OPTICAL FIBER COMMUNICATION SYSTEM INTERFACE WITH SHARC ADSP-21065L

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This report is submitted in partial fulfillment of this requirement for the award of Bachelor of Electronic Engineering (Industrial Electronic) With Honors

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Date : 30 APRIL 2010

DEDICATION

Alhamdulillah , I am most grateful to Almighty ALLAH S.W.T. for blessing me with good health and ideas in completing this research successfully.

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ABSTRACT

This project is about constructing optical fiber communication system and linking the output of the transmission to the Visual DSP++ software via ADSP-21065L EZ-KIT Lite. The purpose of this project is to display the output of optical fiber communication system in systematic form. Thus, in order to achieve this aim, the ADSP-21065L EZ-KIT Lite through the Visual DSP++ software is to be the channel for the output to be displayed on the computer screen. This project mainly has 2 major sections; constructing the hardware and develop the software. The hardware part consists of transmitter circuit and receiver circuit whereby the plastic optical cable is the medium in connecting both of the circuit. There has three inputs located on the transmitter circuit which are sine wave, pulse wave and audio data while the receiver circuit has provides two output devices which are LED and speaker. At the same time, the output of LED is connected to the ADSP-21065L EZ-KIT Lite so that the output will be displayed on the computer screen simultaneously.

ABSTRAK

Projek ini adalah mengenai membina sistem komunikasi fiber optik dan menghubungkan keluaran penghantarannya kepada perisian *Visual DSP++* melalui *ADSP-21065L EZ-KIT Lite.* Tujuan projek ini adalah untuk memaparkan keluaran sistem komunikasi fiber optik dalam bentuk yang sistematik. Jadi, untuk mencapai tujuan ini, *ADSP-21065L EZ-KIT Lite* melalui perisian *Visual DSP++* akan menjadi saluran supaya keluaran dapat dipaparkan pada skrin komputer. Projek ini secara utamanya mempunyai 2 seksyen besar; membina perkakasan dan membina perisian. Bahagian perkakasan terdiri daripada litar penghantar dan litar penerima manakala kabel plastik fiber optik adalah sebagai medium dalam menghubungkan kedua-dua litar. Terdapat tiga masukan pada litar penghantar iaitu gelombang sinusoidal, gelombang denyut dan data audio manakala litar penerima menyediakan dua alat keluaran iaitu *LED* dan pendengar. Pada masa yang sama, keluaran daripada *LED* telah disambungkan kepada *ADSP-21065L EZ-KIT Lite* jadi keluarannya akan dipaparkan pada skrin komputer secara serentak.

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CHAPTER I

INTRODUCTION

The main purpose of producing this document is to precisely report the development process of interfacing the optical fiber communication system with ADSP-21065L and computerizing the output of the optical fiber communication. This chapter includes the project introduction, objectives, problem statement, scope, methodology, and report structure of the project.

1.1 Project Background

Fiber optic communication system can be classified as among the newest communication technology in this region. Optical fiber is used by many telecommunications companies to transmit telephone signals, internet communication, and cable television signals. Due to much lower attenuation and interference, optical fiber has large advantages over existing copper wire in long-distance and high-demand applications. However, infrastructure development within cities was relatively difficult and time-consuming, and fiber-optic systems were complex and expensive to install and operate. Due to these difficulties, fiber-optic communication systems have primarily been installed in long-distance applications, where they can be used to their full transmission capacity, offsetting the increased cost. Since the year 2000, the prices for fiber-optic communications have dropped considerably. The price for rolling out fiber to the home has currently become more cost-effective than that of rolling out a copper based network. Modern fiber-optic communication systems generally include an optical transmitter to convert an electrical signal into an optical signal to send into the optical fiber, a cable containing bundles of multiple optical fibers that is routed through underground conduits and buildings, multiple kinds of amplifiers, and an optical receiver to recover the signal as an electrical signal.

Hence, the idea of this project is to diversify the use of this technology by explore new ideas so that it can be benefited completely. Apart from that, this project also implements such system whereby the output of the optical fiber communication system can be manipulated.

1.2 Problem Statements

Nowadays, there are many types of transmission via fiber optic communication system such as data, audio, video, and data with audio. Unfortunately, the output of these transmission are not been computerized and been analyzed. Thus, perhaps this project could help the further studies about fiber optic communication system.

1.2.1 <u>Display the output of optical fiber communication system in systematic form.</u>

The outputs of data optical fiber communication system which is being use nowadays are not been analyzed, organized and displayed in proper form. Thus, this project will further implement such system whereby the output of the optical fiber communication system can be manipulated.

1.3 Objectives Project

The aim of this project is to construct and design the hardware for the optical fiber communication interface with SHARC ADSP-21065L. In order to achieve the aim, several objectives have been outlined as follows:

1.3.1 To explore the application and methodology of optical fiber communication system.

1.3.2 Develop a system so that the transmission output of the optical fiber communication system can be understood by a computer.

1.3.3 To discover and compare the advantages of using Universal Serial Bus (USB) rather than RS232 in the optical fiber communication system.

1.3.4 To study the characteristics and applications of the SHARC ADSP-21065L.

1.4 Scope of Project

1.4.1 Hardware Construction

The hardware part is basically has two circuits which are transmitter and receiver of the fiber optic communication system. On the transmitter (Tx) circuit board, there is a signal generator, input jack and a circuit to modulate the light emitted from an LED. The signal generator is used to generate the input signal in the form of sine wave and pulse wave whereas the input jack serves as a medium to send the audio data. Thus, the user can examine various types of the data transmission. The LED is contained in a plastic case which allows easy connection of the fiber optic cable. On the receiver (Rx) board there is the photo-darlington receiver unit, speaker, LED and a circuit to convert and amplify the detected signal back into a sound wave. The speaker and LED will be as the output devices. So the user can switch to the any of output device according to what type of the input data.

1.4.2 Software Development

The software will be developed by using the Visual DSP++ software in order to connect and interface the constructed hardware with the ADSP-21065L EZ-KIT Lite and the computer. A special medium to capture the data and convert it to signals understood by computer is needed. Hence this project will use ADSP 21065L as the medium. The transmitted signal from the hardware should appear on the computer if the software is developed successfully.

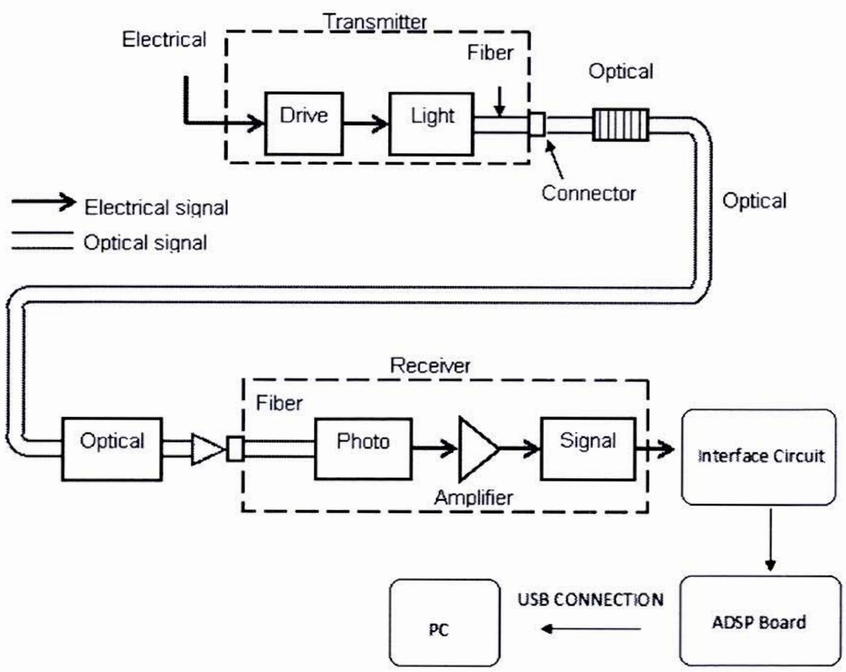

Figure 1.0: Block diagram for this project

1.5 Report Structure

This report consists of five chapters. The following chapters are the outline of the optical fiber communication interface with SHARC ADSP-21065L.

Chapter I Will discuss briefly the overview of this project such as background of the project, objectives, problem statement, scope of the project and report outlines.

Chapter II Contains the research and information about the project on several important concepts of the optical fiber, ADSP-21065L, technology and tools used in the study. Every fact and information, which found through journals or other references, will be compared and the better methods have been chose for the project. This chapter will also include several types of the applications of the ADSP-21065L.

Chapter III Includes the detail of the several specific methodologies used in this project.

Chapter IV Includes the detail about simulation results, analysis, observation and discussion of the optical fiber communication system and the Visual DSP++ software development. This includes the simulation part and the real part.

Chapter V Concludes the overall achievement throughout this project and the future works recommendations.

CHAPTER II

LITERATURE REVIEW

This chapter discussed background research related to this project. The purposed of background research was to gain theory or idea that can be implemented in this project. Basically, this chapter is divided into two sections which are Fiber Optic Communication System and ADSP-21065L.

2.1 Fiber Optic Communication System

Like all other communication system, the primary objective of optical fiber communication system also is to transfer the signal containing information (voice, data, video) from the source to the destination. The source provides information in the form of electrical signal to the transmitter. The electrical stage of the transmitter drives an optical source to produce modulated light wave carrier. Semiconductor LASERs or LEDs are usually used as optical source here. The information carrying light wave then passes through the transmission medium i.e. optical fiber cables in this system. Now it reaches to the receiver stage where the optical detector demodulates the optical carrier and gives an electrical output signal to the electrical stage. The common types of optical detectors used are photodiodes (p-i-n, avalanche), phototransistors, photoconductors etc. Finally the electrical stage gets the real information back and gives it to the concerned destination. It is notable that the optical carrier may be modulated by either analog or digital information signal. In digital optical fiber communication system the information is suitably encoded prior to the drive circuit stage of optical source. Similarly at the receiver end a decoder is used after amplifier and equalizer stage[1]

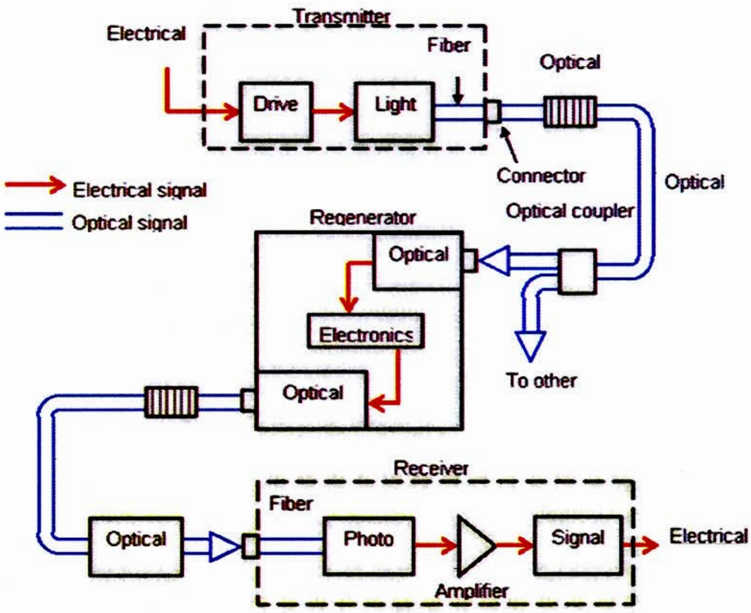

Figure 2.1(a): Major elements used in an optical fiber communication system[1]

In the optical fiber communication system, there are few basic elements that are been used to transmit the information from one point to another point. All these elements include fiber optic cable, connector, transmitter and receiver.

FIBER OPTIC CABLE

Three Types of Composition or Material Makeup Fiber Optic Cables

1. Glass,
2. Plastic
3. Plastic Clad Silica (PCS).

These three candidate types differ with respect to attenuation and cost. The attenuation is principally caused by two physical effects, absorption and scattering. Absorption removes signal energy in the interaction between the propagating light (photons) and molecules in the core. Scattering redirects light out of the core to the cladding. When attenuation for a fiber optic cable is dealt with quantitatively it is referenced for operation at a particular optical wavelength, a window, where it is minimized. [2]

1. Glass

Glass fiber optic cable has the lowest attenuation and comes at the highest cost. A pure glass fiber optic cable has a glass core and a glass cladding. This candidate has, by far, the most wide spread use. It has been the most popular with link installers and it is the candidate with which installers have the most experience. The glass employed in a fiber optic cable is ultra pure, ultra transparent, silicon dioxide or fused quartz. During the glass fiber optic cable fabrication process impurities are purposely added to the pure glass so as to obtain the desired indices of refraction needed to guide light. Germanium or phosphorous are added to increase the index of refraction. Boron or fluorine is added to decrease the index of refraction. Other impurities may somehow remain in the glass cable after fabrication. These residual impurities may increase the attenuation by either scattering or absorbing light. [2]

2. Plastic

Plastic fiber optic cable has the highest attenuation, but comes at the lowest cost. Plastic fiber optic cable has a plastic core and plastic cladding. This fiber optic cable is quite thick. Typical dimensions are 480/500, 735/750 and 980/1000. The core generally consists of PMMA (polymethylmethacrylate) coated with a fluropolymer. The increased interest in plastic fiber optic cable is due to two reasons. First, the higher attenuation relative to glass may not be a serious obstacle with the short cable runs often required in premise networks. Secondly, the cost advantage sparks interest when network architects are faced with budget decisions. Plastic fiber optic cable does have a problem with flammability. Because of this, it may not be appropriate for certain environments and care has to be given when it is run through a plenum. Otherwise, plastic fiber is considered extremely rugged with a tight bend radius and the ability to withstand abuse. [2]

3. Plastic Clad Silica (PCS)

Plastic Clad Silica (PCS) fiber optic cable has an attenuation that lies between glass and plastic and a cost that lies between their cost as well. Plastic Clad Silica (PCS) fiber optic cable has a glass core which is often vitreous silica while the cladding is plastic - usually a silicone elastomer with a lower refractive index. PCS fabricated with a silicone elastomer cladding suffers from three major defects. It has considerable plasticity. This makes connector application difficult. Adhesive bonding is not possible and it is practically insoluble in organic solvents. All of this makes this type of fiber optic cable not particularly popular with link installers. However, there have been some improvements in it in recent years. [2]

Two Types of Mode of Propagation fiber optic cable.

1. Multi-mode

   (i) Step Index (Glass, Plastic or PCS)

   (ii) Graded Index (Glass)

2. Single-mode (Glass)

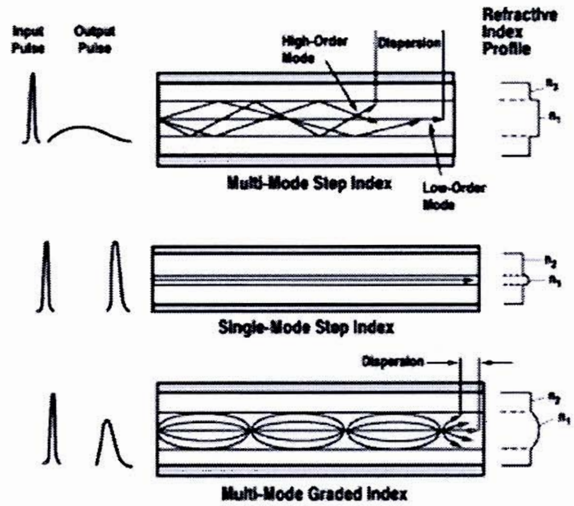

Figure 2.1(b): Types of mode propagation in fiber optic cable [2]

These provide different performance with respect to both attenuation and time dispersion. The single-mode fiber optic cable provides the better performance and at a higher cost.

Light has a dual nature and can be viewed as either a wave phenomenon or a particle phenomenon (photons). For the present purposes consider it as a wave. When this wave is guided down a fiber optic cable it exhibits certain modes. These are variations in the intensity of the light, both over the cable cross section and down the cable length. These modes are actually numbered from lowest to highest. In a very simple sense each of these modes can be thought of as a ray of light. Although, it should be noted that the term ray of light is a holdover from classical physics and does not really describe the true nature of light. In any case, view the modes as rays of light. For a given fiber optic cable the number of modes that exist depend upon the dimensions of the cable and the variation of the indices of refraction of both core and cladding across the cross section. There are three principal possibilities. [2] .These are illustrated in Figure 2.1(a).

1. Multi-mode

(i) Step Index

Consider the top illustration in Figure 2.1(a). This diagram corresponds to multi-mode propagation with a refractive index profile that is called step index. As can be seen the diameter of the core is fairly large relative to the cladding. There is also a sharp discontinuity in the index of refraction as you go from core to cladding. As a result, when light enters the fiber optic cable on the right it propagates down toward the left in multiple rays or multiple modes. This yields the designation multi-mode. As indicated the lowest order mode travels straight down the center. It travels along the cylindrical axis of the core. The higher modes represented by rays, bounce back and forth, going down the cable to the left. The higher the mode the more bounces per unit distance down to the left. [2]

Over to the left of this top illustration are shown a candidate input pulse and the resulting output pulse. Note that the output pulse is significantly attenuated relative to the input pulse. It also suffers significant time dispersion. The reasons for this are as follows. The higher order modes, the bouncing rays, tend to leak into the cladding as they propagate down the fiber optic cable. They lose some of their energy into heat. This results in an attenuated output signal. The input pulse is split among the different rays that travel down the fiber optic cable. The bouncing rays and the lowest order mode, traveling down the center axis, are all traversing paths of different lengths from input to output. Consequently, they do not all reach the right end of the fiber optic cable at the same time. When the output pulse is constructed from these separate ray components the result is time dispersion. Fiber optic cable that exhibits multi-mode propagation with a step index profile is thereby characterized as having higher attenuation and more time dispersion than the other propagation candidates have. However, it is also the least costly and in the premises environment the most widely used. It is especially attractive for link lengths up to 5 km. Usually; it has a core diameter that ranges from 100 microns to 970 microns. It can be fabricated either from glass, plastic or PCS. [2]

(ii) Graded Index

Consider the bottom illustration in Figure 2.1(a). This corresponds to multi-mode propagation with a refractive index profile that is called graded index. Here the variation of the index of refraction is gradual as it extends out from the axis of the core through the core to the cladding. There is no sharp discontinuity in the indices of refraction between core and cladding. The core here is much larger than in the single-mode step index case discussed above. Multi-mode propagation exists with a graded index. However, as illustrated the paths of the higher order modes are somewhat confined. They appear to follow a series of ellipses. Because the higher mode paths are confined the attenuation through them due to leakage is more limited than with a step index. The time dispersion is more limited than with a step index, therefore, attenuation and time dispersion are present, just limited. [2]

To the left of this bottom illustration is shown a candidate input pulse and the resulting output pulse. When comparing the output pulse and the input pulse, note that there is some attenuation and time dispersion, but not nearly as great as with multi-mode step index fiber optic cable. Fiber optic cable that exhibits multi-mode propagation with a graded index profile is thereby characterized as having attenuation and time dispersion properties somewhere between the other two candidates. Likewise its cost is somewhere between the other two candidates. Popular graded index fiber optic cables have core diameters of 50, 62.5 and 85 microns. They have a cladding diameter of 125 microns - the same as single-mode fiber optic cables. This type of fiber optic cable is extremely popular in premise data communications applications. In particular, the 62.5/125 fiber optic cable is the most popular and most widely used in these applications. Glass is generally used to fabricate multi-mode graded index fiber optic cable. However, there has been some work at fabricating it with plastic. [2]