OPTICAL TRANSMISSION OF VOICE SIGNAL USING SQUARE WAVE FREQUENCY MODULATION

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ABSTRAK (BM)

Projek ini merujuk kepada penghasilan satu bentuk modul sistem penghantaran isyarat analog menggunakan pemodulatan frekuensi gelombang segiempat melalui gentian optik atau pancaran cahaya secara terus. Sistem penghantaran ini terdiri daripada tiga litar utama iaitu litar Multiplexer / litar Frequency Modulation (FM), litar Schmitt Trigger dan juga litar pemancar cahaya Pada bahagian multiplexer, isyarat masukan ataupun isyarat suara dengan frekuensi 10 kHz dan kemudian akan dimodulatkan bersama frekuensi pembawa (carrier frequency) yang dijana melalui pengayun tempatan (Local Oscillator) dalam julat 100 kHz untuk mendapatkan satu bentuk isyarat sinus FM termodulat. Keluaran daripada litar ini akan dihantar ke bahagian litar litar Schmitt Trigger dimana litar ini berfungsi untuk menukarkan isyarat FM termodulat kepada satu bentuk isyarat segiempat, seterusnya keluaran daripada litar ini akan dimasukkan ke bahagian akhir sistem penghantaran ini iaitu litar pemancar. Pada bahagian pemancar, isyarat segiempat tadi akan ditapis, dikuatkan dan akan ditukarkan kepada isyarat cahaya sebelum ianya sedia untuk dipancarkan ke bahagian penerima.

ABSTRAK (BI)

The aim of this project is to design a model of analogue transmission using square wave frequency modulation over an optical fibre or a laser. There are three main circuits that will be used. The first one is the Multiplexer / Frequency Modulation (FM) circuit, utilising the AD 630 Balanced Modulator/Demodulator. From this part, the input signal or information signal 10 kHz will modulate by the carrier frequency 100 kHz to produce the FM signal. The second part of this system is the Schmitt Trigger circuit which will convert FM signal to square wave signal. The final stage Transmitter circuit then will filtered, amplified and convert the signal waveform into light form or infra red laser as to complete the transmission system process.

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NOMENCLATURE

AM	Amplitude Modulation
FM	Frequency Modulation
RF	Radio Frequency
PCB	Printed Circuit Board
FDM	Frequency Division Multiplex
LED	Light Emitting Diode
KHz	Kilo Hertz
KW	Kilo Watt
SNR	Signal-to-noise ratio

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CHAPTER I

INTRODUCTION

1.1 Introduction

The goal of this project is to design a model of communication system. In order to build a good communication system, a good transceiver is very crucial. Generally, 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 model of transmission system for voice signal using square wave frequency modulation through an optical fibre or directly without any fibre optics.

There are three major circuit that will be used in the transmission system that is the Multiplexer / FM Circuit, Schmitt-trigger circuit and transmitter circuit. In the multiplier, the audio signal or information signal of 10 kHz frequency will be modulated with carrier frequency 100 kHz, produced by the local oscillator to generate the Frequency Modulation (FM) signal. The output from this circuit will be fed to Schmitt-trigger circuit that will convert the sinusoidal FM into square wave signal. By the end from this process, the square wave signal will be filtered, amplified and converted into the light signal and transmitted to the receiver.

1.2 Problem Statement

There are two modulation methods that commonly used in the analogue system 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 AM signal operated in Medium frequency range (535 kHz to 1605 kHz), noise will be easy to introduced, whilst the signal is amplitude modulated, common forms of radio interference are also amplitude in nature. To get away from this amplitude affect by noise Frequency Modulation (FM) in 88 - 108 MHz was devised to limit the amplitude. By limiting the amplitude of the signal all AM components (including noise) are thereby removed.

Sinusoidal waveform difficult to analysis because it have a value along the time travel so signal transmission using square wave is more better compared to sinusoidal waveform when through an optical fibre, since it's a periodic signal square wave signal will be easily analysed.

Lastly, project is to overcome the environment distortion, by using radio frequency (RF) signal or any other method transmission medium such as twisted pair and coaxial cable, signal travel on this medium may be attenuated and interference by the environment distortion. Fibre offers many well-known advantages over twisted pair and coaxial cable, including immunity to electrical interference and superior bandwidth. For these and many other reasons, fibre optic transmission systems have been increasingly integrated into a wide range of applications across many industries.

1.3 Objectives

1.3.1 To understand the concept of signal transmission via optic cable or infra red.

1.3.2 To learn the transmission concept of square wave by using Frequency Modulation (FM) method

1.3.3 To familiarize the student about the optical technology in the communication system.

1.4 Scopes of Project

1.4.1 Involved the analysis process and comparison between sinusoidal and square wave signals in term of advantages and disadvantages

1.4.2 Define the suitable circuits

1.4.3 Understand the concept and circuit operation

1.4.4 Involved the simulation to design the circuit by using Multisim® or Protel® software

1.4.5 Implement the circuit into Printed Circuit Board (PCB) layout

1.4.6 Making the comparison between the simulation result and the actual result

CHAPTER II

LITERATURE REVIEW

2.1 Modulation

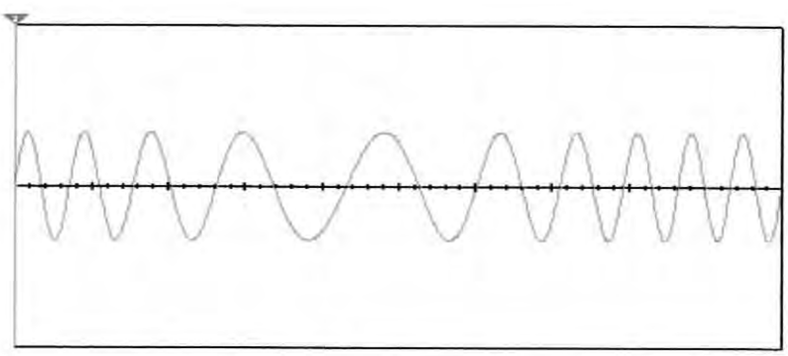
Modulation is the process of varying a periodic waveform, normally a sinusoid carrier signal, in order to use that signal to convey information. The three key parameters of a sinusoid are its amplitude, its phase and its frequency, all of which can be modified in accordance with an information signal to obtain the modulated signal.

A device that performs modulation is known as modulator and a device that performs the inverse operation of demodulation is known as a demodulator (sometimes detector). A device that can do both operations is a modem (a contraction of the two terms).

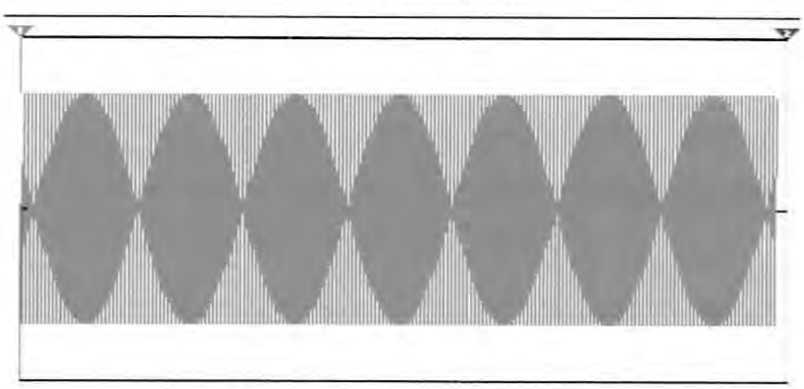
In aim of analogue modulation is to transfer an analogue lowpass signal, for example an audio signal or TV signal, over an analogue bandpass channel, for example a limited radio frequency band or a cable TV network channel. The aim of digital modulation is to transfer a digital bit stream over an analogue bandpass channel, for example over the public switched telephone network or a limited radio frequency band. Analogue and digital modulation facilitate frequency division multiplex (FDM), where several low pass information signals are transferred simultaneously over the same shared physical medium, using separate bandpass channels.

The aim of digital baseband modulation methods, also known as line coding, is to transfer a digital bit stream over a lowpass channel, typically a non-filtered copper wire such as a serial bus or a wired local area network. The aim of pulse modulation methods is to transfer a narrowband analogue signal, for example a phone call over a wideband lowpass channel or, in some of the schemes, as a bit stream over another digital transmission system.

2.2 The Difference between Frequency Modulation (FM) and Amplitude Modulation (AM)



FM Waveform Form



AM Enveloped Waveform Form

Figure 2.2: The Difference between FM and AM

FM radio works the same way that AM radio works. The difference is in how the carrier wave is modulated, or altered. With AM radio, the amplitude, or overall strength, of the signal is varied to incorporate the sound information. With FM, the frequency (the number of times each second that the current changes direction) of the carrier signal is varied. FM signals have a great advantage over AM signals. Both signals are susceptible to slight changes in amplitude. With an AM broadcast, these changes result in static. With an FM broadcast, slight changes in amplitude don't matter since the audio signal is conveyed through changes in frequency the FM receiver can just ignore changes in amplitude. The result: no static at all.

2.3 Analogue Transmission over Fibre

Analogue fibre optic transmission systems supported in both AM and FM versions. In both types of systems, the optical transmitter takes in an analogue, baseband video, audio or data signal and converts it to an optical signal. At this point, the systems begin to vary.

In an AM (amplitude modulation) system, the optical signal is generated as a beam of light that varies in intensity with respect to variations in the original, incoming, electrical analogue signal. Either a light emitting diode (LED) or a laser diode serves as the source of the optical signal. Unfortunately, both LED's and laser diodes are nonlinear devices. This means that it is difficult to control the brightness of their light in a controlled continuum, from completely off to completely on with all variations in between. However, in an AM system, this is exactly how they are used. As a result, various distortions to the transmitted signal occur, such as:

- Degradation in the signal-to-noise ratio, or SNR, as the length of the fibre optic cable is increased
- Nonlinear differential gain and phase errors of video signal
- Poor dynamic range of audio signals

In an effort to improve upon the performance of AM-based fibre optic transmission systems, FM design techniques were introduced. In these systems, the signal is conveyed by pulsing the LED or laser diode completely on and off, with the speed of pulsing varying with respect to the original incoming signal.

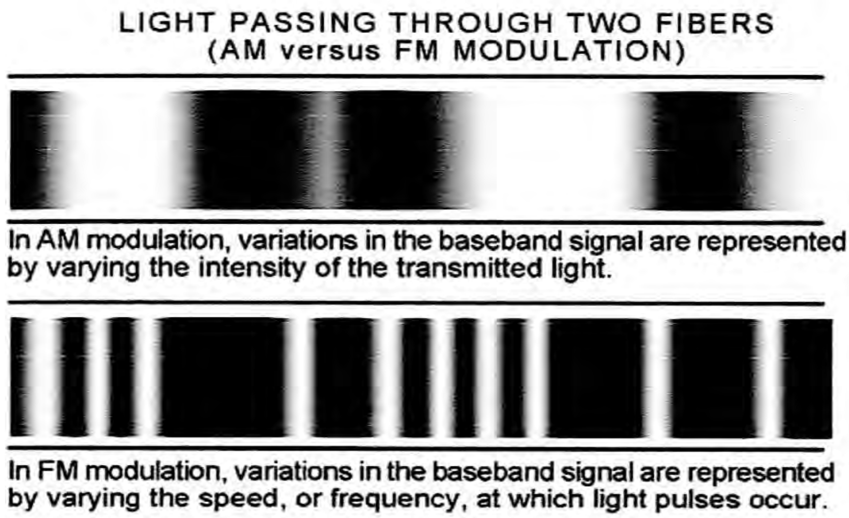


Figure 2.3: Light Passing Through Two Fibres (AM versus FM Modulation)

For those familiar with FM transmission over mediums other than fibre, the term "FM" for this type of system may be a bit confusing. FM stands for "frequency modulation" and might be interpreted, within the context of fibre optics, to mean that the signal is transmitted by modulating the frequency of the light itself.

While FM transmission systems eliminate many of the problems found in AM systems, which result from difficulties in controlling the varying brightness level of light emanating from the diode, FM systems offer their own unique set of problems.

One distortion common in FM systems is called crosstalk. This occurs when multiple FM carriers are transmitted over a single optical fibre, such as when using a multiplexer. Crosstalk originates within either the transmitter or receiver unit and is the result of a drift in alignment of critical filtering circuits designed to keep each carrier separate. When the filters do not perform properly, one FM carrier may interfere with and distort another FM carrier. Fibre optic engineers can design FM systems that minimize the likelihood of crosstalk occurring, but any improvement in design also means an increase in price.

Another type of distortion is called intermodulation. Like crosstalk, this problem occurs in systems designed to transmit multiple signals over a single fibre. Intermodulation originates in the transmitter unit and is most often the result of a non-linearity present in a circuit common to the FM carriers. The result is that the two (or more) original incoming signals interfere with each other before being combined into a single optical signal, causing reduced fidelity in the transmitted optical signal.

2.4 Performance Consistency

Unlike in analogue and frequency modulation (AM and FM) systems pure digital transmission guarantees that the fidelity of the baseband video, audio and data signals will remain constant throughout the system's entire available optical budget. This is true whether you are transmitting one or multiple signals through the fibre, over short or long distances (up to the longest distance allowed by the system).

By contrast, analogue systems using AM signalling techniques exhibit a linear degradation in signal quality over the entire transmission path. This characteristic, combined with the fact that AM systems can only transmit over multimode fibre, limits the use of these systems to applications in which a relatively short transmission distance must be covered. FM systems fare a bit better, with signal quality remaining relatively constant over short transmission distances, but decreasing dramatically at longer distances. And even at short distances, there is some signal degradation. Only systems that use pure digital transmission techniques can claim to have an absolutely uniform signal quality over the entire transmission path, from transmitter to receiver.

Consistent signal quality or lack thereof, is also an issue when considering systems designed to transmit more than one signal over a single fibre (multiplexers). For example, a multichannel analogue system designed to carry four channels of video or audio might restrict the bandwidth allocated to each signal in order to accommodate all the desired signals to be transmitted. Systems using digital transmission need not make this compromise. Whether sending one, four, or even ten signals over a single fibre, the fidelity of each signal remains the same.

CHAPTER III

PROJECT METHODOLOGY

3.1 Project methodology

This project consists of 3 major phases:

3.1.1 Phase 1: Literature Review

In order to understand all the basic theory and concept of the related topic of this project, some researches were made in: Background and study in Multisim® or Protel®. In formation gathering including journals, newsletter, magazines and public work

3.1.2 Phase 2: Analysis and Simulation

Analysing analogue transmission over fibre to generate early ideas and concept about how the transmitter will be design. The main goal of this phase is to make comparison between Amplitude Modulation (AM)-Frequency Modulation (FM), Sine wave-Square wave in term of their performance to interface with the fibre optic cable or directly without fibre optic. On the other hand Multisim program is used to simulate the designed transmitter circuit and also record the simulation result to the comparison with the real result of this transmitter.

3.1.3 Phase 3: Design the Transmitter Module

A complete transmitter will be design in this stage including designing additional peripheral circuit for the transmitter to work properly which requires Analogue system. In order to implement this transmitter circuit, PROTEL software will be used to design the Printed Circuit Board (PCB). Components installation, soldering and troubleshooting stage also applies at this phase.