Department of Electronics & Communication Engineering

LAB MANUAL

SUBJECT: DIGITAL COMMUNICATION [06BEC201]

B.Tech III Year – VI Semester

(Branch: ECE)

BHAGWANT UNIVERSITY

SIKAR ROAD, AJMER

OBJECTIVES:

The purpose of this lab is to explore digital communications with a software radio to understand how each component works together. The lab will cover, analog to digital conversion, modulation, pulse shaping, and noise analysis.

DEPARTMENT OF ECE

II YEAR III SEMESTER ECE

LIST OF EXPERIMENTS

OBJECTIVES:

The purpose of this lab is to explore digital communications with a software radio to understand how each component works together. The lab will cover, analog to digital conversion, modulation, pulse shaping, and noise analysis

1. Signal Sampling and reconstruction
2. Amplitude modulation and demodulation
3. Frequency modulation and demodulation
4. Pulse code modulation and demodulation.
5. a) Delta modulation

   b) Adaptive delta Modulation
6. BFSK modulation and Demodulation
7. BPSK modulation and Demodulation
8. TDM and FDM
9. Line Coding Schemes
10. FSK, PSK and DPSK schemes (Simulation)

EXP. NO :1	SIGNAL SAMPLING AND RECONSTRUCTION
DATE:	

Aim:

To study the different types of signal sampling and its reconstruction.

Apparatus Required:

1. Sampling and its reconstruction Kit - DCL 01
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram for natural sampling
2. Connect the power supply in proper polarity to the kit and & switch it on.
3. Using the clock selector switch select 8 KHz sampling frequency and using switch SW2 select 50% duty cycle.
4. The input and output waveforms are measured using DSO.
5. The procedure above is repeated for sample & hold and flat top sampling.

Tabular Column:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (S)	FREQ(HZ)
I/P Signal Clock Signal O/P a) Natural Sampling b) Sample hold c) Flat top sampling			

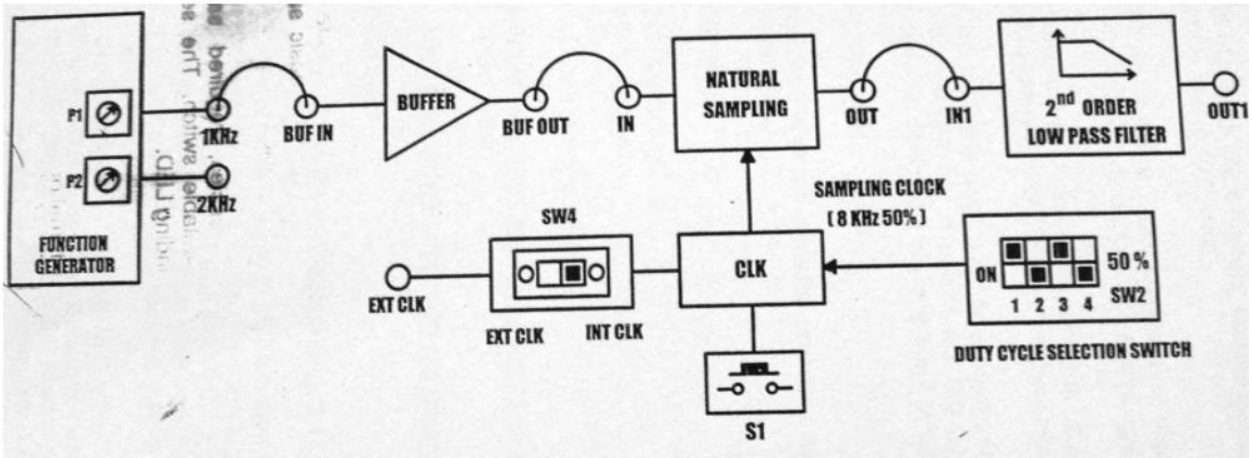


Fig. 1.1 Block Diagram for Natural Sampling

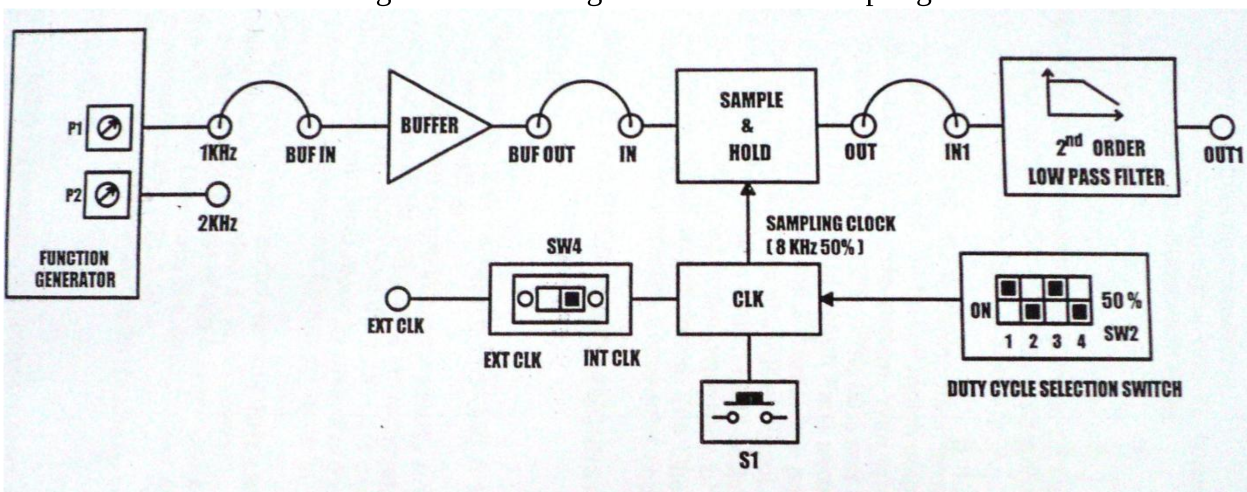


Fig. 1.2 Block Diagram for Sample and Hold

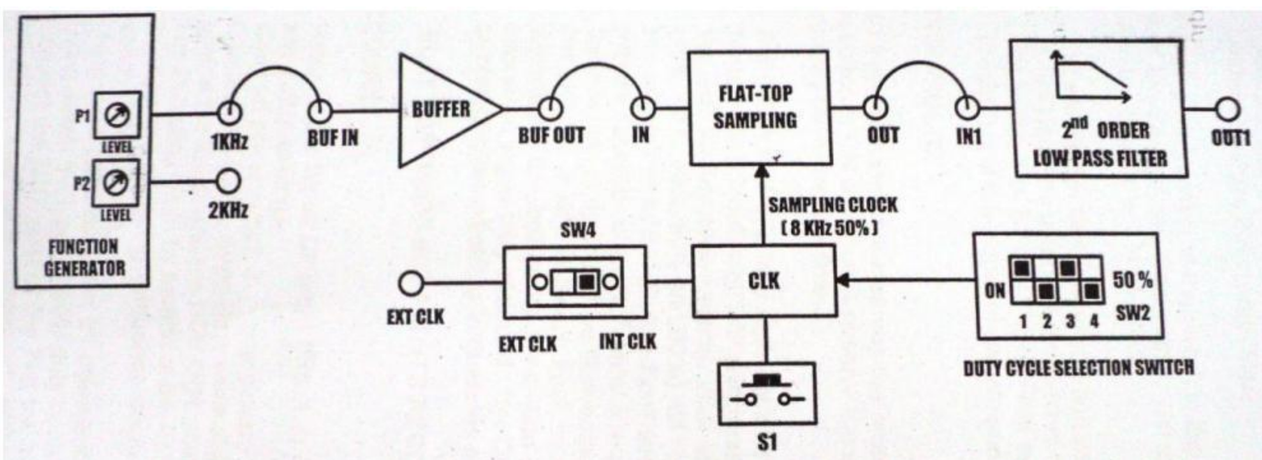


Fig. 1.3 Block Diagram for Flat Top Sampling

MODEL GRAPH

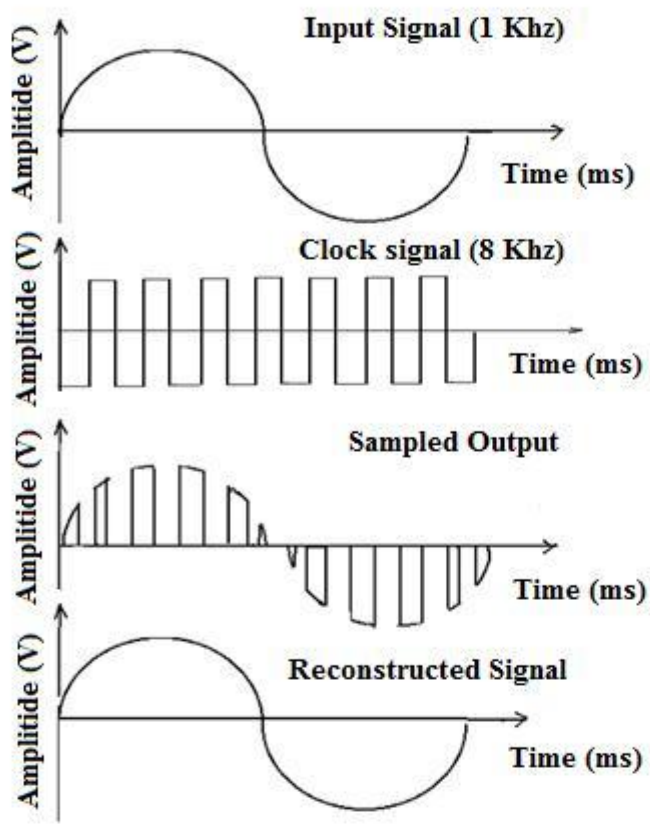


Fig 1.4 Model Graph for Signal sampling and reconstruction using sample & hold.

Result:

Comparing the reconstructed output of 2nd order Low Pass Butterworth filter for all three types of sampling , it is observed that the output of the sample and hold is the better when compared to the outputs of natural sampling and the flat top sampling.

EXP. NO :2	GENERATION AND DETECTION OF AMPLITUDE MODULATION
DATE:	

Aim:

To study an amplitude modulation & demodulation circuit and to calculate modulation index of AM.

Apparatus Required:

1. AM transmitter and receiver kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Set the modulating signal frequency at 1KHz and carrier signal frequency at 500Khz
3. Vary the amplitude of the modulating signal and check for the three following conditions
    a. Modulation index (m) lesser than 1
    b. Modulation index (m) equal to 1
    c. Modulation index (m) greater than 1

Block Diagram

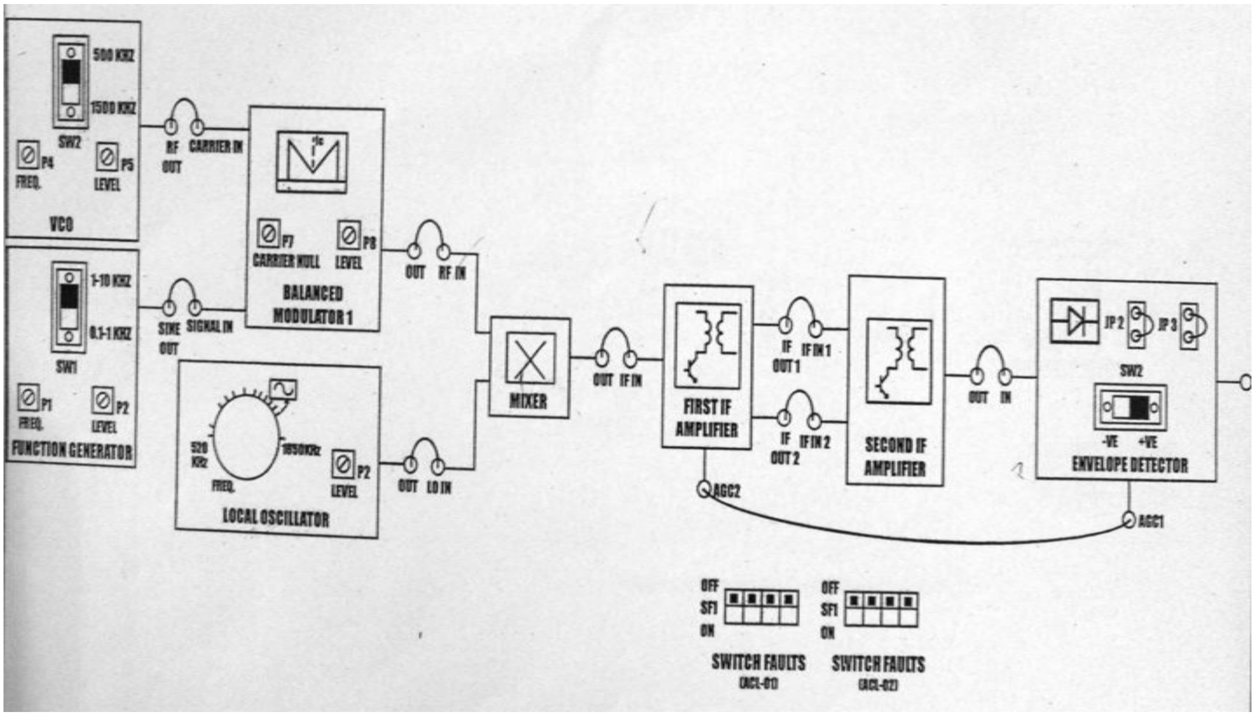


Fig. 2.1 Block Diagram for AM Modulation and Demodulation

MODEL GRAPH

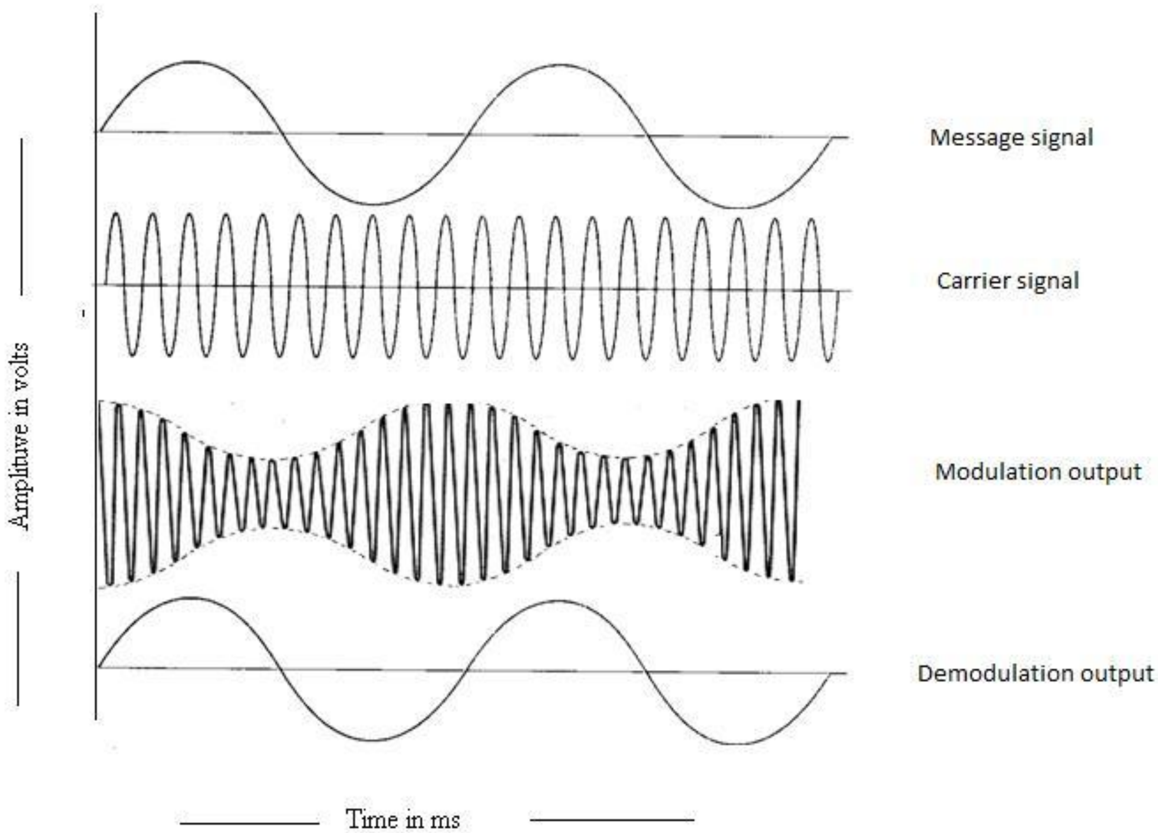


Fig 2.1 Model Graph for AM Modulation and demodulation.

Tabular Column:

Message Frequency = Carrier Frequency =

S.NO	Am	Ac	Emax	Emin	%M

Result:

Amplitude Modulation and Demodulation are verified in the hardware kit and its waveforms are analyzed for different modulation index.

EXP. NO:3	GENERATION AND DETECTION OF FREQUENCY MODULATION
Date :	

Aim:

To study frequency modulation & demodulation and to calculate modulation index of FM.

Apparatus Required:

1. FM transmitter and receiver kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Set the modulating signal frequency at 1KHz and carrier signal frequency at 500Khz
3. Vary the frequency of the modulating signal and check for the three following conditions
    a. Modulation index (m) lesser than 1
    b. Modulation index (m) equal to 1
    c. Modulation index (m) greater than 1

Tabulation:

Message Frequency = **Carrier Frequency =**

S.NO	Am	T_L	T_H	F_L	F_H	Freq.Deviation	%M

Block Diagram

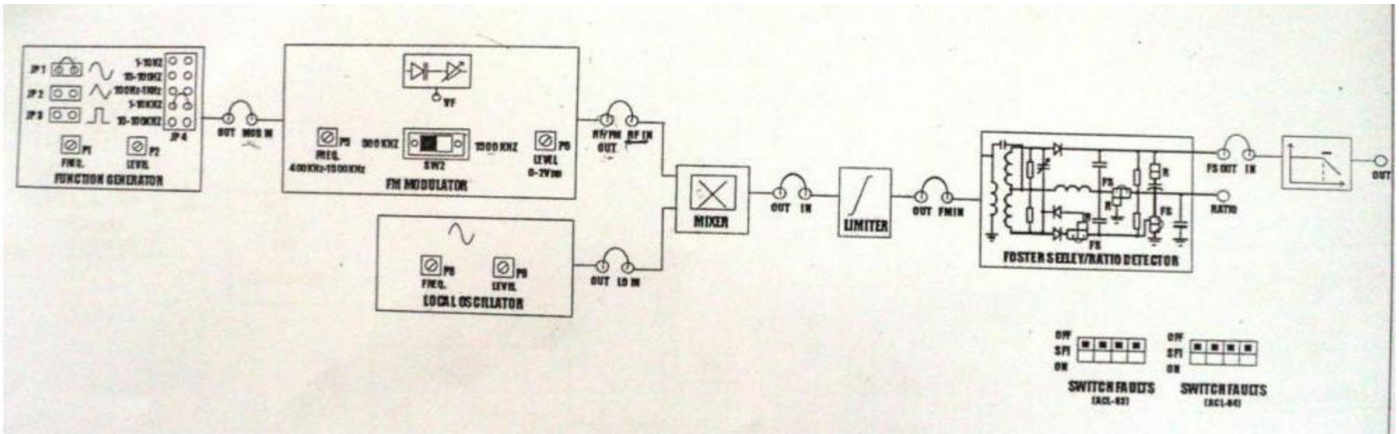


Fig 3.1 Block diagram for FM modulation and demodulation

Model Graph

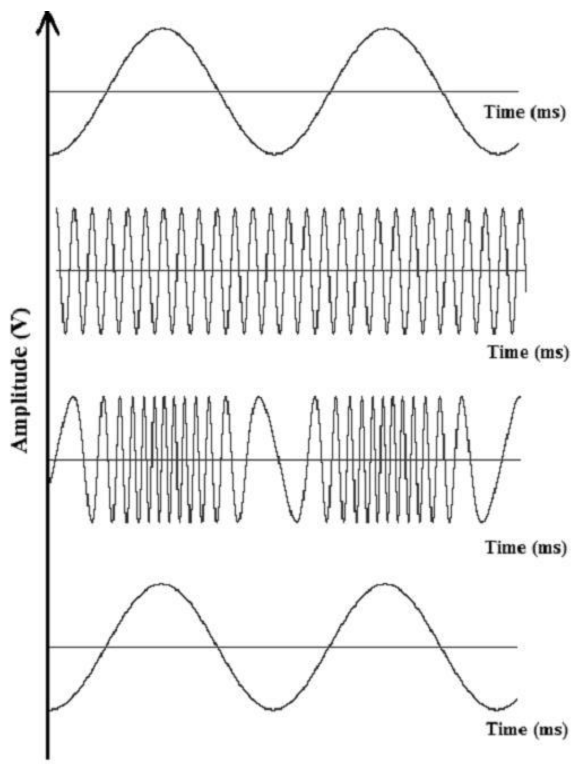


Fig 3.2 Model Graph for FM modulation and demodulation

Result:

Frequency Modulation and Demodulation are verified in the hardware kit and its waveforms are analyzed for different modulation index.

EXP. NO :4	PULSE CODE MODULATION & DEMODULATION
DATE:	

Aim:

To construct and study a PCM transmitter and receiver kit

Apparatus Required:

1. PCM Transmitter and Receiver Kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Connect power supply in proper polarity to kits DCL-03 and DCL-04 and switch it on.
3. Set the function generator , clock generator and speed selection switch SW1 to fast mode.
4. Observe the modulated output and demodulated output.
5. Measure the observed output and with the values plot the graph.

Tabular Column:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (s)	FREQUENCY(Hz)
Message Signal_1			
Message Signal_2			
Clock Signal _1			
Clock Signal _2			
PCM (Modulated Output)			
Demodulated Signal_1			
Demodulated Signal_2			

Block Diagram

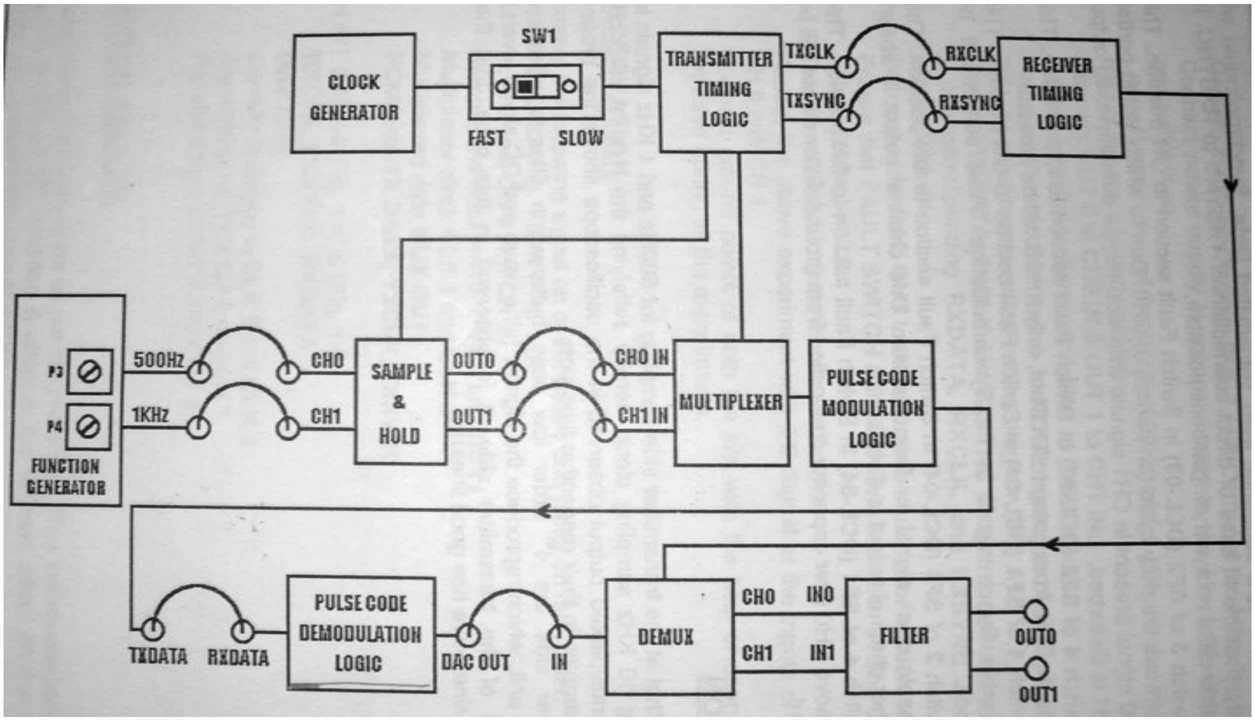
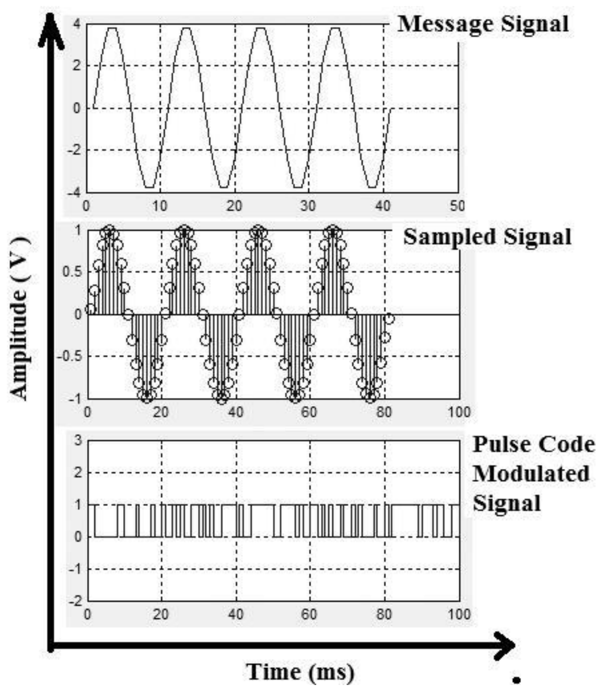


Fig. 4.1 Block Diagram for PCM Modulation and Demodulation

Model Graph



Result:

Pulse Code Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO:5a	DELTA MODULATION AND DEMODULATION
DATE:	

Aim:

To study the characteristics of delta modulation and demodulation kit.

Apparatus Required:

1. Delta modulation and demodulation Kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Connect power supply in proper polarity to kits DCL-07 and switch it on.
3. Keep the Switch S2 in Delta position.
4. Keep the Switch S4 High.
5. Observe the various tests points in delta demodulator section and observe the reconstructed signal through 2nd order and 4th order filter .

TABULATION

	AMPLITUDE	TIME PERIOD	FREQUENCY
Message Signal			
Digital Sampler O/P			
Integrator -3 O/P			
Filter O/P			

Block Diagram

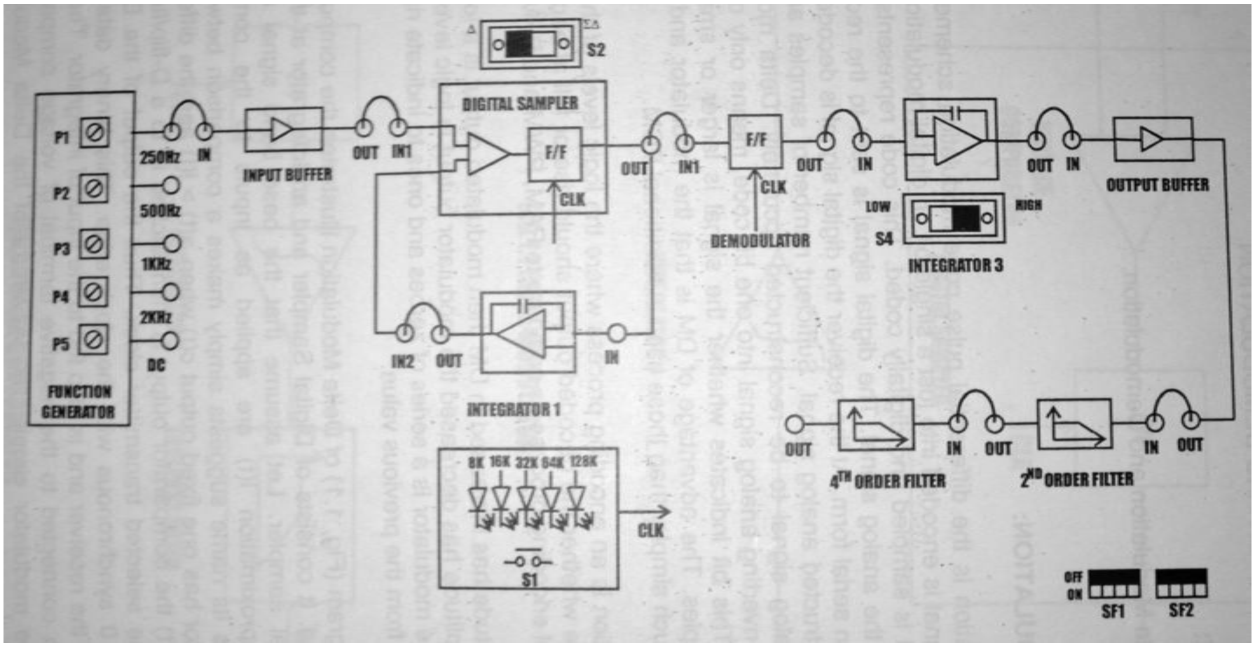
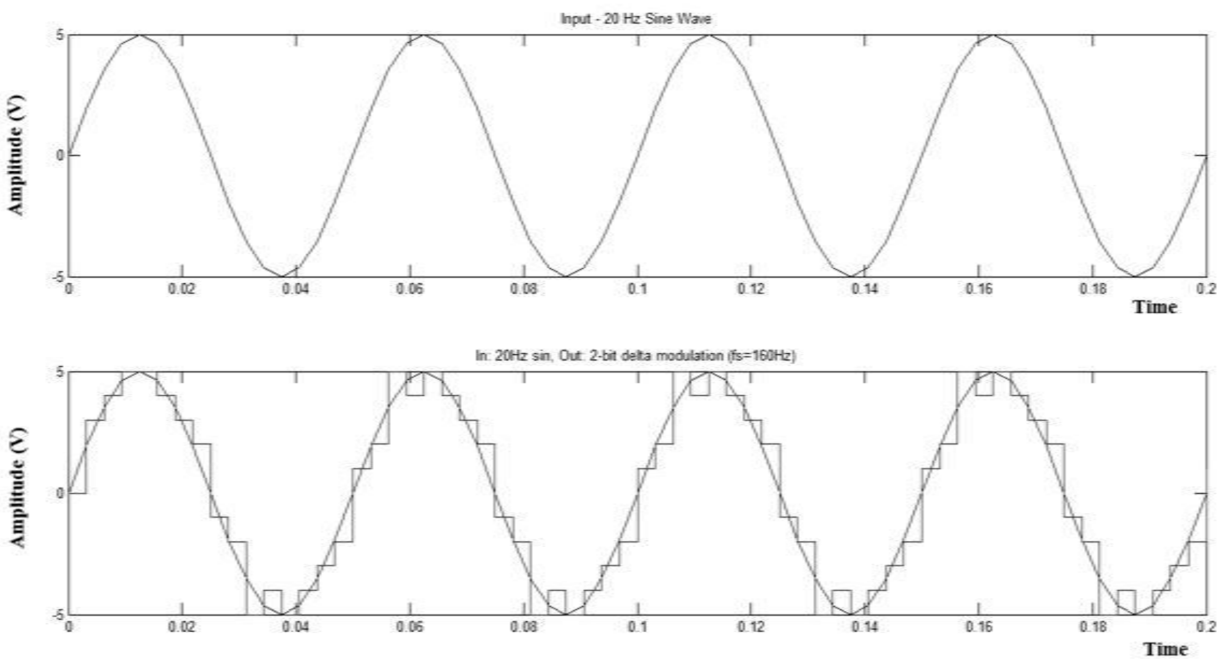


Fig 5.1a Block diagram for delta modulation and demodulation

MODELGRAPH



RESULT

Delta Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO:5b	ADAPTIVE DELTA MODULATION &DEMODULATION
DATE:	

Aim:

To study the characteristics of adaptive delta modulation and demodulation kit.

Apparatus Required:

1. Delta modulation and demodulation Kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Connect power supply in proper polarity to kits DCL-07 and switch it on.
3. Keep the Switch S2 in sigma delta position.
4. Keep the Switch S3 High.
5. Observe the various tests points in demodulator section and observe the reconstructed signal through 2^{nd} order and 4^{th} order filter .

Tabulation

	AMPLITUDE	TIME PERIOD	FREQUENCY
Message Signal			
Digital Sampler O/P			
Integrator -3 O/P			
Filter O/P			

BLOCK DIAGRAM

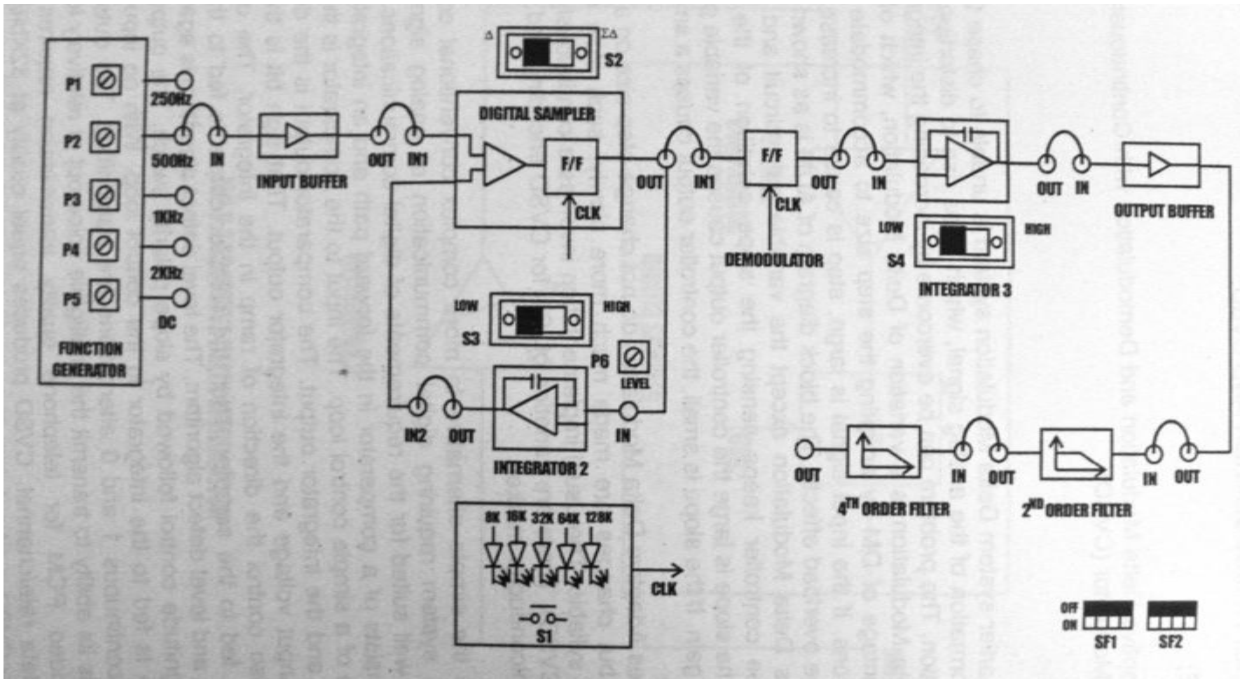
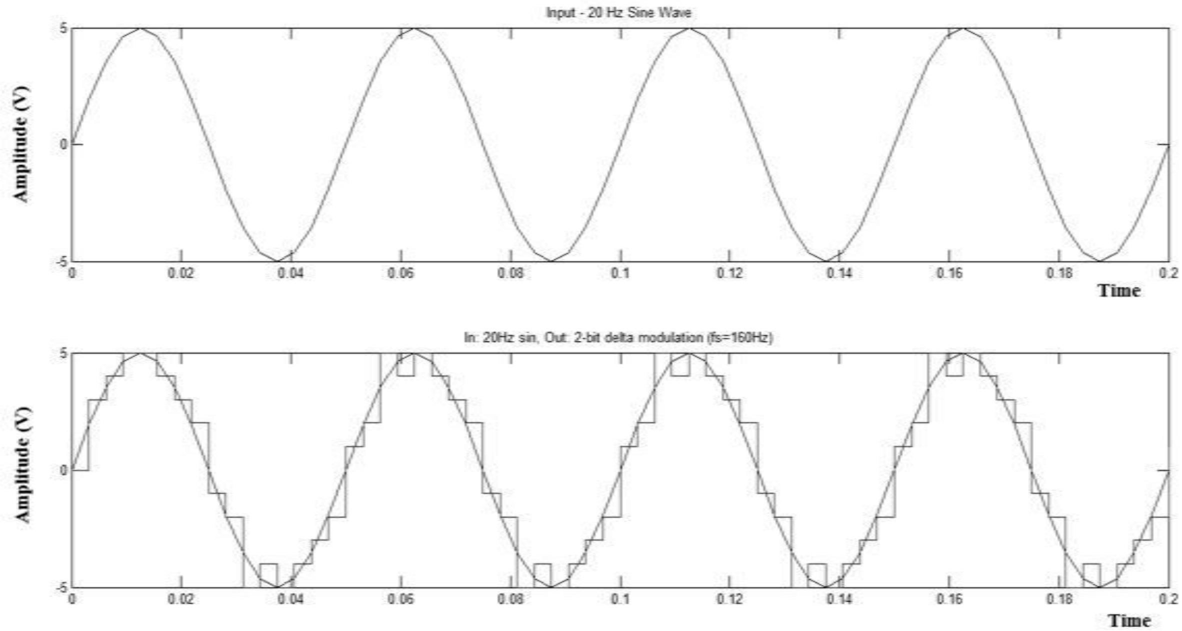


Fig 5.1b Block diagram for Adaptive delta modulation and demodulation

MODELGRAPH



RESULT

Adaptive Delta Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO :6	BFSK MODULATION AND DEMODULATION
DATE:	

Aim:

To study the characteristics of Binary Frequency Shift keying (BFSK) modulation and demodulation.

Apparatus Required:

1. BFSK Modulation (DCL-05) and demodulation kit (DCL-06)
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Connect the power supply in proper polarity to the kit and & switch it on.
3. Set the amplitude of the sine wave as desired.
4. Observe the waveforms at the
   a. Clock
   b. SIN 1 & SIN 2
   c. MODULATOR OUTPUT
   d. FSK OUT

   and plot it on graph paper

Tabulation:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (s)	Frequency(Hz)
Clock Signal			
Input 1			
Input2			
Modulator Output			
Demodulated Output			

Block Diagram:

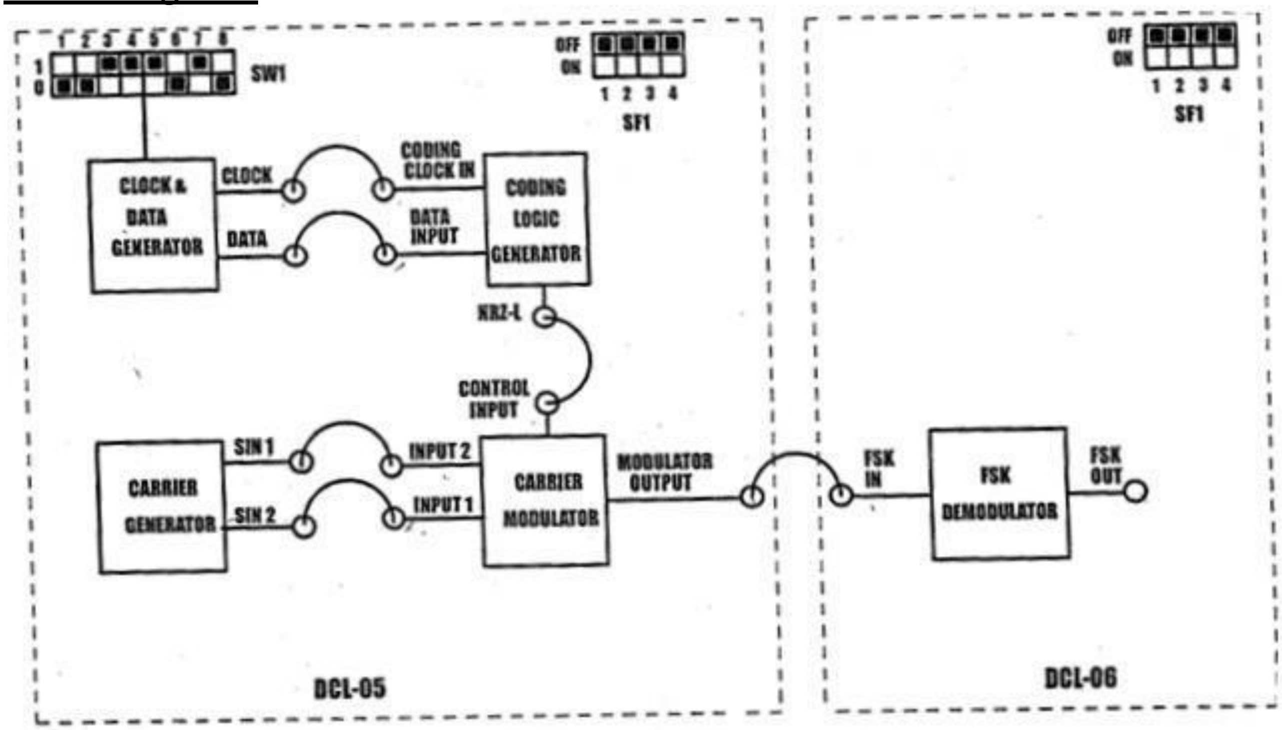
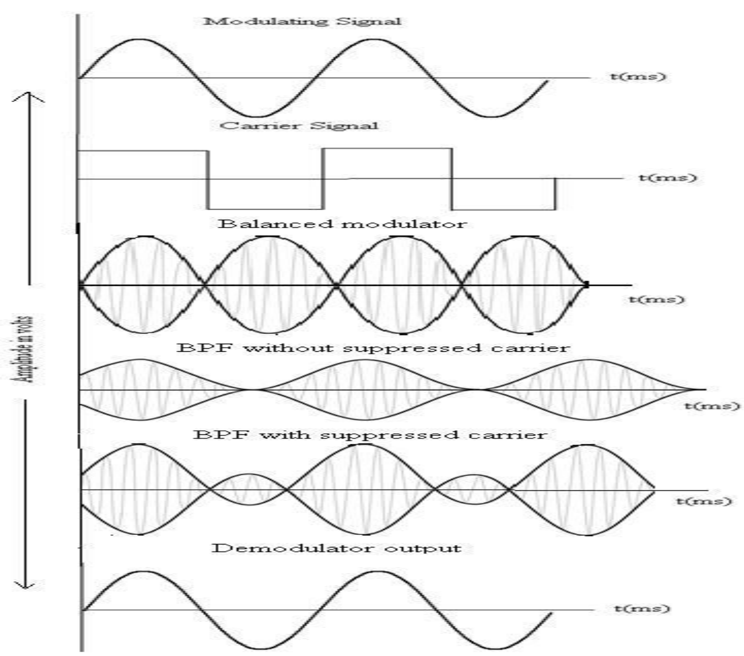


Fig 6.1 Block diagram for Frequency Shift Keying

Model Graph:



RESULT

BFSK Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO : 7	BPSK MODULATION AND DEMODULATION
DATE:	

Aim:

To construct and study the characteristics of BPSK modulation and demodulation.

Apparatus Required:

1. BPSK Modulation and demodulation kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

5. The connections are given as per the block diagram.
6. Connect the power supply in proper polarity to the kit and & switch it on.
7. Set the amplitude of the sine wave as desired.
8. Observe the waveforms at the
   a. Clock
   b. SIN 1 & SIN 2
   c. MODULATOR OUTPUT
   d. PSK OUT

   and plot it on graph paper

Tabulation:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (s)	Frequency(Hz)
Clock Signal			
Input 1			
Input2			
Modulator Output			
Demodulated Output			

Block Diagram:

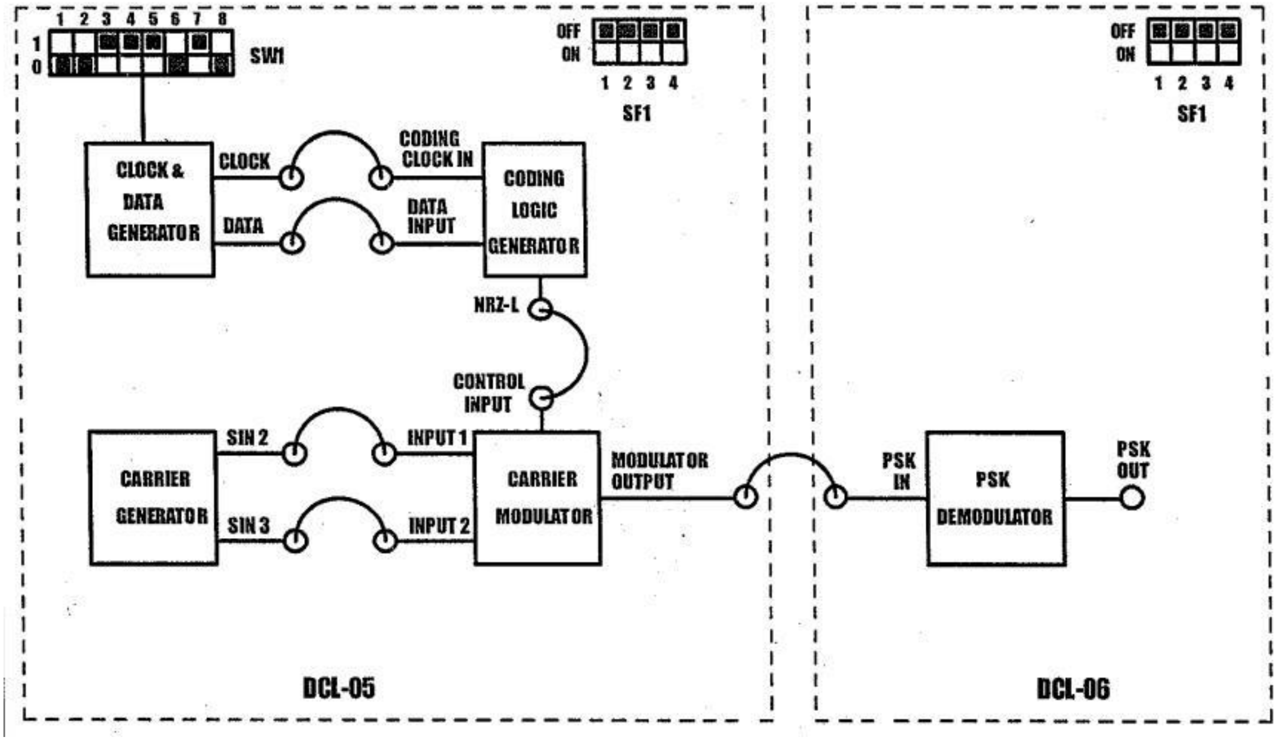
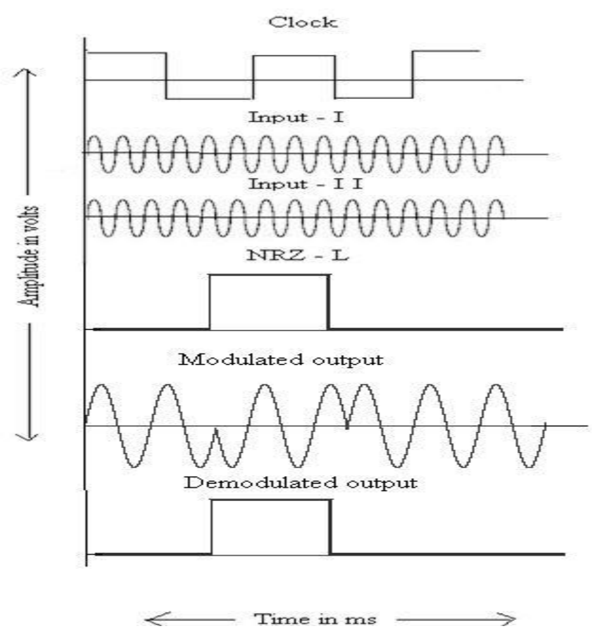


Fig 7.1 Block diagram for Binary Phase Shift Keying

Model Graph:



RESULT

BPSK Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO: 8a	TIME DIVISION MULTIPLEXING AND DEMULTIPLEXING
DATE:	

Aim:

To study the Time Division Multiplexing (TDM) and draw its waveforms.

Apparatus Required:

1. DCL 02 TDM kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Connect the power supply in proper polarity to the kit and & switch it on.
3. Set the amplitude of the sine wave as desired.
4. Observe the following waveforms at the
   a. Input Channel
   b. Multiplexer Output (TXD)
   c. Reconstructed Signal (OUT0, OUT1,OUT2,OUT3)

   and plot it on graph paper

Tabulation:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (s)	Frequency(Hz)
CARRIER (CLK)		TON= TOFF=	
MODULATING1 MODULATING2 MODULATING3 MODULATING4			
MODULATED	V1= V2= V3= V4=	T1= T2= T3= T4=	
DEMODULATED	V1= V2= V3= V4=	T1= T2= T3= T4=	

Block Diagram:

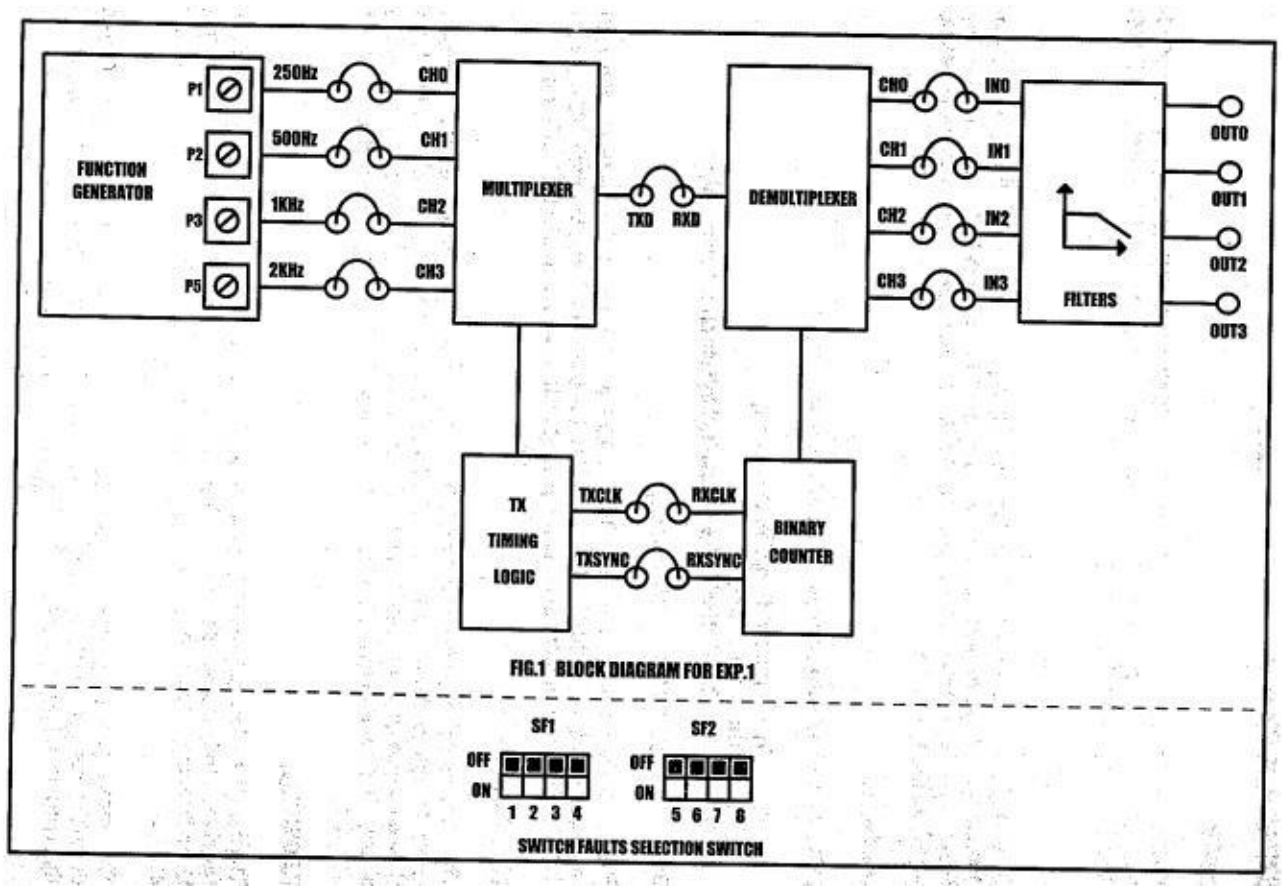
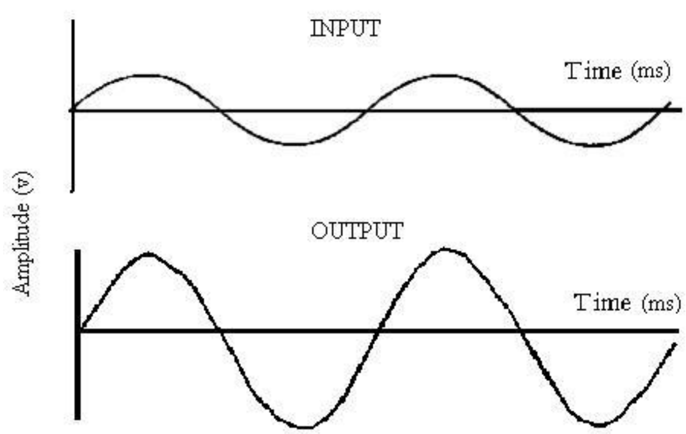


Fig 8.1a Block diagram for Time Division Multiplexing

Model graph



RESULT

TDM Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO: 8b	FREQUENCY DIVISION MULTIPLEXING AND DEMULTIPLEXING
DATE:	

Aim:

To study the Frequency Division Multiplexing (FDM) and draw its waveforms.

Apparatus Required:

1. ACL 06 FDM kit
2. Digital Storage Oscilloscope (DSO)
3. Power supply
4. Patch cords

Procedure:

1. The connections are given as per the block diagram.
2. Connect the power supply in proper polarity to the kit and & switch it on.
3. Observe the following waveforms at the
    a. Input Channel
    b. Multiplexer Output (TXD)
    c. Reconstructed Signal (OUT0, OUT1,OUT2,OUT3)

 and plot it on graph paper

Block Diagram:

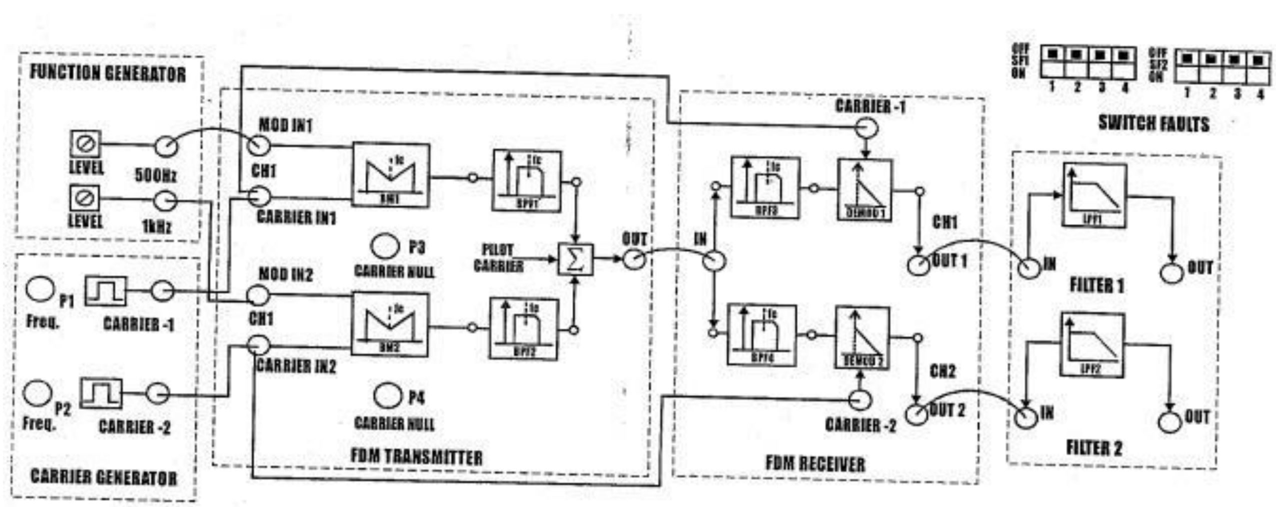
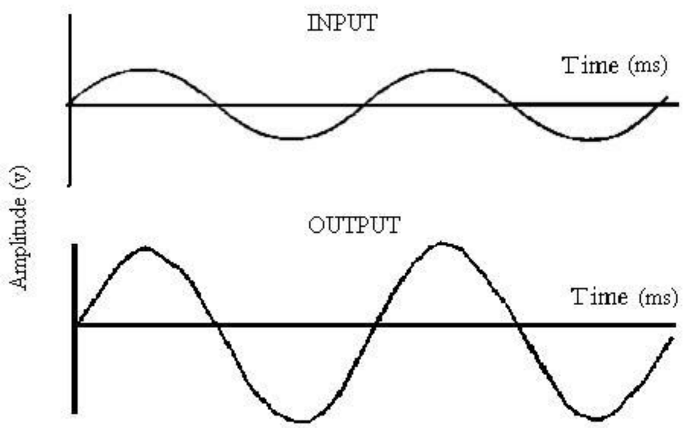


Fig 8.1b Block diagram for Frequency Division Multiplexing

Tabular Column:

SIGNAL	AMPLITUDE (V)	TIME PERIOD (s)	Frequency(Hz)
Input 1			
Input 1			
Modulated Input			
Demodulated Output 1			
Demodulated Output 2			

Model graph



RESULT

FDM Modulation and Demodulation are verified in the hardware kit and its waveforms are studied.

EXP. NO: 9	LINE CODING AND DECODING TECHNIQUE
DATE:	

AIM:

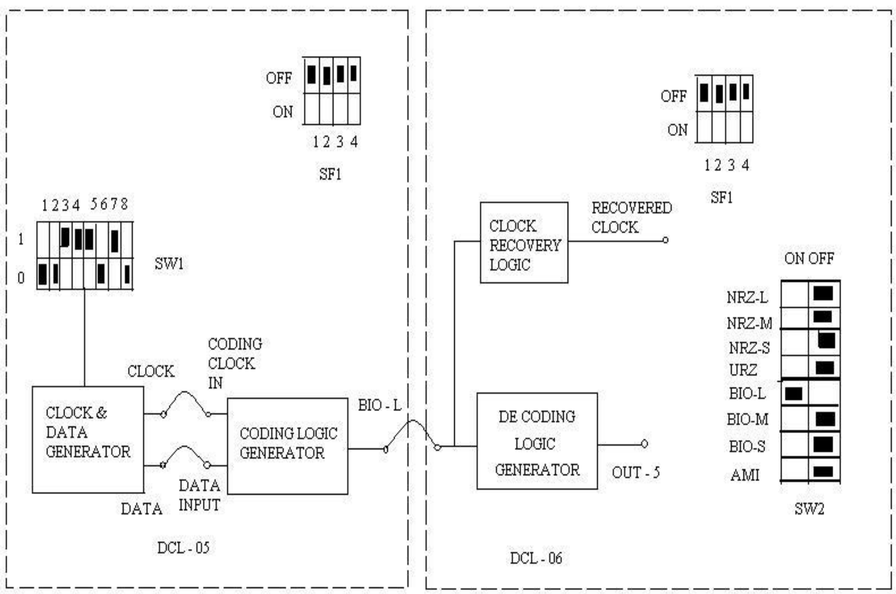
To perform data coding and decoding techniques for phase encoded format.

APPARATUS REQUIRED

1. Experiment kits DCL-05 & DCL-06
2. Patch cords
3. Power supply

DIAGRAM:

BLOCK DIAGRAM FOR BIPHASE LEVEL CODING / DECODING TECHNIQUE



THEORY

This phase – encoded – group consists of

a) Biphase – level

b) Biphase – mark

c) Biphase – Space

With the Biphase – L ‘ one’ is represented by a half bit wide pulse partitioned during the first half the bit interval and a ‘zero’ is represent by a half bit white pulse partitioned during the second half of the bit interval.

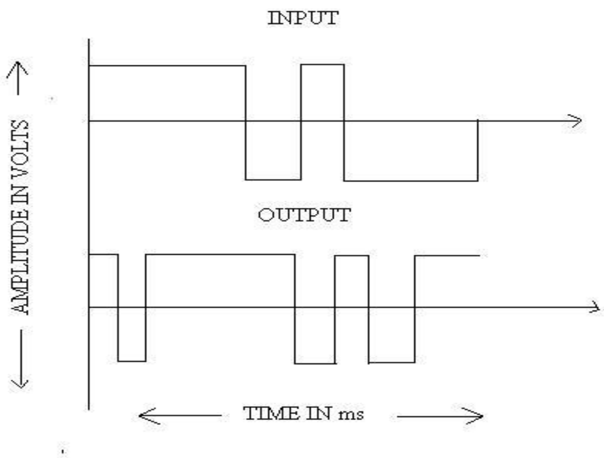
PROCEDURE

1. Connections are given as per the circuit diagram
2. Connect CLOCK and data generated on DCL-05 to coding CLOCK IN and data input respectively by means of patch cords.
3. Connect the coded data NRZ – L on DCL-05 to corresponding DATA INPUT NRZ–L of the decoding logic on DCL-06
4. Keep the switches SW2 for NRZ-L to ON position
5. Observe the coded and decoded signal on the oscilloscope ,Observe the waveform

TABULATION:

SIGNALS	AMPLITUDE (V)	TIME (ms)
Input		
Output		

MODEL GRAPH:



RESULT:

The data coding and decoding techniques for phase encoded format are studied.

EXP. NO: 10	AMPITUDE SHIFT KEYING (ASK),FREQUENCY SHIFT KEYING TECHNIQUE (FSK) & PHASE SHIFT KEYING (PSK) USING MATLAB
DATE:	

AIM

To write a program to perform ASK,FSK & PSK using MATLAB and to obtain its output waveforms.

APPARATUS REQUIRED

Personal computer, MATLAB R2012a

PROCEDURE

1. Click start, select All programs, select MATLAB R2012a
2. Click file, select new M-file
3. Type the program
4. Save it with extension.m
5. Click RUN to obtain the output waveform

PROGRAM

ASK

```
clc %for clearing the command window
close all %for closing all the window except command window
clear all %for deleting all the variables from the memory
fc1=input('Enter the freq of 1st Sine Wave carrier:');
fc2=input('Enter the freq of 2nd Sine Wave carrier:');
fp=input('Enter the freq of Periodic Binary pulse (Message):');
amp=input('Enter the amplitude (For Both Carrier & Binary Pulse Message):');
amp=amp/2;
t=0:0.001:1;
c1=amp.*sin(2*pi*fc1*t);
c2=amp.*sin(2*pi*fc2*t);
subplot(5,1,1);
plot(t,c1)
xlabel('Time')
ylabel('Amplitude')
title('Carrier 1
Wave') subplot(5,1,2)
```

```
plot(t,c2)
xlabel('Time')
ylabel('Amplitude')
title('Carrier 2 Wave')
m=amp.*square(2*pi*fp*t)+amp;
subplot(5,1,3)
plot(t,m)
xlabel('Time')
ylabel('Amplitude')
title('Binary Message
Pulses') for i=0:1000
   if m(i+1)==0
      mm(i+1)=c2(i+1);
      else
      mm(i+1)=c1(i+1);
   end
end
subplot(5,1,4)
plot(t,mm)
xlabel('Time')
ylabel('Amplitude')
title('Modulated Wave')
for i=0:1000
   if mm(i+1)==c2(i+1)
      dm(i+1)=m(i+1);
   else
      dm(i+1)=m(i+1);
   end
end
subplot(5,1,5)
plot(t,dm)
xlabel('Time')
ylabel('Amplitude')
title('Demodulated signal')
```

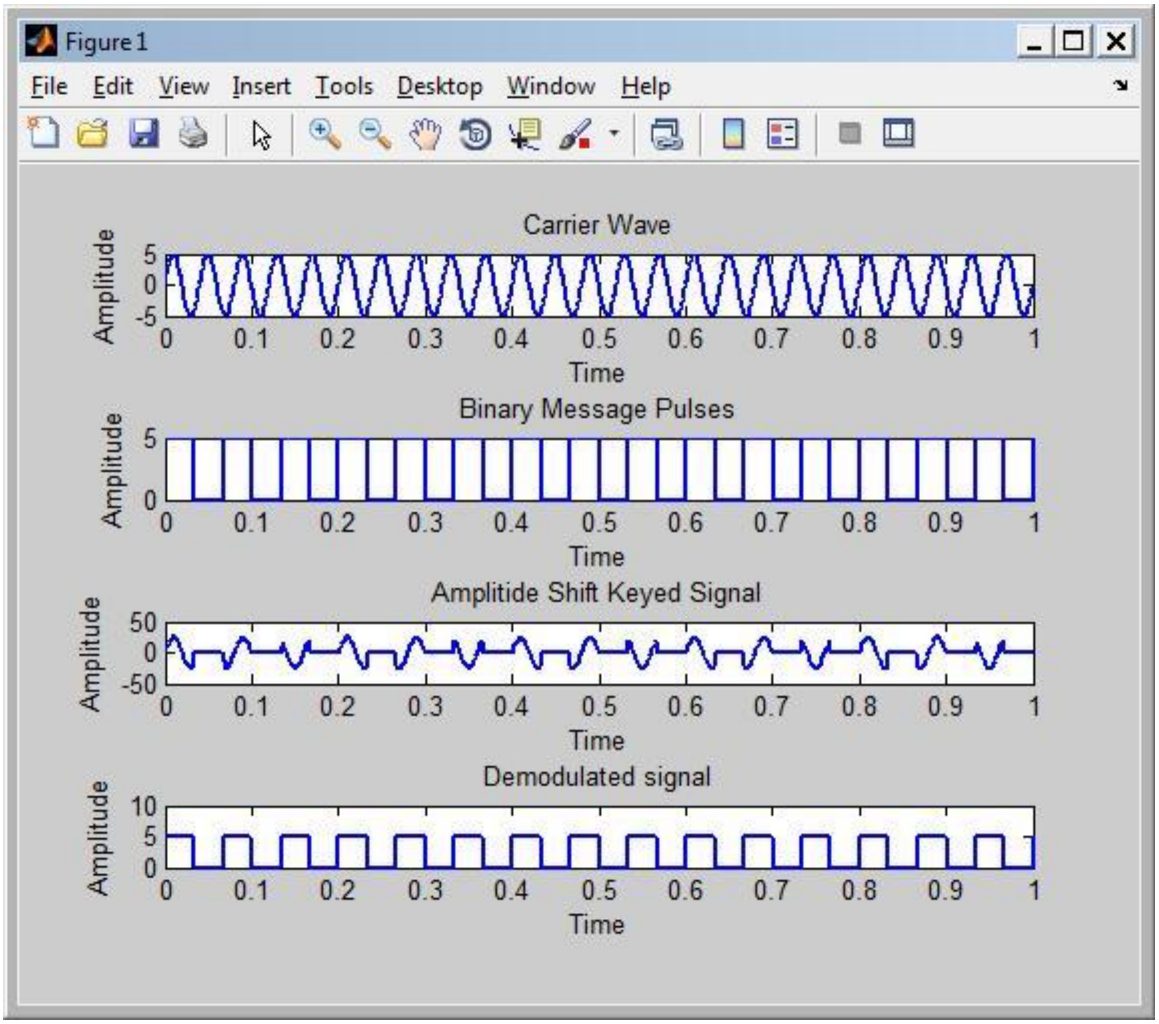


Fig 10.1 Matlab Simulation of ASK

<u>FSK</u>

```
clc %for clearing the command window
close all %for closing all the window except command
window clear all %for deleting all the variables from the
memory fc1=input('Enter the freq of 1st Sine Wave carrier:');
fc2=input('Enter the freq of 2nd Sine Wave carrier:');
fp=input('Enter the freq of Periodic Binary pulse (Message):');
amp=input('Enter the amplitude (For Both Carrier & Binary Pulse
Message):'); amp=amp/2;
t=0:0.001:1;
c1=amp.*sin(2*pi*fc1*t);
c2=amp.*sin(2*pi*fc2*t);
subplot(5,1,1);
plot(t,c1)
xlabel('Time')
```

```
ylabel('Amplitude')
title('Carrier 1 Wave')
subplot(5,1,2)
plot(t,c2)
xlabel('Time')
ylabel('Amplitude')
title('Carrier 2 Wave')
m=amp.*square(2*pi*fp*t)+amp;
subplot(5,1,3)
plot(t,m)
xlabel('Time')
ylabel('Amplitude')
title('Binary Message
Pulses') for i=0:1000
    if m(i+1)==0
        mm(i+1)=c2(i+1);
        else
        mm(i+1)=c1(i+1);
    end
end
subplot(5,1,4)
plot(t,mm)
xlabel('Time')
ylabel('Amplitude')
title('Modulated
Wave') for i=0:1000
    if mm(i+1)==c2(i+1)
        dm(i+1)=m(i+1);
    else
        dm(i+1)=m(i+1);
    end
end
subplot(5,1,5)
plot(t,dm)
xlabel('Time')
ylabel('Amplitude')
title('Demodulated signal')
```

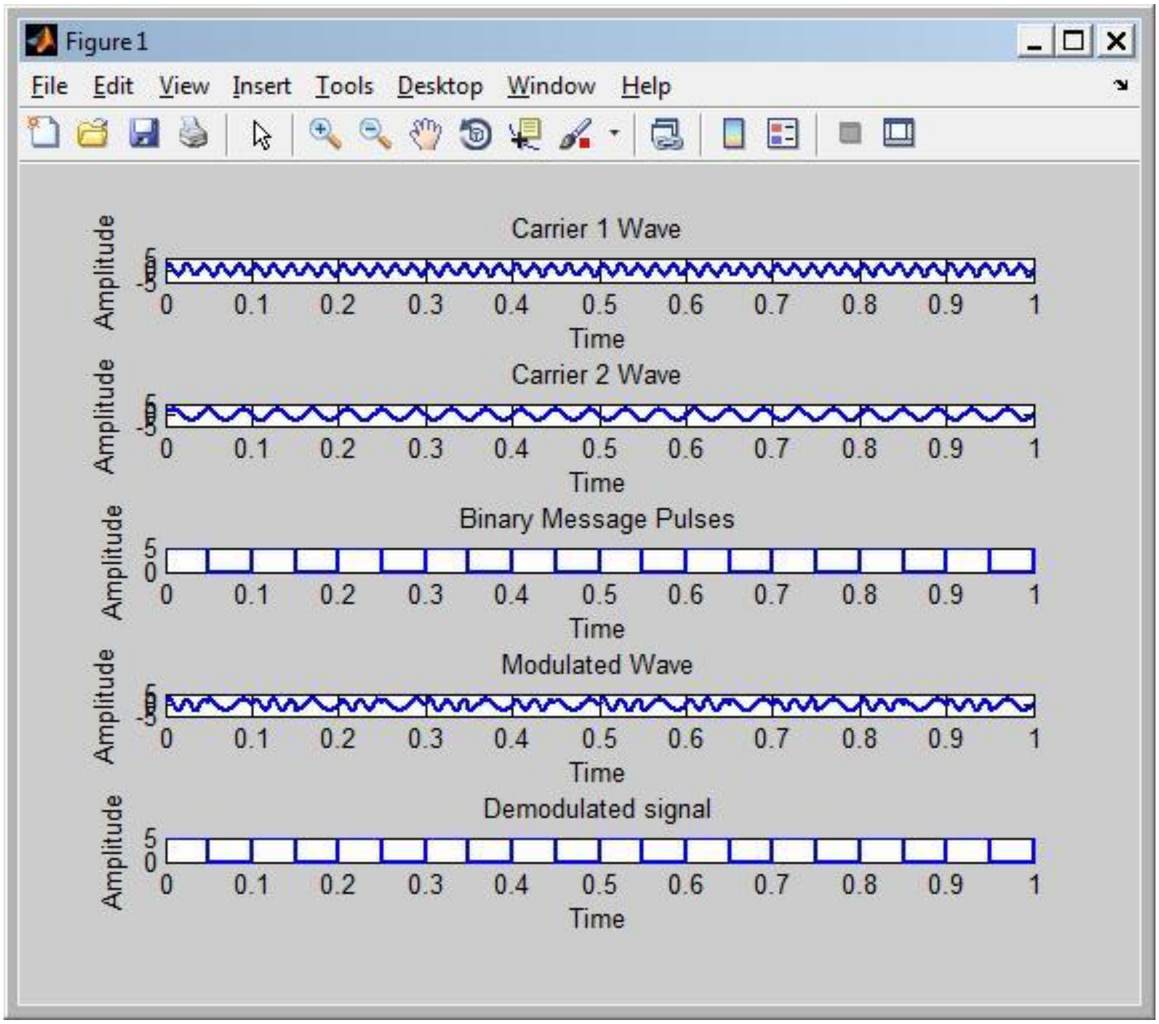


Fig 10.2 Matlab Simulation of FSK

PSK

```
clear all;
clc;
close all;
set(0,'defaultlinelinewidth',2);
A=5;
t=0:.001:1;
f1=input('Carrier Sine wave frequency
='); f2=input('Message frequency =');
x=A.*sin(2*pi*f1*t);%Carrier Sine
subplot(4,1,1);
plot(t,x);
xlabel('time');
ylabel('Amplitude');
```

```
title('Carrier');
grid on;
u=square(2*pi*f2*t);%Message
signal subplot(4,1,2);
plot(t,u);
xlabel('time');
ylabel('Amplitude');
title('Message
Signal'); grid on;
 v=x.*u;%Sine wave multiplied with square wave
subplot(4,1,3);
plot(t,v);
xlabel('t');
ylabel('y');
title('PSK');
grid on;
 d=v./x;%Sine wave multiplied with square
wave subplot(4,1,4);
plot(t,d);
xlabel('t');
ylabel('y');
title('Demodulated
PSK'); grid on;
```

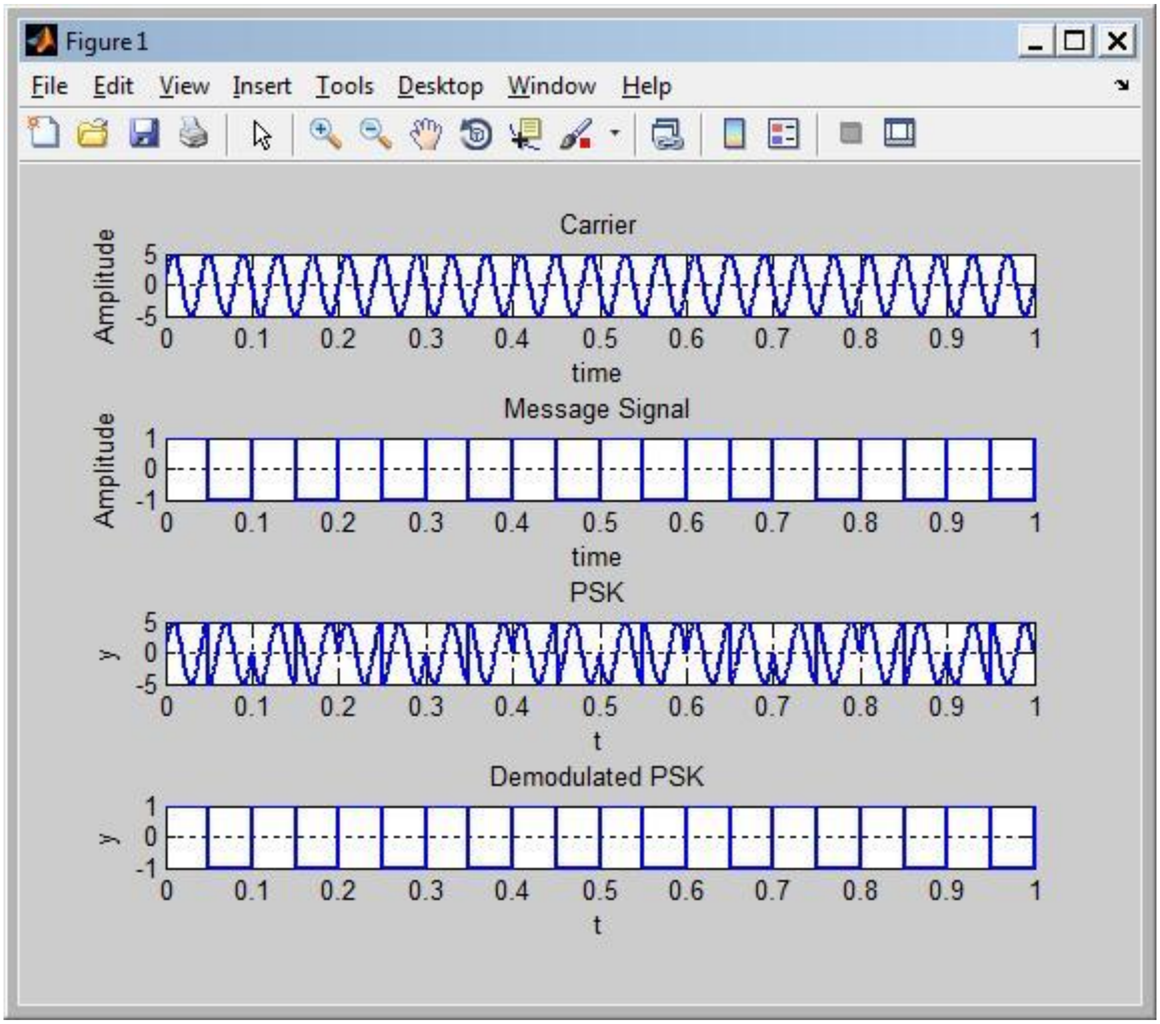


Fig 10.2 Matlab Simulation of PSK

RESULT

Thus the program for performing frequency shift keying using MATLAB was performed.