIGNED FIBER OPTIC MODEL

4.1. Fiber Optic Transmitter model

Here we need a Transmitter LED Type (DC coupled Source) of wavelength 660nm with Input signal digital data type.

Maximum I/P voltage +5V and the supply Voltage here we are taking as +15V ,also we need DC Function Generator I.e. TTL Output at Variable Frequency with data rate 1 Mbps and

LED Interface which is Self locking Cap LED and lastly the important factor is driver i.e. On board IC Driver Serial Port IC Max232 Driver with Supply current 100 mA (Maximum) with Interface connectors 2mm socket.

Circuit component	Quantity
ICMax232	2
Capacitor	4
Resistor	6
Diode	4
Transistor	1
LED	1
Microphone	1

Table 2 Circuit components of Transmitter

4.2. Fiber Optic Receiver model

The receiver model ckt is shown in figure 4 and the prototype model shown in figure 5. for this we require analog components which are used in Sigma Delta-ADC but digital Receiver type it require DC coupled Diode Wavelength within the range (660nm – 850nm) and data rate is about 5 Mbps Photo diode Interface is self locking cap photo diode Driver: Internal Diode Driver Serial Port: IC Max232 Driver Optical cable used is Plastic fiber multimode (1000 Micron core) Fiber cladding index is 1.402 Supply current we can take 50mA (maximum) Interface connector require is 2mm socket The MAX232 driver IC uses some external capacitor to enhance the voltage levels to RS232 level [19] . All requirements for transmitter and receiver are shown in table 2 and 3. Led and laser difference shown in table 4.

Circuit component	Quantity
IC Max232	1
Capacitor	11
Resistor	10
Op-Amp	2
Transistor	1
Speaker	1

Table 3 Circuit component of Receiver

	Output power	Couple power	Speed	Band width
LED	Linearly proportional to drive current	Medium	Slower	Moderate
LASER	proportional to the current above threshold	High	Fast	High

Table 4 Difference in LED and LASER

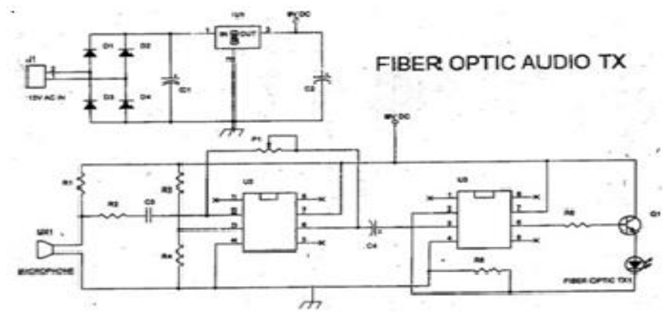

Figure 2 Transmitting Model

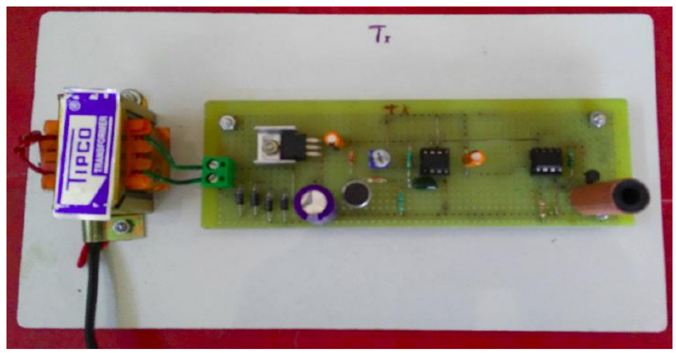

Figure 3 Wired model for Transmitter

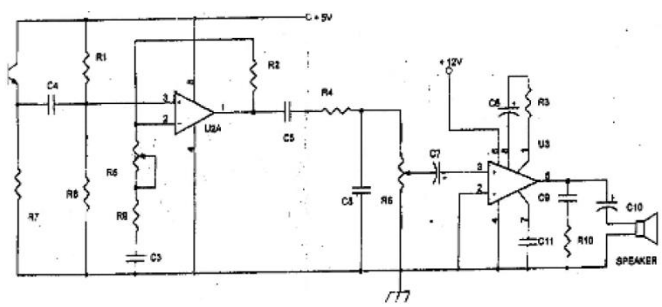

Figure 4 Receiving model

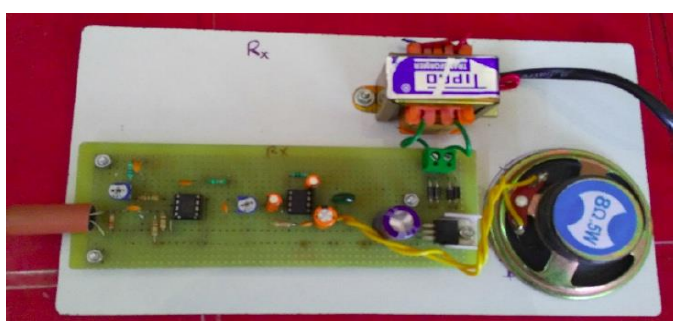

Figure 5 Wired model

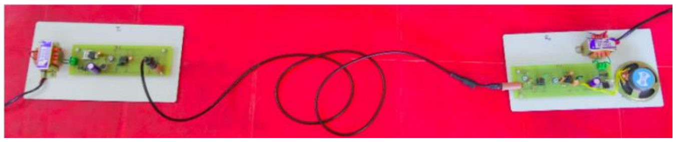

Figure 6 Wired model for audio communication through fiber

5. RESULTS AND DISCUSSIONS

Here we can make a prototype model shown in figure 6 for audio transmitter as well as audio receiver through optical fiber medium. As the cost of the prototype model is less expensive so it is a good for practical point of view. This fiber communication are going to grow more sophisticated and demand of require future. Fiber optic technology is the best technology for high speed ,high quality eventually replacing both telephone and cable TV lines.

6. CONCLUSION

Optical fiber transmission system for audio signal was constructed. The purpose of the system will be used for high quality audio transmitter in place of the coaxial or copper wire data transmitting system. Prototype model test have no difficulty arise while transmitting audio signal. Furthermore care must be taken to ensure that all connection should be perfect. Here we reached the purposed of our paper.

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