DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,
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Rajshahi University of Engineering & Technology, Bangladesh

EEE - 3218– Communication Engineering II Sessional

Sessional Report

Student Lab Report

Submitted by

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Experiment no. 01

1.1 Experiment Name

To get familiar with the equipment's of communication lab

1.2 Objectives

- To get acquainted with the operation of the AM and FM Transmitter and Receiver Kit
- To get familiar with line code encoder and decoder, and their kit functions
- To become accustomed with the modulation and demodulation circuitry, such as ADM, ASK, PSK, PWM, PCM, DM, FSK modulator and demodulator, and their kit functions

1.3 Theory

The process of encoding information in a signal is referred to as modulation. Similarly, the process of retrieving information from a transmitted signal is referred to as demodulation. Modulation and demodulation are critical in the telecommunications industry.

In the telecommunications system, many modulations, demodulations, and transmission devices or apparatuses were developed. Among these, the following were introduced in this experiment as a learning process.

1.3.1 Amplitude modulation (AM) transmitter & demodulation (ADM) receiver

Amplitude modulation (AM) transmitter is defined as a technique used in electrical communication to transfer messages via a radio wave. The wave's amplitude varies in proportion to the message signal, such as an audio signal. The practical application includes portable two-way radios, citizen band radio, VHF aviation radio, and computer modems.

Amplitude demodulation (ADM) receiver, on the other hand is used for opposite of an AM transmitter. ADM is the process by which the original information bearing modulation signal, is extracted from the overall received incoming signal.

Demodulation of amplitude modulated signals can be accomplished in a variety of ways, each with its own set of advantages.

Amplitude demodulation receiver can be found in broadcast receivers, professional radio communication equipment, and walkie talkies—AM is still utilized for air-band radio communications.

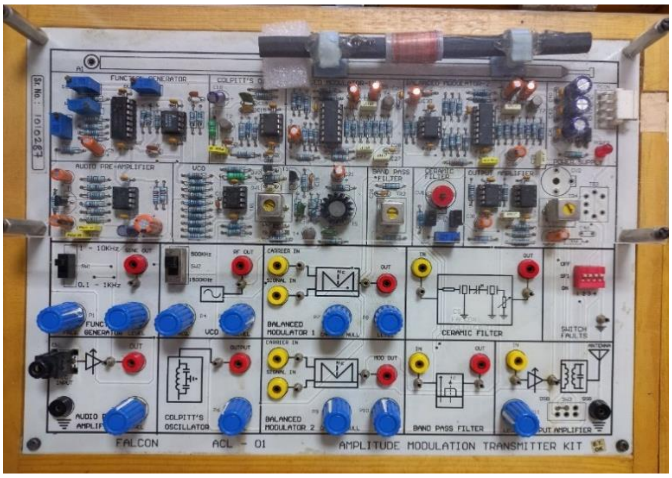

Fig.1.1: Amplitude modulation transmitter kit

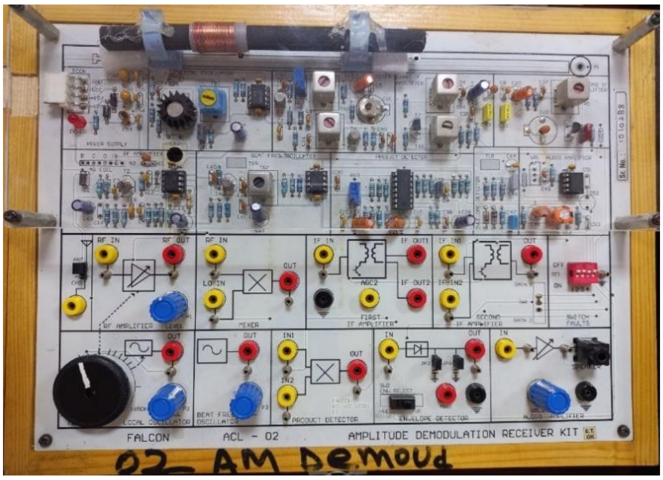

Fig.1.2: Amplitude demodulation receiver kit

1.3.2 Frequency modulation (FM) transmitter & demodulation (FDM) receiver

Frequency modulation is defined as the process of encoding information in a carrier wave by altering the wave's instantaneous frequency. The difference between the carrier frequency and its center frequency, has a functional relationship to the modulating signal amplitude in analog frequency modulation, such as radio broadcasting of an audio signal representing voice or music.

A frequency modulation transmitter is a very high frequency (VHF) Colpitts oscillator capable of transmitting sound to standard FDM receiver.

FM demodulation is a critical step in receiving a frequency modulated transmission. After the signal has been received, filtered, and amplified, the original modulation from the carrier must be recovered.

Telecommunications, radio transmission, signal processing, and computers all employ the technology.

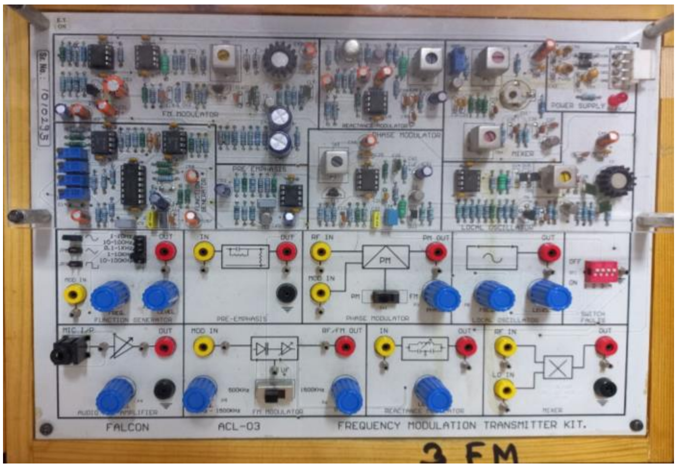

Fig.1.3: Frequency modulation transmitter kit

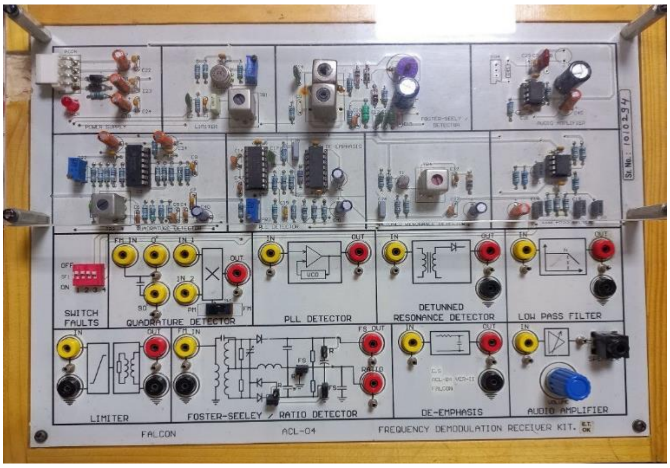

Fig.1.4: Frequency demodulation receiver kit

1.3.3 Line code encoder & decoder

The line code encoder provides as an interface between the transmitter's TTL level signals and those of the analog channel. Similarly, the line code decoder acts as a bridge between the channel's analog signals and the TTL level signals required by the digital receiver.

1.3.4 PWM modulator & demodulator

PWM, or pulse width modulation, is a modulation process or technique used in most communication systems to encode the amplitude of one signal (the carrier signal) into the pulse width or length of another signal (the source signal).

It is really used to adjust the amplitude of digital signals in order to control power or electricity-requiring equipment and applications. Demodulating PWM requires converting it to pulse amplitude modulation (PAM) and passing it through a low pass filter.

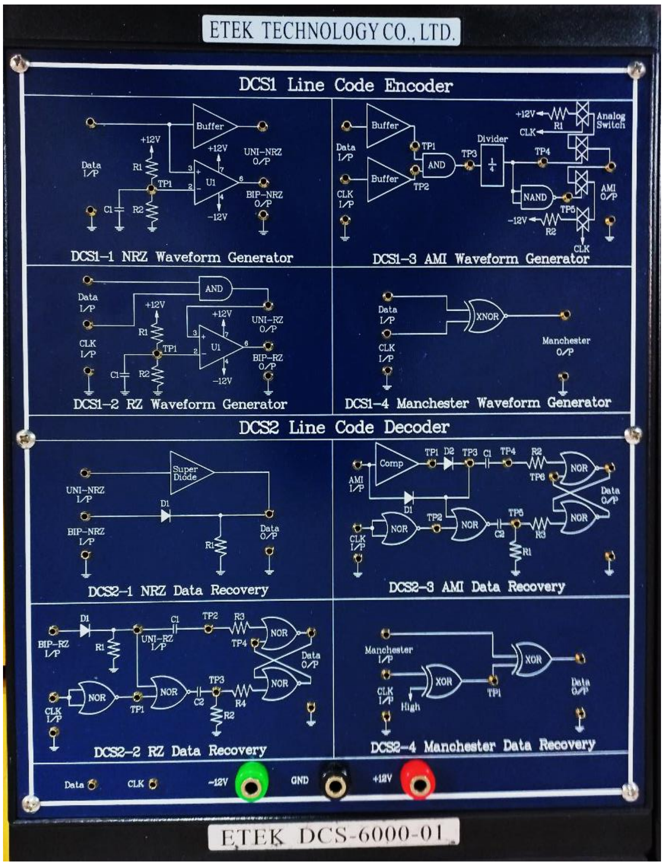

Fig.1.5: Line code encoder & decoder kit

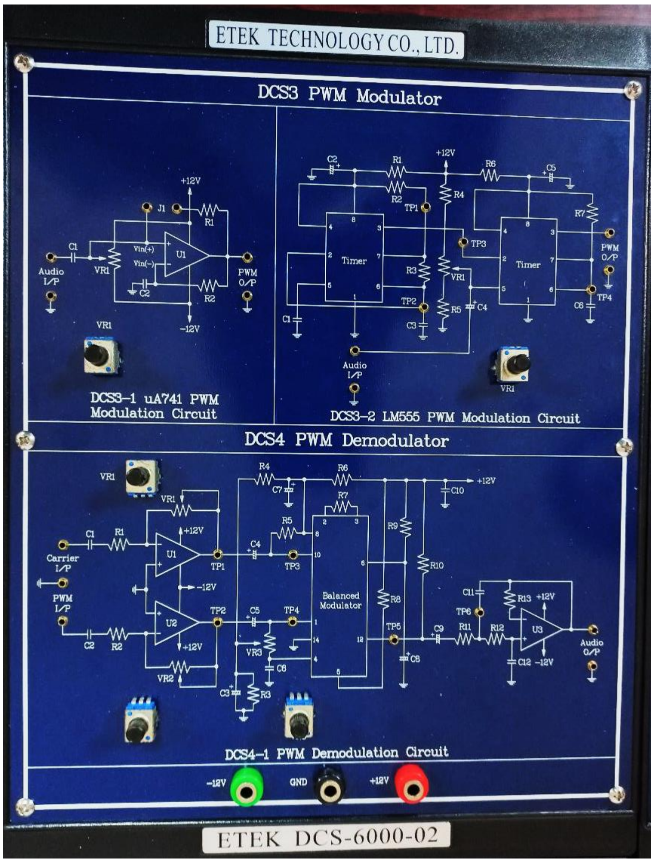

Fig.1.6: PWM modulator & demodulator kit

1.3.5 PCM modulator & demodulator

PCM stands for Pulse Code Modulation. To study pulse modulation and demodulation, a pulse code modulator and demodulator kit is utilized.

Pulse code modulation is a technique for converting an analog signal into a digital signal. Because PCM is binary, there are only two conceivable states: high and low (0 and 1).

Demodulation can also be used to recover our analog signal.

1.3.6 DM modulator & demodulator

Delta modulation is abbreviated as DM. Delta modulation is mostly used for data transport and is an analog-to-digital and digital-to-analog signal conversion technique. A delta modulation system's transmitter circuit consists of a modulator, channel, and demodulator.

There is a Ts delay in the integrator circuit. The output of the integrator is a Ts-delayed staircase approximation.

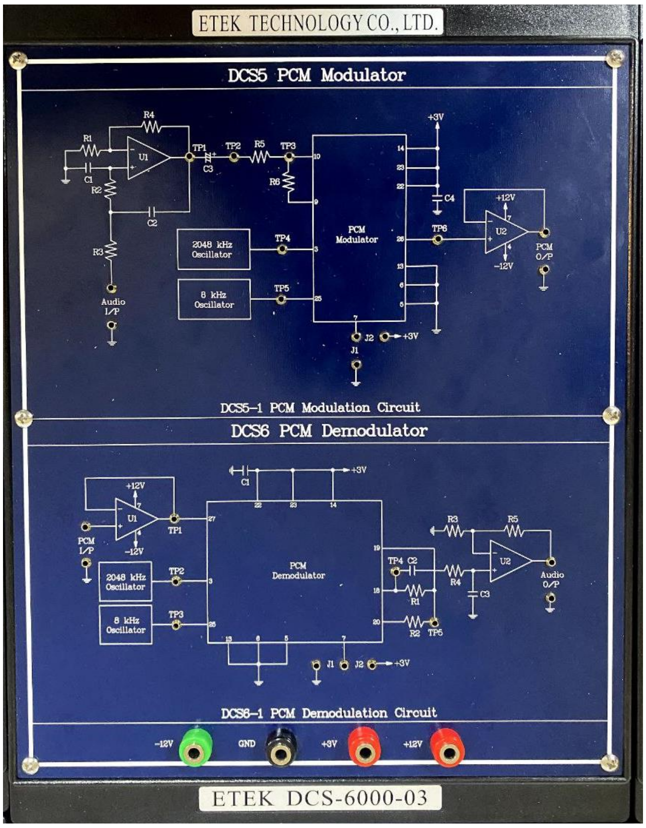

Fig.1.7: PCM modulator & demodulator kit

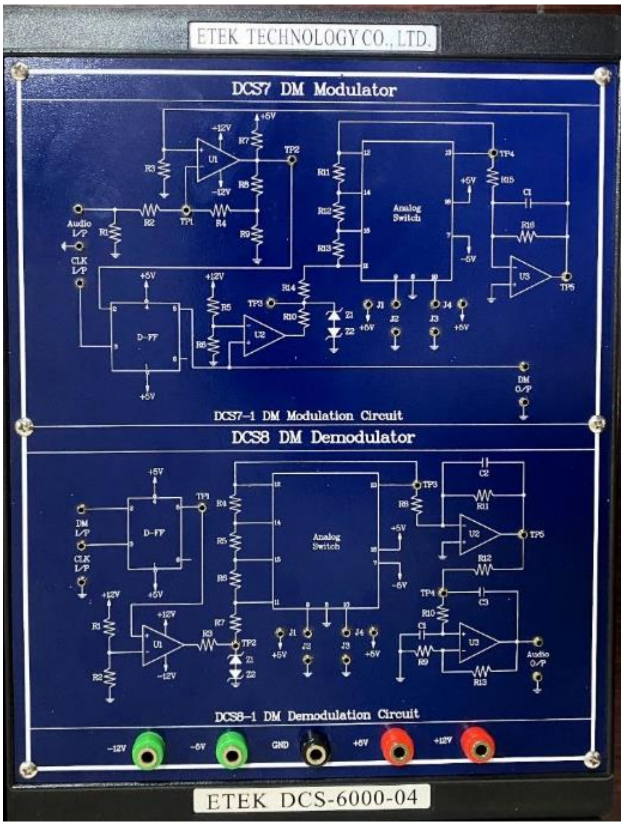

Fig.1.8: DM modulator & demodulator kit

1.3.7 ADM modulator & demodulator

ADM stands for Adaptive Delta Modulation.

This is an example of delta modulation in which the step size is not fixed. Rather, when several consecutive bits have the same direction value, the encoder and decoder assume that slope overload is occurring, and the step size becomes progressively larger.

1.3.8 ASK modulator & demodulator

ASK is a type of amplitude modulation in which digital data is represented as fluctuations in the amplitude of a carrier wave.

A symbol representing one or more bits is delivered in an ASK system by delivering a fixed-amplitude carrier wave at a given frequency for a specific time length.

For example, if each symbol represents a single bit, the carrier signal could be carried at full amplitude when the input value is 1, but at decreased amplitude or not at all when it is 0.

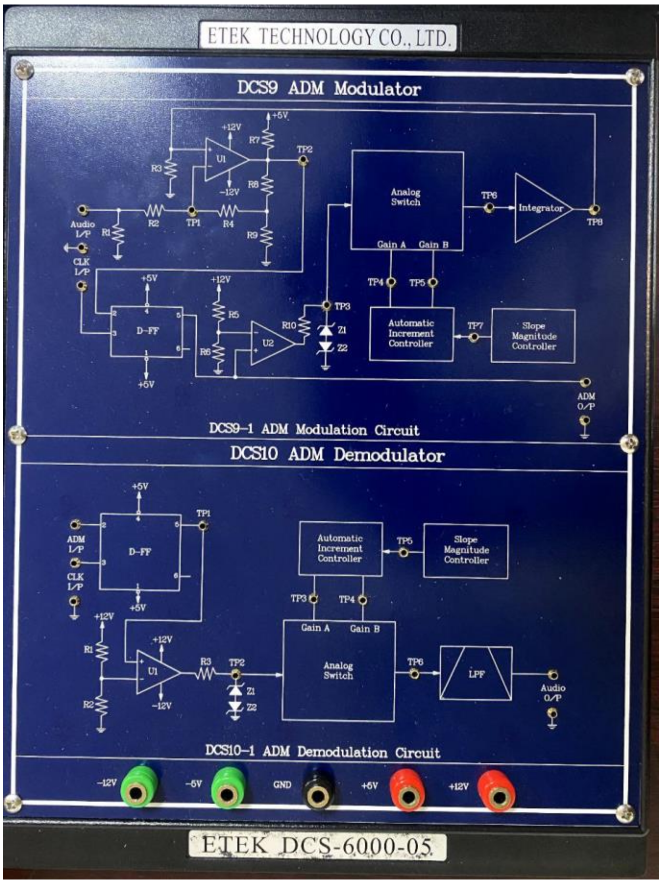

Fig.1.9: ADM modulator & demodulator kit

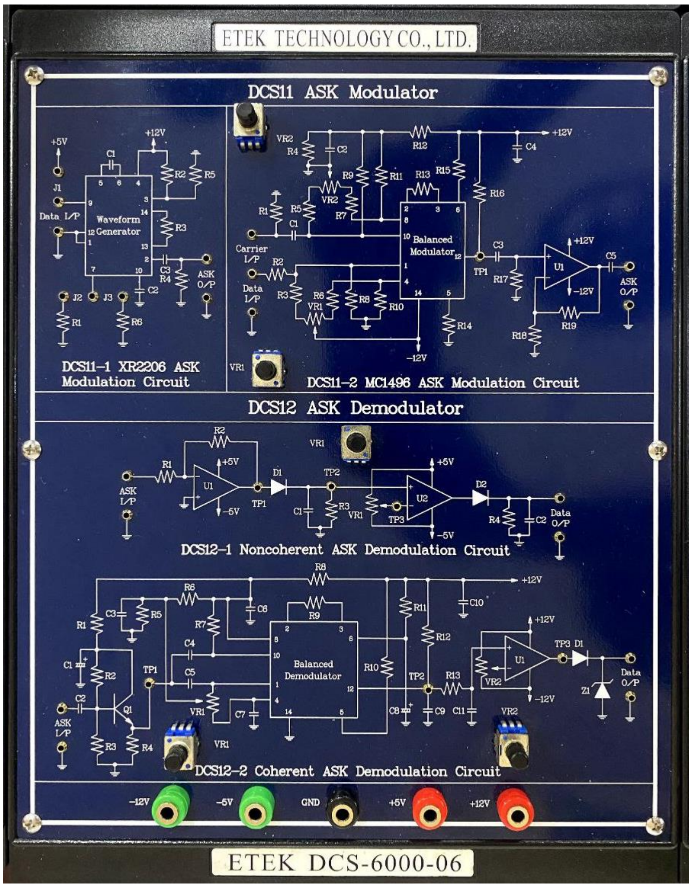

Fig.1.10: ASK modulator & demodulator kit

1.3.9 FSK modulator & demodulator

Frequency-shift keying (FSK) is a frequency modulation method that transmits digital information via discrete frequency shifts in a carrier signal.

Binary FSK is the most basic type of FSK (BFSK). To transmit binary data, BFSK employs a pair of discrete frequencies (0s and 1s).

For example, Telemetry, weather balloon radiosondes, caller ID, garage door openers, and low frequency radio transmission in the VLF and ELF.

1.3.10 PSK modulator & demodulator

Phase-shift keying is a type of digital modulation that transmits data by varying the phase of a constant frequency reference signal (the carrier wave).

Modulation is achieved by altering the sine and cosine inputs at specific times. It's common in wireless LANs, RFID, and Bluetooth communication.

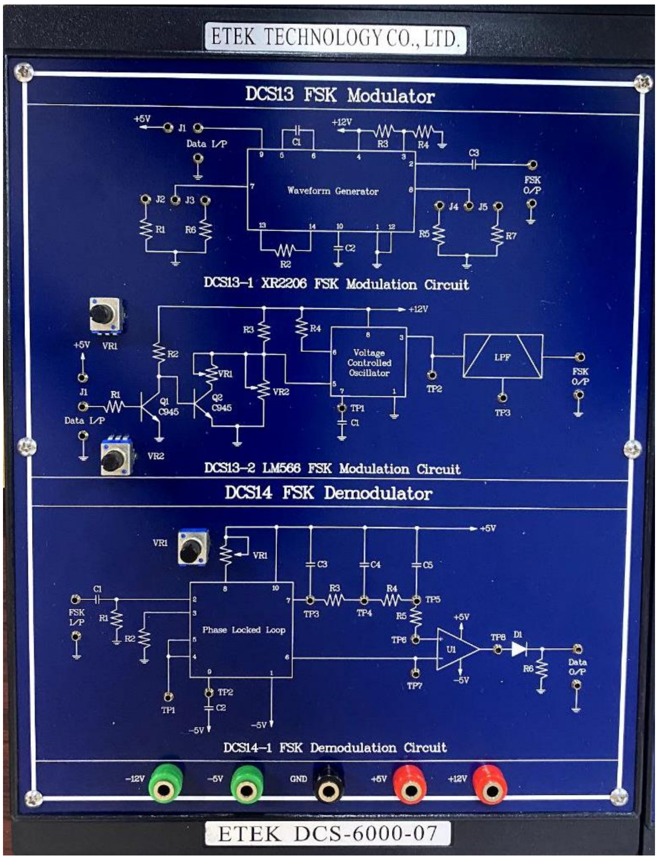

Fig.1.11: FSK modulator & demodulator kit

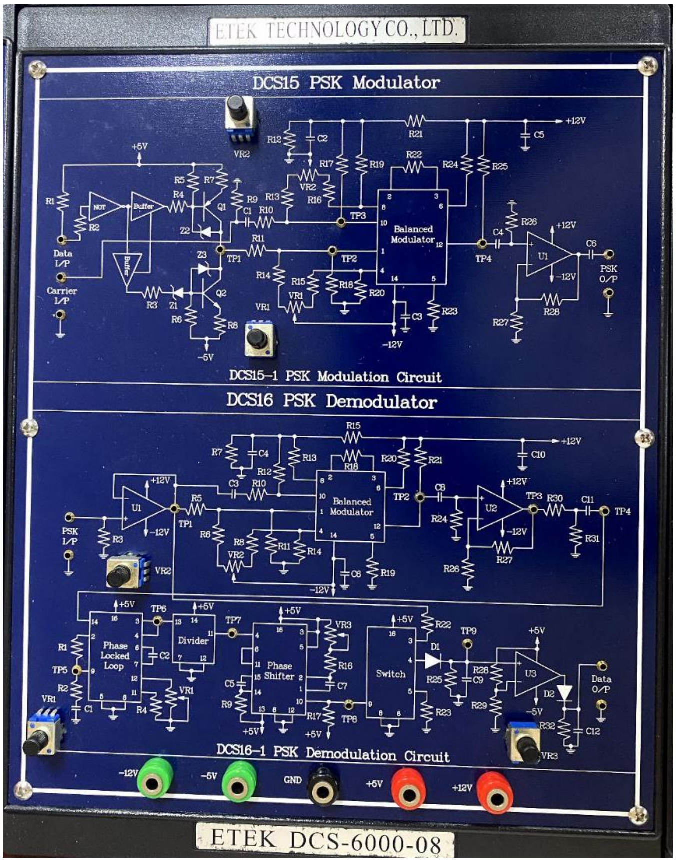

Fig.1.12: PSK modulator & demodulator kit

1.4 Apparatus

- Line code encoder & decoder
- PWM modulator & demodulator
- PCM modulator & demodulator
- PSK modulator & demodulator
- ASK modulator & demodulator
- DM modulator & demodulator
- FSK modulator & demodulator
- AM transmitter & receiver
- FM transmitter & receiver

1.5 Discussion & Conclusion

In this experiment, the functions and purposes of many types of communication laboratory kits were briefly reviewed. Their operation and working principle were also learnt and discussed. Through this experiment, interconnection of these kits was also discussed for better understanding. Thus, the main objective of this experiment was achieved.

1.6 Reference

- Book:
  Electronic Communication System- George Kennedy
- Links:
  https://byjus.com/physics/pulse-width-modulation/
  https://www.tutorialspoint.com/digital_communication/digital_com

Experiment no. 02

2.1 Experiment Name

Experimental study of amplitude modulation and demodulation

2.2 Objectives

- To combine message and carrier frequencies, send the signal, receive the same signal, and separate the message signal
- To get acquainted with Amplitude modulation and demodulation techniques
- To carry out amplitude modulation and demodulation functions for under, perfect, and over modulation conditions

2.3 Theory

Amplitude modulation, or AM for short, is one of the oldest modulation technologies used in radio transmission. Amplitude modulation is a modulation technique utilized in many areas of communication engineering, most notably in the transmission of messages over radio waves.

A message transmission may contain an audio signal or a speech signal. In amplitude modulation, the modulating voltage, whose frequency is typically lower than that of the carrier, changes the amplitude of a carrier signal. The modulation index is the ratio of the magnitude of the message voltage to the magnitude of the carrier voltage. The types of AM are:

- Double sideband-suppressed carrier modulation (DSB-SC)
- Single Sideband Modulation (SSB)
- Vestigial Sideband Modulation (VSB)

Let the modulating voltage & carrier voltage v_m, v_c and, respectively, be represented by

$$v_c = V_C \sin(w_c t)$$

$$v_m = V_m \sin(w_m t)$$

The modulation index is,

$$m = \frac{V_m}{V_C}$$

The modulation index is a number lying between 0 and 1, and it is very often expressed as a percentage and called the percentage modulation. Our purpose is to get 100% modulation i.e., when m=1 The amplitude of the modulated voltage is,

$$A = V_C + v_m = V_C + V_m \sin(w_m t) = V_C\,(1 + m\sin(w_m t))$$

Thus, the instantaneous voltage of the resulting amplitude-modulated wave is,

$$v = V_c \sin(w_m t) + (mVc/2)\cos(w_c - w_m)\,t - (mVc/2)\cos(w_c + w_m)\,t$$

2.4 Apparatus

- Oscilloscope (Model: GWINSTEK GOS 6112, 100MHz)
- Amplitude Modulation Transmitter Kit (FALCON ACL 01)
- Amplitude Modulation Receiver Kit (FALCON ACL 02)

- Jumper Wires

2.5 Block Diagram & Kit

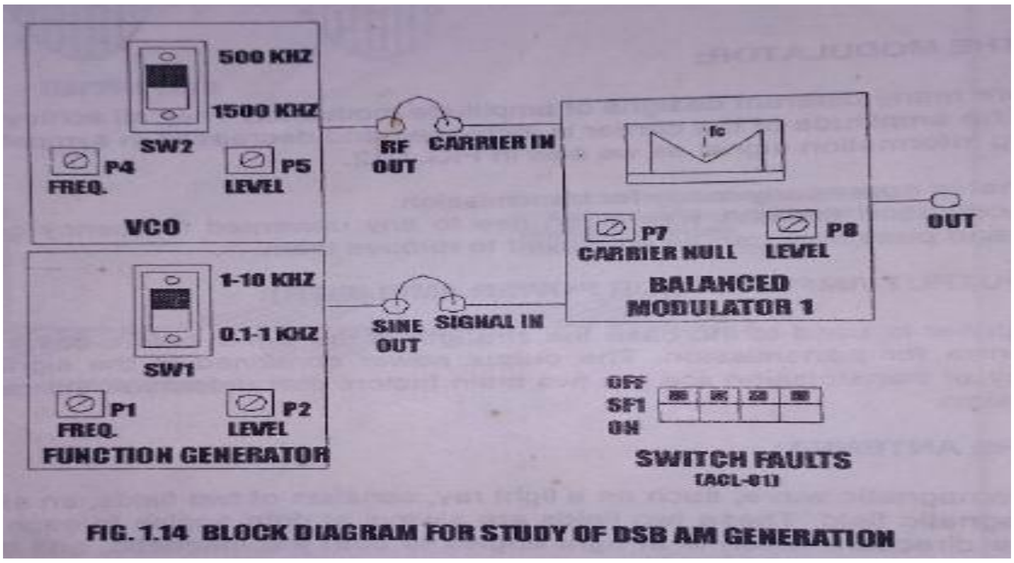

Fig.02.1: Block diagram for amplitude modulation

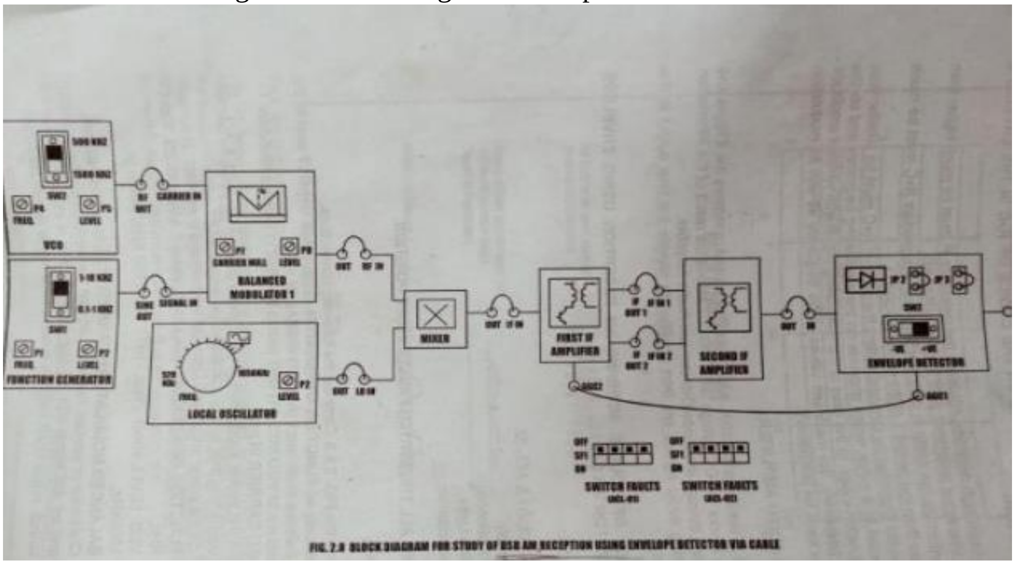
Fig.02.2: Block diagram for amplitude demodulation

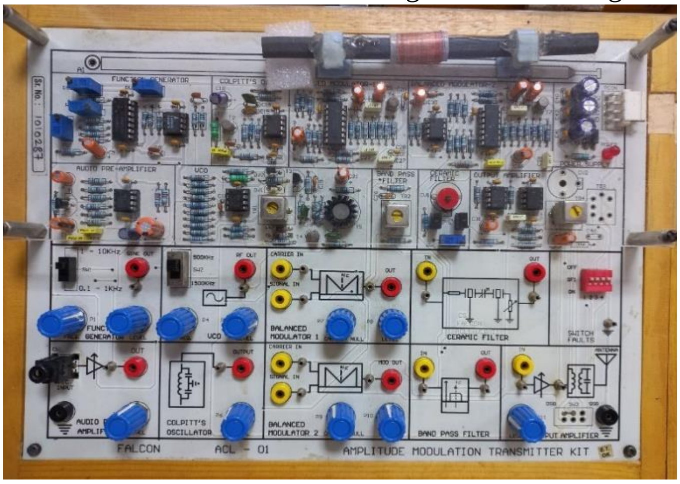
Fig.02.3: Amplitude modulation transmitter kit

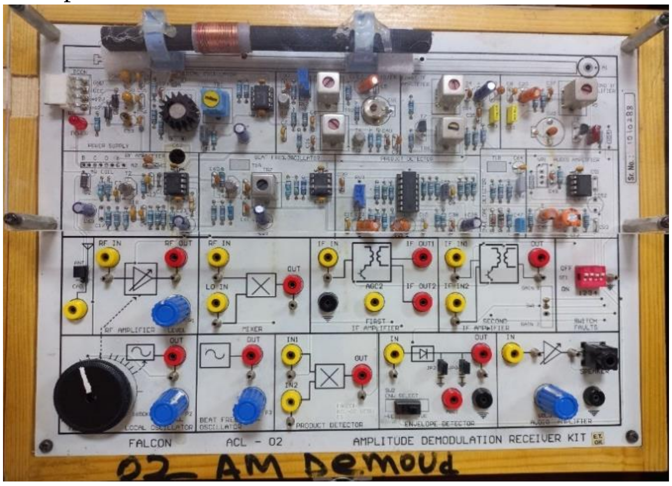
Fig.02.4: Amplitude demodulation receiver kit

Fig.02.5: Experimental Setup of Amplitude modulation and demodulation Experiment

2.6 Waveforms

- **Message Signal Waveform**

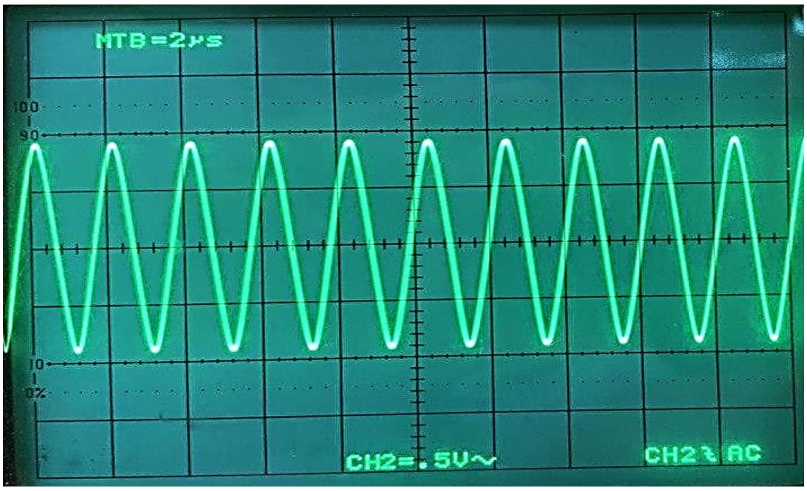

Fig.02.6: Message signal waveform

- **Carrier Signal Waveform**

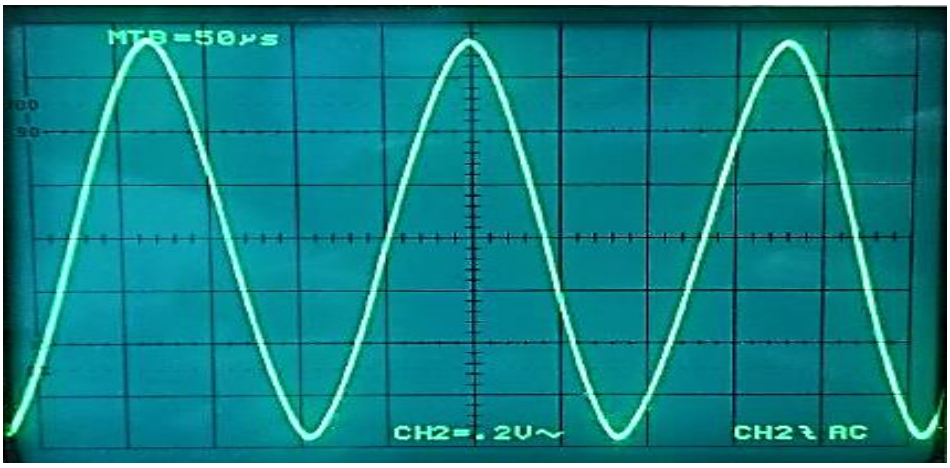

Fig.02.7: Carrier signal waveform

- **Modulated Signal Waveform**

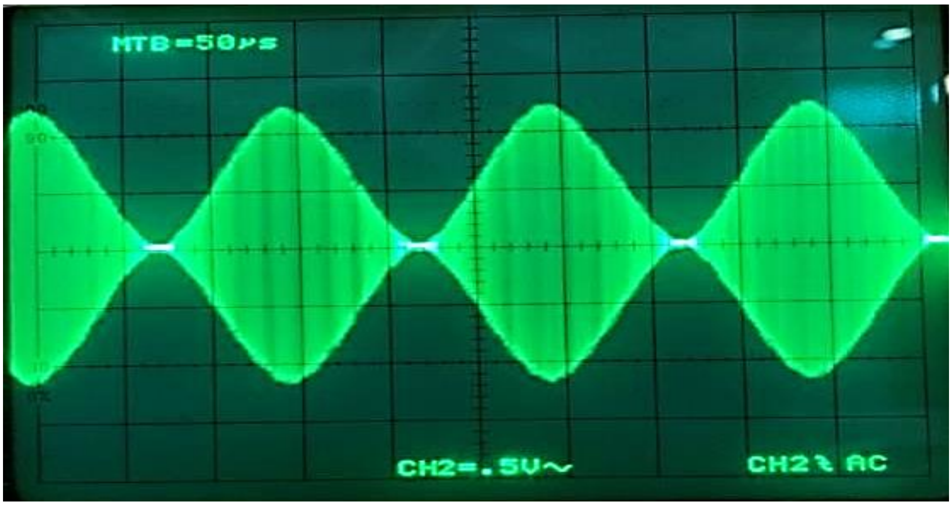

Fig.02.8: Perfectly modulated signal waveform **(m=1)**

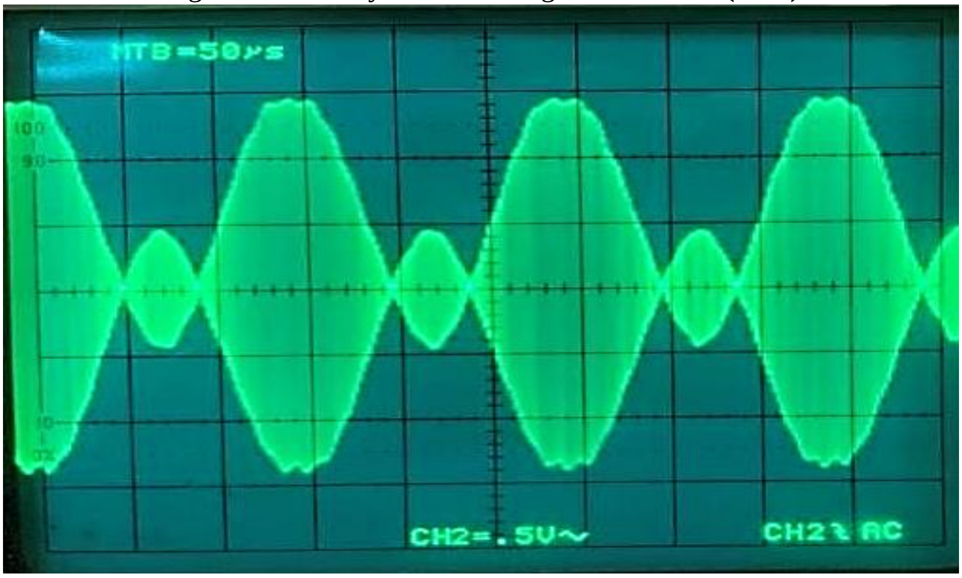

Fig.02.9: Over modulated signal waveform **(m>1)**

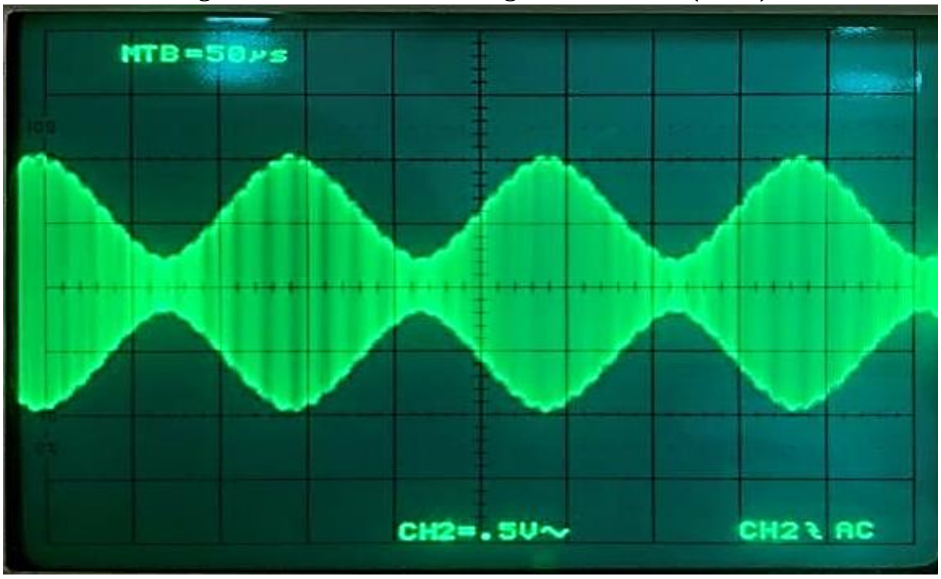

Fig.02.10: Under modulated signal waveform **(m<1)**

2.7 MATLAB code

```
clc;%Clears previous data from command window
clear all; %Removes all variables from the current workspace
m = input('Modulation Index = '); %Modulation index range in from 0 to 1
Am = 5; %Amplitude of the modulating signal
f = 2000; %Frequency
T = 1/f; %Time period of modulating signal
t = 0: T: .2;
fa = 20; %message frequency
ym = Am*sin(2*pi*fa*t);
%ploting modulating signal
subplot(3,1,1)
plot(t,ym)
title('Modulating signal')

%carrier signal
Ac = Am/m; %Carrier Amplitude
fc = fa*10; %Carrier frequency
Tc = 1/fc; %Time period of carrier signal
yc = Ac*sin(2*pi*fc*t);
%ploting carrier signal
subplot(3,1,2)
plot(t,yc)
title('Carrier Signal');

%AM modulation
y = Ac+(1+m*sin(2*pi*fa*t)).*sin(2*pi*fc*t);
%ploting amplitude modulated signal
subplot(3,1,3)
plot(t,y)
title('Amplitude Modulated Signal')
```

2.8 MATLAB output waveform

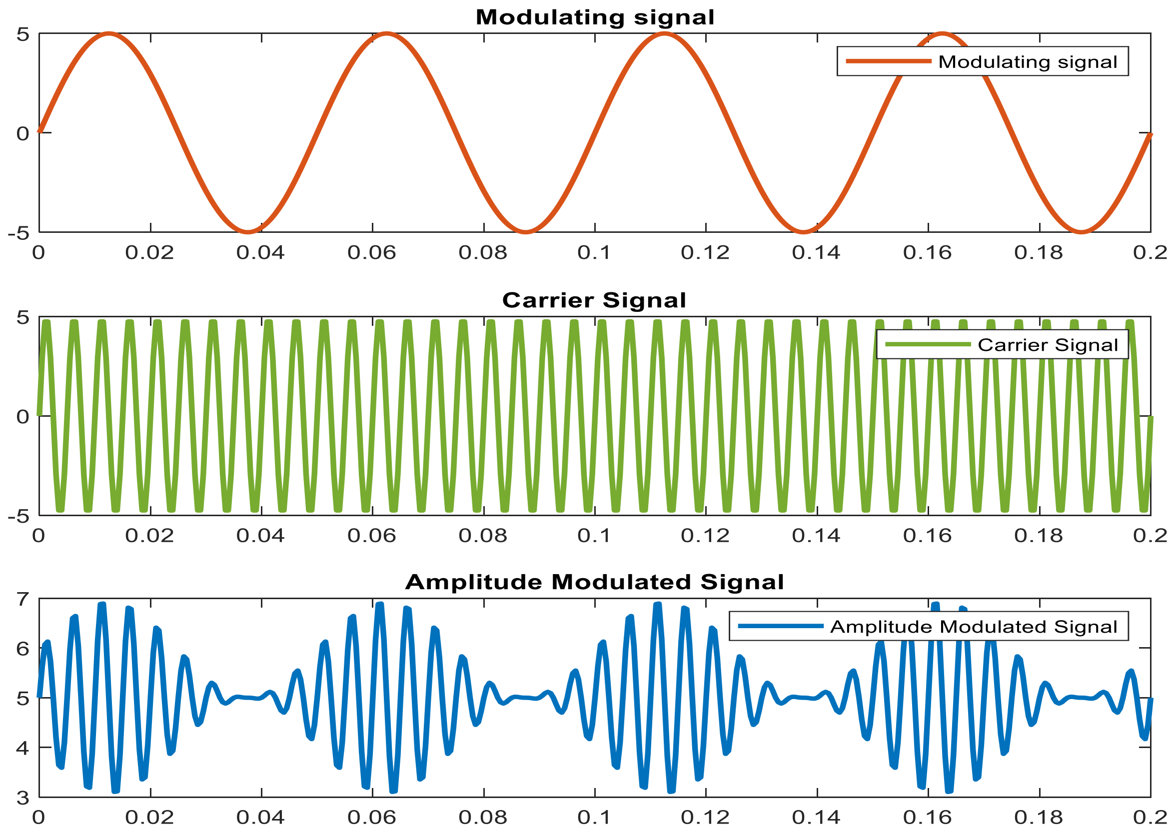

Fig.02.11: Perfectly modulated signal waveform **(m=1)**

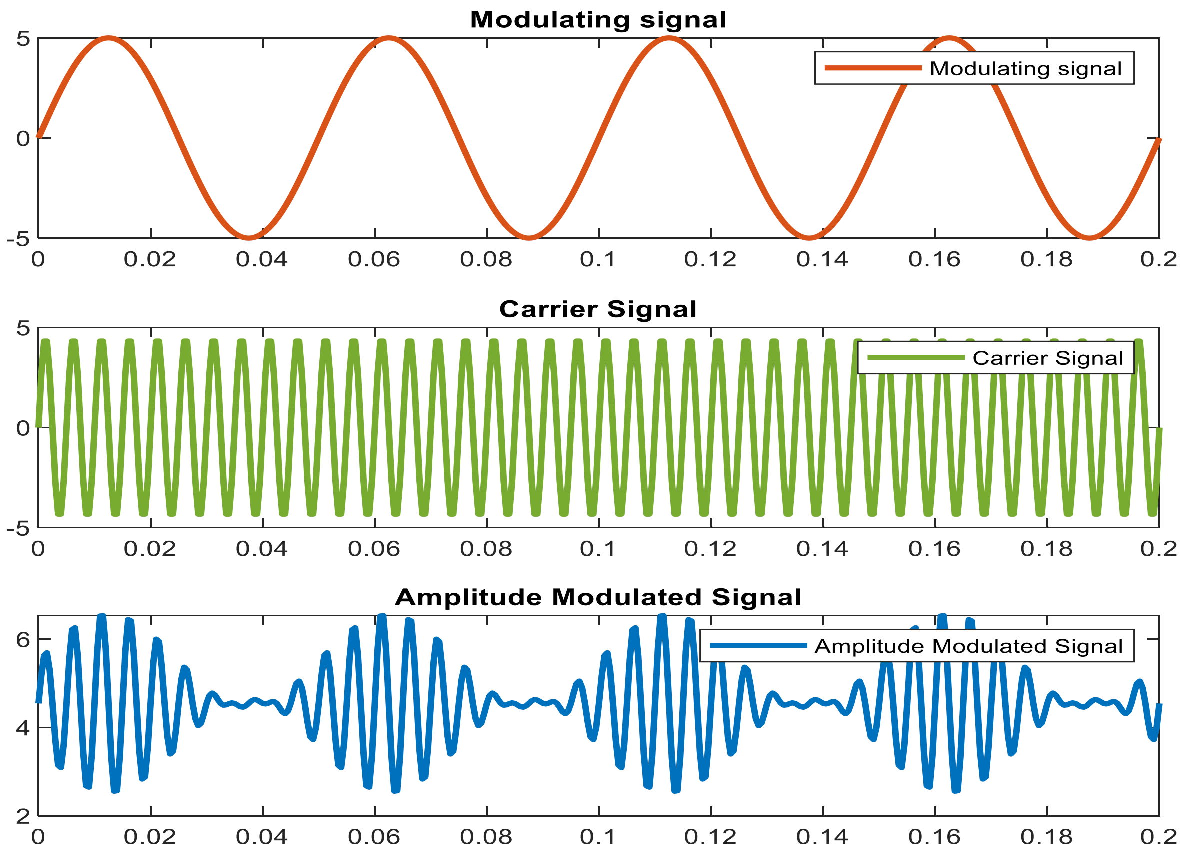

Fig.02.12: Over modulated signal waveform **(m>1)**

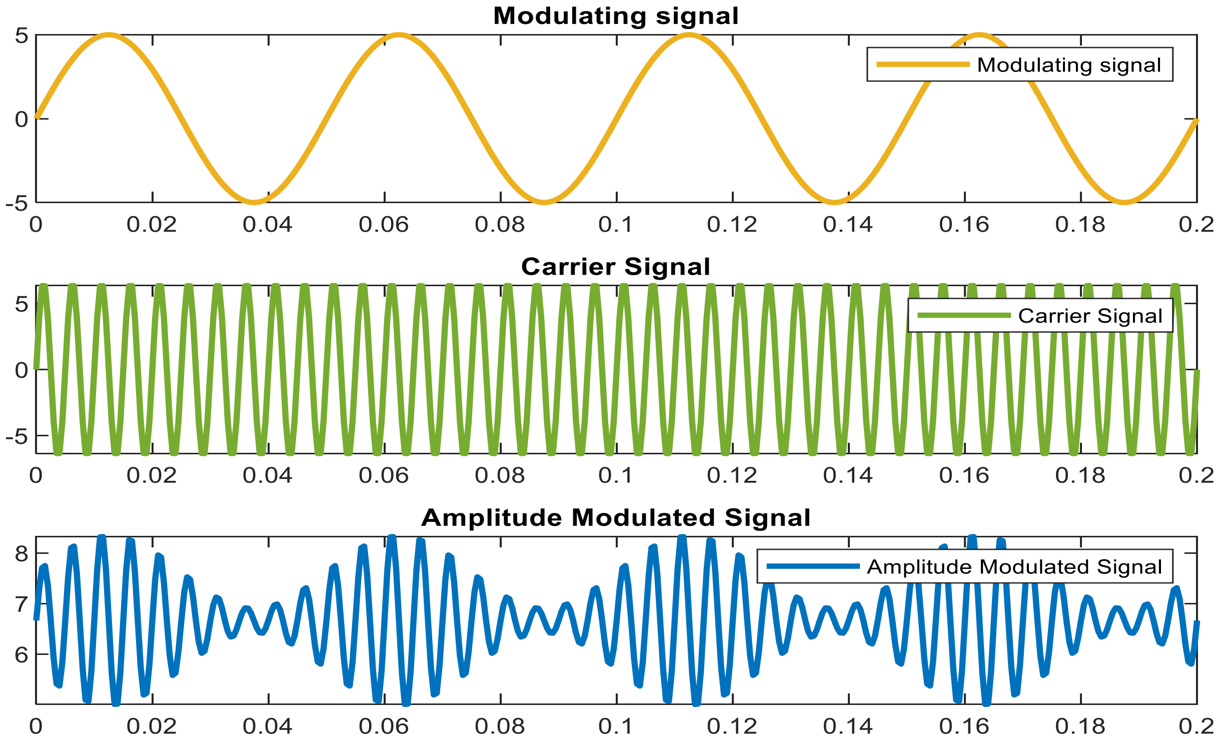

Fig.02.13: Under modulated signal waveform **(m<1)**

2.9 Discussion & Conclusion

In this experiment, the functions and purposes of amplitude modulated signal through laboratory kits were briefly reviewed. Their operation and working principle were also learnt and discussed.

Theoretically, sending a typical voice signal into open space to the receiving end is impractical because the signal becomes distorted and the power is insufficient to transmit. To transmit the signal, the message signal is mixed with the carrier signal, which is then broadcast into the air for reception by the receiver.

Similarly, the modulated signal is decoded at the receiving end, the carrier is separated, and the true message signal is retrieved.

There was noise in the message signal while receiving it during the experiment. Stray capacitance was developed at the kit and wire junction point, causing the message signal to become slightly distorted.

It was also possible to compare experimentally obtained modulated signal with MATLAB code generated signal. Because the expected consequence was reached, the experiment was declared successful.

2.10 Reference

- Book:
  Electronic Communication System- George Kennedy
- Links:
  https://www.indiamart.com/proddetail/acl-am-amplitude-modulation-transmitter-kit-23707428491.html
  https://eletechlabinstrument.com/product/amplitude-modulation-demodulation-trainer-kit/

Experiment no. 03

3.1 Experiment Name

Experimental study of frequency modulation and demodulation

3.2 Objectives

- To combine message and carrier frequencies, send the signal, receive the same signal, and separate the message signal
- To get acquainted with frequency modulation and demodulation techniques
- To carry out frequency modulation and demodulation functions for under, perfect, and over modulation conditions

3.3 Theory

Frequency modulation is defined as the process of encoding information in a carrier wave by altering the wave's instantaneous frequency. The difference between the carrier frequency and its center frequency, has a functional relationship to the modulating signal amplitude in analog frequency modulation, such as radio broadcasting of an audio signal representing voice or music.

FM radio broadcasts have several times the bandwidth of AM signals to do this. If vc and vm represent the carrier and message signals, respectively,

$$\boldsymbol{v_c = V_c cos\omega_c t \; ; v_m = V_m cos\omega_m t}$$

The FM voltage instantaneous value can then be written as,

$$\boldsymbol{v = Acos\left(\omega_c t + \frac{\delta}{f_m} sin\omega_m t\right) = Acos(\omega_c t + msin\omega_m t)}$$

Where, $\boldsymbol{A}$ = amplitude of FM signal;
$\boldsymbol{\delta}$ = Maximum deviation;
$\boldsymbol{f_m}$ = Modulating frequency and
$\boldsymbol{m =}$ frequency modulating index

3.4 Apparatus

- Oscilloscope (Model: GWINSTEK GOS 6112, 100MHz)
- Frequency Modulation Transmitter Kit
- Frequency Modulation Receiver Kit
- Jumper Wires

3.5 Block Diagram & Kit

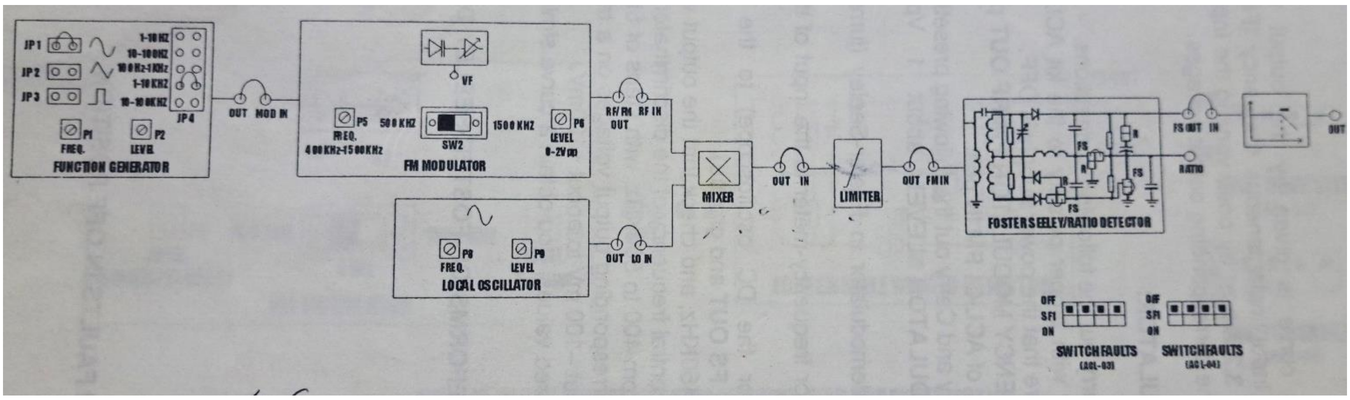

Fig.03.1: Block diagram for frequency demodulation

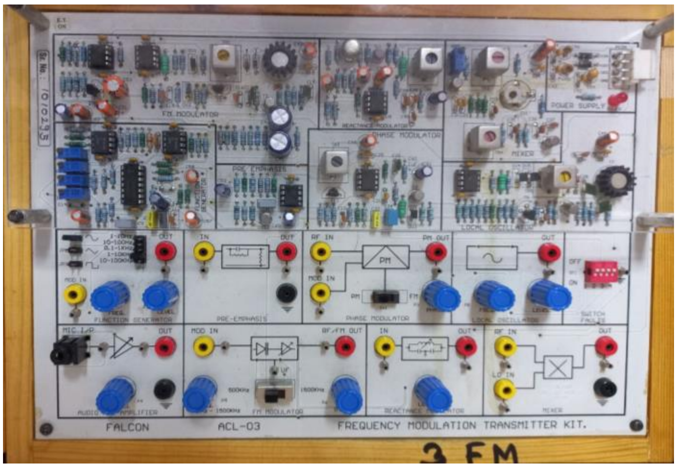

Fig.03.2: Frequency modulation transmitter kit

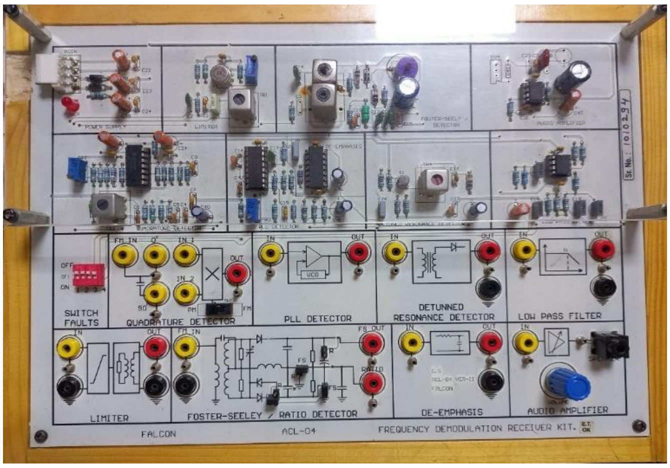

Fig.03.3: Frequency demodulation receiver kit

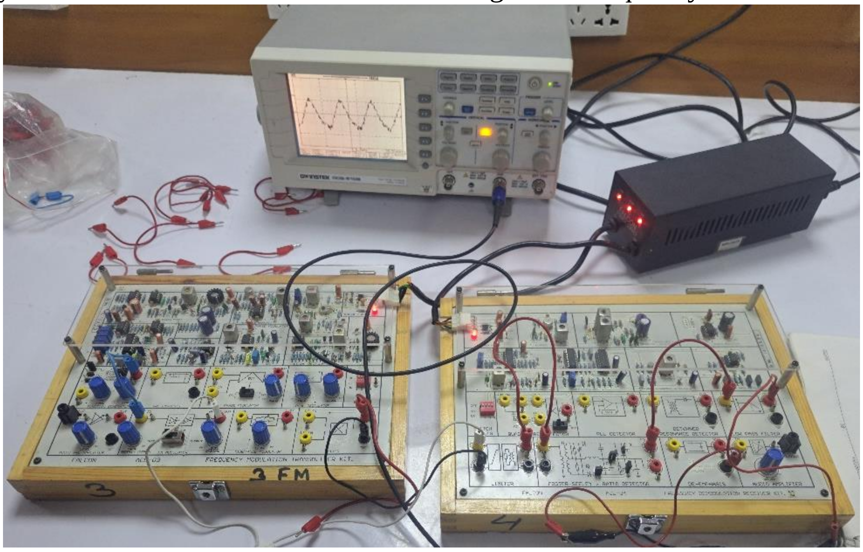

Fig.03.4: Experimental Setup of Frequency modulation and demodulation Experiment

3.6 Waveforms

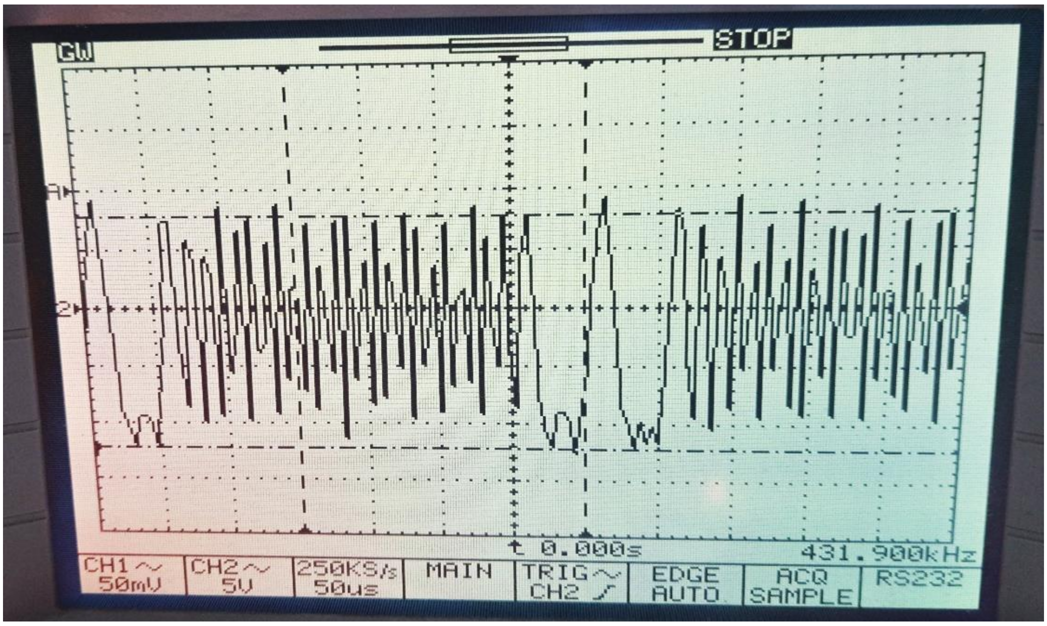

Fig.03.5: Frequency modulated signal

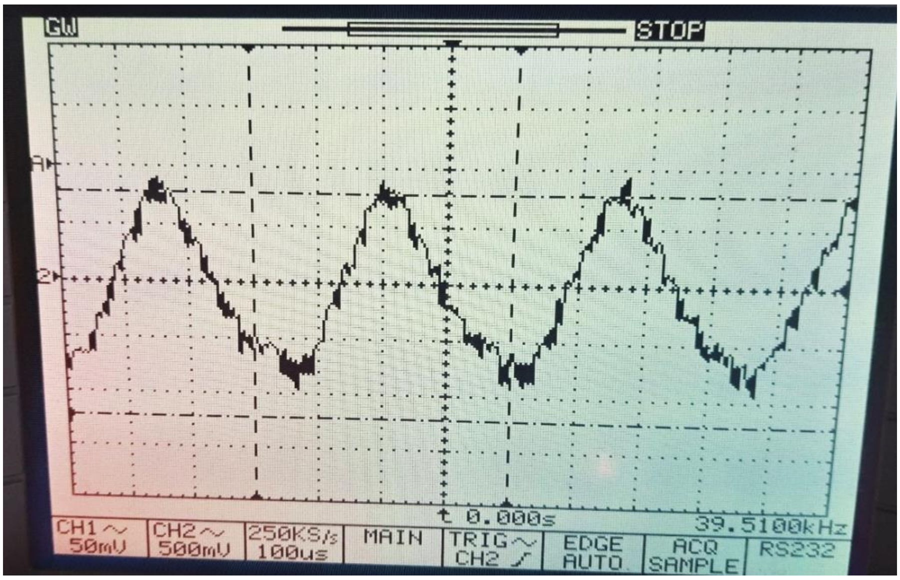

Fig.03.5: Frequency demodulated signal

3.7 MATLAB code

```
clc;%Clears previous data from command window
clear all; %Removes all variables from the current workspace
fs = 1000; %Messege signal frequency
fc = 200;  %Carrier signal frequency
t = (0:1/fs:0.2)';
%Create two-tone sinusoidal signal with frequencies 30 and 60 Hz.
x = sin(2*pi*30*t)+2*sin(2*pi*60*t);
%Set the frequency deviation to 50 Hz.
fDev = 50;
%Frequency modulate x.
y = fmmod(x,fc,fs,fDev);
%Demodulate z.
z = fmdemod(y,fc,fs,fDev);
%Plot the original and demodulated signals.
plot(t,y,t,z);
xlabel('Time (s)')
ylabel('Amplitude')
legend('Modulated Signal','Demodulated Signal')
```

3.8 MATLAB output waveform

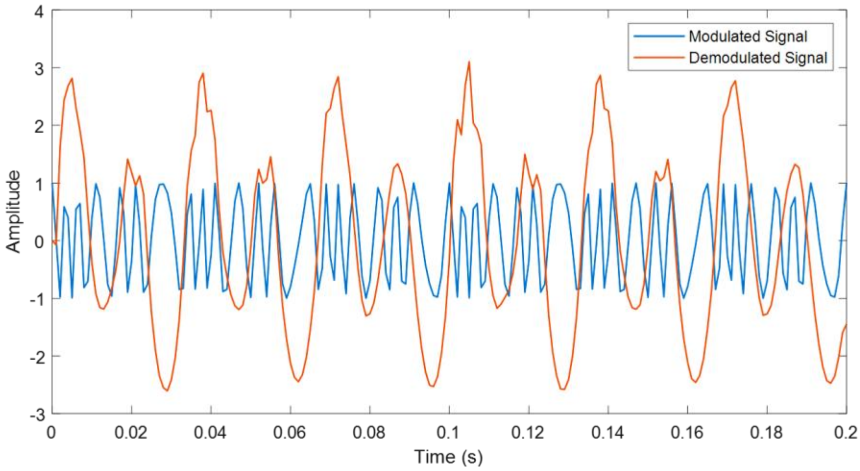

Fig.03.7: Frequency modulated signal waveform

3.9 Discussion & Conclusion

In this experiment, the functions and purposes of frequency modulated signal through laboratory kits were briefly reviewed. Their operation and working principle were also learnt and discussed. It was also possible to compare experimentally obtained modulated signal with MATLAB code generated signal. Because the expected consequence was reached, the experiment was declared successful.

3.10 Reference

- Book:
  Electronic Communication System- George Kennedy

Experiment no. 04

4.1 Experiment Name

Experimental study of Pulse width and Pulse code modulation and demodulation techniques

4.2 Objectives

- To combine message and carrier frequencies, send the signal, receive the same signal, and separate the message signal
- To get acquainted with pulse width modulation and demodulation techniques
- To get acquainted with pulse code modulation and demodulation techniques
- To observe input and output waveshapes of both techniques individually

4.3 Theory

PWM, or pulse width modulation, is a modulation process or technique used in most communication systems to encode the amplitude of one signal (the carrier signal) into the pulse width or length of another signal (the source signal).

It is really used to adjust the amplitude of digital signals in order to control power or electricity-requiring equipment and applications. Demodulating PWM requires converting it to pulse amplitude modulation (PAM) and passing it through a low pass filter.

The PWM signal was generated using the square generator and the monostable multivibrator circuits. A decoder or demodulator in the receiver circuit is required to recover the original audio signal from a PWM pulse. We can regulate the breadth of the pulse if we can control the time fluctuation of the electric level. When the amplitude of the audio signal increases, so does the pulse width.

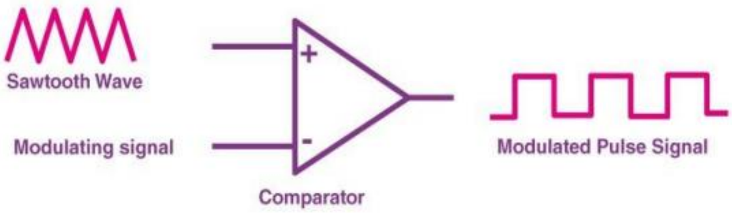

Fig.04.1: Generation of PW modulated signal

PCM stands for **Pulse Code Modulation**. To study pulse modulation and demodulation, a pulse code modulator and demodulator kit is utilized. Pulse code modulation is a technique for converting an analog signal into a digital signal. Because PCM is binary, there are only two conceivable states: high and low (0 and 1). Demodulation can also be used to recover our analog signal.

The steps of generating PCM are,

Filtering (Low Pass Filter) – Sampling – Quantization -- Encoding.

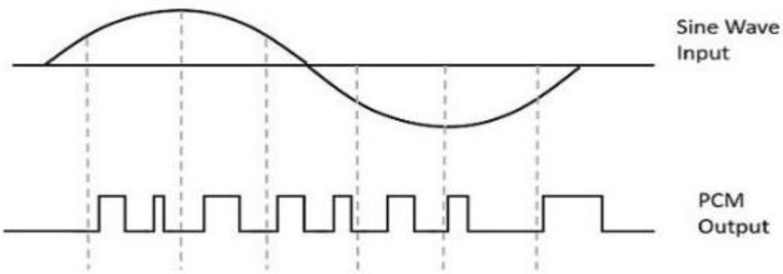

Fig.04.2: Generation of PC modulated signal

4.4 Apparatus

- Oscilloscope
- Pulse Width modulation and demodulation kit
- Pulse Code modulation and demodulation kit
- Jumper Wires

4.5 Block Diagram & Kit

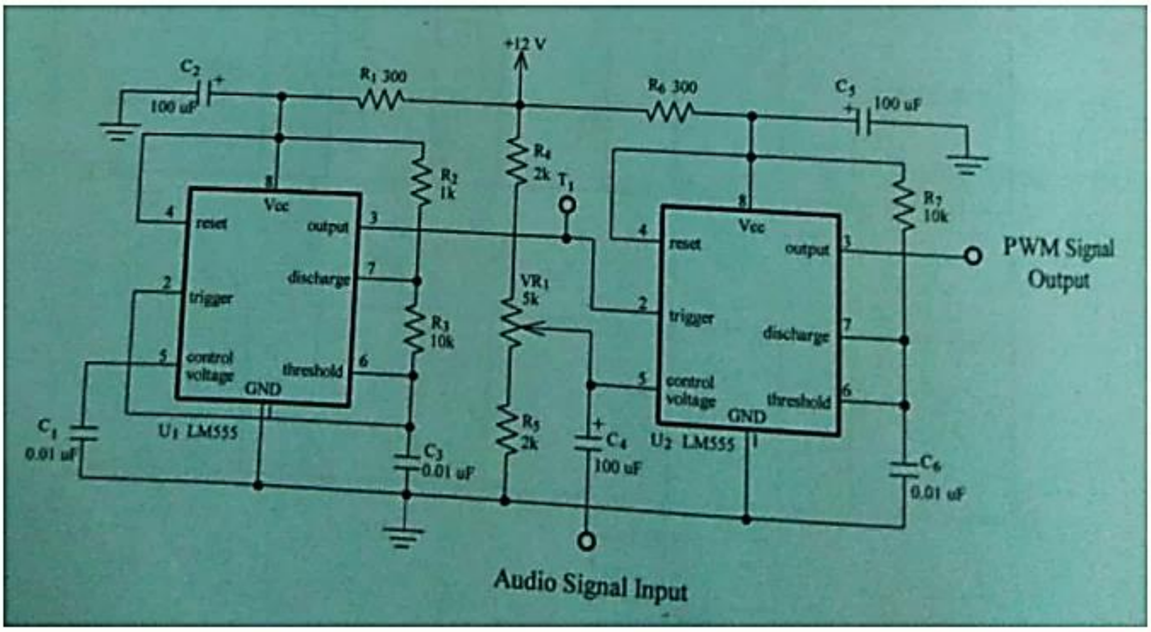

Fig.04.3: Block diagram for PW modulation and demodulation

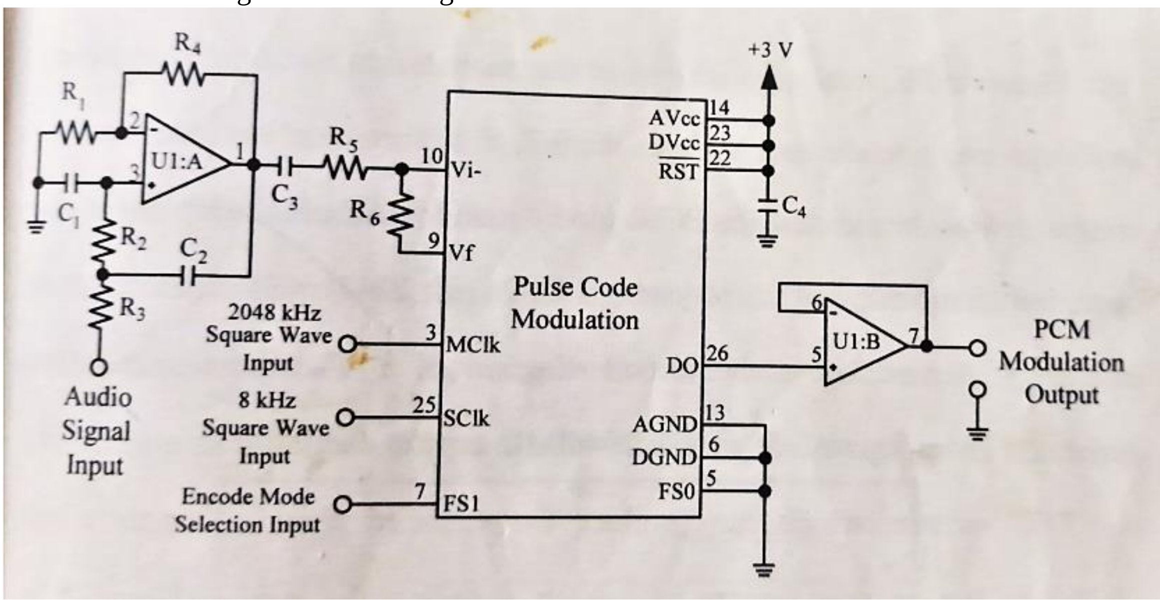

Fig.04.4: Block diagram for PC modulation

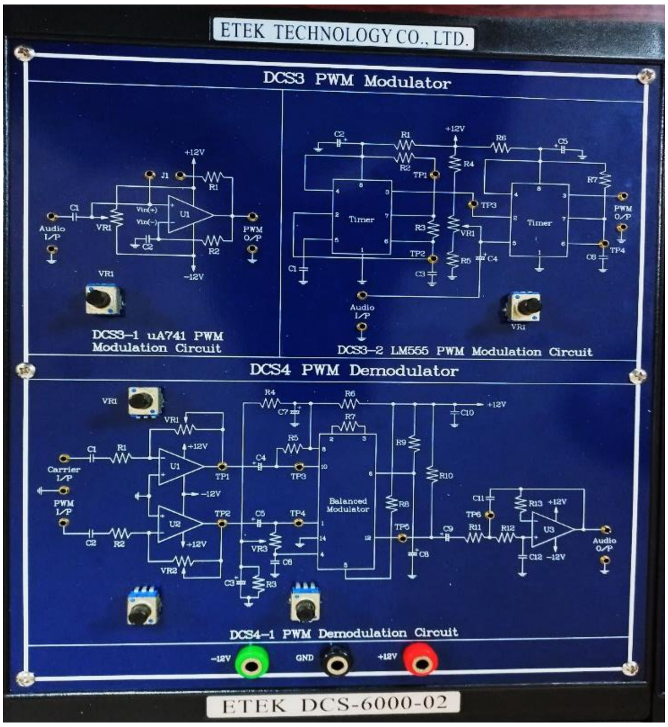

Fig.04.5: PW modulation and demodulation kit

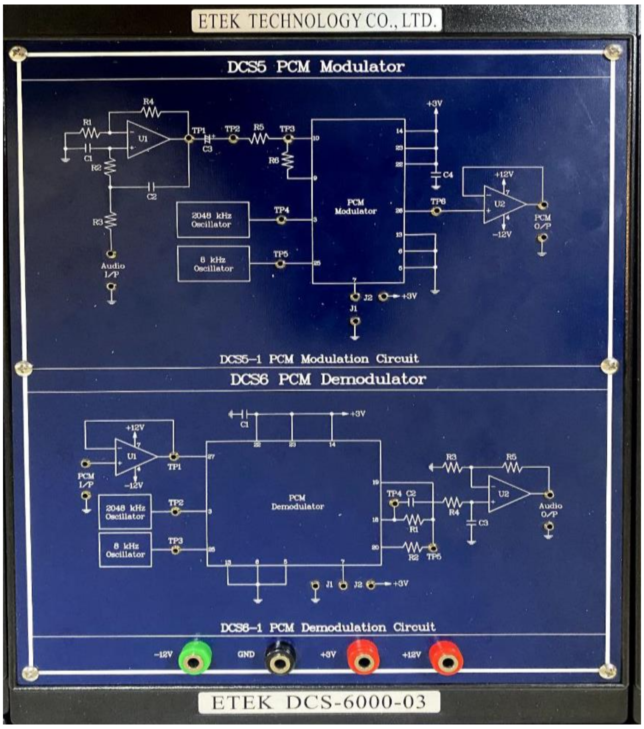

Fig.04.6: PC modulation and demodulation kit

Fig.04.7: Experimental Setup of Pulse Width modulation and demodulation Experiment

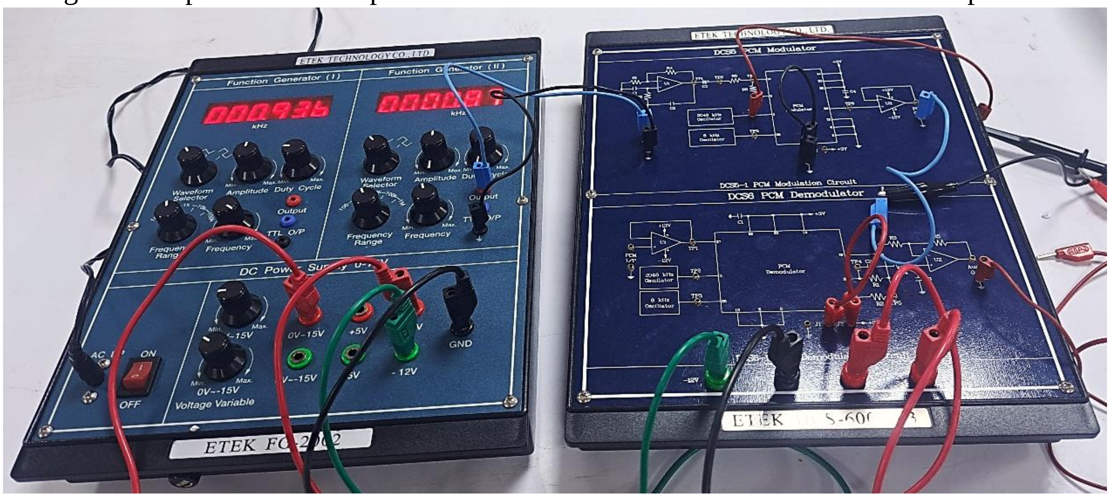

Fig.04.8: Experimental Setup of Pulse Code modulation and demodulation Experiment

4.6 Waveforms

- **PWM**

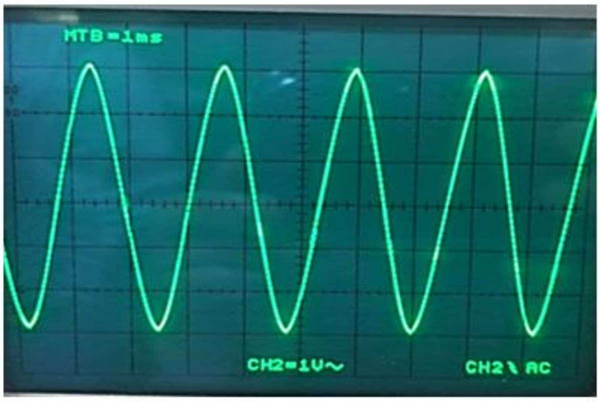

Fig.04.9: 6V input PWM voltage

Fig.04.10: 6V output PWM voltage

Fig.04.11: 0V output PWM voltage

Fig.04.12: -6V output PWM voltage

- **PCM**

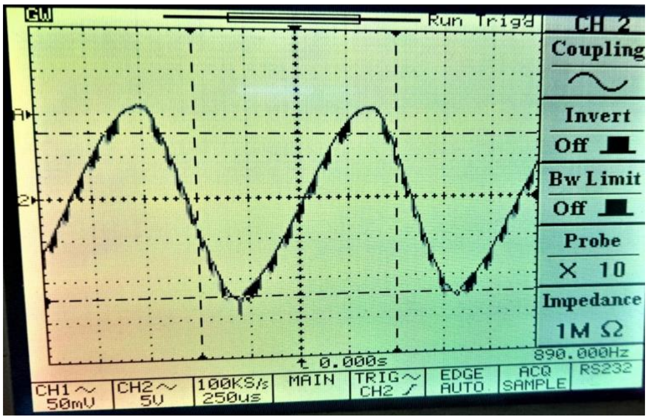

Fig.04.13: Input PCM voltage

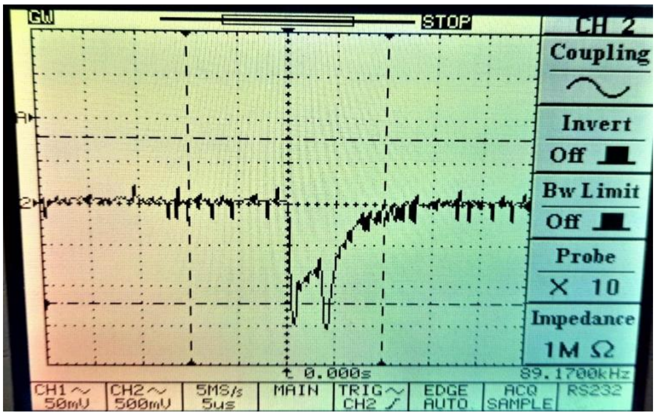

Fig.04.14: Output PCM voltage

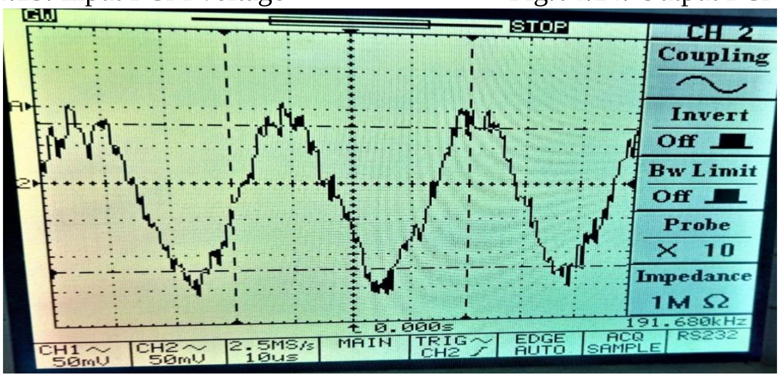

Fig.04.15: Output PCDM voltage

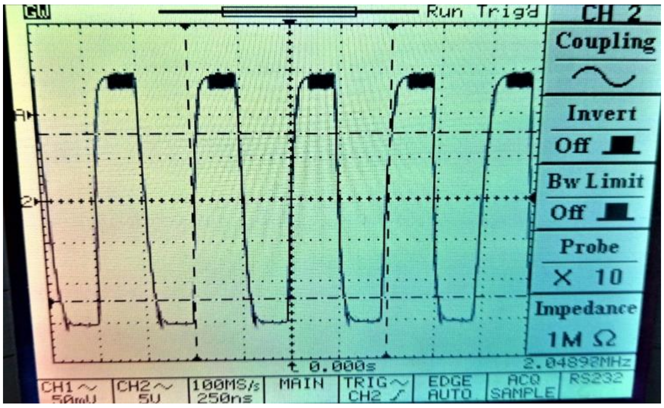

Fig.04.16: TP4 type PCM technique

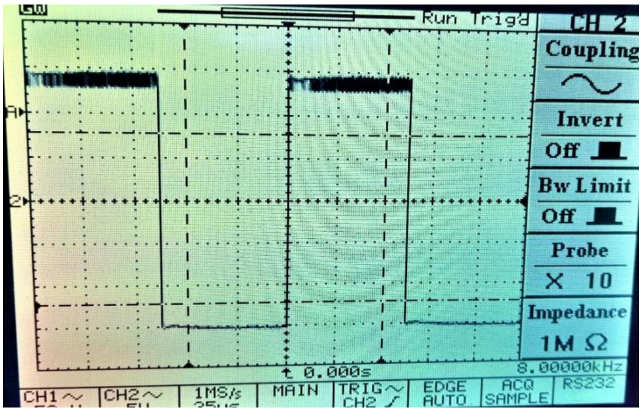

Fig.04.17: TP5 type PCM technique

4.7 Discussion & Conclusion

In this experiment, the functions and purposes of pulse width modulated and demodulated signal through laboratory kits were briefly reviewed. Their operation and working principle were also learnt and discussed.

The first was pulse-width modulation. The input pulse was produced by the signal generator, the output was visible through the scope, and the connections were made in line with the instructions. The pulse code modulation approach was used in the second occurrence. After applying the pulse to the modulator kit, the modulated output was discovered. The modulated data was further demodulated, and the output was examined through the scope. In both situations, the intended output as manual was discovered. As a result, the experiment was carried out correctly.

Thus, experiment was a success.

4.8 Reference

- Book: Electronic Communication System- George Kennedy
- Book: Communication Systems – Haykin
- https://en.wikipedia.org/wiki/Pulse-width_modulation
- https://en.wikipedia.org/wiki/Pulse-code_modulation

Experiment no. 05

5.1 Experiment Name

Experimental study of ASK and FSK modulation and demodulation techniques

5.2 Objectives

- To understand the operation of ASK modulation and demodulation techniques
- To get acquainted with FSK modulation and demodulation techniques
- To observe input and output waveshapes of both techniques individually

5.3 Theory

Amplitude-shift keying (ASK) is a type of amplitude modulation in which digital data is represented as fluctuations in the amplitude of a carrier wave. A symbol representing one or more bits is delivered in an ASK system by delivering a fixed-amplitude carrier wave at a given frequency for a specific time length.

For example, if each symbol represents a single bit, the carrier signal could be carried at full amplitude when the input value is 1, but at decreased amplitude or not at all when it is 0.

Frequency-shift keying (FSK) is a frequency modulation method that transmits digital information via discrete frequency shifts in a carrier signal. Binary FSK is the most basic type of FSK (BFSK). To transmit binary data, BFSK employs a pair of discrete frequencies (0s and 1s).

For example, Telemetry, weather balloon radiosondes, caller ID, garage door openers, and low frequency radio transmission in the VLF and ELF.

5.4 Apparatus

- Oscilloscope
- ASK modulation and demodulation kit
- FSK modulation and demodulation kit
- Jumper Wires

5.5 Block Diagram & Kit

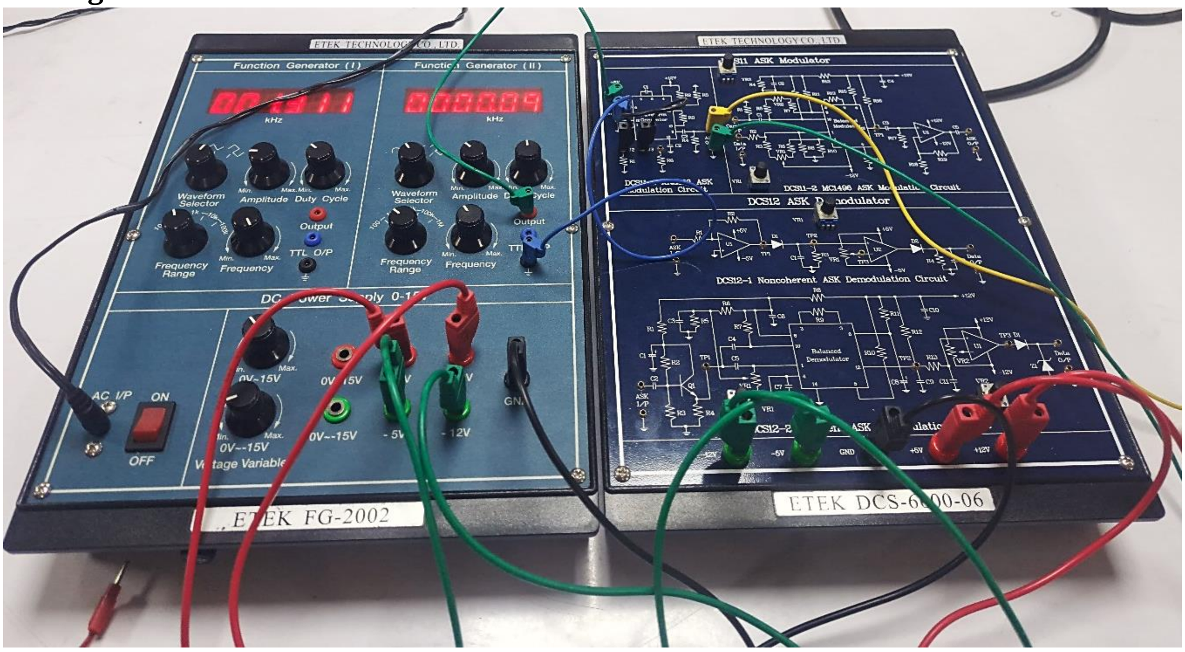

Fig.05.1: Experimental setup for ASK modulation and demodulation

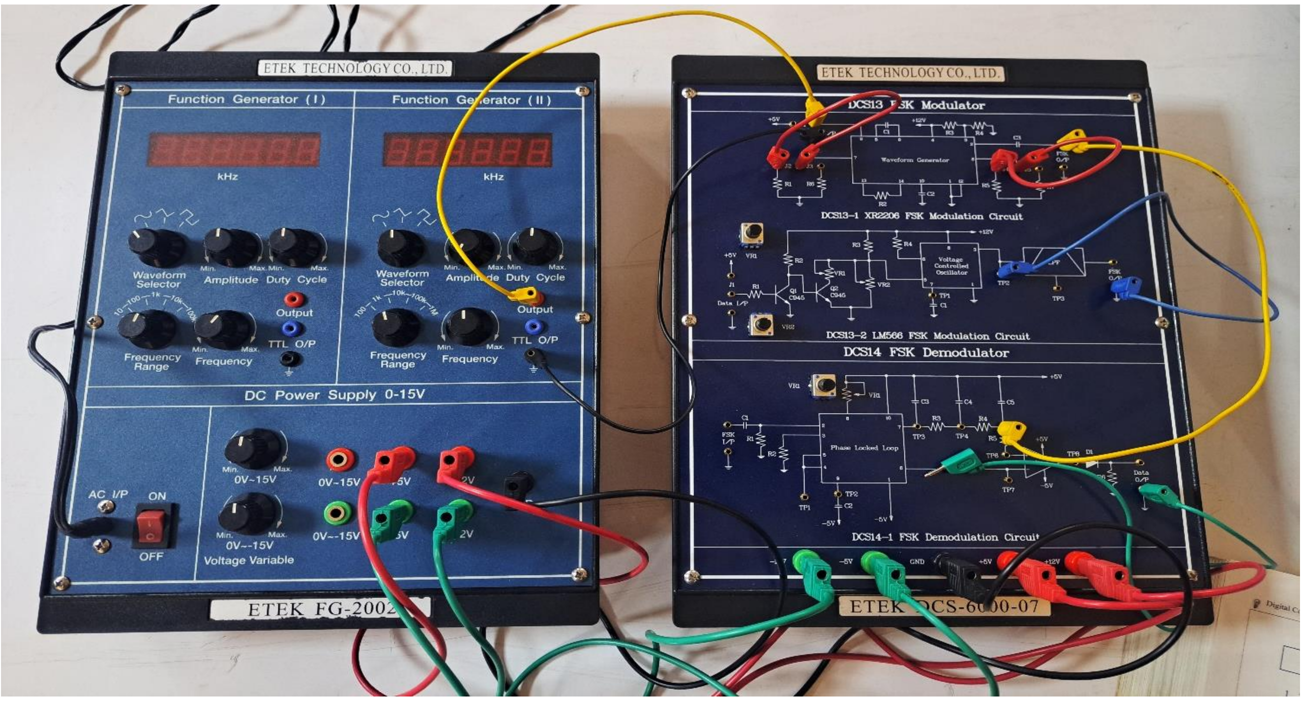

Fig.05.1: Experimental setup for FSK modulation and demodulation

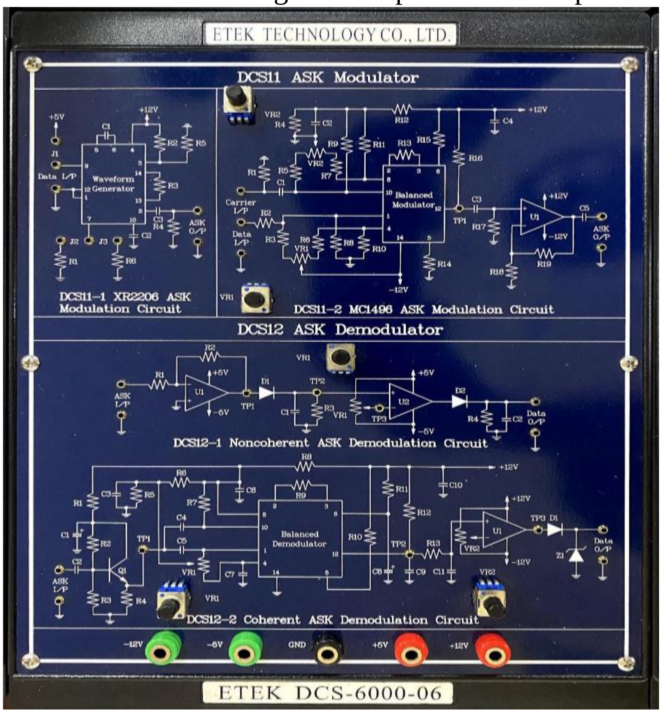

Fig.05.3: ASK modulation and demodulation kit

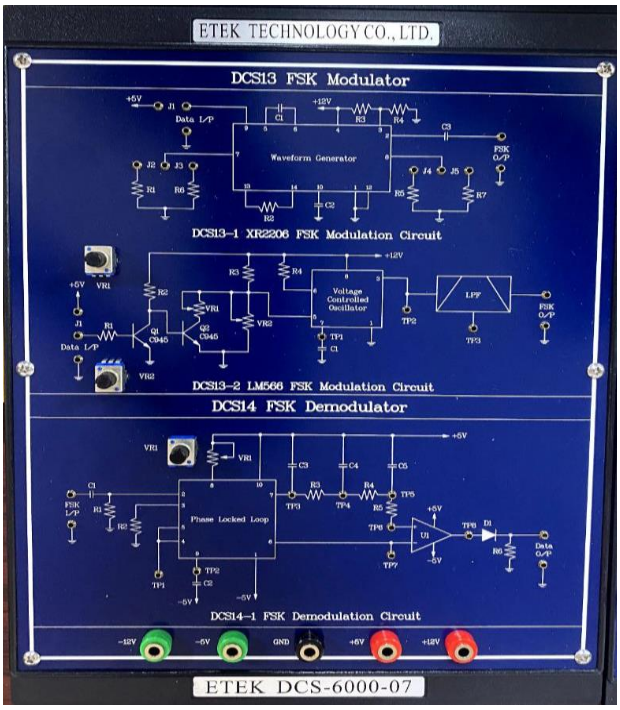

Fig.05.4: FSK modulation and demodulation kit

5.6 Waveforms

- **ASK modulated and demodulated signal**

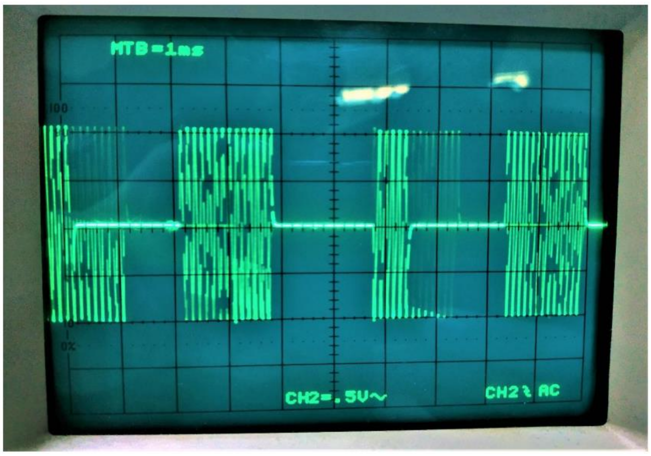

Fig.05.5: ASK modulated signal

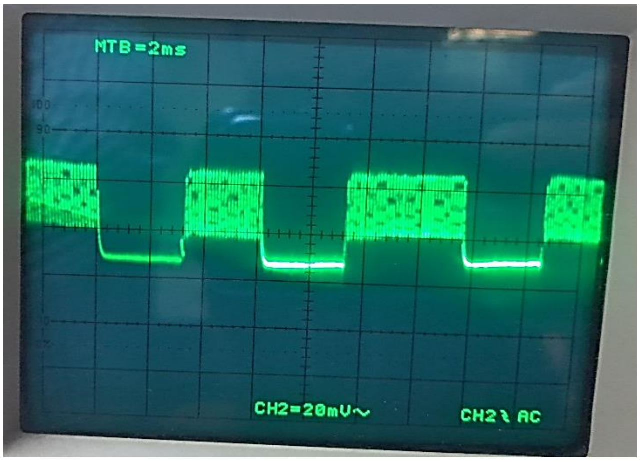

Fig.05.6: ASK demodulated signal

- **FSK modulated and demodulated signal**

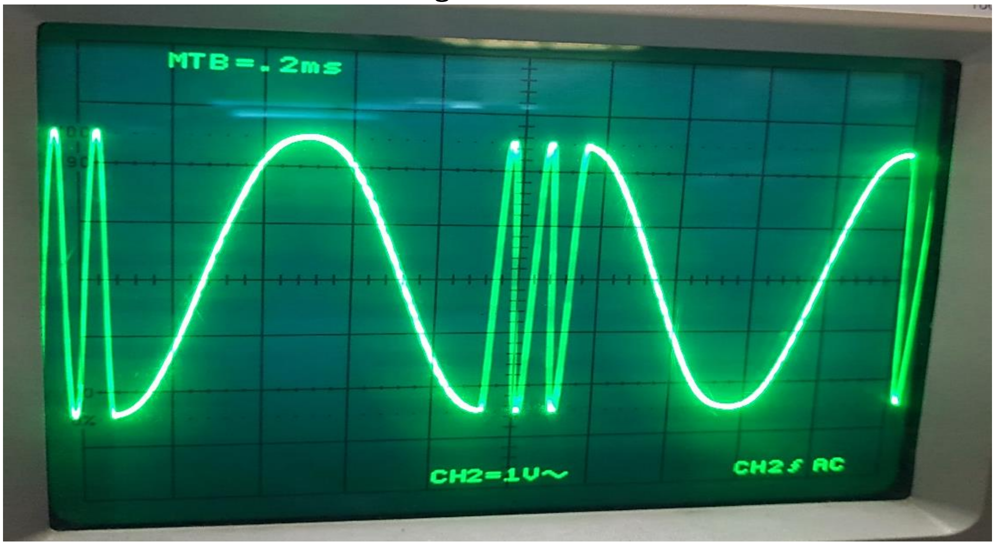

Fig.05.5: FSK demodulated signal

5.7 Discussion & Conclusion

In this experiment, the functions and purposes of ASK and FSK modulated and demodulated signal through laboratory kits were briefly reviewed. Their operation and working principle were also learnt and discussed.

The initial method was amplitude shift keying (ASK). The connections were made according to the instructions, the output was visible through the scope, and the signal generator generated the input pulse.

In the second scenario, frequency shift keying (FSK) was used. The modulated output was discovered after the pulse was delivered to the modulator kit. The modulated data was demodulated further, and the output was examined using a scope. In both cases, the expected result as manual was discovered. Thus, the experiment was carried out properly.

5.8 Reference

- Book: Electronic Communication System- George Kennedy
- https://www.elprocus.com/frequency-shift-keying-fsk-working-applications/
- https://en.wikipedia.org/wiki/Amplitude-shift_keying
- https://en.wikipedia.org/wiki/Frequency-shift_keying