PLASTIC OPTICAL FIBER COMMUNICATION SYSTEM

ROSLINA BINTI RAMLI

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Faculty of Electronic and Computer Engineering

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CHAIRULSYAH WASLI
Pensyarah
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Karung Berkunci No 1752
Pejabat Pos Durian Tunggal
76109 Durian Tunggal, Melaka

Tarikh: 30 APRIL 2009

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DEDICATION

I would like to dedicate the appreciation to my beloved family especially to my parents as their support.

I would like also to thank my supervisor Mr Chairulsyah Bin Abdul Wasli for his advices.

ABSTRACT

This project is about to design the communication system that including the optical fiber. The optical fiber that is used in this project is plastic. Plastic optical fiber (POF) has larger diameter than fiber glass. However, the price is cheaper and easier to roll out. This project will develop a POF communication system that can be used for two ways voice communication. In this project, there are two circuits for receiver and two circuits for transmitter that have to be constructed. The receiver circuit is connected to the speaker. The transmitter is connected to the microphone. The task for develop this project is including the study literature, link design, simulation, implement and test. The major operation of the system is consists of optical transmission. The signal is an analog signal and it has gone through the fiber optic cable. The electric analog input signal is converted into an optical signal. After that, it was coupled over that fiber optic, and then it received and converted back into an electrical signal. The output signal is then go to a speaker.

ABSTRAK

Projek ini bertujuan mereka sebuah sistem komunikasi yang melibatkan penggunaan fiber optik. Fiber optik yang digunaan sebagai alat perhubungan adalah merupakan jenis plastik. Fiber optik jenis plastik mempunyai ukuran lilit yang lebih besar berbanding dengan jenis kaca. Walau bagaimanapun, ia adalah lebih murah dan mudah digunakan. Projek ini merupakan sejenis sistem komunikasi dua hala. Di mana terdapat dua litar penerima dan dua litar pemancar yang perlu dihasilkan. Litar penerima disambungkan terus ke penguat. Manakala litar pemancar disambungkan ke pembesar suara. Di dalam menghasilkan projek ini, tugas yang perlu dilakukan termasuklah juga dengan pengiraan, simulasi, mereka dan menganalisa data. Operasi paling utama dalam sistem komunikasi dua hala ini termasuklah dengan pemancar optikal. Isyarat yang diterima merupakan jenis isyarat analog and ia melalui kabel fiber optik. Isyarat masukan elektrik analog ditukar kepada isyarat optikal. Selepas itu, ia dipasangkan menggunakan fiber optik dan kemudiannya ditukar kembali ke isyarat elektrikal. Isyarat yang keluar itu akan keluar melalui penguat.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

This project is design a two ways voice communication system using fiber optic cable as transmission path. In spite of this, my project will be combined the transmitter circuit and receiver circuit. The receiver circuit is connecting to the speaker. So, the voice signal can be heard. The transmitter circuit is connecting to the microphone to generate the signal. The two ways voice communication system can be used by two person and they can communicate each other. The communication system can be represented by Figure 1.1 below. There are two transmitters and two receivers that were connected via fiber optic cable.

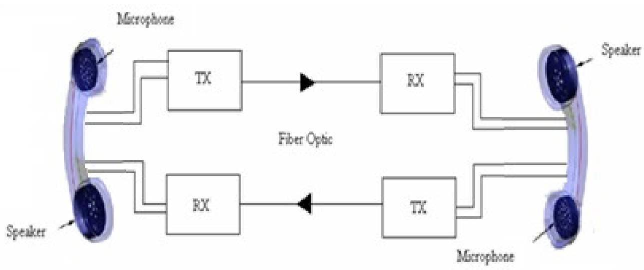

Figure 1.1: Block Diagram of Fiber Optic Voice Communication System

This project is important because from develop the two ways voice communication system, we can use it in this country. As we all know, nowadays we use copper cable as the transmission path. To improve the system, we can use fiber optic cable. It is because, the fiber optic cable has smaller losses compared to the copper cable. In other way, the fiber optic cable is easier to use and easier for the maintenances.

1.2 OBJECTIVES

The objective of this project is to design and develop plastic optical fiber voice communication system. In this project, there are two circuits for receiver and two circuits for transmitter that have to be constructed. The receiver circuit is connected to the speaker while the transmitter is connected to the microphone. The transmitter circuit is used to generate the signal frequency from 300 Hz to 3.4 kHz. This signal is from our voice. When the signal is transmitted, the fiber optic cable will bring the signal to receiver. From receiver, the person can hear the voice at the speaker.

The other objective of designing this project is to use this system in telephony network. Nowadays, everyone can communicate each other by using this communication system. The communication system can be upgraded using optical fiber cable by replacing the copper cable. Copper cable is cheaper than optical fiber cable. However it has many disadvantages compared to optical fiber. Copper has large cost of maintenance because it easy to broken or breakdown. That is one of the reasons why we use plastic optical fiber as our transmission path. The other reason is because of their performance. The copper cable gives low performance compare to the fiber optic cable.

1.3 SCOPES OF WORK

The scopes of works in this project are:

- Study literature. This part need to understand how the two ways voice communication system is functioned using plastic optical fiber as the connector.

- Design two way voice communication systems using Plastic Optical Fiber. The designing process need to build one system that can be used for two persons for their communication tools.

- Design the link. In this part, the transmitter, receiver and the amplifier circuit have to design. The circuit is search from the internet and from books and redesign it until the suitable circuit is get.

- The simulation has been done in the software. Example of software is Multisim. From the simulation, the result is finding.

- Build the hardware and measure its performance. However, the hardware design will be develop for the next semester.

- Do the measurement. The measurement is including the input and output of voltage, current and power. From that measurement, the loss can be measured too.

- Analyse the result from the hardware. The measurement from hardware and software will be compared and be analysed.

- Write the thesis report and discuss about this entire project. This thesis report is about how the project is done.

1.4 PROBLEM STATEMENT

From our real life, we have used copper cable as the transmission path of the communication system. The disadvantage when we use copper cable is because of the performance. The receive signal from the copper cable is higher noise compare to optical fiber cable. The signal is not truly clear although the cost is cheaper. Meanwhile, we want to upgrade the system by using fiber optic cable. There are many types of fiber optic. Two main types are glass and plastic. Compared for both type, there are many advantage and disadvantage. The disadvantages of glass optical fiber is the price is expensive and it easy to broken especially when it is in vibration and pressure. To solve this problem, we have to use plastic optical fiber and short distance communication is more efficient if we use plastic optical fiber.

CHAPTER II

LITERATURE REVIEW

2.1 PLASTIC OPTICAL FIBER

Optical fibers are extremely thin strands of glass, which are made up of many layers. They use laser light to carry information, sounds and images over very large distances. Optical communications systems have the capability of carrying thousands of telephone calls or television programs simultaneously, which is just one of their superior aspects in comparison to our current systems. Fiber-optic networks are quicker in transmitting data and make it possible to transmit these data further distances [7].

The optical fiber, in its 0.005 meter diameter entirety, is made up of three layers, the core, cladding, and the coating. The core is the center of the fiber, which is made of pure glass. This is the region in which the laser light carrying the images, sounds, or data travel at the speed of light. The cladding is also made up of glass. However, this layer is constructed of even purer glass. The coating is made of a plastic like material called acrylate, which acts to protect the inner glass fiber [7].

Plastic optical fiber (POF) is an optical fiber which is made out of plastic. Since the late 1990s, much higher performance POF based on perfluorinated polymers has begun to appear in the market. In large diameter of fibers, 96% of the cross section is the core that allows the transmission of light. Similar to traditional glass fiber, POF transmits light through the core of the fiber. The core size of POF is 100 times larger than glass fiber [3].

Figure 2.1: Plastic Optical Fiber

Figure 2.1 above shows plastic optical fiber. POF has been called "consumer" optical fiber because the fiber and associated optical links, connectors and installation are all inexpensive. The traditional POF fibers are commonly used for low speed, short distance (up to 100 meters) applications in digital home appliances, home network, industrial networks (PROFIBUS and PROFINET), and car networks (MOST) [3].

The perfluorinated polymer fibers are commonly used for much higher-speed applications such as data center wiring and building LAN wiring. In relation to the future request of high-speed home networking, there has been an increasing interest in POF as a possible option for next generation Gigabit/s links inside the house [2].

Figure 2.2: Optical Fibers

Figure 2.2 above shows the core of optical fiber. It was made from silica glass fiber. For telecommunications, the more difficult to use glass optical fiber is more common. This fiber has a core of germania-doped silica. Although the actual cost of glass fibers are lower than plastic fiber, their installed cost is much higher due to the special handling and installation techniques required. One of the most exciting developments in polymer fibers has been the development of microstructured polymer optical fibers, a type of photonic crystal fiber [2].

Plastic optical fibers have long been a poor relation of glass. Traditionally regarded as inexpensive, flexible, lightweight and easy to handle, plastic seems to offer some important attractions. These potential advantages can be hard to realize in practice, since silica fibers are reasonably priced and flexible in the small diameters used for telecommunications applications. However, the biggest problem of plastic optical fibers have been attenuation levels many times that of glass, making commercial types impractical for distances beyond 100 meters [1].

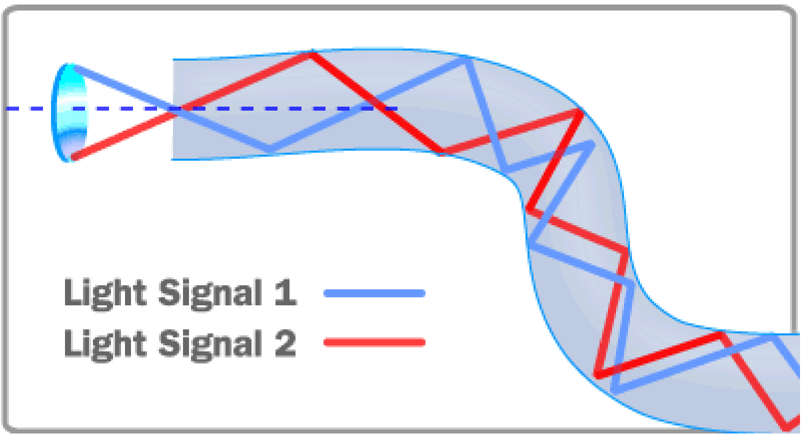

Figure 2.3: Flexibility of Plastic Optical Fiber

By referring to Figure 2.3 above, the flexibility of POF can be imagined. The flexibility of the cable is when it can be bend at maximum radius. When the diameter of plastic optical fiber is larger, it will cause the flexibility of the cable. It was similar properties to plastic fibers optics, but with much greater diameter for large-scale flexible light transfer in the visible spectrum. The light can be transferred over long distances without visible changing of the input color. Diameters of 3mm, 6mm and 10mm allow for much great light transference than normal size fibers. Excellent flexibility (8x diameter bend radius) allows maneuvering of fibers around tight spaces [6].

Years of research have reduced plastic loss considerably, but it still remains for higher than that of glass. The best laboratory plastic fibers have minimum loss around 50 dB/km. At the 650 nm wavelength preferred for communications using red LEDs, commercial plastic fibers have minimum attenuation as low as 150 dB/km. Unlike glass fibers, the loss of plastic fibers is somewhat lower at shorter wavelengths and much higher in the infrared [6].

For this reason, plastic optical fiber has found only limited applications. One is in flexible bundles for image transmission and illumination, where the light does not have to travel far and the flexibility and lower cost of plastic are important. Another application is in short data links, particularly within automobiles, where the case of handling plastics is a major advantage and the required distances and data rates are small [6].

Figure 2.4 below shows the point source in optical fiber. In this figure, it used glass as the core. The point light source are affected the distance of data can be transferred. Glass fiber can be used at long distance communication while plastic fiber is suitable for short distance communication.

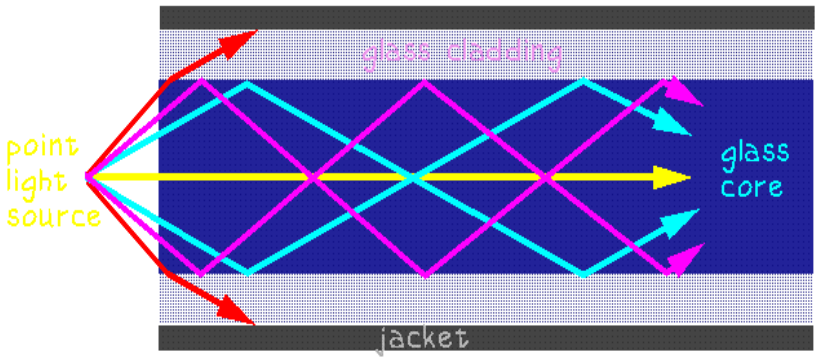

Figure 2.4: Point Light Source in Optical Fiber

Another important concern with plastic optical fiber is long-term degradation at high operating temperature. Typically plastic fibers can not be used above 85°C (185°F). This may sound safety above normal room temperature, but it leaves little margin in many environments. The engine compartments of cars, for example, can get considerably hotter. Newer plastics can withstand temperatures to 125°C (257°F), but their optical properties are not as good [3].

Plastic fibers are made using the same principles as glass fibers. A low-index core surrounds a higher index cladding. The refractive-index difference can be large. So many plastic fibers have large numerical apertures. Commercial plastic fibers are multimode types with large cores. Most are step-index but a few are graded-index. There is little interest in single-mode plastic fibers because the material's high loss makes long-distance transmission impossible [6]. In optical fiber cable, there is a core that was covered by cladding and the outer side is buffer. The buffer is used to avoid the core from break and make the cable flexible. It can be shown by Figure 2.5 below.

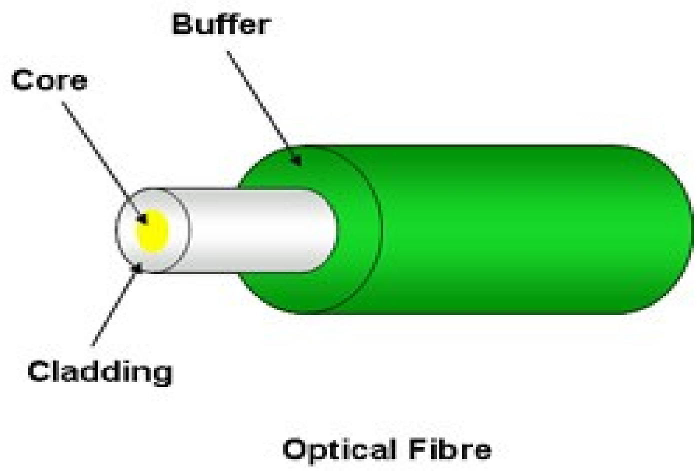

Figure 2.5: Inside of the Optical Fiber

Standard step-index plastic fibers have core of polymethyl methacrylate (PMMA) and a cladding of a lower index polymer, which usually contains fluorine. The differences in refractive index typically are larger than in silica or glass fibers, leading to a large numerical aperture. For example, one commercial plastic fiber designed for short-distance communication has a PMMA core with refractive index of 1.492 and a cladding with index of 1.402, giving the NA of 0.47 [1].

Plastic optical fibers typically have core diameters from about 85 μm to more than 3 mm (3000 μm). The smallest fibers typically are used only in