

**FM RADIO BOARD FOR LABWORK OF BENG 2413**

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**Bachelor of Electrical Engineering  
(Control, Instrumentations & Automation)**

**May 2009**

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**A report submitted in partial fulfillment of the requirements for the Degree of  
Bachelor in Electrical Engineering (Control, Instrumentations & Automation)**

**Faculty of Electrical Engineering  
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*Specially dedicated to  
My beloved parents, brothers and sisters who have encouraged,  
guide and inspired me throughout my final year project and my project report.*

*Mr Hyreil Anuar Bin Kasdirin and all my friends,  
Thanks for guidance and support...*

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## **ABSTRACT**

This project is to develop the FM radio board for laboratory work of BENG 2413. This trainer board used as a Computer Based Trainer (CBT) that be used for laboratory work of FM modulation and FM demodulation for subject BENG 2413. For the hardware part in this project, the FM modulator circuit will combined with the FM demodulator circuit in one trainer board. The development of graphical user interface (GUI) will be implementing in this project by using Visual Basic. To help students more understand about the concept of FM modulation and FM demodulation, the trainer board (FM radio board) will link to the software. This software will make the FM modulation and FM demodulation is easily to study and analysis. The computer interface will be use to connect between software and hardware. The interfacing will do via serial port. The users will be able to analysis the output from this trainer with oscilloscope and speaker. From this computer based trainer, the users will enjoy and can experience also mastered in this communication subject especially FM modulation and FM demodulation topics.

## ABSTRAK

Projek ini adalah untuk membangunkan *FM radio trainer* untuk kerja amali bagi subjek BENG 2413. Alat ini berfungsi sebagai *Computer Based Trainer* (CBT) yang mana akan digunakan untuk kerja-kerja amali bagi eksperimen FM modulasi dan FM demodulasi bagi subjek BENG 2413. Untuk bahagian perkakasan dalam projek ini, litar FM modulasi akan digabungkan dengan litar FM demodulasi dalam satu *trainer*. Pembangunan antara muka pengguna grafik (GUI) akan dilaksanakan dalam projek ini dengan menggunakan perisian *Visual Basic*. Bagi membantu pelajar-pelajar lebih memahami tentang konsep FM modulasi dan FM demodulasi, *trainer* ini (*FM Radio trainer*) akan dihubungkan untuk GUI. Perisian ini akan memudahkan kajian dan analisis bagi topik FM modulasi dan FM demodulasi. Di dalam projek ini, antara muka komputer digunakan sebagai alat yang menghubungkan perisian dan perkakasan. Pengguna akan dapat menganalisis keluaran daripada alat ini dengan menggunakan osiloskop dan *speaker*. Daripada *Computer Based Trainer* ini, pengguna akan dapat memahami subjek ini dengan lebih mendalam terutama pada topik FM modulasi dan FM demodulasi.



## TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	<b>ACKNOWLEDGEMENTS</b>	v
	<b>ABSTRACT</b>	vi
	<b>TABLE CONTENTS</b>	viii
	<b>LIST OF TABLES</b>	xii
	<b>LIST OF FIGURES</b>	xiii
	<b>LIST OF APPENDIXES</b>	xv
<b>1</b>	<b>INTRODUCTION</b>	
	1.0 Project Introduction	1
	1.1 Project Objective	2
	1.2 Scope of Work	2
	1.3 Problem Statements	3
	1.4 Report Structure	3
<b>2</b>	<b>LITERATURE REVIEW</b>	
	2.0 Introduction	5
	2.1 Electronic communication Systems	6
	2.1.1 FM Modulation	6
	2.1.2 FM Demodulation	7

2.1.3	Frequency Versus Amplitude Modulation	8
2.2	FM Radio Circuit	8
2.2.1	.Single Chip FM Radio Circuit	9
2.2.2	Single Chip FM Receiver	11
2.3	Parallel Communication Interfaces	11
2.3.1	Technical Specifications Of Parallel Port Pins	12
2.4	Serial port – RS232	13
2.4.1	Integrated circuit of MAX232	15
2.5	Comparison between serial and parallel port	16
2.6	Graphical User Interface (GUI)	17
2.7	Visual Basic	18
2.7.1	Visual Basics Language Features	19
2.7.2	Example code	19
2.7.3	Comparison Between Visual Basic and Other Programming Languages	19
2.8	FM radio board trainer	20
2.8.1	Trainer Module KL-93004	21
2.8.2	ST2203 (Frequency Modulation /Demodulation Trainer)	22
2.8.3	Frequency Modulation Trainer Model COM104A-1	22
2.8.4	PLL Frequency Demodulation Trainer	
2.8.5	Model-COM104A-2	23
2.9	PIC16F877A Microcontroller microchip	24
2.10	Summary	25

### 3

## PROJECT METHODOLOGY

3.0	Introduction	26
3.1	Work Planning of the project	26
3.1.1	Literature Review	29
3.1.2	Hardware Development	29
3.1.2.1	Power Supply	31
3.1.2.2	FM Modulator	31
3.1.2.3	FM Radio Receiver	32
3.1.2.4	PIC Microcontroller Start Up Kit as interface circuit	33
3.1.3	Software Development	35
3.1.3.1	Multisim 2001	35
3.1.3.2	Visual Basic 6.0	36
3.1.3.3	Proteus 7 Professional	37
3.1.4	Interfacing Software and Hardware	39
3.1.5	Checking and Troubleshooting	39
3.1.6	Correction and Re-analysis	39
3.1.7	End of The Experiment	40
3.2	Summary	40

### 4

## RESULT AND DISCUSSION

4.0	Introduction	41
4.1	Findings	41
4.2	Result for simulation	41
4.2.1	Simulation Result for Power Supply Circuit	42
4.2.2	Simulation Result for Controller Circuit	43
4.3	Result for Hardware	44
4.3.1	Power Supply Circuit (+5V)	45
4.3.2	Power Supply Circuit (-5V)	46

4.3.3	FM Radio circuit	47
4.3.4	FM modulation circuit	48
4.4	Result for Software	49
4.5	Experiment Result and Analysis	50
4.5.1	Experiment of FM modulation	51
4.6	Problem Encountered and Troubleshooting	52
4.7	Discussion	53
4.8	Summary	55

## **5**

### **CONCLUSION**

5.0	Introduction	54
5.1	Conclusion	54
5.2	Recommendation	55

<b>REFERENCES</b>	<b>56</b>
-------------------	-----------

<b>APPENDICES</b>	<b>58</b>
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## LIST OF TABLES

<b>NO</b>	<b>TITLE</b>	<b>PAGE</b>
2.0	Function of each connection at parallel port	13
2.1	Commonly-used RS-232 signals and pin assignments	14
2.2	Functions of DB9 Serial Port	15
2.3	Comparison between visual basic and other programming languages	20

## LIST OF FIGURES

NO	TITLE	PAGE
2.0	Simplified block diagram of an electronic Communication system	6
2.1	Unmodulated signal	7
2.2	Modulating signal	7
2.3	Frequency Modulation signal	7
2.4	FM demodulation	8
2.5	Block diagram of FM radio	9
2.6	Circuit Diagram of single chip FM radio circuit	10
2.7	Circuit Diagram of Single Chip FM Receiver	11
2.8	A parallel port	12
2.9	DB9 serial Port pinout	14
2.10	Pin configurations and internal circuitry of MAX232	16
2.11	Modern graphical user interface	17
2.12	Microsoft Visual Basic front page	18
2.13(a)	FM trainer Module KL-93004	21
2.13(b)	Module KL-92001 (Audio Generator)	21
2.14	Radio Trainer Module ST2203	22
2.15	Frequency Modulation Trainer	23
2.16	PLL Frequency Demodulation Trainer Model-COM104A-2	24
2.17	PIC16F877A	24
2.18	Pin configurations for PIC16F877A	25
3.0	The flow chart methodology for overall of the project	27
3.1	Block diagram of the overall hardware development	29

3.2	The flow chart methodology of project development	30
3.3	+5V power supply	31
3.4	Block diagram of FM Modulator	32
3.5	FM Modulator circuit	32
3.6	Block Diagram of FM Radio Receiver	33
3.7	FM Radio circuit	33
3.8	Block Diagram of PIC Microcontroller Start up Kit	34
3.9	PIC Microcontroller Start up Kit circuit	35
3.10	Multisim User Interface	36
3.11	Microsoft Visual Basic front page	37
3.12	Proteus main screen	38
3.13	Libraries Manager	38
3.14	PCB layout	39
4.0	Power Supply circuit	41
4.1	Output Voltage	42
4.2	Output Waveform	42
4.3	Controller circuit	43
4.4(a)	Controller circuit simulation (motor rotate clock wise)	43
4.4(b)	Controller circuit simulation (motor rotate counter clock wise)	44
4.5	IC LM7805	45
4.6	+5V Power supply circuit (hardware)	45
4.7	-5VDC Power Supply (hardware)	46
4.8	FM radio circuit	46
4.9	FM radio circuit (hardware)	47
4.10	FM modulation circuit	47
4.11	FM modulation circuit (hardware)	48
4.12	Graphical User Interface ( GUI )	49
4.13	Output Frequency of 50KHz	50
4.14	1KHz audio input	50
4.15	Output waveform	51

## LIST OF APPENDIXES

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
A	AM/FM Test Source	58
B	ST2501 Elementary Fiber Optics Trainer	59
C	LM386	61
D	TDA7000	63
E	LM566	65



# CHAPTER 1

## INTRODUCTION

### 1.0 Project Introduction

This project is to develop a FM radio board that can be used as equipment for helping in the communication subject for laboratory work of BENG 2413 at Faculty of Electrical Engineering ( FKE ), UTeM as a Computer Based Trainer (CBT). In this project, it will focus on development the suitable circuit for FM modulation and FM demodulation and also development of Grafical User Interface (GUI)

Frequency modulation (FM) is the method of varying a carry wave's frequency proportionally to the frequency of the other signal. The overall, this trainer module should be miniature to enable portability. Frequency modulation (FM) has several advantages compare to the amplitude modulation (AM), the most important of these advantages is that Frequency modulation (FM) has a greater freedom from interference and static and the FM demodulation is not sensitive to such disturbances when it is tuned to an FM signal of sufficient strength. Also, the signal-to-noise ratio in an FM system is much higher than that of an AM system.

There are 3 main parts involve in this project which are hardware part, software part and interfacing part. The hardware part is divided to 2 part, FM Modulation and FM Radio circuit (Demodulation circuit). Software part focuses on design Graphical User Interface, meanwhile interfacing part focuses on interfacing between GUI and hardware by using serial port RS 232 and serial driver MAX 232.

## 1.1 Project Objectives

To realize this project, the project objectives have been completed in the duration time given. The project is aimed to meet the following objectives:

- i. To develop the FM radio board as a Computer Based Trainer for laboratory work of BENG 2413.
- ii. To design graphical user interface (GUI) using Visual Basic software.
- iii. To link between trainer board (FM radio board) with the computer using serial port.
- iv. To learn, understand and gain new knowledge about FM modulation and FM demodulation.

## 1.2 Scope of Work

This project will focus on the design and development of a FM modulation and FM demodulation circuit and graphical user interface (GUI) to connect a trainer to a single personal computer. In this project, limitation task have been made that we call scope of work. This project consists of 2 parts which a software part and hardware part. The scope of this project were :

- i. Literature study on FM modulation and FM demodulation theory.
- ii. The FM radio board trainer will be built as a hardware part.
- iii. Design the Graphical User Interface using Visual Basic programming as a software part. From this GUI, student can control the volume of speaker and also can turn on and off the switch button.
- iv. A serial port will be used as the connection between the trainer and the computer.

### **1.3 Problem Statement**

This project is develop to overcome some problems :

- i. FKE don't have their own FM radio trainer that used for laboratory work of BENG 2413. This project is developed to make FKE have their own trainer board for laboratory work of BENG 2413 which link to the graphical user interface (GUI).
- ii. The current board trainer that used now is more heavy and larger. After finish this project, the trainer board that produced is smaller than the current trainer board.
- iii. The current trainer not have speaker, meanwhile this trainer has a speaker. At the output of this trainer, student can observed the output waveform by oscilloscope and also can listen from the speaker.

### **1.4 Report Structure**

In this report, it consist of 5 chapters namely Introduction, Literature Review, Project Methodology, Project Result and Analysis and Conclusion.

- i. Introduction explained about the important communication system. It also explained about the project scope that will guide throughout this project development.
- ii. Literature Review described about FM modulation and demodulation. These theories helped as guidelines and gave a brief idea about what should have and get in this project.
- iii. Project Methodology defined the method that being used in developing the FM radio trainer project. This method helped to organize time and work so that the project runs as planned.

- iv. Project Results showed the results that have been achieved throughout the project development. It also includes the analyses that have been done in this project.
- v. Conclusions discussed about future development, suggestions and improvement that can be added to the project in the future.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.0 Introduction

In this project, FM radio trainer develops to easier student studying FM modulation and demodulation process through the practical work. It is important to have strong knowledge about communication system and fundamental concept to make this project is easier to develop. In this chapter, some literature review of communication system, fundamental concept and current trainer are discussed.

#### 2.1 Electronic communication systems

In communication system, there are more part consist in order to transmit and receive the signal. The part includes a transmitter, a transmission medium, a receiver, and system noise. A transmitter is a collection of one or more electronics devices or circuit that convert the original source information to a form more suitable for transmission over a particular transmission medium. The transmission medium provides a means of transporting signals between a transmitter and a receiver. System noise is any unwanted electrical signals that interface with the information. *Receiver is the sub-system that takes in the transmitted signal from the channel and processes it to retrieve the information signal.* Modulation is performed in a transmitter by a circuit called a modulator. Demodulation is performed in a receiver by a circuit called a demodulator. Demodulation is performed in a receiver by a circuit called a demodulator. Radiotelephony, broadcasting, point-to-point, mobile communications, computer communications, radar and satellite systems are

examples of electronic communication mechanism.[1]. Figure 2.0 shows a simplified block diagram of an electronic communication system.

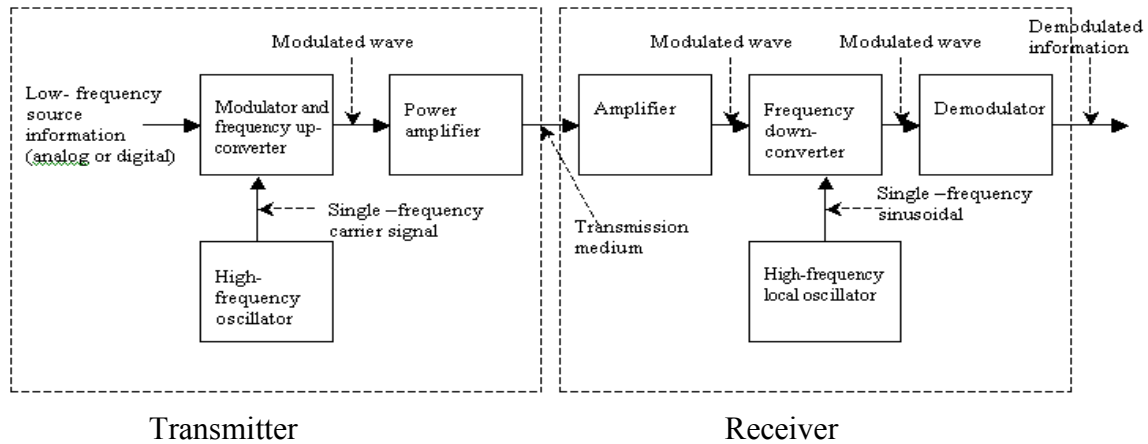


Figure 2.0 : Simplified block diagram of an electronic communication system [1].

### 2.1.1 FM modulation

In [telecommunications](#) technologies, frequency modulation (FM) conveys [information](#) over a [carrier wave](#) by varying its [frequency](#). This frequency modulation (FM) is contrast with [amplitude modulation](#) (AM), in which the [amplitude](#) of the carrier is varied while its frequency remains constant. The instantaneous frequency of the carrier is directly proportional to the instantaneous value of the input signal in [analog](#) applications. FM signal does not have an envelope, therefore the FM receiver does not have to respond to amplitude variations, it can ignore noise to some extent[1][2]. The figure 2.1 , 2.2 and 2.3 below show demonstrates this concept.

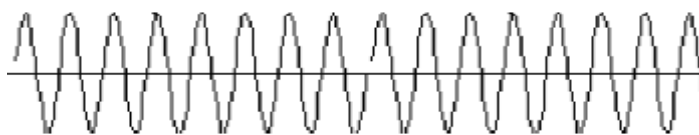


Figure 2.1 : Unmodulated signal [1]

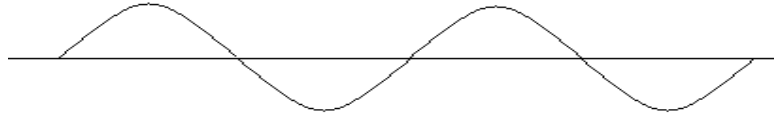


Figure 2.2 : Modulating signal [1]

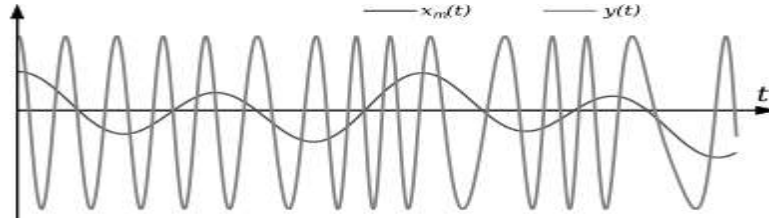


Figure 2.3 : Frequency modulation signal [1]

### 2.1.2 FM Demodulation

FM demodulation is the reverse process of FM modulation, which instantaneous frequency variations are converted to linear changes. Frequency demodulator, also called frequency discrimination is an [electronic circuit](#) used to recover the information content from the [carrier wave](#) of a signal. The term is traditionally used in connection with [radio receivers](#), but many other systems use many kinds of demodulators. There are many types of circuit for demodulated the signal such as phase-shift discriminators, FM to AM conversion and phase-locked loop (PLL) frequency demodulator [1][3]. The concept of demodulation is shown in figure 2.4 below.

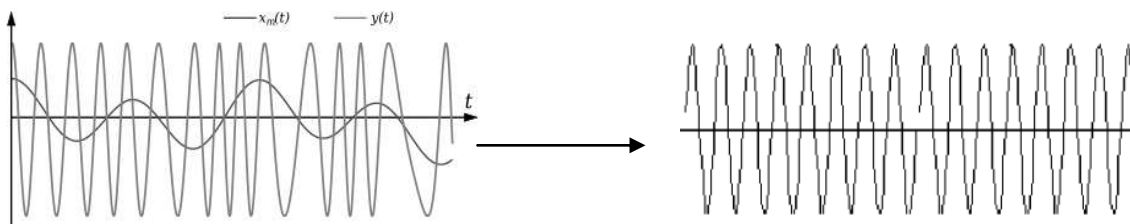


Figure 2.4 : FM demodulation [1]

### **2.1.3 Frequency versus Amplitude modulation**

Frequency modulation (FM) is used in microwave radio systems rather than amplitude modulation (AM) because AM signals are more sensitive to amplitude nonlinearities inherent in wideband microwave amplifiers. FM signals are relatively insensitive to this type of nonlinear distortion and can be transmitted through amplifiers that have compression or amplitude nonlinearity with little penalty. In addition, FM signals are less sensitive to random noise and can be propagated with lower transmit powers. At the same time, the FM is better transmitter efficiency compared to AM. Meanwhile, the FM also has disadvantages. The disadvantages of FM are excessive use of spectrum and more complex and costly circuits.[1]

## **2.2 FM radio circuit**

For this project, FM radio circuit is used to develop the FM modulation circuit. There are many circuits to develop the FM radio. FM radio or receiver consists of some parts, which are RF Amplifier, Mixer/Oscillator, Filter, IF Amplifier, Limiter, Frequency Demodulator and AF Amplifier. RF Amplifier is used to provide amplification for the signal as soon as it arrives from the antenna. At the same time, it also functions to select and amplify the desired station from the many stations. Mixer/Oscillator is used to translate the frequency of the incoming signal to the intermediate frequency, meanwhile filter is used to keep out unwanted noise and unwanted signals. IF Amplifier is used to fix the signal, the frequency demodulator functions to recover the audio signal and discard the radio frequency carrier and an audio frequency amplifier is used to amplify the audio signal and pass it on to a speaker for the listener to enjoy. Figure 2.5 below shows the block diagram of the FM radio.