TRANSMISSION OF AUDIO AND VIDEO SIGNAL USING SQUARE WAVE FREQUENCY MODULATION

AHMAD SYAFUAN BIN SULAIMAN

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

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

April 2009

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	TRANSMISSION OF AUDIO AND VIDEO SIGNAL USING SQUARE WAVE FREQUENCY MODULATION
Sesi Pengajian	:	2008/2009

Saya AHMAD SYAFUAN BIN SULAIMAN mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD***	(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	**TIDAK TERHAD**	

Disahkan oleh:

_____
(TANDATANGAN PENULIS)

_____
(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: 14, HALA PEGOH 1,
TAMAN SRI PENGKALAN,
31650 IPOH, PERAK

Tarikh: 30 APRIL 2009

Tarikh: 30 APRIL 2009

"I hereby declare that this report is the result of my own work except for quotes as cited in the references."

Signature :

Author : AHMAD SYAFUAN BIN SULAIMAN

Date : 30 APRIL 2009

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) With Honours."

Signature :
Supervisor's Name : MR. FAUZI BIN ABDUL WAHAB
Date : 30 APRIL 2009

ACKNOWLEDGEMENT

First and foremost, I would like to thank to Allah S.W.T. for helping me through all the obstacles that I faced during the work of this project.

I wish to express my sincere gratitude to my supervisor, Mr. Fauzi Bin Abdul Wahab, lecturer in the Telecommunication Electronics Engineering Department, Universiti Teknikal Malaysia Melaka for the guidance throughout this project. Thank you for the help, support, motivation and advice.

To dear friends; Mohd Nazreen Bin Abdul Majid and Mashitah Binti Ramli, thank you all for lending hands during the progress of the project. Your contributions are highly appreciated.

To the family, thank you for your prayers and moral support. Without your supports, I might not be able to complete this project. Last but not least, million of thanks to lecturers, classmates and friends who contributed in this project directly or indirectly.

ABSTRACT

Optical fibre transmission is an attractive technology for point-to-point transmission of audio and video signals. It is use to replace conventional copper cable transmission. Electromagnetic interference (EMI) susceptibility of the copper cable can be eliminated. The purposes of this project are design, modulate and study performance system of square wave frequency modulation (SWFM) technique for optical fibre transmission. The results indicate that SWFM system is bandwidth efficient and low-cost alternative compared to the more complex and expensive digital system requiring far greater bandwidth.

ABSTRAK

Penghantaran isyarat audio dan video dari satu tempat ke tempat yang lain melalui fiber optik merupakan sebuah teknologi yang menarik. Ia digunakan untuk menggantikan penghantaran melalui kabel kuprum yang biasa. Masalah gangguan electromagnet pada kabel kuprum dapat diatasi. Projek ini bertujuan untuk mereka bentuk, memodulasi dan mengkaji prestasi sistem teknik pemodulatan frekuensi gelombang segiempat (SWFM). Hasil keputusan mendapati teknik SWFM adalah lebih praktikal berbanding teknik lain yang kompleks, memerlukan kos yang tinggi dan penggunaan sistem digital yang mahal.

TABLE OF CONTENTS

CHAPTER	TITLE		PAGE
	PROJECT TITLE		**i**
	REPORT STATUS FORM		**ii**
	STUDENT DECLARATION		**iii**
	SUPERVISOR DECLARATION		**iv**
	ACKNOWLEDGEMENT		**v**
	ABSTRACT		**vi**
	ABSTRAK		**vii**
	TABLE OF CONTENTS		**viii**
	LIST OF TABLES		**xi**
	LIST OF FIGURES		**xii**
	LIST OF ABBREVIATIONS		**xiv**
	LIST OF APPENDIXES		**xv**
I	**INTRODUCTION**		1
	1.1	Project Introduction	2
	1.2	Project Objective	2
	1.3	Problem Statement	3
	1.4	Scope of Work	3
	1.5	Methodology	4

II	**LITERATURE REVIEW**	5
2.1	Basic Telecommunication System	6
2.2	Analogue and Digital Signals	7
	2.2.1 Frequency and Bandwidth	8
2.3	Video Technologies	10
	2.3.1 Bandwidth versus Video Resolution	11
	2.3.2 Visual Resolution	13
2.4	Modulation	15
	2.4.1 Frequency Modulation	15
	2.4.2 Amplitude Modulation	17
2.5	Oscillator	18
	2.5.1 Hartley Oscillator	21
	2.5.2 Voltage-Controlled Oscillator (VCO)	23
2.6	Operational Amplifiers	23
2.7	Square Wave Converter	23
	2.7.1 Schmitt Trigger	24
2.8	Multiplexing	25
	2.8.1 Multiplexer	25
2.9	Types of Fibre	25
	2.9.1 Optical Source	26
	2.9.2 Optical Detector	28
	2.9.3 Fibre Measurement	29
	2.9.4 Optical Fibre Communication	30
2.10	Project Design	31
	2.10.1 Video and Audio Signals	31
	2.10.2 Low Pass Filter	32
	2.10.3 IC SN74S124N VCO Oscillator	33
	2.10.4 IC LM358N Operational Amplifier	34

III	**PROJECT METHODOLOGY**		35
	3.1	Phase of Methodology	36
	3.2	Project Flow Chart	37
	3.3	Project Gantt Chart	38
	3.4	Project's Flow	39
IV	**RESULT & DISCUSSION**		40
	4.1	Circuit Diagram	41
	4.2	Circuit Discussion	42
	4.3	Circuit Schematic using Multisim	43
	4.4	Circuit Schematic using Proteus 7 Professional	45
	4.5	Simulation using Multisim	47
	4.6	Calculation from Multisim	48
V	**CONCLUSION & RECOMMENDATION**		49
	5.1	Conclusion	49
	5.2	Recommendation	50
	REFERENCES		51
	APPENDIXES		52

LIST OF TABLES

NO	TITLE	PAGE
2.1	Performance Requirements for Various Video Standards	14
2.2	Reactance Element	19
2.3	Comparison of PIN and APD	27
3.1	Gantt Chart	36
4.1	Output Graph of Simulation	47
4.2	Calculation from Output Graph	48

LIST OF FIGURES

NO	TITLE	PAGE
1.1	Block Diagram of Project	4
2.1	Block Diagram of Telecommunication System	6
2.2	Analogue Signal	7
2.3	Digital Signal	7
2.4	Low-Pass Filter	8
2.5	High-Pass Filter	9
2.6	Bandpass Filter	9
2.7	Notch Filter	9
2.8	Modulating Signal Superimposed On the Carrier Wave	15
2.9	Resulting Frequency-Modulated Signal	16
2.10	Amplitude Modulation Signal	18
2.11	Basic Block Diagram of Oscillator	19
2.12	Basic Configuration of Resonant Circuit Oscillator	20
2.13	AC Equivalent of Hartley Oscillator	21
2.14	Hartley Oscillator Circuit	22
2.15	Schmitt Trigger Symbol	24
2.16	Comparator Implementation	24
2.17	HFBR-1524Z LED Source	27
2.18	Low Pass Filter RC Network	32
2.19	IC SN74S124N Configuration	33

2.20	IC LM358N Pin Configuration	34
3.1	Flow Chart Progress of Project	37
3.2	Testing Continuity of the Circuit	39
4.1	FM Pre-Modulation Circuit	41
4.2	Circuit Diagram of Video Amplifier, Square-Wave VCO & E/O Converter	41
4.3	FM Pre-Modulation 7 MHz Multisim Circuit	43
4.4	Video Amplifier & Low Pass Filter 4.2 MHz Multisim Circuit	43
4.5	E/O Converter Multisim Circuit	44
4.6	FM Pre-Modulation Proteus 7 Professional Circuit	45
4.7	Video Amplifier Proteus 7 Professional Circuit	45
4.8	Low Pass Filter 4.2 MHz Proteus 7 Professional Circuit	46
4.9	E/O Converter (Transmitter) Proteus 7 Professional Circuit	46

LIST OF ABBREVIATIONS

AM	-	Amplitude Modulation
EMI	-	Electromagnetic Interference
FDM	-	Frequency Division Multiplexing
FM	-	Frequency Modulation
IC	-	Integrated Circuit
MUX	-	Multiplexer
NTSC	-	National Television System Committee
PAL	-	Phase Alternating Line
PM	-	Phase Modulation
SECAM	-	Sequential Color with Memory
SWFM	-	Square Wave Frequency Modulation
TDM	-	Time Division Multiplexing
WDM	-	Wavelength Division Multiplexing

LIST OF APPENDIXES

NO	TITLE	PAGE
A	List of 7400 Series ICs That Contain Schmitt Trigger	52
B	List of 7400 Series ICs That Contain Multiplexer	53
C	Circuit Layout	54
D	Data Sheet	56

CHAPTER I

INTRODUCTION

This chapter is about the project introduction, project objective, problems statement, scope of work and short methodology.

1.1 Project Introduction

The purpose of this project is to design a system for optical fibre transmission of audio and video signal. Transmission of analogue signal competes with, or even excels the performance of digital system in some cases. Besides that, analogue system is attractive because of the simplicity and lower costs.

The audio and video signal is modulate using square wave frequency modulation (SWFM) technique. The modulated signal is transmit in a safe and efficient way over an optical fibre cable as the physical medium of transmission. The performance will be monitored by using computer simulation and building the hardware.

1.2 Project Objective

The main objectives that should be achieved at the end of this project are:

(a) To design system for optical fibre transmission of audio and video signal.
(b) To modulate square wave frequency modulation (SWFM).
(c) To study performance of square wave frequency modulation (SWFM) technique for optical fibre transmission.

1.3 Problem Statement

Transmission audio and video signal using copper cable has many disadvantages. There is undesired phase shift which can distort chrome information in long transmission lines. Possibility of ground loops and reflections can be result from improper termination of coaxial distribution systems.

Signal quality degradation is usually caused by inferior electromagnetic interference (EMI) of metal wire cable lines. EMI is electromagnetic energy that causes undesirable responses, degradation, or complete system failure.

Besides that, there is problem about the transmitted signal. Sinusoidal waveform is difficult to analyze because it have value along the travel time where as signal transmission using square wave is easier to analyze because it is a periodic signal.

1.4 Scope of Work

There are several areas that being identified or considered that need to be work out:

(a) Receive audio and video signal from external source:
  (i) Audio frequency range: 10 Hz – 20 kHz
  (ii) Video frequency range: 100 Hz – 4.2 MHz

(b) Modulate signal into frequency modulation:
  (i) Audio and video signal need to modulate separately.
  (ii) Use oscillator to generate carrier frequency to modulator.

(c) Convert sine wave to square wave:
  (i) Use Voltage-Controlled Oscillator IC as converter

(d) Convert electronic into optical interface.

(e) Provide output connection to fibre optic cable.

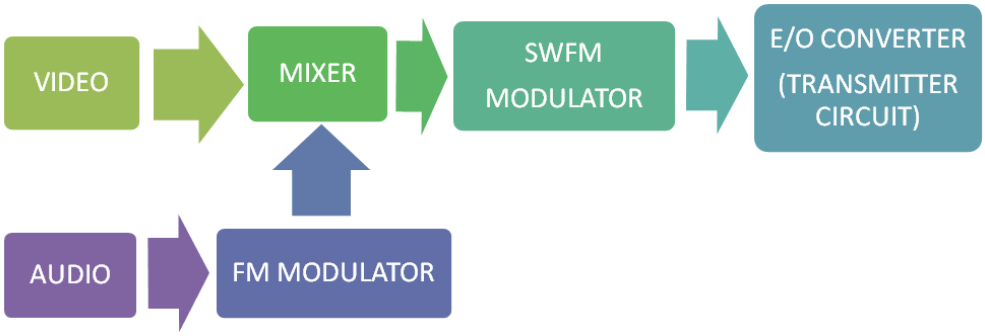

Figure 1.1 Block Diagram of Project

1.5 Methodology

There are five phases involved in order to achieve the objective of this project:

(a) Project Planning
- Identify project and discussion with supervisor
- Prepare Gantt Chart for guidelines and progress of project

(b) Literature Review
- Background studies and references
- Searching for suitable circuit

(c) Simulation
- Simulation using Multisim software

(d) Hardware Construction
- Components and parts identification
- Designing circuit boards and assembling
- Testing, analyzing and diagnose circuits

(d) Finishing
- Testing of prototype in operation, application and results.
- Presentation on outcome of project.

CHAPTER II

LITERATURE REVIEW

This chapter will review research that has been done about the project, including theory and circuits related to the project.

2.1 Basic Telecommunication System

Telecommunication is the transport of information from one place to another. The word has its roots in both Greek (tele) and Latin (communicatio) meaning distant connection. While telephony refers to telephone communications over wire or through the air (wireless), telecommunications today implies the transfer of analogue or digital, voice, video, or data signals over copper wire, wireless, or fibre-optic media.

Block diagram of telecommunication system consist transmitter, transmission medium, receiver and system noise. Transmitter is a collection of one or more electronic devices or circuits that converts the original source information to form more suitable for transmission over particular transmission medium. The transmission medium or communications channel provides transporting signals between transmitter and receiver. It can be as simple as pair of copper wires or complex as sophisticated microwave, satellite, or optical fibre communication systems. System noise is unwanted electrical signals that interfere with the information signal. Receiver is collection of electronic devices and circuits that accepts the transmitted signals from the transmission medium and converts those signals back to their original form.

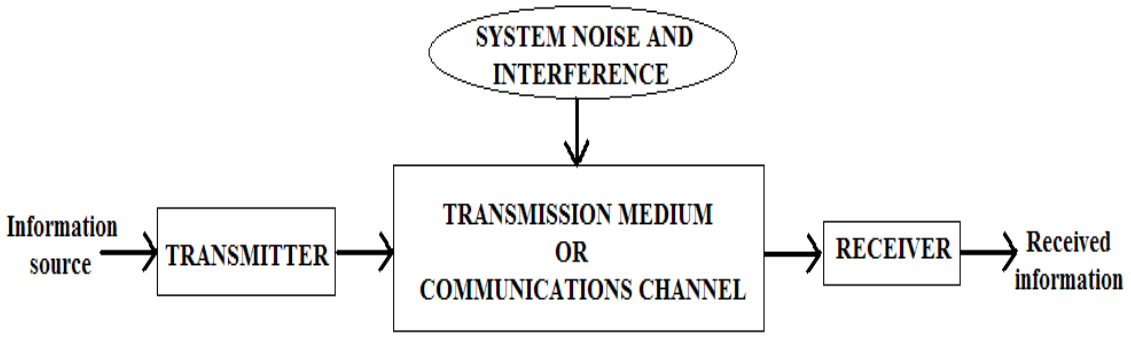

Figure 2.1 Block Diagram of Telecommunication System

2.2 Analogue and Digital Signals

An analogue signal is continuous, such as an electric voltage or current. All values between the maximum and the minimum are allowed. When a voice is converted into an electrical voltage or current, the result is an analogue electrical signal. A digital signal, on the other hand, is discrete in that only certain values are allowed. Most communications signals are now digital. This digital signal uses a binary code (one or zero) to represent discrete values of some original signal or information. The binary code can also be used to represent letters of the alphabet and numbers such as in the ASCII character code. Additional bits for error detection and correction can be added. Using digital signals, any information can be converted to digital form and transport through a communication system.

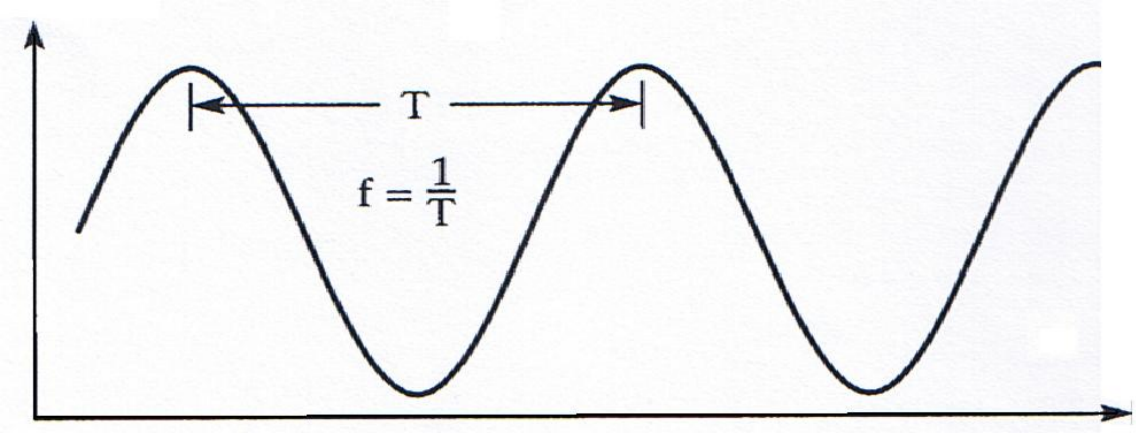

Figure 2.2 Analogue Signal

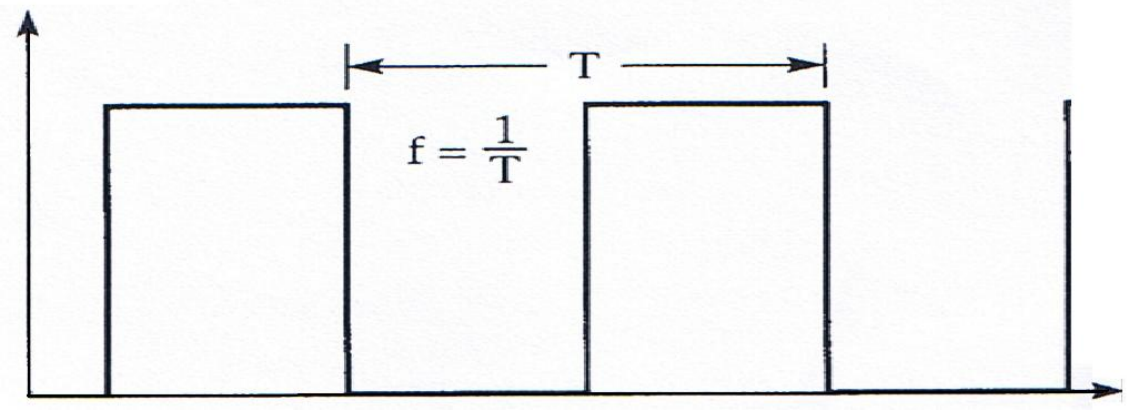

Figure 2.3 Digital Signal

2.2.1 Frequency and Bandwidth

Any time-varying periodic signal can be defined in terms of its frequency, which is the number of cycles per second or equivalently in units of Hertz (Hz). The frequency is also equal to the reciprocal of the period (T). Systems often use filters to control the frequencies to be passed. Filters can allow only lower frequencies (low-pass), higher frequencies (high-pass), or a range of intermediate frequencies (band-pass) to be transmitted. A notch filter passes all frequencies except for a small band.

Bandwidth (BW) used to describe the range of analogue frequencies passed by filter. For digital signals the bit rate is defined as the number of bits transmitted per second (bps). If one bit is sent per digital period, the digital bandwidth is equal to the data rate. Through modulation and multiplexing techniques, often more than one bit can be sent per cycle.

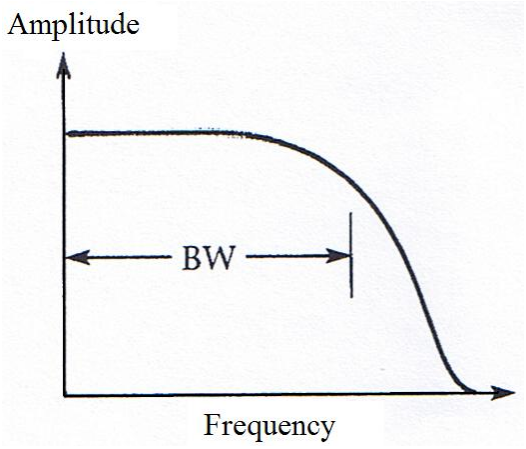

Figure 2.4 Low-Pass Filter

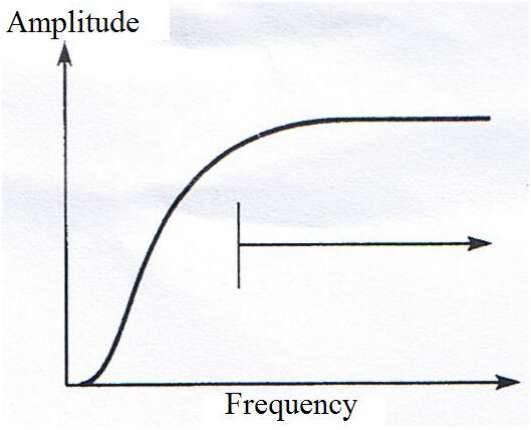

Figure 2.5 High-Pass Filter

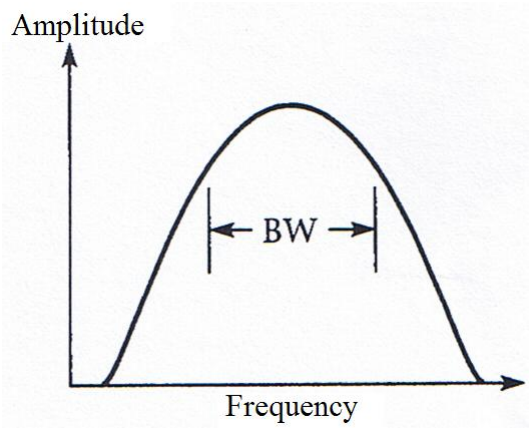

Figure 2.6 Bandpass Filter

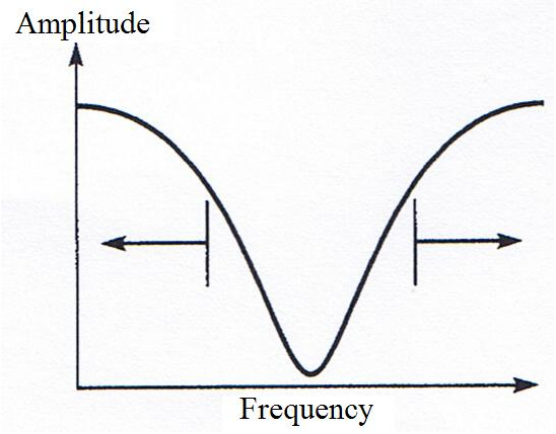

Figure 2.7 Notch Filter