OPTICAL RECEPTION OF VOICE SIGNAL USING SQUARE WAVE FREQUENCY MODULATION

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This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) with honours

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Specially dedicated to:

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ABSTRACT

This project deals with the design of receiver for optical communication. The type of modulation for receiver signals are square wave frequency modulation which has been differentially with sinusoidal modulation for others receiver. This project consists of several parts to extract the voice signal from square wave frequency to sine wave as output. The important parts of these projects are square to sine wave frequency converter, demultiplex or demodulator. The goal of this project is to improve the efficiency, quality and range of the communication system. In order to build a good communication system, a good transceiver is necessary. Generally speaking, each transceiver is designed for its own purpose and for some specific applications. A transceiver works perfectly for one application may not suit for another situation. This project will establish a new reception model system of voice signal using square wave frequency modulation through optical sources like LED and Laser. This project will consist of 3 major parts. Firstly, analyze the suitable circuits and components to use for this project. Secondly, simulate the circuit to get the correct result. The simulation and comparison will be in form of simulation using Mutisim® and Proteus®. Lastly, this report will reveal project implementation and development.

ABSTRAK

Pojek ini merujuk kepada merekabentuk penerima sistem perhubungan optik. Jenis mudulasi yang digunakan untuk menerima isyarat ialah modulasi frekuensi segiempat yang mana mudulasi ini berbeza dengan modulasi sinus untuk sistem penerima yang lain. Projek ini terdiri dari beberapa bahagian untuk mengekstrak isyarat suara dari frekuensi segiempat ke frekuensi sinus sebagai keluaran (isyarat suara). Dalam projek ini, bahagian yang paling penting adalah pengubah frekuensi segiempat kepada frequensi sinus, penyahmodulat. Tujuan projek ini adalah untuk meningkatkan kecekapan, kualiti dan julat sistem komunikasi. Di peringkat membina suatu sistem komunikasi baik, penghantar dan penerima yang baik adalah perlu. Projek ini akan mewujudkan satu sistem model isyarat suara baru gelombang radio mengguakan modulasi gelombang segiempat melalui sumber-sumber optikal seperti LED dan Laser. Projek ini akan terdiri daripada 3 bahagian yang utama. Pertama, menganalisis litar-litar yang sesuai dan komponen-komponen yang digunakan untuk projek ini. Keduanya, simulasi litar-litar untuk mendapatkan keluaran yang betul. Simulasi dan perbandingan menggunakan Mutisim® dan Proteus®. Akhirnya, laporan ini akan menghuraikan pelaksanaan projek dan pembangunan projek.

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NOMENCLATURE

AM - Amplitude Modulation

FM – Frequency Modulation

FDM - Frequency Division Multiplex

PM - Phase modulation

DSB-SC - Double-sideband suppressed-carrier transmission

DSB-RC - Double-sideband reduced carrier transmission

SSB - Single-sideband modulation

SSB-SC - Single-sideband suppressed carrier modulation

VSB - Vestigial-sideband modulation

QAM - Quadrature amplitude modulation

L.F – Low Frequency

A.F – Audio Frequency

KHz – Kilo Hertz

KW- Kilo Watt

LED - Light Emitting Diode

SNR - Signal-to-noise ratio

PPM - Pulse Position Modulation

CHAPTER 1

INTRODUCTION

1.1 Application Background

Today, local communication was done over wires, as this presented a cost effective way of ensuring a reliable transfer of information. For long distances communication, transmission of information over radio waves was needed. Although this was convenient from a hardware standpoint, radio wave transmission raised doubts over the corruption of the information and was often dependent on high power transmitter to overcome weather condition, large buildings, and interference from other sources of electromagnetic. The various modulation techniques offered solutions in terms of cost effectiveness and quality of received signal but until recently were still largely analogue.

This project deals with the design and develops optical reception of voice signal using square wave frequency modulation technique. This project consists of several parts to extract the voice signal from square wave frequency to sine wave as output.

The important parts of these projects are square to sine wave frequency converter, demultiplex or demodulator. The goal of this project is to improve the efficiency, quality and range of the communication system. In order to build a good communication system, a good transceiver is necessary. Generally speaking, each transceiver is designed for its own purpose and for some specific applications. A transceiver works perfectly for one application may not suit for another situation. This project will establish a new reception model system of voice signal using square wave frequency modulation through an optical fibre or infra red.

There are three major paths that will use in this reception system. The paths are consists receiver circuit, square wave to sine wave converter circuit and demodulator or demultiplexer. The receiver circuit receive the signal from transmitter by optical signal that convert to electrical signal. The signals are sending through photo diode and received through detector. Then, the signal passes trough converter circuit and lastly to demodulator. In the demodulator, the audio signal or information signal with **10 KHz** frequency range and carrier frequency with **100 KHz** that modulated by demodulator at transmission part will demodulate to get the original signal at the receiver part. By the end from this process, the original signal will generate or the audio signals are generated.

1.2 Objectives

- To understand the concept of optical reception design where there are a few characteristics will be considers on design it.
- To make a comparison between the receiver circuit using optical and without optical or electrical. To know the comparison of signal transmit between the both circuits.
- To familiar the student with the optical technology. In the future, almost all communications will employ fibre optics.

1.3 Problem Statement

There are two modulation methods that commonly used in the analogue modulation to transmit the signal, that is Amplitude Modulation (AM) and Frequency Modulation (FM) and it's depend of what kind of application that will be used. Although AM signal it easy to transmit compare with FM signal, this signal is actually have so many problem or disadvantages for example the modulation process of AM signal we generate at least two copies of the intelligence plus the carrier and the signal is half the transmitted power in each side band of which we only need one. Since the signal AM operated in Medium frequency range (535 KHz to 1605 KHz),

1.3.1 Coherence

Incoherent light means that the phase is always changing. While no practical sources are totally coherent, lasers in general have a high degree of coherence while incandescent lights are incoherent. The degree of coherence can be either temporal or spatial.

1.3.2 Interference

When we combine different waves we observe interference. Interference is due to the linear superposition of electromagnetic waves, whereby the amplitude at any point is equal to the sum of the individual amplitudes at that point. The result under certain conditions is constructive interference. Interference can be optimized to reflect or transmit specific wavelengths as in the Fabry-Perot cavity.

1.3.3 Diffraction

Another important result of the wave model is diffraction, or how light can spread out after it passes through a small aperture. Since diffraction is wavelength-dependent we can use this property to separate light into its component wavelengths. If we construct a diffraction grating with evenly spaced obstructions (such as a series of slits) we obtain bands of different colors spread out in a plane parallel to the grating.

1.3.4 Scattering

Light scattering is the spreading apart of light caused by an interaction with matter. A common phenomenon responsible for our blue sky, scattering is divided into two basic categories.

- Rayleigh scattering, often referred to as molecular scattering, is caused by particles with diameters less than or equal to one-tenth of the wavelength of light. Light is scattered equally in all directions perpendicular to the plane of polarization, with shorter wavelengths scattered more than longer ones.
- Mie scattering is scattering from particles larger than one-tenth wavelength. Often caused by impurities, the scattering is out of phase and propagates mostly in the direction of the original light wave. Some other types of scattering will be covered when we discuss nonlinear optic

1.3.5 Nonlinear Optics

Nonlinear optics refers to optical interactions other than absorption or scattering, which vary with the intensity of light raised to some power rather than varying linearly with light intensity. These effects include four-wave mixing, phase modulation, and Brillouin and Raman scattering and are negligible except at higher optical powers. While nonlinear phenomena are undesirable in many cases, some have found application in fiber-optic communications devices.

1.3.6 Intersymbol Interference (ISI)

When the signal waveform goes through a communication system, its shape will be broadened in time because the bandwidth of the system is limited. If the bandwidth of the system is much higher than the data rate, this broadening will be insignificant but receiver noise will be a problem. From both noise and implementation considerations it is desirable to narrow the system bandwidth as much as possible. Consequently, the effect of pulse broadening becomes significant. The pulse of each symbol will spread in time and overlap to the adjacent symbols. This overlap causes intersymbol interference. An example of intersymbol interference is shown in Figure below.

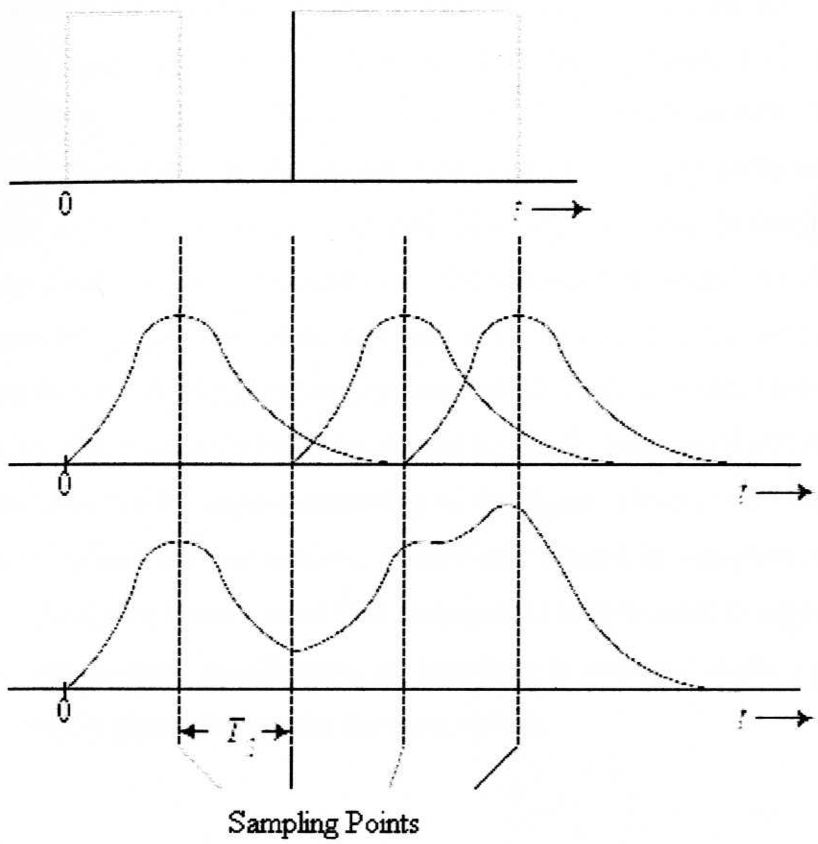

Figure 1.3.6 Examples of ISI on received pulses in a communication system

Bandwidth limitations in the transmitter, fiber, or receiver cause the pulses to spread out in time. Each pulse will overlap to the adjacent pulses. The amplitude of each pulse at the sampling point is changed because of intersymbol interference. The change in amplitude may lead to the wrong decision in the decision circuit; thus, increasing the bit-error-rate. For example, at the second bit, the transmitted bit was 0, but the amplitude of the received pulse for this bit at the sampling point is not zero because of the effect of pulse broadening from the first bit. And this may cause the wrong decision on this bit. In an optical communication system, intersymbol interference is potentially a problem since the system bandwidth is not infinite. Pulse broadening in optical communication systems is mainly caused by fiber dispersion and the receiver bandwidth if the bandwidth of the transmitter is assumed to be very large. When the optical signal travels along the fiber, each spectral component of the signal travels with a particular propagation velocity, which is different from those of other spectral components. Consequently, each spectral component will reach the receiver at a different time. This causes the pulse spreading at the receiver end. The effect of fiber dispersion limits the bit rate-distance product that can be achieved. The receiver bandwidth can also introduce intersymbol interference in the received signal. As mentioned in the previous section, the noise depends on the effective receiver bandwidth; thus, to reduce the noise at the receiver the effective receiver bandwidth should be small. This small effective receiver bandwidth will result in the pulse broadening of the signal. However, in the absence of fiber dispersion, transmitter and receiver bandwidths should be matched and a proper spectral shape should be chosen such that intersymbol interference is negligibly small. To reduce the intersymbol interference, an equalizer is required at the receiver. This component is usually placed before the decision circuit.

1.4 Scopes of Works

Do the research about the relevant component in optical reception circuit like square wave to sine wave converter, dimultiplex or demodulator integrated circuit.

- Designed a receiver circuit by using MULTISIM® software to obtain the expected result from the simulation
- Use Proteus ® to design circuit and then fabricate the circuit
- Find and construct an additional peripheral circuit to form a complete receiver
- Make a comparison between the receivers that had fabricated with the simulation with the circuit real circuit that had done constructed.

1.5 Project Methodology

This project has 4 phases which every phase has a description of project overcome. The literature review can be done by gathering information about this project via Internet, journals, magazines, published work and reference books. Besides, in the same time, study the software implementation. The next step is built a receiver circuit schematic in multisim and simulates the design the circuit to obtain the result. The other step in this project is designing the real circuit that have simulated. The circuits are consists receiver, converter and demodulator part. The last step in this project is to measure the result and make a comparison with the simulation result.

1.6 Report Structure

This report have seven chapter which every chapter will be discuss how to design a hardware in implement and development to complete the optical reception of voice signals using square wave frequency modulation. In first chapter, it has 6 sub topics which related to discuss overall this project and give the feature detail about project objective. It also narrates the overview of the Project including application background, problem statement and scope of project. The second chapter is about literature review regarding to the project. It will give more basic information about this project. In third chapter is about methodology and approach taken and a closer look on how the project is actualized. It will explain what method is use for this project to solve project problem. In chapter four, there is all about the circuits operation. In this chapter will describe about the receiver converter and demodulator circuits. Analysis and simulation will describe in chapter 5. . In chapter six, there is all about the Result and discussion of this project. Here shows the comparison between the simulation and measurements result. Lastly for chapter seven for this report will state conclusion and suggestion for this project development in future.