DIGITAL COMMUNICATIONS

LAB MANUAL

Subject Code	: AEC105
Regulations	: IARE-R16
Class	: V Semester
Branch	: ECE

Prepared by

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Department of Electronics & Communication Engineering
INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad – 500 043

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Electronics & Communication Engineering

Vision
To produce professionally competent Electronics and Communication Engineers capable of effectively and efficiently addressing the technical challenges with social responsibility.

Mission
The mission of the Department is to provide an academic environment that will ensure high quality education, training and research by keeping the students abreast of latest developments in the field of Electronics and Communication Engineering aimed at promoting employability, leadership qualities with humanity, ethics, research aptitude and team spirit.

Quality Policy
Our policy is to nurture and build diligent and dedicated community of engineers providing a professional and unprejudiced environment, thus justifying the purpose of teaching and satisfying the stake holders. A team of well qualified and experienced professionals ensure quality education with its practical application in all areas of the Institute.

Philosophy
The essence of learning lies in pursuing the truth that liberates one from the darkness of ignorance and Institute of Aeronautical Engineering firmly believes that education is for liberation. Contained therein is the notion that engineering education includes all fields of science that plays a pivotal role in the development of world-wide community contributing to the progress of civilization. This institute, adhering to the above understanding, is committed to the development of science and technology in congruence with the natural environs. It lays great emphasis on intensive research and education that blends professional skills and high moral standards with a sense of individuality and humanity. We thus promote ties with local communities and encourage transnational interactions in order to be socially accountable. This accelerates the process of transfiguring the students into complete human beings making the learning process relevant to life, instilling in them a sense of courtesy and responsibility.

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Electronics & Communication Engineering

Program Outcomes	
PO1	An ability to apply knowledge of basic sciences, mathematical skills, engineering and technology to solve complex electronics and communication engineering problems
PO2	An ability to identify, formulate and analyze engineering problems using knowledge of Basic Mathematics and Engineering Sciences
PO3	An ability to provide solution and to design Electronics and Communication Systems as per social needs
PO4	An ability to investigate the problems in Electronics and Communication field and develop suitable solutions.
PO5	An ability to use latest hardware and software tools to solve complex engineering problems
PO6	An ability to apply knowledge of contemporary issues like health, Safety and legal which influences engineering design
PO7	An ability to have awareness on society and environment for sustainable solutions to Electronics and Communication Engineering problems
PO8	An ability to demonstrate understanding of professional and ethical responsibilities
PO9	An ability to work efficiently as an individual and in multidisciplinary teams
PO10	An ability to communicate effectively and efficiently both in verbal and written form
PO11	An ability to develop confidence to pursue higher education and for life-long learning
PO12	An ability to design, implement and manage the electronic projects for real world applications with optimum financial resources
Program Specific Outcomes	
PSO1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.
PSO2	**Problem-Solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.
PSO3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

S. No.	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Understand Sampling theorem.	PO 1	PSO1
2	Understand Analyse Pulse Amplitude modulation.	PO 1	PSO1
3	Understand Pulse width modulation.	PO 1	PSO1
4	Understand Pulse position modulation.	PO 1	PSO1
5	Analyze the generation and detection of PCM.	PO 5	PSO1
6	Analyze the generation and detection of Differential Pulse Code modulation.	PO 1	PSO1
7	Analyze the generation and detection of Delta modulation.	PO 2	PSO1
8	Analyze the generation and detection of Frequency Shift Keying.	PO 5	PSO1
9	Analyze the generation and detection of Phase Shift Keying.	PO 5	PSO1
10	Analyze the generation and detection of DPSK.	PO 2	PSO1
11	Analyze the generation and detection Amplitude Shift Keying.	PO 5	PSO1
12	Study Of The Spectral Characteristics of PAM and QAM.	PO 1	PSO1
13	Analyze the generation and detection of Quadrature Phase Shift Keying.	PO 5	PSO1
14	Determine the bandwidth and phase of the signals using MATLAB for QPSK & DPSK.	PO 5	PSO1

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Certificate

This is to Certify that it is a bonafied record of Practical work done by Sri/Kum.______________________________bearing the Roll No.________________________of_____________ Class____ Branch in the______________________________laboratory during the Academic year____________________under our supervision.

Head of the Department

Lecture In-Charge

External Examiner

Internal Examiner

Electronics and Communication Engineering

Course Overview:

This laboratory course builds on the "digital communications" which is mandatory for all students of electronics and communication engineering. The course aims at practical experience with the processing the digital signals for various modulations and demodulations. Experiments cover fundamental concepts of the digital modulation and demodulation process. The objective of this laboratory is to enable the students to acknowledge with various digital modulation techniques. They can critically analyze the behavior of their implementation

Course Out-Come:

Upon the completion of Digital Communications practical course, the student will be able to:

1. **Understand** Basics of conversions from analog signals into digital signals.
2. **Analyze** the generation Various Signals and detection of the signals.
3. **Determine** the bandwidth and phase of the signals.

INSTRUCTIONS TO THE STUDENTS

1. Students are required to attend all labs.
2. Students should work individually in the hardware and software laboratories.
3. Students have to bring the lab manual cum observation book, record etc along with them whenever they come for lab work.
4. Should take only the lab manual, calculator (if needed) and a pen or pencil to the work area.
5. Should learn the pre lab questions. Read through the lab experiment to familiarize themselves with the components and assembly sequence.
6. Should utilize 3 hour's time properly to perform the experiment and to record the readings. Do the calculations, draw the graphs and take signature from the instructor.
7. If the experiment is not completed in the stipulated time, the pending work has to be carried out in the leisure hours or extended hours.
8. Should submit the completed record book according to the deadlines set up by the instructor.
9. For practical subjects there shall be a continuous evaluation during the semester for 30 sessional marks and 70 end examination marks.
10. Out of 30 internal marks, 20 marks shall be awarded for day-to-day work and 10 marks to be awarded by conducting an internal laboratory test.

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DIGITAL COMMUNICATION LAB SYLLABUS

Recommended Systems/Software Requirements:

Function Generator: 0-
500MHz RF Generators: A, B,
C, D, E, F band of frequencies
MATLAB and hardware related to experiments.

LIST OF EXPERIMENTS	
Week-1	**SAMPLING THEOREM VERIFICATION**
Verification of sampling theorem for under, perfect, over sampling cases.	
Week-2	**PULSE AMPLITUDE MODULATION AND DEMODULATION**
Generation of Pulse Amplitude modulation and demodulation using hardware and matlab.	
Week-3	**PULSE WIDTH MODULATION AND DEMODULATION**
Generation of Pulse width modulation and demodulation using hardware and matlab.	
Week-4	**PULSE POSITION MODULATION AND DEMODULATION**
Generation of pulse position modulation and demodulation using hardware and matlab.	
Week-5	**PULSE CODE MODULATION**
Generation of pulse code modulation and demodulation using hardware and understanding the concept analog to digital conversion.	
Week-6	**DIFFERENTIAL PULSE CODE MODULATION**
Generation of differential pulse code modulation and demodulation using hardware.	
Week-7	**DELTA MODULATION**
Generation of delta modulation and demodulation using hardware .Understanding difference between PCM and DM.	
Week-8	**FREQUENCY SHIFT KEYING**
Generation of Frequency shift keying modulation and demodulation using hardware.	
Week-9	**PHASE SHIFT KEYING**
Generation of Phase shift keying modulation and demodulation using hardware.	
Week-10	**DIFFERENTIAL PHASE SHIFT KEYING**
Generation of Differential Phase shift keying modulation and demodulation using hardware.	
WeeK-11	**AMPLITUDE SHIFT KEY(ASK)**

Generation of Amplitude Shift Key modulation and demodulation using hardware.	
Week-12	**STUDY OF THE SPECTRAL CHARACTERISTICS OF PAM AND QAM**
Understand frequency domain description of PAM and QAM.	
Week 13	**QUADRATURE PHASE SHIFT KEYING**
Generation of QPSK modulation and demodulation using hardware.	
Week 14	**MATLAB for QPSK & DPSK**
Understand frequency domain description of amplitude modulation and frequency modulation.	

EXPERIMENT No: 1

VERIFICATION OF SAMPLING THEOREM

1.1 Aim

To perform and verify the sampling theorem and reconstruction of sampled wave form.

1.2 Equipment Required

S.No	Equipment / Components Required	Range	Quantity
1	Sampling Theorem Trainer Kit	-----	1
2	Function Generator	(0-2) MHz	1
3	C.R.O.	(0-30) MHz	1
4	Connecting wires.	----	-
5.	BNC Probes		

1.3 Theory

Sampling theorem states that if the sampling rate in any pulse modulation system exceeds twice the maximum signal frequency the original signal can be reconstructed in the receiver with minimum distortion. Let m (t) be a signal whose highest frequency component is fm. Let the value of m (t) be obtained at regular intervals separated by time T far far less than (1/2 fm) The sampling is thus periodically done at each TS seconds. Now the samples m(nTS) where n is an integer which determines the signals uniquely. The signal can be reconstructed from these samples without distortion.

Time Ts is called the SAMPLING TIME.
The minimum sampling rate is called NYQUIST RATE.

The validity of sampling theorem requires rapid sampling rate such that at least two samples are obtained during the course of the interval corresponding to the highest frequency of the signal under analysis. Let us consider an example of a pulse modulated signal, containing speech information, as is used in telephony. Over standard telephone channels the frequency range of A.F. is from 300 Hz to 3400 Hz. For this application the sampling rate taken is 8000 samples per second. This is an International standard. We can observe that the pulse rate is more than twice the highest audio frequency used in this system. Hence the sampling theorem is satisfied and the resulting signal is free from sampling error.

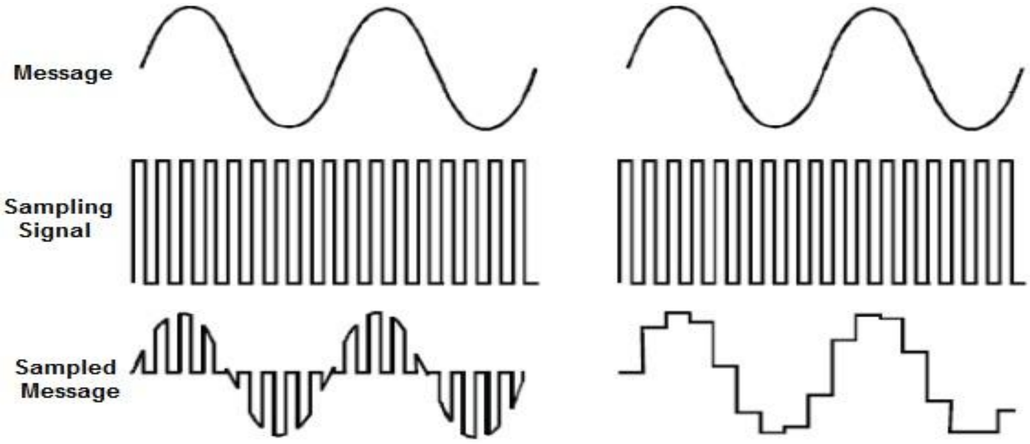
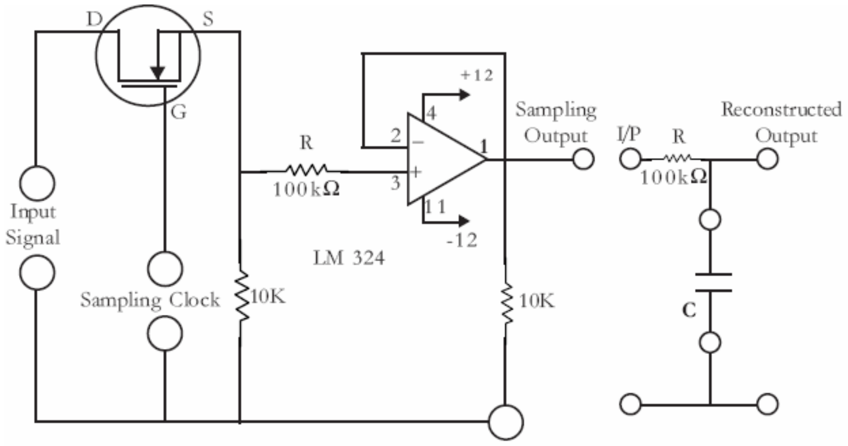


Figure 1(a) Figure 1(b)

1.4 Circuit Diagram



1.5 Procedure

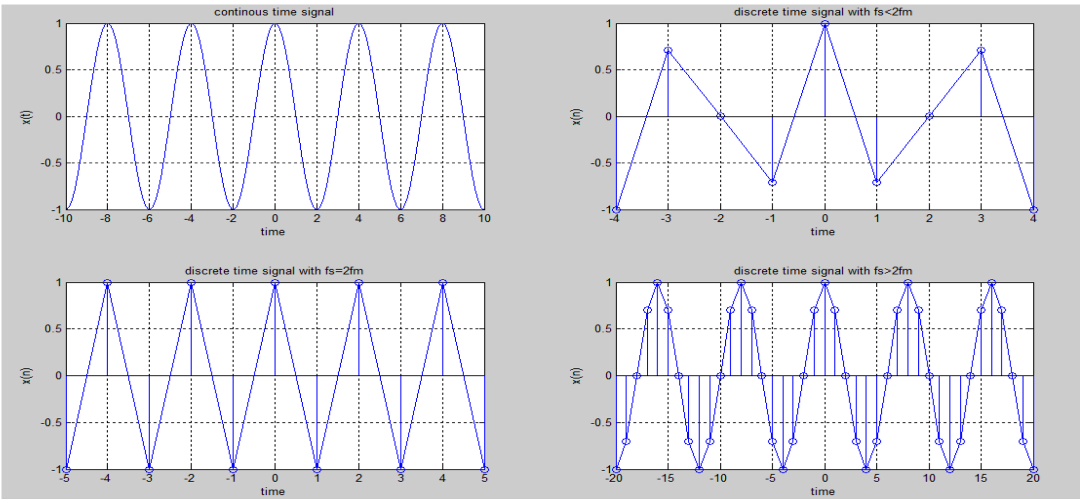
1. Connections are made as per the Circuit diagram.
2. Apply the input signal with a frequency of 500Hz (VP-P) using a function generator.
3. Sampling clock frequency which is variable of 3 KHz to 50KHz should be connected across the terminals which is indicated.
4. Now observe the sampling output of the circuit at the o/p.
5. By using the capacitors provided on the trainer, reconstruct the signal and Verify it with the given input.
6. Reconstructed signal voltage will be depends on capacitor value.
7. Vary the sampling frequency and study the change in reconstructed signal.
8. If the sampling clock frequency is below 20 KHz you will observe the distorted demodulated output.

1.6 Matlab Program

```
close all;
clear all
clc
t=-10:.01:10;
T=4;
fm=1/T;
x=cos(2*pi*fm*t); % input signal
subplot(2,2,1);
plot(t,x);
xlabel('time');
ylabel('x(t)');
title('continous time signal');
grid;
n1=-4:1:4;
fs1=1.6*fm;
fs2=2*fm;
fs3=8*fm;
%discrete time signal with fs<2fm
x1=cos(2*pi*fm/fs1*n1);
subplot(2,2,2);
stem(n1,x1);
xlabel('time');
ylabel('x(n)');
title('discrete time signal with fs<2fm');
hold on
subplot(2,2,2);
```

```
plot(n1,x1)
grid;
%discrete time signal with fs=2fm
n2=-5:1:5;
x2=cos(2*pi*fm/fs2*n2);
subplot(2,2,3);
stem(n2,x2);
xlabel('time');
ylabel('x(n)');
title('discrete time signal with fs=2fm');
hold on
subplot(2,2,3);
plot(n2,x2)
%discrete time signal with fs>2fm
grid;
n3=-20:1:20;
x3=cos(2*pi*fm/fs3*n3);
subplot(2,2,4);
stem(n3,x3);
xlabel('time');
ylabel('x(n)');
title('discrete time signal with fs>2fm');
hold on
subplot(2,2,4);
plot(n3,x3)
grid;
```

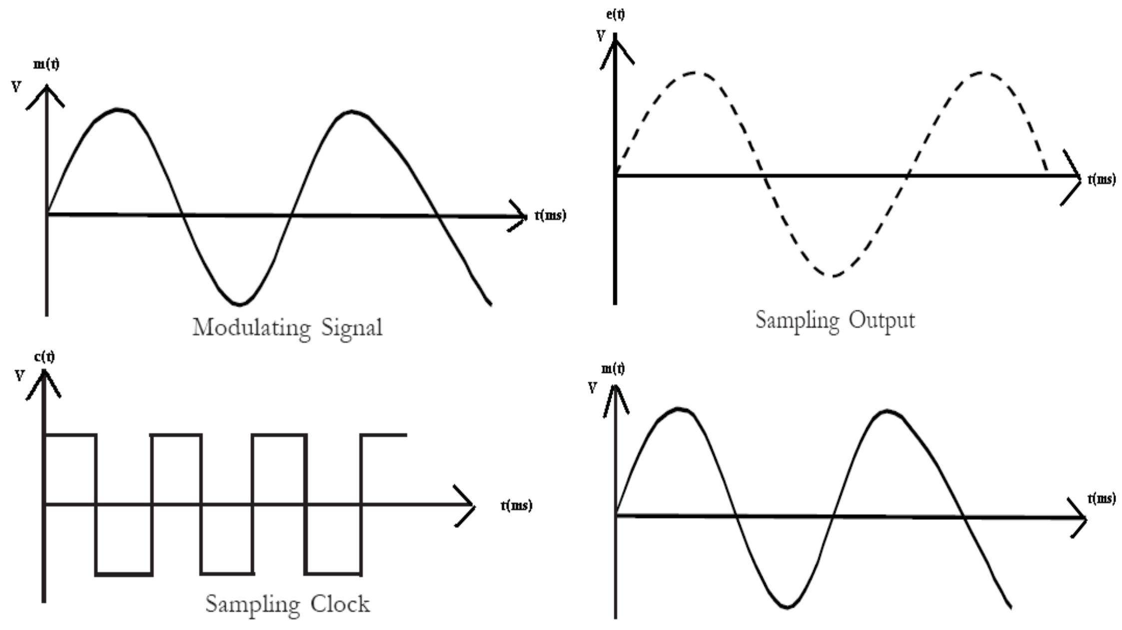
1.7 Expected Waveforms



1.8 Precautions

1. Check the connections before giving the power supply
2. Observation should be done carefully

1.9 Expected Waveforms



1.10 Pre Lab Questions

1. Define Sampling Theorem.
2. What is aliasing effect?
3. Explain Need for Sampling?

1.11 Lab Assignment

1. Observe the Sampling output of Triangular wave.
2. Observe the reconstruction waveform for fs<2fm.

1.12 Post Lab Questions

1. Define Nyquist Rate.
2. Explain different methods of Sampling.
3. How Sampling affects the input signal.

Result:

Hence, sampling theorem is verified and the sampled waveform is reconstruct

EXPERIMENT No: 2

PULSE AMPLITUDE MODULATION AND DEMODULATION

2.1 Aim

To perform the operation pulse amplitude modulation and demodulation using Trainer Kits

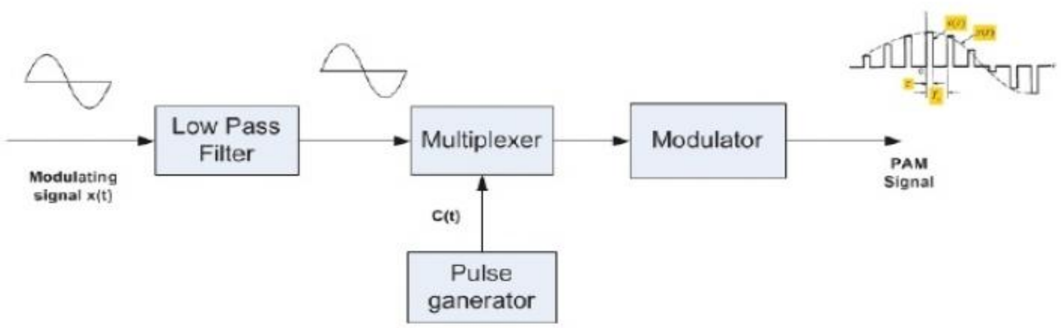
2.2 Equipment / Components Required

S.No	Equipment / Components Required	Range	Quantity
1	Pulse amplitude modulation trainer(PHY-60)	--------	1
2	Signal generator		
3	C.R.O.	(0-30)MHz	1
4	Connecting wires.	-------	-

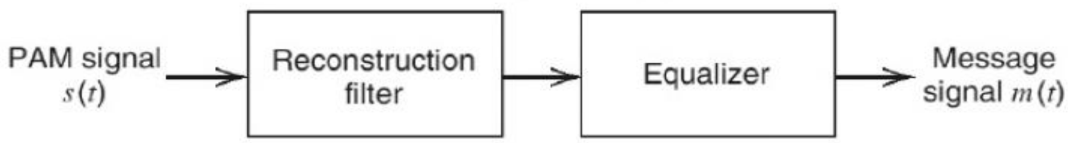
2.3 Theory

Pulse Amplitude Modulation (PAM) is the simplest and most basic form of analog pulse modulation, In PAM, the amplitudes of regularly spaced pulses are varied in proportional to the corresponding sample values of a continuous message signal; the pulses can be of a rectangular form or some other appropriate shape.

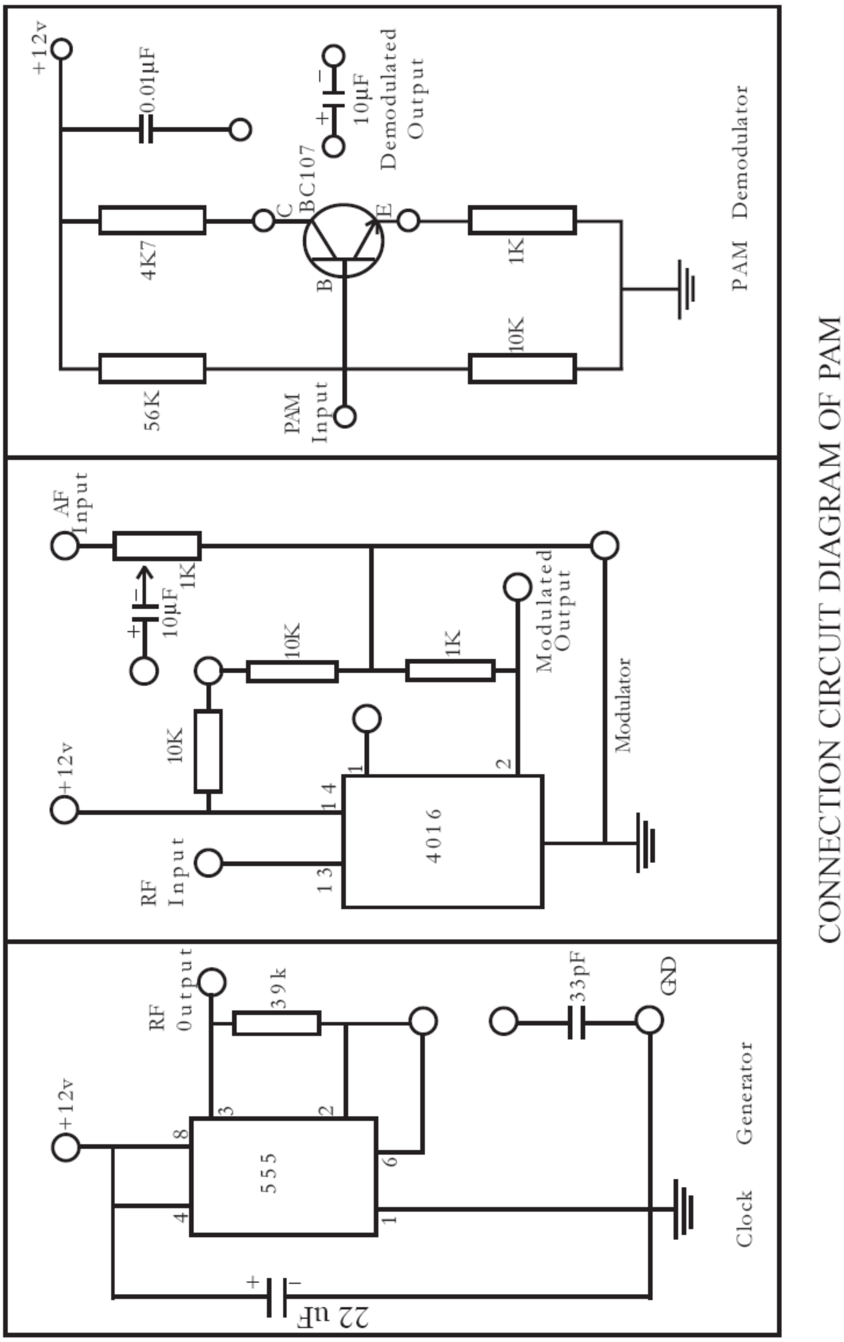
Block diagram of PAM generation



System for recovering message signal m(t) from PAM signal s(t).



2.4 Circuit diagram



2.5 Procedure

1. Switch on Physitech's pulse Amplitude modulation and demodulatioin trainer.
2. In clock generator section connect pin 6 of 555IC to the 33pfcapacitor terminal.
3. Check the clock generator (RF) output signal.
4. Connect RF output of clock generator to the RF input of modulator section.
5. Connect a 1 KHz; 2vp-p of sine wave from function generator to the AF input of modulator section.
6. Short the 10F terminal and 10k terminal of modulator.
7. Connect 10k terminal to pin 1 of IC 4016.
8. Connect the CRO to modulated output of modulator section.

9. Adjust the 1k potentiometer to vary the amplitude of the modulatd signal.
10. Adjust the AF signal frequency from 1KHZ-10KHZ to get stable output waveform. While increases the AF signal freqency decreses the output signal pulses.
11. During demodulation, connect the the modulated output to the PAM input of Demodulator section.
12. Connect channel 1 of CRO to modulating signal and channel-2 to demodulated output. Observe the two waveforms that they are 1800out of phase, since the transistor detector operates in CE configuration.

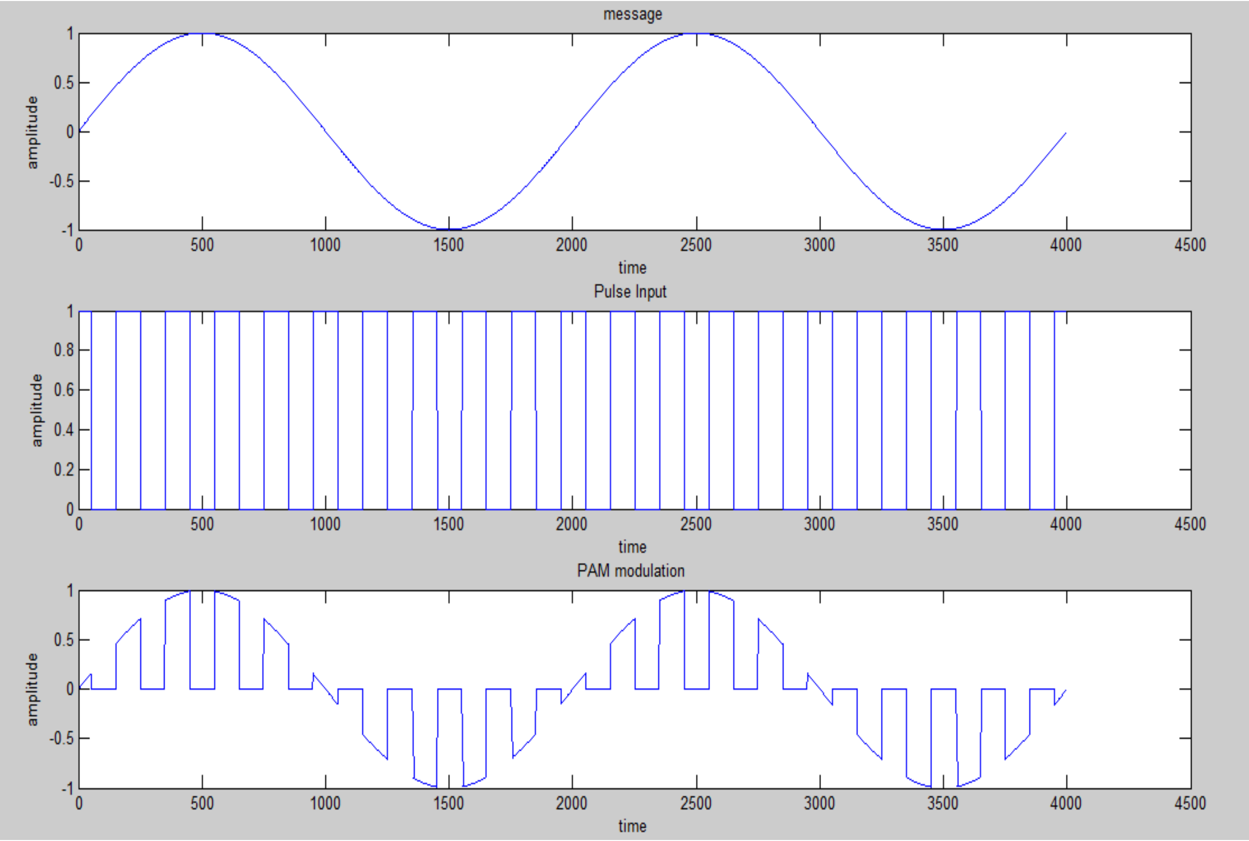
2.6 Precautions

1. Check the connections before giving the power supply
2. Observation should be done carefully

2.7 Matlab Program

```
close all
clear all
clc
t = 0 : 1/1e3 : 4; % 1 kHz sample freq for 1 sec
d = 0 : 1/5 : 4;
x = sin(2*pi/4*2*t); %message signal
figure;
subplot(3,1,1)
plot(x);
title('message');
xlabel('time');
ylabel('amplitude');
y = pulstran(t,d,'rectpuls',0.1); %generation of pulse input
subplot(3,1,2)
plot(y);
title('Pulse Input ');
xlabel('time');
ylabel('amplitude');
z=x.*y; % PAM output
subplot(3,1,3)
plot(z);
title('PAM modulation ');
xlabel('time');
ylabel('amplitude');
```

2.8 Expected Waveforms:



2.9 Pre Lab Questions

1. Compare pulse modulation with continuous modulation
2. Classify pulse modulation Techniques
3. What are applications of pulse modulation techniques

2.11 Post Lab Questions

1. Explain PAM generation?
2. **Write** Merits and Demerits of PAM.
3. What is the BW of PAM?
4. Explain PAM demodulation

Result: Hence Pulse amplitude modulation and demodulation is Verified.

EXPERIMENT No: 3

PULSE WIDTH
MODULATION & DEMODULATION

3.1 Aim

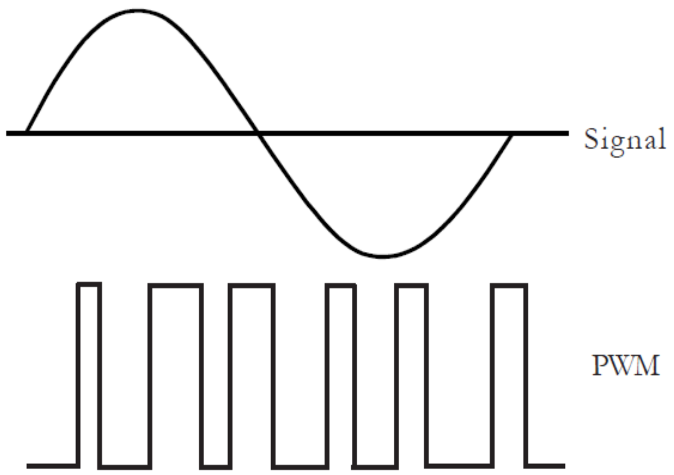
To perform Pulse Width Modulation and Demodulation using Trainer kit.

3.2 Equipment / Components Required

1. Physitech's Pulse width modulation and Demodulation Trainer.
2. CRO
3. BNC probes and Connecting Wires

3.3 Theory

The Pulse-width modulation of PTM is also called as Pulse-duration modulation (PDM), or pulse length modulation (PLM). In this modulation, the pulses have constant amplitude and variable time duration. The time duration (or width) of each pulse is proportional to the instantaneous amplitude of the modulating signal. In this system, as shown in fig. below, we have fixed amplitude and starting time of each pulse, but the width of each pulse is made proportional to the amplitude of the signal at that instant. In this case, the narrowest pulse represents the most negative sample of the original signal and the widest pulse represents the largest positive sample. When PDM is applied to radio transmission, the carrier frequency has constant amplitude, and the transmitter on time is carefully controlled.



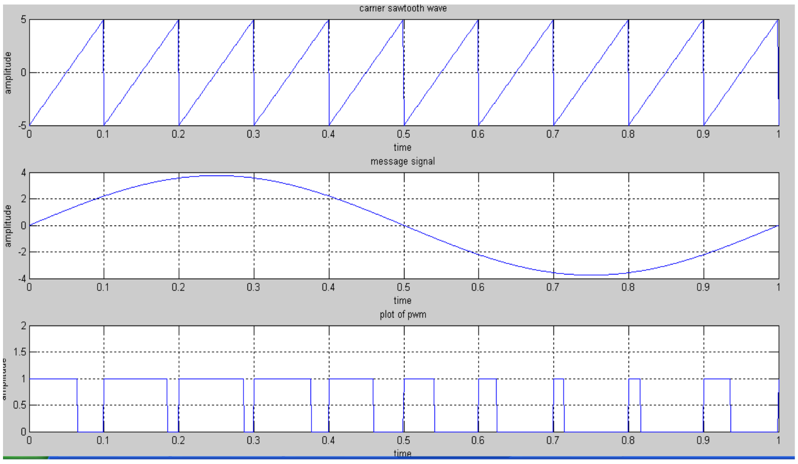
3.4 Procedure

1. Switch on pulse width modulation and Demodulation trainer kit
2. Connect the Clk O/P to the clk I/P terminal of PWM modulation.
3. Connect the AF O/P to AF I/P terminal of PWM modulation.
4. Observe the PWM O/P at pin 3 of 555 IC on CRO.
5. By varying frequency and amplitude of the modulating signal, observe the corresponding change in the width of the output pulses.
6. During demodulation, connect the PWM O/P of PWM modulation to the PWM I/P of PWM demodulation.
7. Observe the demodulated output at AF O/P of PWM demodulation on CRO.

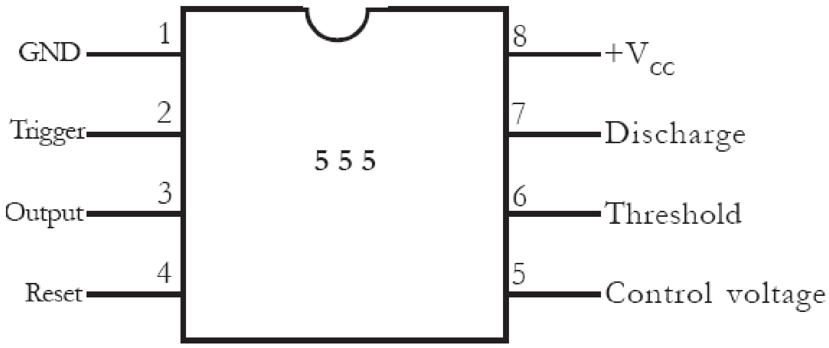
3.5 Matlab Program

```
clc;
clear all;
close all;
f2=input('message frequency=');
f1=input('carrier sawtooth frequency=');
A=5;
t=0:0.001:1;
c=A.*sawtooth(2*pi*f1*t);
subplot(3,1,1);
plot(t,c);
xlabel('time');
ylabel('amplitude');
title('carrier sawtooth wave');
grid on;
m=0.75*A.*sin(2*pi*f2*t);
subplot(3,1,2);
plot(t,m);
xlabel('time');
ylabel('amplitude');
title('message signal');
grid on;
n=length(c);
for i=1:n
    if(m(i)>=c(i))
        pwm(i)=1;
    else
        pwm(i)=0;
    end
end
subplot(3,1,3);
plot(t,pwm);
xlabel('time');
ylabel('amplitude');
title('plot of pwm');
axis([0 1 0 2]);
grid on;
```

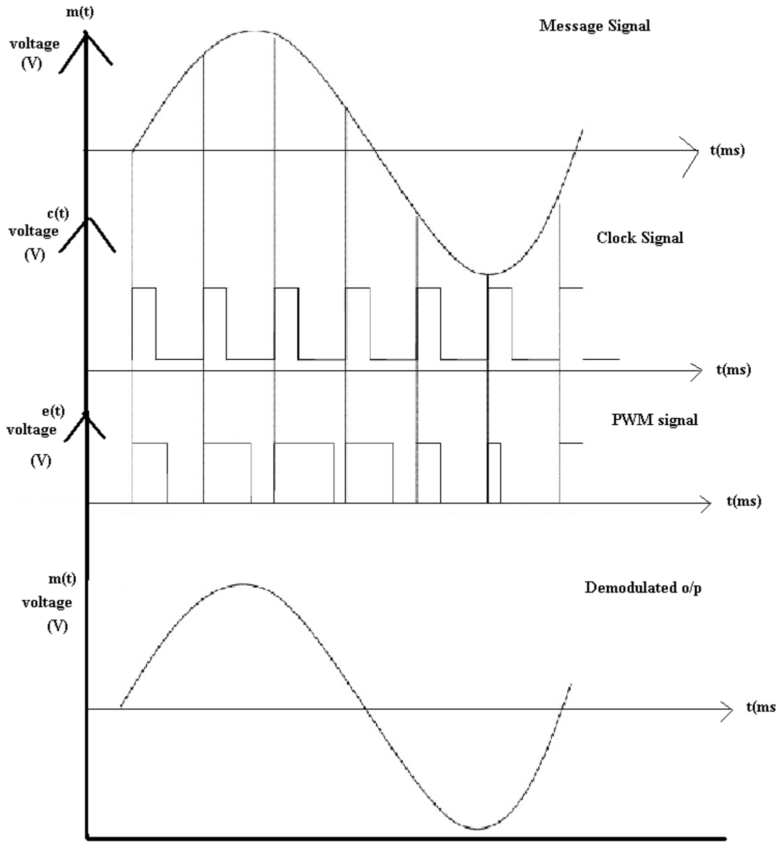
3.6 Expected Waveforms



3.7 PI N DIAGRAM OF IC 555 TIMER



3.8 Expected waveforms (Hardware)



3.9 Pre Lab Questions

1. Compare pulse modulation with continuous modulation
2. Classify pulse modulation Techniques
3. What are applications of pulse modulation techniques?

3.10 Lab Assignment

1. Observe spectrum of PWM wave

3.11 Post Lab Questions

1. Explain PWM generation?
2. **Write** Merits and Demerits of PWM.
3. What is the BW of PWM?
4. Explain PWM demodulation

Result:

Hence Pulse width modulation and demodulation is demonstrated and verified.

EXPERIMENT No: 4

PULSE POSITION

MODULATION & DEMODULATION

4.1 Aim

To perform the operation of pulse position modulation and demodulation using trainer kit.

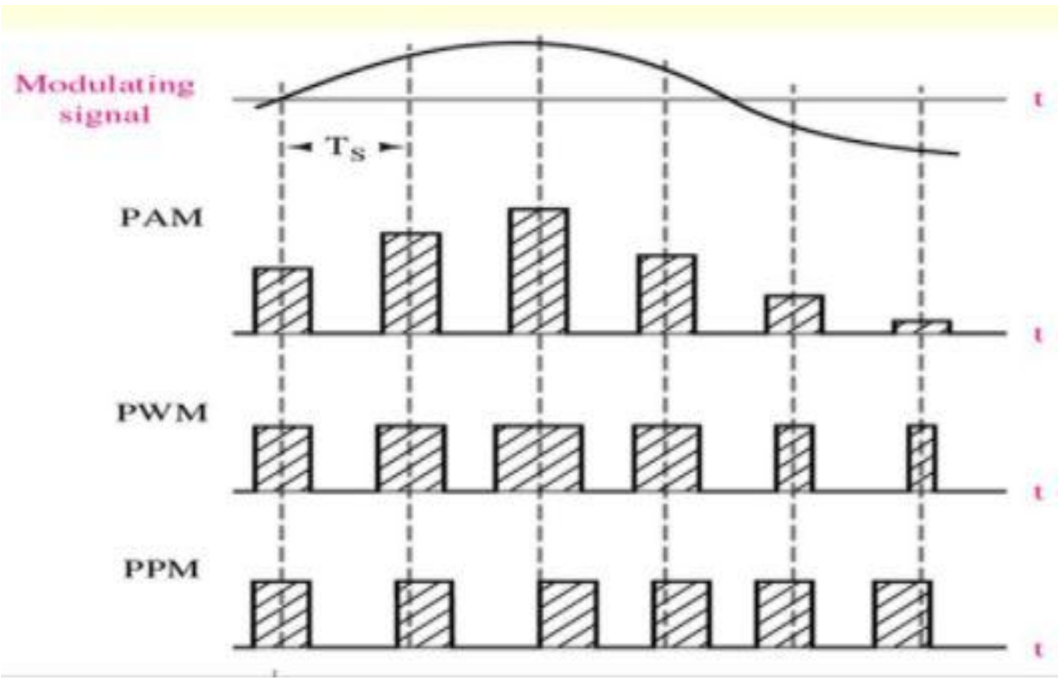
4.2 Equipment/Components Required

1. Physitech's Pulse position modulation and demodulation trainer.
2. CRO
3. BNC probes and Connecting Wires

4.3 Theory

Pulse position modulation (PPM) is more efficient than PAM or PDM for radio transmission. In PPM all pulses have the same constant amplitude and narrow pulse width. The position in time of the pulses is made to vary in proportion to the amplitude of the modulating signal. The simplest modulation process for pulse position modulation is a PDM system with the addition of a monostable multivibrator as shown in fig. below. The monostable is arranged so that it is triggered by the trailing edges of the PDM pulses. Thus, the monostable output is a series of constant-width, constant- amplitude pulses which vary in position according to the original signal amplitude.

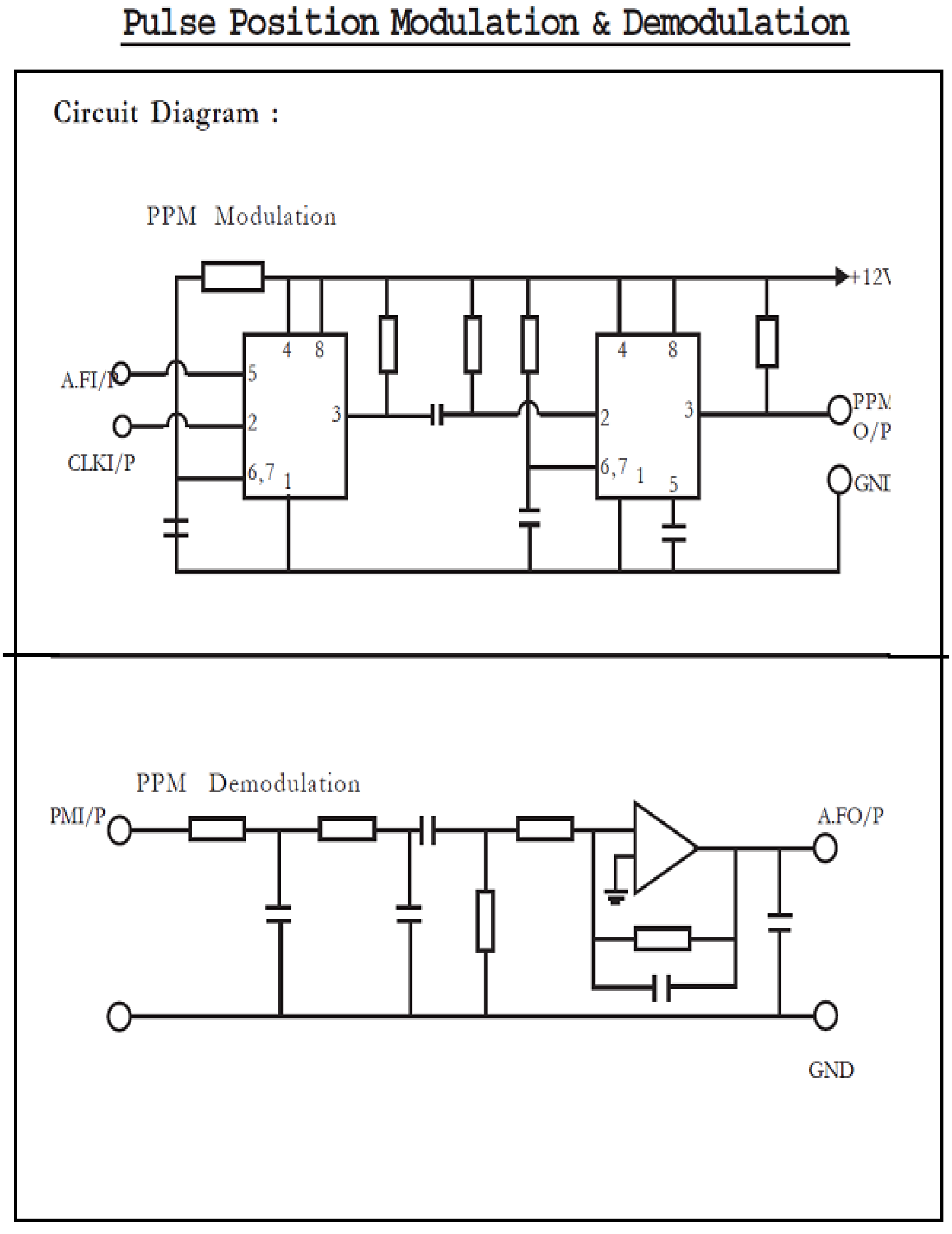
PPM uses less power than PDM and essentially has all the advantages of PDM. One disadvantage of PPM is that the demodulation process, to recover the original signal is more difficult than with PDM.



4.4 Procedure

1. Switch on PPM modulator and demodulator trainer kit.
2. Connect the CLK O/P to the Pin 2 of 555 IC.
3. Connect the AF O/P to the pin 5 of 555 IC.
4. Observe the PPM O/P at pin 3 of second IC 555 on CRO.
5. Connect the PPM O/P to the PPM I/P of PPM demodulation.
6. Observe the demodulated O/P on CRO.

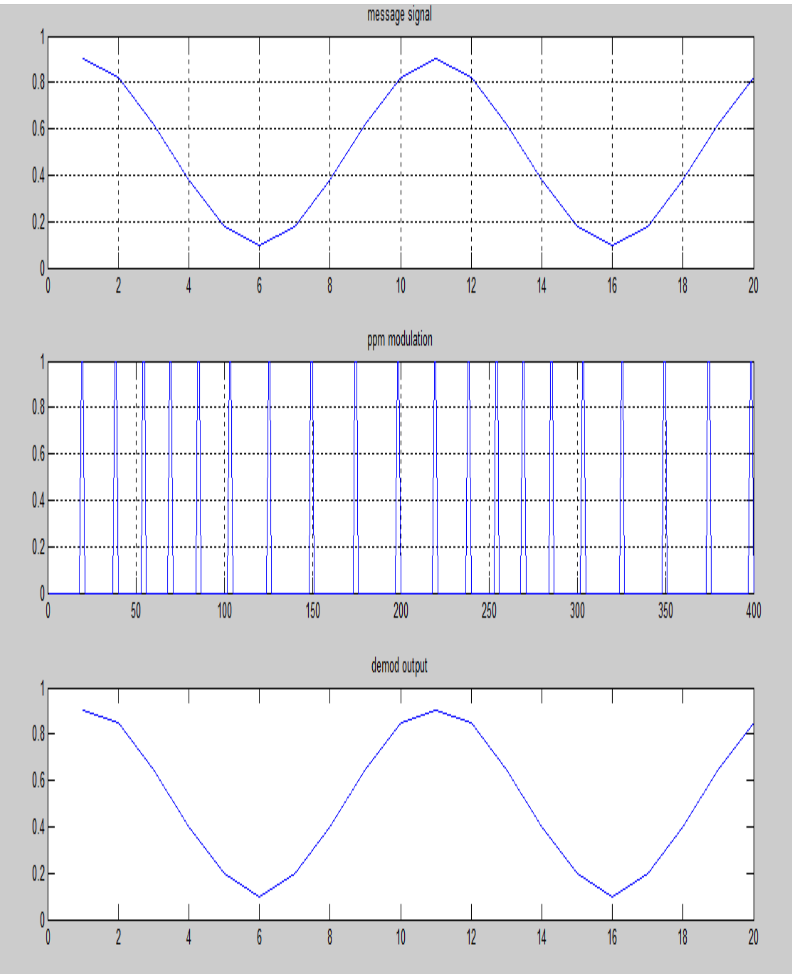
4.5 Circuit Diagram



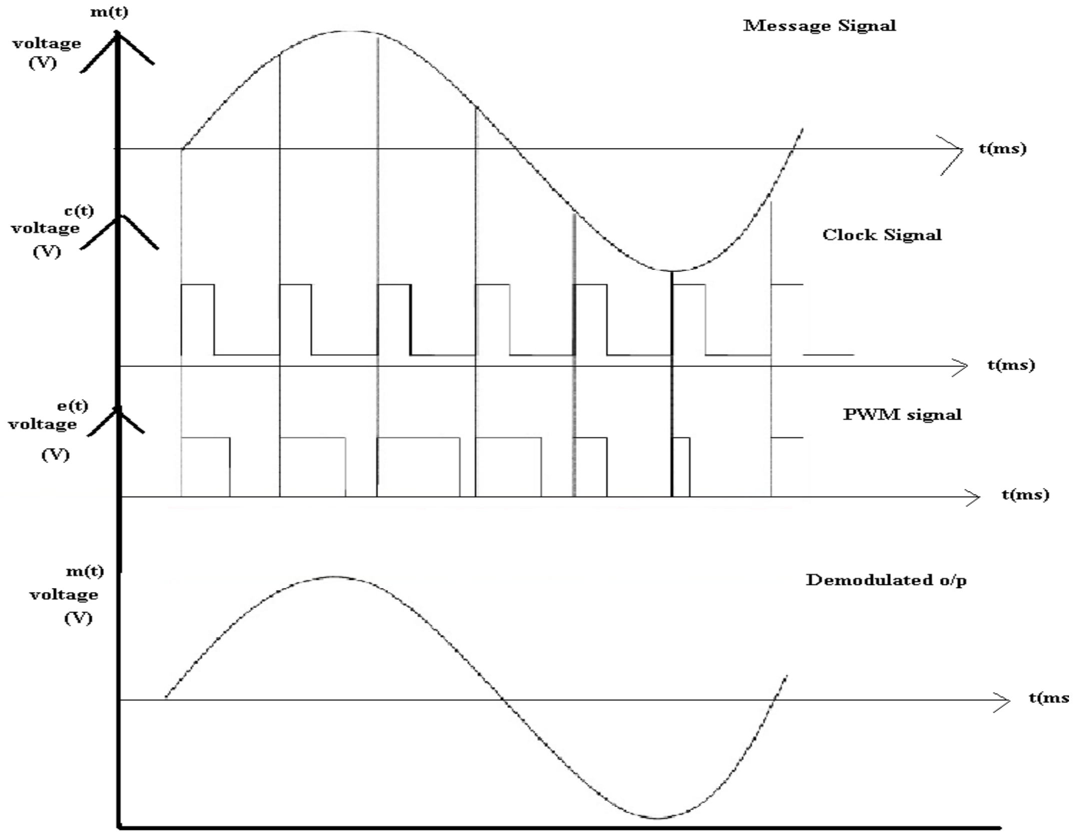
4.6 MatLab Program

```
clc;
clear all;
close all;
fc=50;
fs=1000;
f1=100;f2=300;
t=0:1/fs:((2/f1)-(1/fs));
x1=0.4*cos(2*pi*f1*t)+0.5;
subplot(3,1,1);
plot(x1);
title('message signal');
grid;
subplot(3,1,2);
y=modulate(x1,fc,fs,'ppm');
plot(y);
title('ppm modulation');
grid;
z=demod(y,fc,fs,'ppm');
subplot(3,1,3);
plot(z);
title('demod output');
```

4.7 Expected Waveforms



4.8 EXPECTED WAVEFORMS (Hardware)



4.9 Pre Lab Questions

1. Compare pulse modulation with continuous modulation.
2. Classify pulse modulation Techniques.
3. What are applications of pulse modulation techniques?

4.10 Lab Assignment

1. Explain how PPM is converted from PWM

4.11 Post Lab Questions

1. Explain PPM generation?
2. **Write** Merits and Demerits of PPM.
3. What is the BW of PPM?
4. Explain PPM demodulation

Result:

Hence Pulse position modulation and demodulation is demonstrated and output waveforms are verified

EXPERIMENT No: 5

PULSE CODE MODULATION AND DEMODULATION

AIM: To perform pulse code modulation and demodulation using trainer kit.

APPARATUS:

1. Physitech's Pulse Code Modulation &Demodulation
2. CRO
3. Connecting wires.

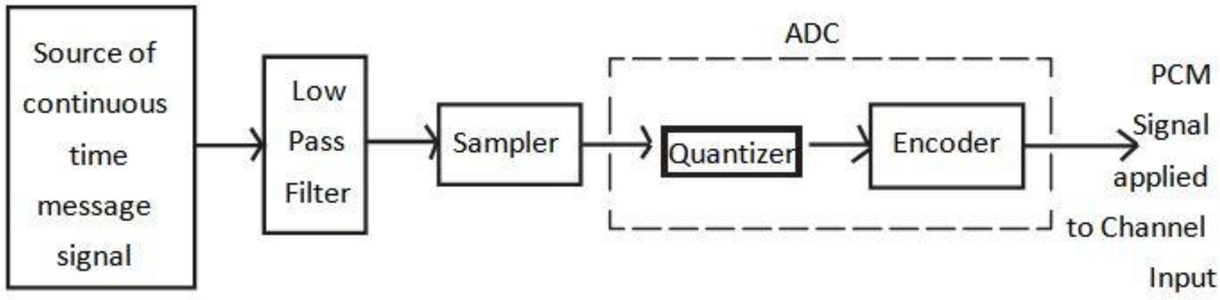
THEORY:

In pulse code modulation (PCM), a message signal is represented by a sequence of coded pulses, which is accomplished by representing the signal in discrete from in both time and amplitude. The basic elements of a PCM system are shown in fig. Below.

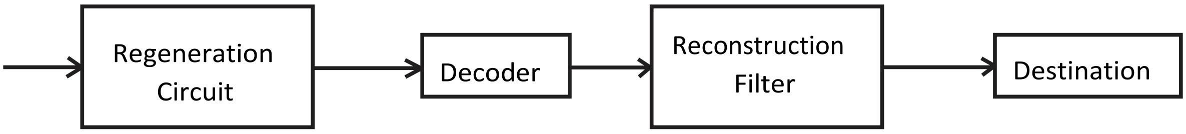
The basic operations performed in the transmitter of a PCM system are sampling, quantizing and encoding. The Low pass filter prior to sampling is included to pre vent aliasing of the message signal. The incoming message signal is sampled with a tra in of narrow rectangular pulses so as to closely approximate the instantaneous sampling process. To ensure perfect reconstruction of the message signal at the receiver, the sampling rate must be greater than twice the highest frequency component W of the message signal in accordance with the sampling theorem.

The quantizing and encoding operations are usually performed in the same circuit, which is called an analog-to-digital converter. The same circuit, which is called an analog-to-digital converter. The sampled version of the message signal is then quantized, thereby providing a new representation of the signal that is discrete in both time and amplitude.

In combining the process of sampling and quantization, the specification of a continuous message (baseband) signal becomes limited to a discrete set of values, but not in the form best suited to transmission. To exploit the advantages of sampling and quantizing for the purpose of making the transmitted signal more robust to noise, interference and other channel impairments, we require the use of an encoding process to translate the discrete set of sample values to a more appropriate form of signal.



(a) Transmission Path



(b) Receiver

REGENERATION:

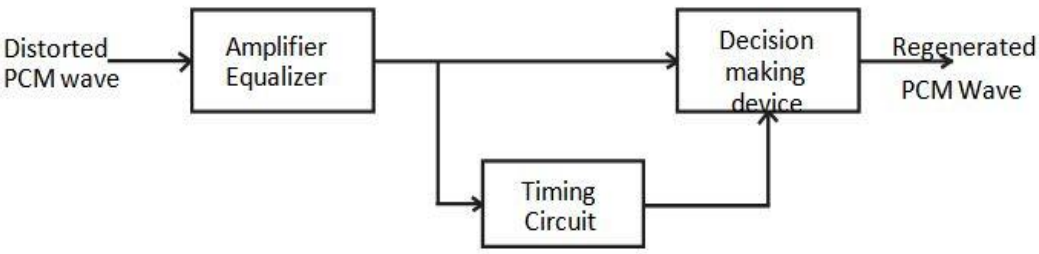
The most important feature of PCM systems lies in the ability to control the effects of distortion and noise produced by transmitting a PCM signal through a channel. This capability is accomplished by reconstructing the PCM signal by means of a chain of regenerative repeaters located at sufficiently close spacing along the transmission route. As illustrated in fig. Below three basic functions are performed by a regenerative repeater: equalization, timing and decision making.

The equalizer shapes the received pulses so as to compensate for the effects of amplitude and phase distortions produced by the non ideal transmission characteristics of the channel.

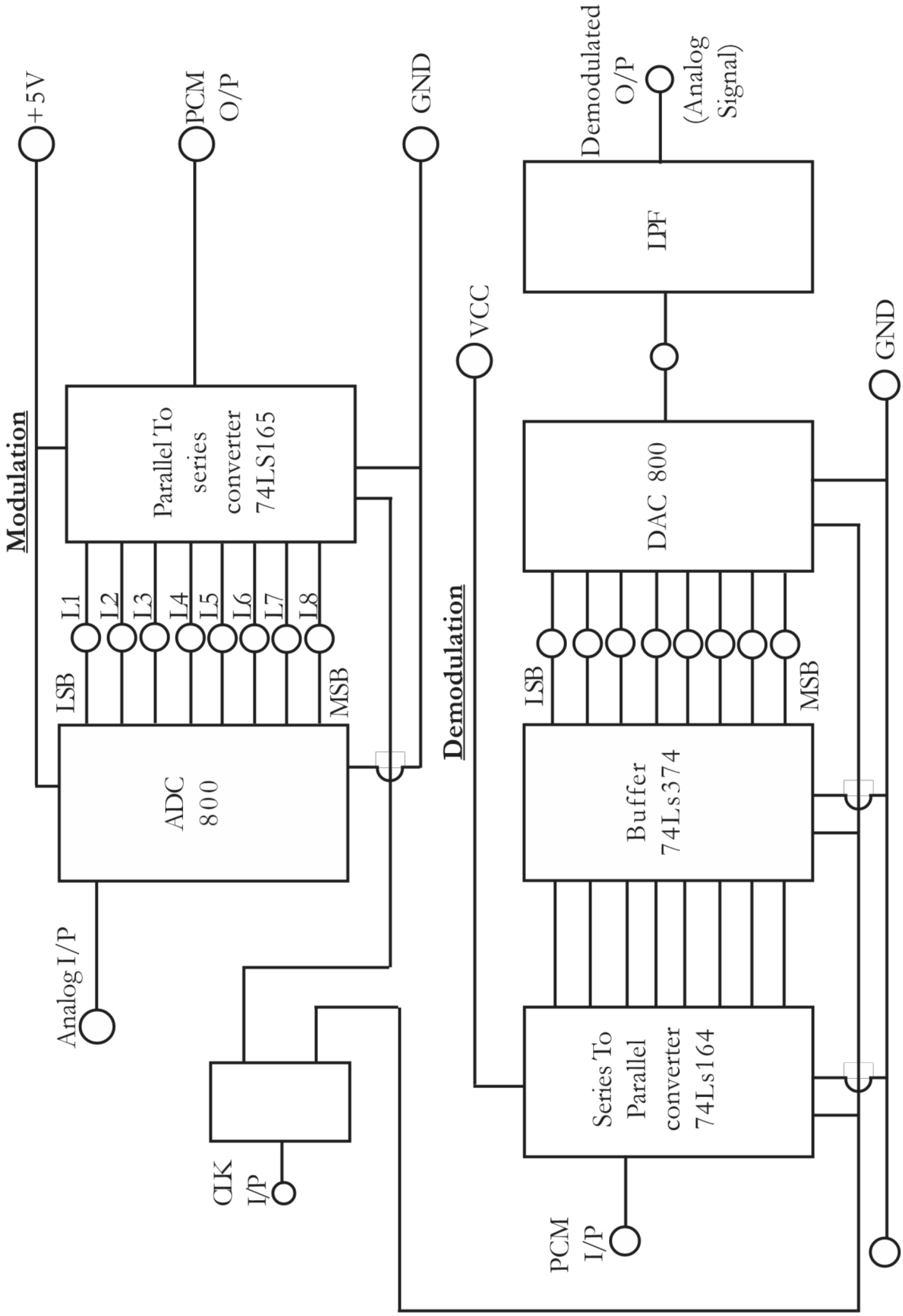
The timing circuitry provides a periodic pulse tra in, derived from the received pulses, for sampling the equalized pulses at the instants of time where the signal-to-noise ratio is maximum.

Each sample so extracted is compared to a pre determined threshold in the decision making device. In each bit interval, a decision is then made whether the symbol is a 1 or 0 on the basis of whether the threshold is exceeded or not. If the threshold is exceeded, a pulse representing symbol „1" is transmitted. In the way, the accumulation of distortion &noise in a repeater span is completely removed.

The basic operations in the receiver are regeneration of impaired signals, decoding and reconstruction of the train of quantized samples. The first operation in the receiver is to regenerate (i.e., reshape & clean up) the received pulses one last time. These clean pulses are then regrouped into code words and decoded into a quantized PAM signal. The decoding process involves generating a pulse, the amplitude of which is the linear sum of all the pulses in the codeword. The final operation in the receiver is to recover the message signal by passing the decoder output through a low -pass reconstruction filter whose cutoff frequency is equal to the message bandwidth W. Assuming that the transmission path is error free, the recovered signal includes no noise with the exception of the initial distortion introduced by the quantization process.



CIRCUIT DIAGRAM:



CIRCUIT DESCRIPTION:

A variable sinusoidal frequency generator is provided with frequency from 0Hz to 200Hz. To see the actual bits that are transmitted through the communication channel, a variable dc (-5V to 5V) source is provided on the panel.

The modulating signal is applied to the input of Analog to-Digital (A/D) converter which performs the two functions of quantization and encoding, producing a 8-bit binary coded number. The signal is to be transmitted i.e., modulating signal is sampled at regular intervals. To transmit all the bits in one channel actually it is often sent as binary number back to front by parallel to serial converter transmits the code bits in serial fashion.

--As the receiver, the received data will be in serial form. The serial data is converted back to parallel form by serial to parallel converter and passes the bits to a Digital-to-Analog converter for decoding which has in-built sample and hold amplifier which maintains the pulse level for the duration of the sampling period, recreating the staircase waveform which is approximation of modulating signal. A low pass filter may be used to reduce the quantization noise and to yield the original modulating signal.

PROCEDURE:

1 .Switch on PHYSITECH"s Pulse code modulation and demodulation.

2 . Connect the variable DC O/P to the Analog I/P of modulation section.

3 . Connect the clock O/P of bit clock generator to the clk I/P of modulation section.

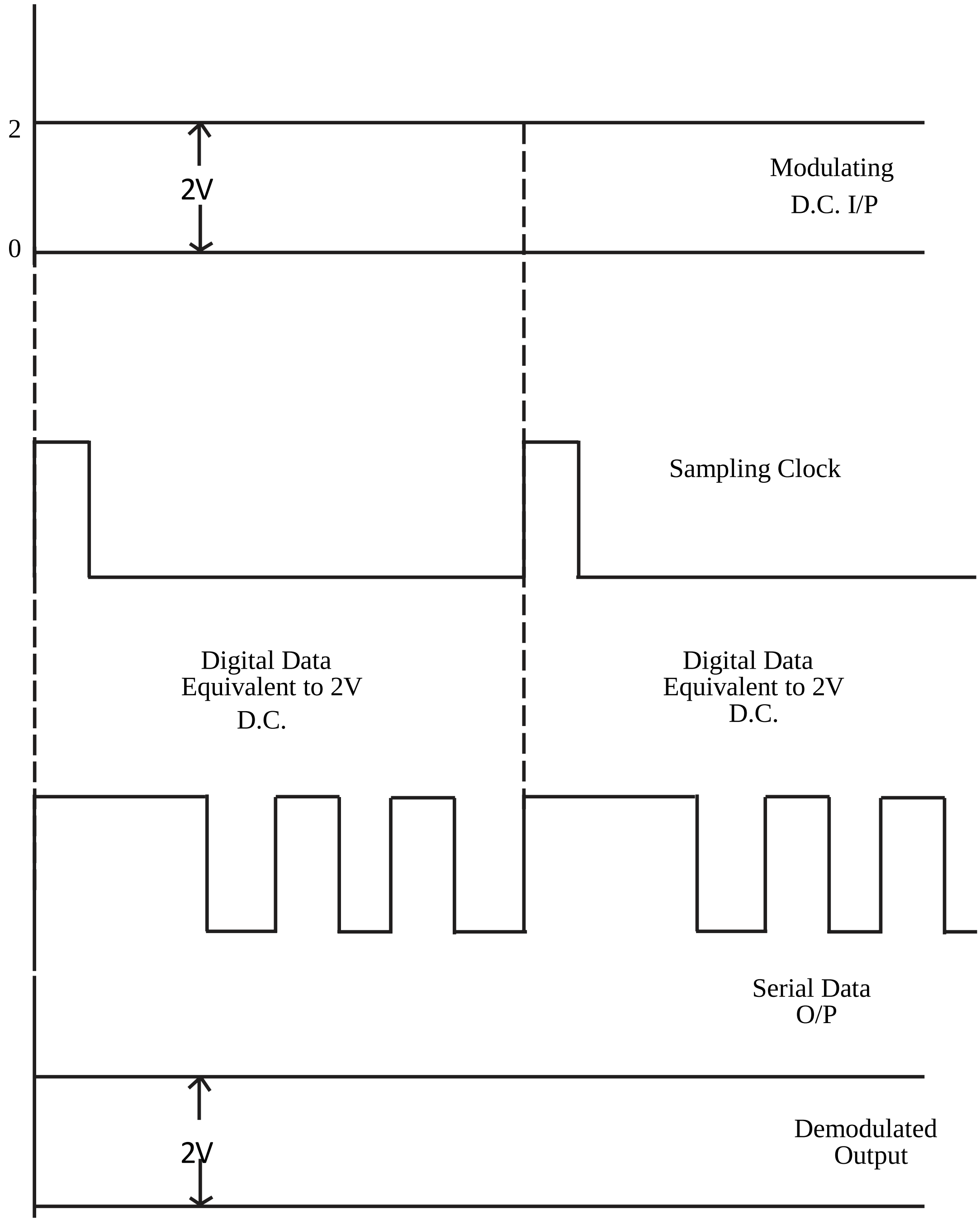
4 .By varying the variable DC O/P observes the PCM O/P on CRO.

5 . Connect the AF output to Analog I/P of modulation section by re moving variable DC O/P

6 .Connect the PCM O/P to PCM I/P of demodulation section.

7 . Observe the DAC O/P at channel 1 of CRO and observe the demodulated O/P at channel 2 of CRO.

EXPECTED WAVEFORMS:



Pre Lab Questions

1) What is sampling theorem?
2) What is quantization?
3) What is encoder

Lab Assignment

1) What is the difference between analog and digital communication?
2) What is pulse code modulation?

Post Lab Questions

1) What is the need of processing of analog to digital convertion?
2) What is sample and hold circuit?
3) What are the applications of PCM?

RESULT: Hence the Pulse Code Modulation and Demodulation has been studied and the modulated and demodulated output wave forms were observed.

EXPERIMENT No: 6

DIFFERENTIAL PULSE CODE MODULATION AND DEMODULATION

AIM: To Study & understand the operation of the Differential Pulse Code Modulation.

APPARATUS:

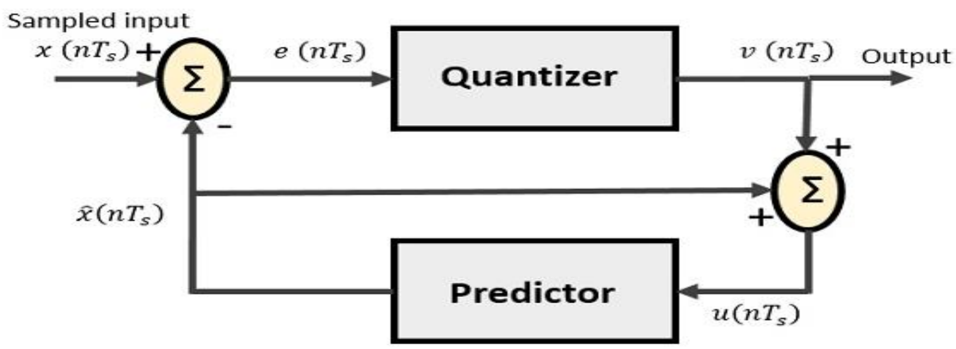
1. DPCM Modulator and Demodulator Trainer Kit
2. CRO
3. Connecting Wires

THEORY:

For the samples that are highly correlated, when encoded by PCM technique, leave redundant information behind. To process this redundant information and to have a better output, it is a wise decision to take a predicted sampled value, assumed from its previous output and summarize them with the quantized values. Such a process is called as Differential PCM (DPCM) technique.

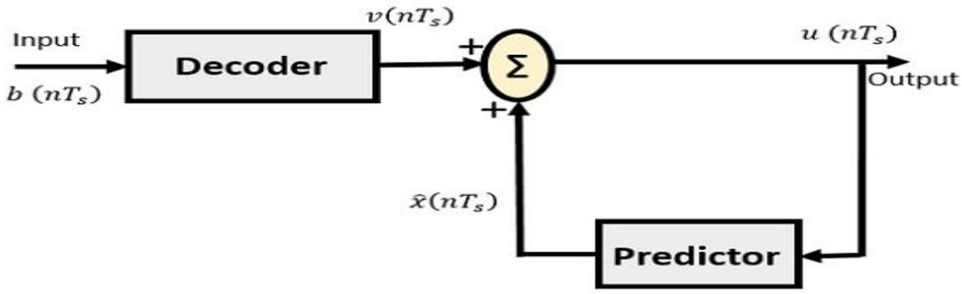
DPCM Transmitter

The DPCM Transmitter consists of Quantizer and Predictor with two summer circuits. Following is the block diagram of DPCM transmitter.



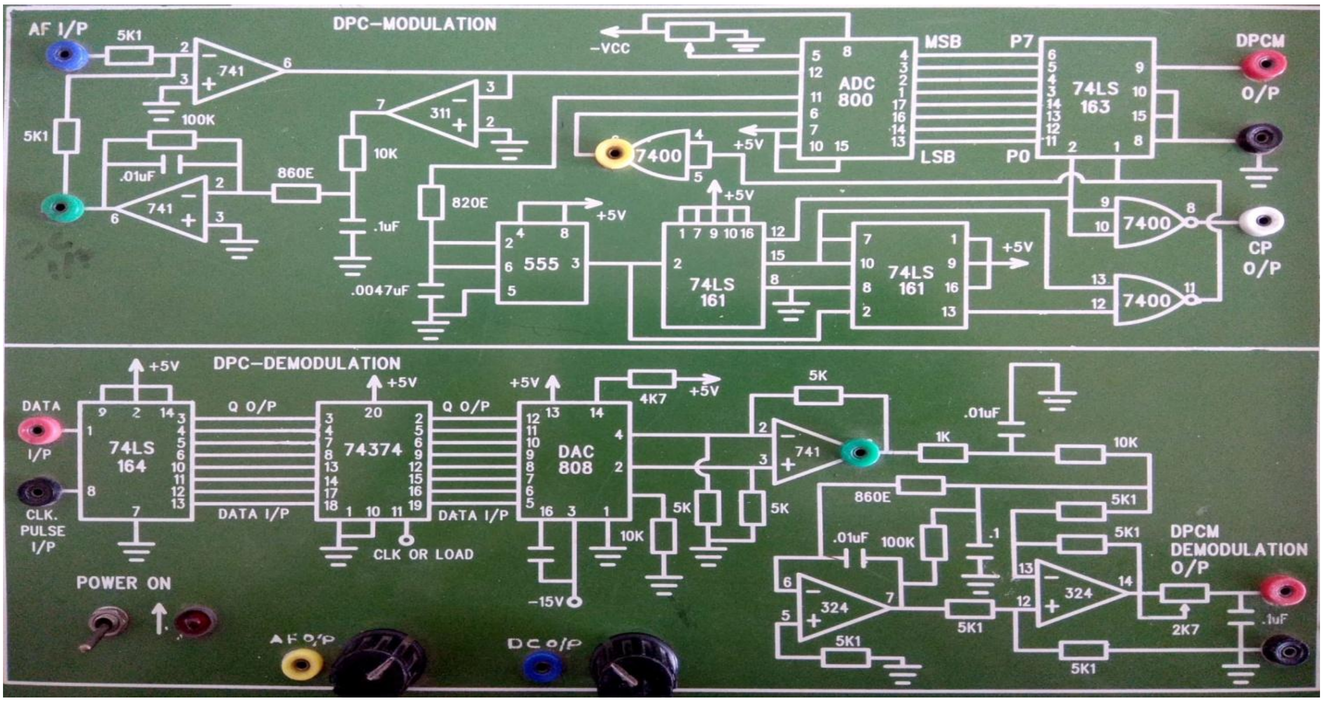
DPCM Receiver

The block diagram of DPCM Receiver consists of a decoder, a predictor, and a summer circuit. Following is the diagram of DPCM Receiver.



The notation of the signals is the same as the previous ones. In the absence of noise, the encoded receiver input will be the same as the encoded transmitter output.As mentioned before, the predictor assumes a value, based on the previous outputs. The input given to the decoder is processed and that output is summed up with the output of the predictor, to obtain a better output.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Study the theory of operation thoroughly.
2. Connect the trainer (Modulator) to the mains and switch on the power supply.
3. Observe the output of the AF generator using CRO, it should be Sine wave of

400 Hz frequency with 3V pp amplitude.

4. Verify the output of the DC source with multimeter/scope; output should vary 0 to +290mV.

5. Observe the output of the Clock generator using CRO, they should be 64 KHz and 8 KHz fre quency of square with 5 Vp-p amplitude.

6. Connect the trainer (De Modulator) to the mains and switch on the power supply.

7. Observe the output of the Clock generator using CRO; it should be 64 KHz square wave with amplitude of 5 pp.

DPCM Operation (with DC input):

Modulation:

1. Keep CRO in dual mode. Connect one channel to 8 KHz signal (one which is connected to the Shift register) and another channel to the DPCM output.
2. Observe the DPCM output with respect to the 8 KHz signal and sketch the Waveforms.

Note: Form this waveform you can observe that the LSB bit enters the output First.

Demodulation

3. Connect DPCM signal to the demodulator (S-P register) from the DPCM modulator with the help of coaxial cable (supplied with the trainer).
4. Connect clock signal (64 KHz) from the transmitter to the receiver using coaxial cable.
5. Connect transmitter clock to the timing circuit.
6. Observe and note down the S-P shift register output data and compare it with the transmitted data (i.e. output A/D converter at transmitter) notice that the output of the S-P shift register is following the A/D converter output in the modulator.
7. Observe D/A converter output (demodulated output) using multimeter/scope and compare it with the original signal and can observe that there is no loss in information in process of conversion and transmission.

DPCM Operation (with AC input):

Modulation:

8. Connect AC signal of $3V_{PP}$ amplitude to positive terminal of the summer circuit.

9. The output of the summer is internally connected to the sample and hold circuit

10. Keep CRO in dual mode. Connect one channe l to the AF signal and another channel to the Sample and Hold output. Observe and sketch the sample & hold output

11. Connect the Sample and Hold output to the A/D converter and observe the DPCM output using oscilloscope.

12. Observe DPCM output by varying AF signal voltage.

Demodulation:

13. Connect DPCM signal to the demodulator input (S-P shift register) from the DPCM modulator with the help of coaxial cable (supplied with trainer).

14. Connect clock signal (64 KHz) from the transmitter to the receiver using coaxial cable.
15. Connect transmitter clock to the timing circuit.

16. Keep CRO in dual mode. Connect one channel to the sample& hold output and another channel to the D/A converter output.

17. Observe and sketch the D/A output

18. Connect D/A output to the LPF input and observe the output of the LPF.

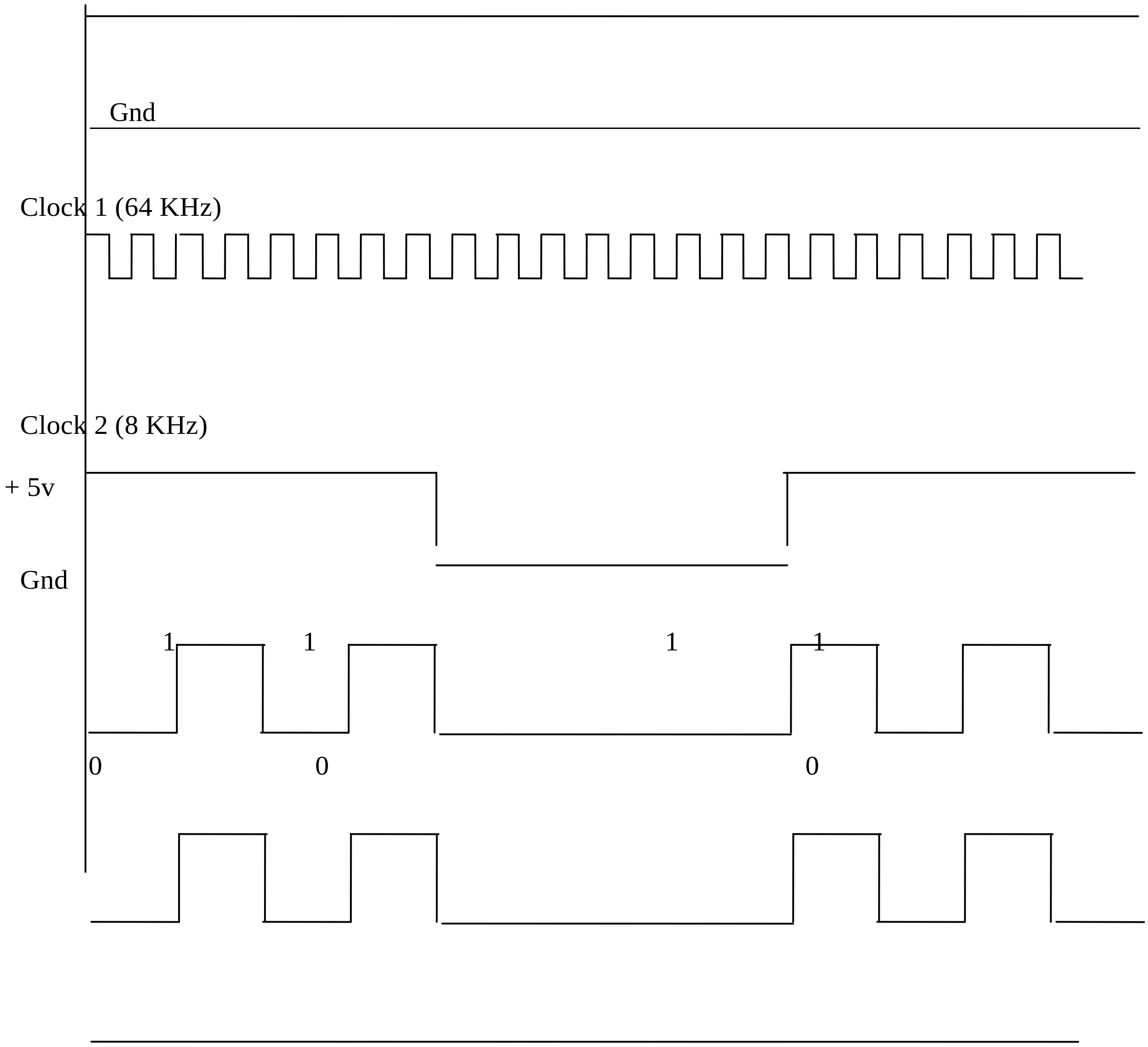
19. Observe the wave form at the output of the summer circuit.

20. Disconnect clock from transmitter and connect to the local oscillator (i.e., clock generator output from Demodulator) with remaining setup as it is.

Observe D/A output and compare it with the previous result. This signal is little bit distorted in shape. This is because lack of synchronization between clock at transmitter and clock at receiver.

EXPECTED WAVEFORMS:

Input signal



Pre Lab Questions

1) Define modulation?
2) How, DPCM gives improved performance over PCM?
3) What is quantization ?

Lab Assignment

1) Difference between PCM and DPCM?

2) What are the advantages of DPCM?

Post Lab Questions

1) How many levels are reduced in DPCM over PCM?
2) How to applicable the DPCM in real time applications?
3) Why converting the parallel to serial conversion in the modulation?

RESULT: Hence the Differential Pulse Code Modulation and Demodulation has been studied and the modulated and demodulated output wave forms were observed.

EXPERIMENT No: 7

DELTA MODULATION AND DEMODULATION

AIM: To perform the Delta modulation process by comparing the present signal with the previous signal of the given modulating signal.

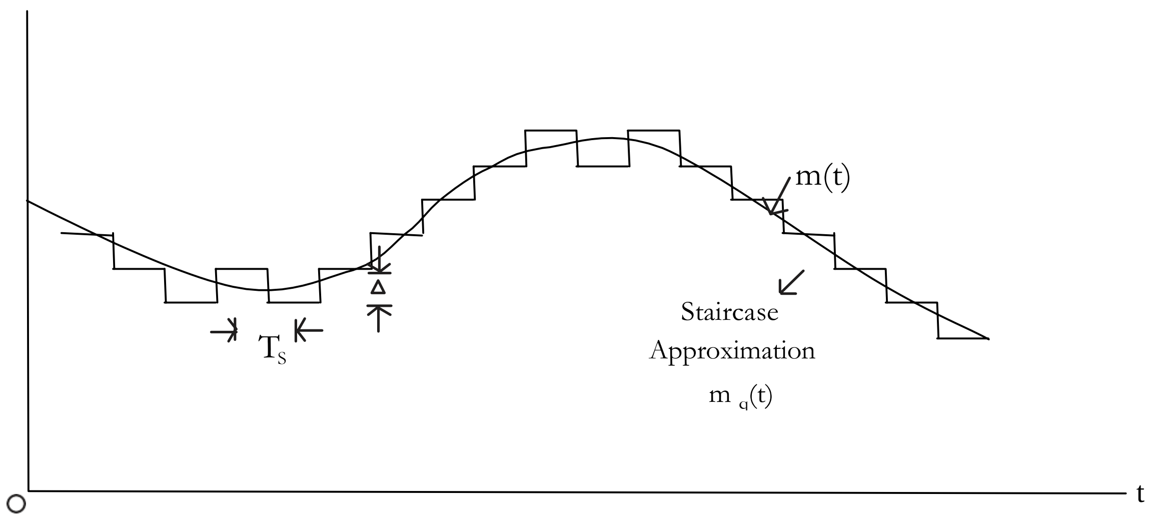
APPARATUS:

1. PHYSITECH'S Delta Modulation trainer kit
2. CRO
3. Connecting wires.

THEORY:

By the Delta Modulation technique, an analog signal can be encoded into bits. Hence, in one sense a DM is also a PCM. Differential pulse code modulation (DPCM) and Delta modulation (DM) are the two most commonly used versions of the PCM. DPCM systems use differential quantizes and PCM encoders. Delta modulation schemes use a differential quantizer with two output levels Ìor -Ì; these two levels are encoded using a single binary digit before transmission. Thus Delta modulation is a special case of DPCM.

In its basic form, DM provides a stair case approximation to the over sampled version of the message signal, as illustrated in fig. below.



Binaries sequence at modulator o/p 0 0 1 0 1 1 1 1 1 0 1 0 0 0 0 0 0

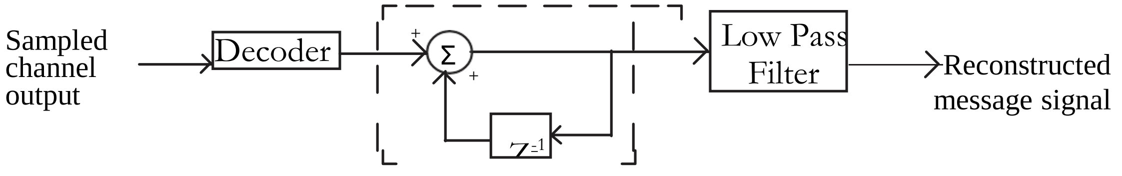
Illustration of Delta Modulation

The difference between the input and the approximation is quantized into only two levels namely, +Ì, corresponding to positive and negative differences. Thus if the approximation falls below the signal at any sampling epoch, it is increased by Ì. Or if the approximation lies above the signal, it is diminished by ê. Provided that the signal does not change too rapidly from sample to samples we find that the staircase approximation remains within +Ì of the input signal.

at the sampling instant nTs, the accumulator increments the approximation by a step ê in a positive or negative direction depending on the algebra IC sign of the error sample e(n).

If the input sample m(n) is greater than the most recent approximation mq(n), a positive increment +Ì is applied to the approximation. If the input sample is smaller, a negative incre ment –Ì is applied to the approximation.

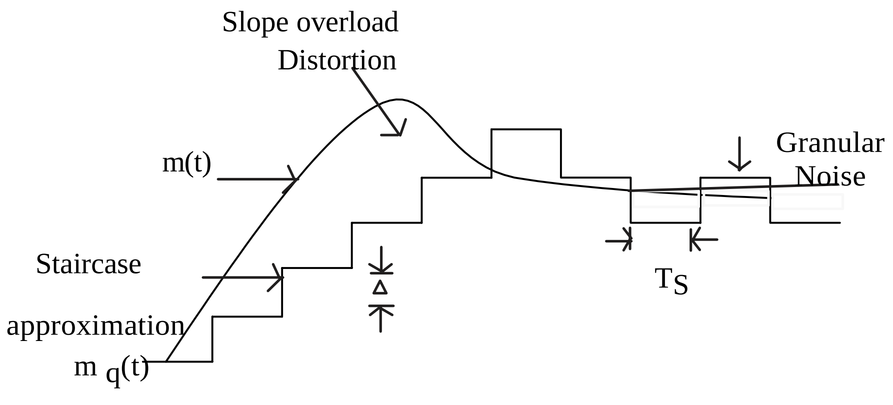
In the Receiver shown in fig. below, the staircase approximation is reconstructed by passing the sequence of positive and negative pulses, produced at the decoder output, through an accumulator in a manner similar to that used in the transmitter. Low pass filter is used to re ject the out- of- band quantization noise in the high frequency staircase waveform, with a bandwidth equal to the original message bandwidth.



Receiver of Delta modulation

Delta modulation is subject to two types of quantization errors:

1. Slope overload distortion.
2. Granular Noise.



Two different forms of quantization errors in DM

The step size Ì is too small for the staircase approximation mq(t) to follow a steep segment of the input waveform m(t), with result that mq(t) fa lls behind m(t), as illustrated in fig. above. This condition is called slope overload and the resulting quantization error is called slope – overload distortion.

Granular noise occurs when the step size ê is too large re lative to the local slope characteristics of the input waveform m(t), there by causing the staircase approximation mq(t) to

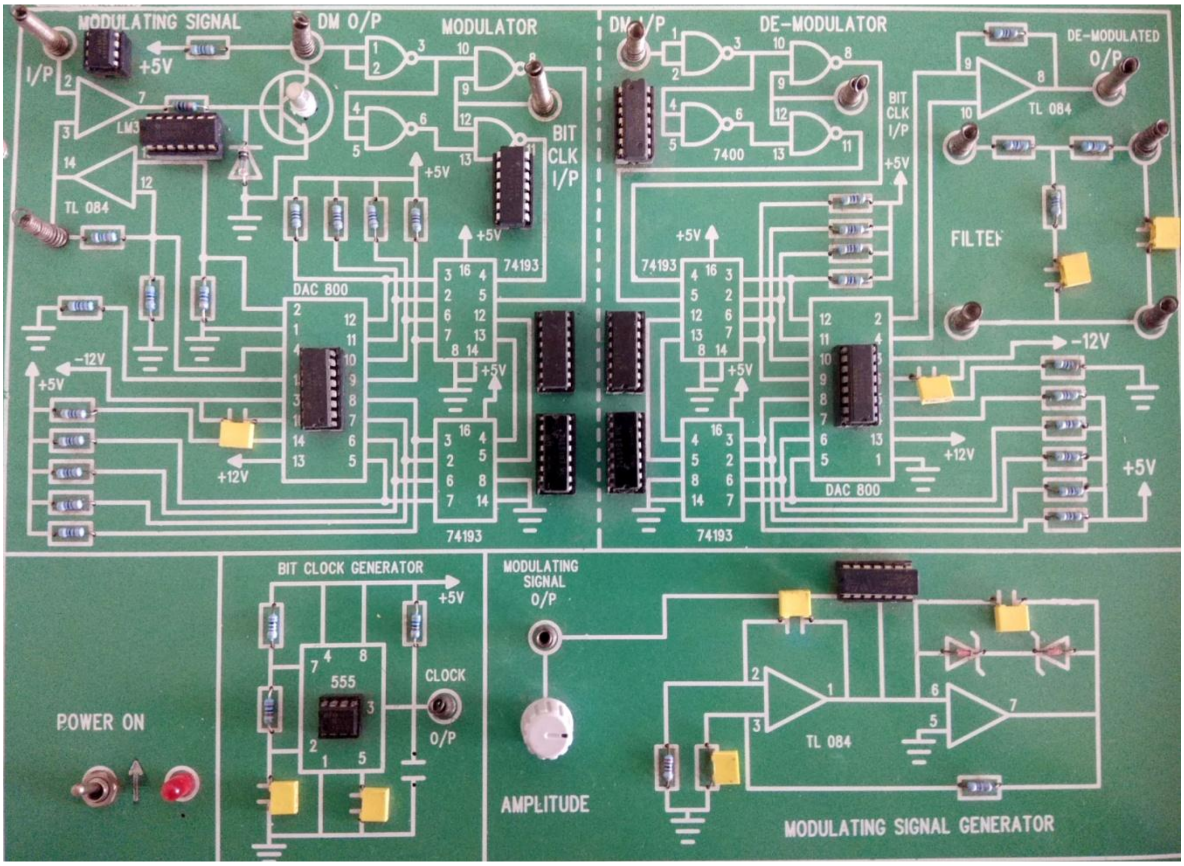
Hunt around a relatively flat segment of the input waveform. Granular noise is analogous to quantization noise in PCM system.

The limitations of Delta modulation can be alleviated by filtering the signal to limit the maximum rate of change or by increasing the stepsize and/or the sampling rate. Filtering the signal & increasing the stepsize will result in poor signal resolution, and increasing the sampling rate will lead to larger bandwidth requirements.

To avoid these limitations, we need to make the Delta modulator "Adaptive", in the sense that the step size is made to vary in accordance with the input signal. Systems using signal dependent step sizes are called Adaptive Delta modulation (ADM) systems.

ADM is also known as continuous variable slope Delta modulator (CVSDM).

CIRCUIT DIAGRAM:



CIRCUIT DESCRIPTION:

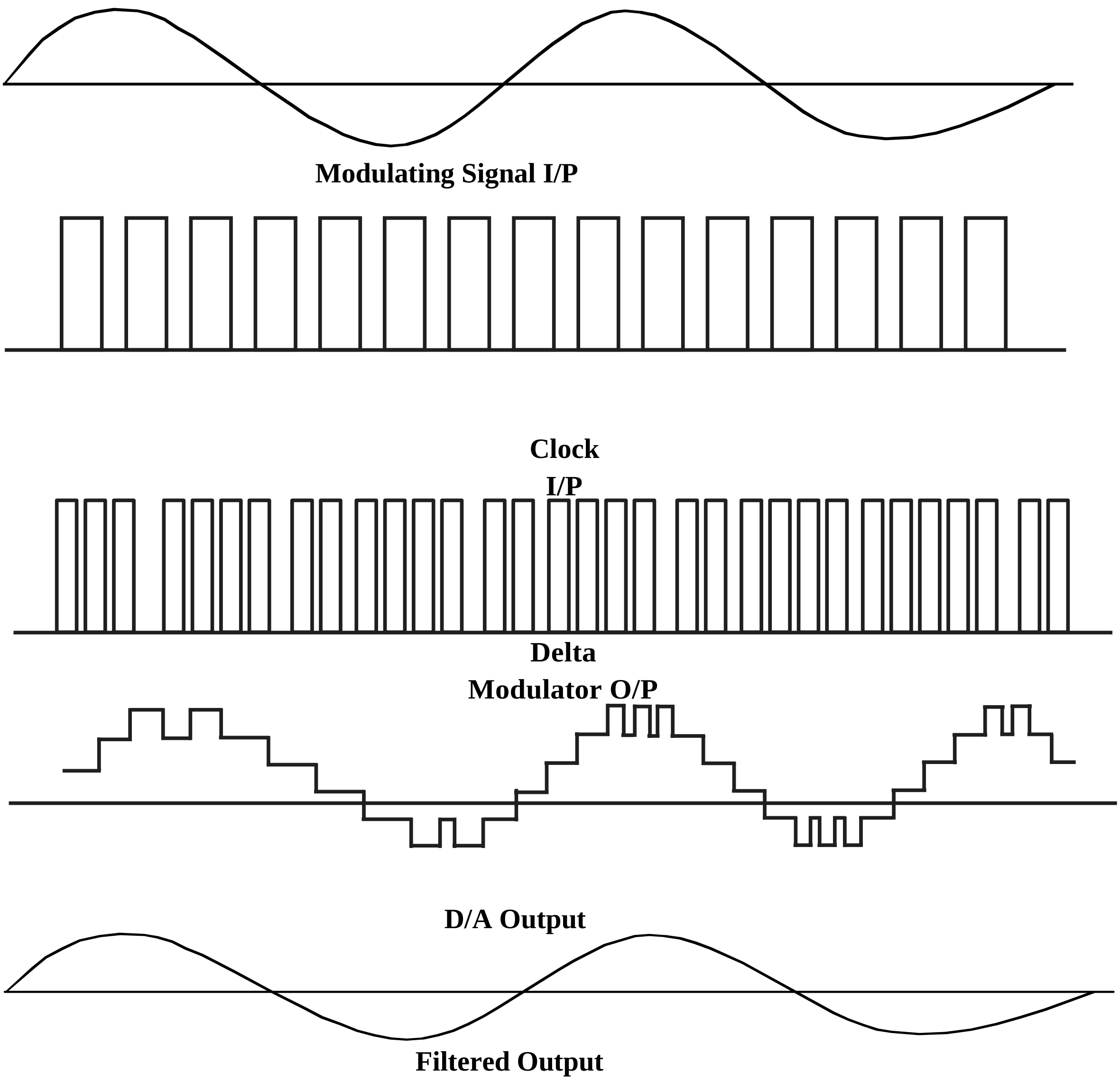
In modulator section, the comparator compares the input signal m(t) and reconstructed signal r(t). If m(t)>r(t) a logic 1 is generated at the output of the comparator, otherwise logic 0 is generated. The value of logic 1 or logic 0 turned as Ì(t) is held for the bit duration by the sample and hold current to generate the Delta modulated output.

During demodulation, the delta modulated output is fed to the 8 bit binary up/ down counter to control its count direction. A logic 1 at the mode control input increases the count value by one and a logic 0 decrements the count value by one. All the 8 outputs of the counter are given to DAC to reconstruct the original signal. In essence the counter and decoder forms the Delta modulator in the feedback loop of the comparator. Thus, if the input signal is higher than the reconstructed signal the counter increments at each step so as to enable the DAC output ot reach to the input signal values. Similarly if the input signal m(t) is lower than the reconstructed signal r(t), the counter decrements at each step, and the DAC output gets reduced to reach a value to that of m(t).

PROCEDURE:

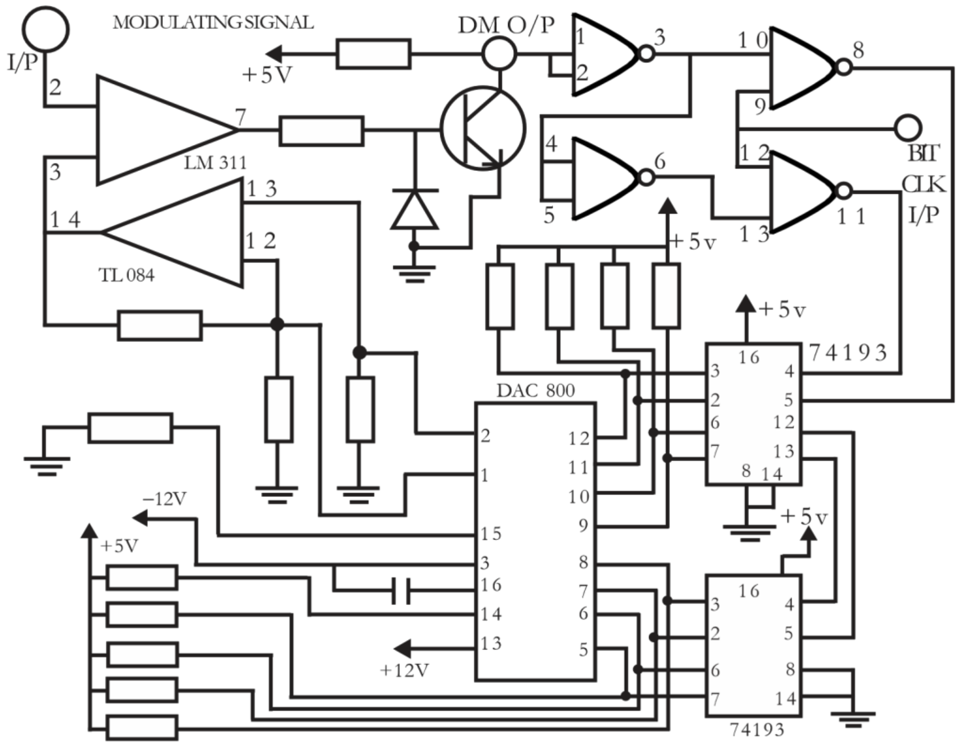
1. Switch on the experimental board
2. Connect the clock signal of Bit clock generator to the bit clock input of Delta modulator circuit.
3. Connect modulating signal of the modulating signal generator to the modulating signal input of the Delta modulator.
4. Observe the modulating signal on Channel 1 of CRO
5. Observe the Delta modulator output on channel 2 of CRO
6. Connect the DM o/p of modulator to the DM I/P of Demodulator circuit.
7. Connect the clock signal to the Bit clock I/P of Demodulator circuit.
8. Observe the demodulated o/p on channel 2 of CRO.
9. Connect the demodulated o/p to the filter input of demodulator circuit.
10. Observe the demodulated o/p w ith filter on CRO.

EXPECTED WAVEFORMS:

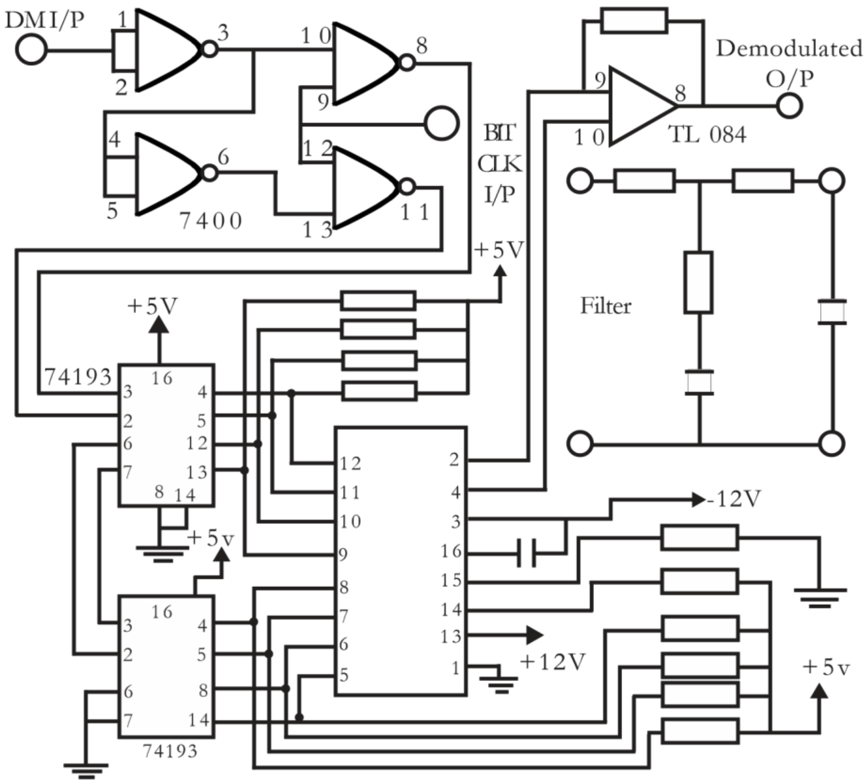


Circuit Diagram :

Modulator



Demodulator



Post Lab Questions

1) What are two types of quantization errors?
2) What is the advantage of delta modulation over PCM?
3) What is slope overload distortion?

Lab Assignment

1) What is granular noise?
2) What happens to the output signal if the variation of the message signal is

   (i) greater than the step size (ii) less than the step size

Pre Lab Questions

1) Compare DPCM, PCM& Delta modulation?
2) How to re duce the quantization noise that occurs in DM?
3) Mention the applications of DM?

RESULT: Hence the Delta Modulation and Demodulation has been studied and the modulated and demodulated output wave forms were observed.

EXPERIMENT No: 8

FREQUENCY SHIFT KEYING GENERATION AND DETECTION

AIM: To perform frequency shift key (FSK) Modulator and Demodulator using trainer kit.

APPARATUS:

1 Physitech's FSK Modulator-FSK Demodulator.

2 Function Generator.

3 CRO.

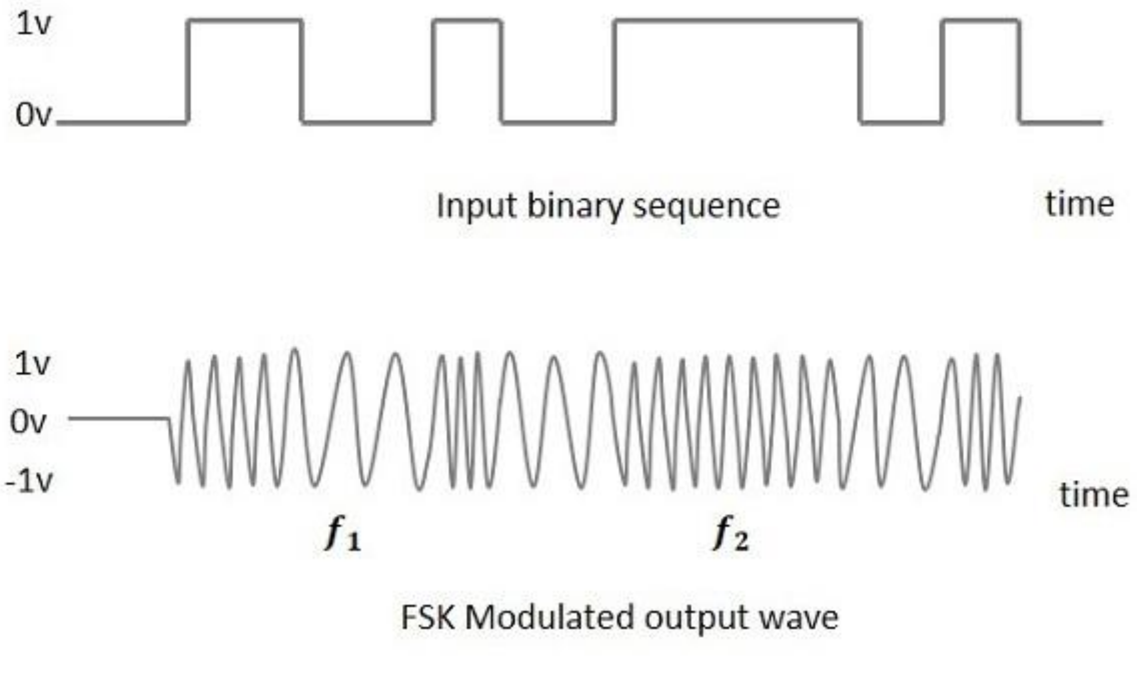
4 BNC Probes.

THEORY :

Frequency Shift Keying (FSK) is the digital modulation technique in which the frequency of the carrier signal varies according to the digital signal changes. FSK is a scheme of frequency modulation.

The output of a FSK modulated wave is high in frequency for a binary High input and is low in frequency for a binary Low input. The binary 1s and 0s are called Mark and Space frequencies.

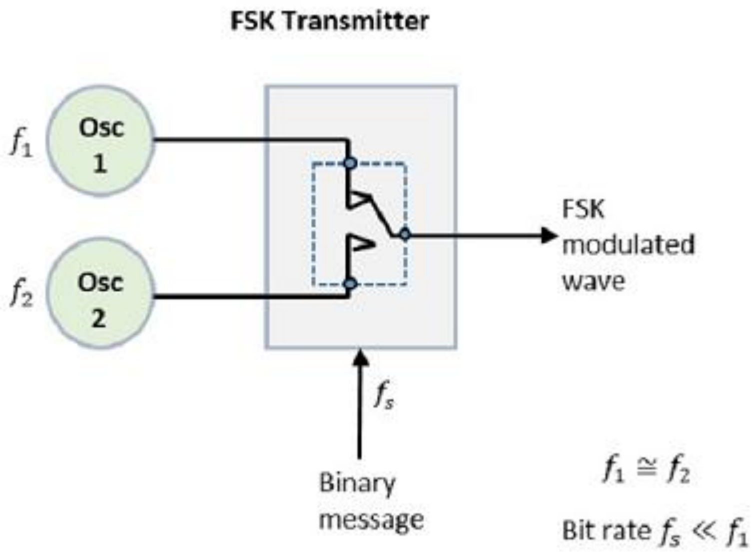
The following image is the diagrammatic representation of FSK modulated waveform along with its input.



To find the process of obtaining this FSK modulated wave, let us know about the working of a FSK modulator.

FSK Modulator

The FSK modulator block diagram comprises of two oscillators with a clock and the input binary sequence. Following is its block diagram.



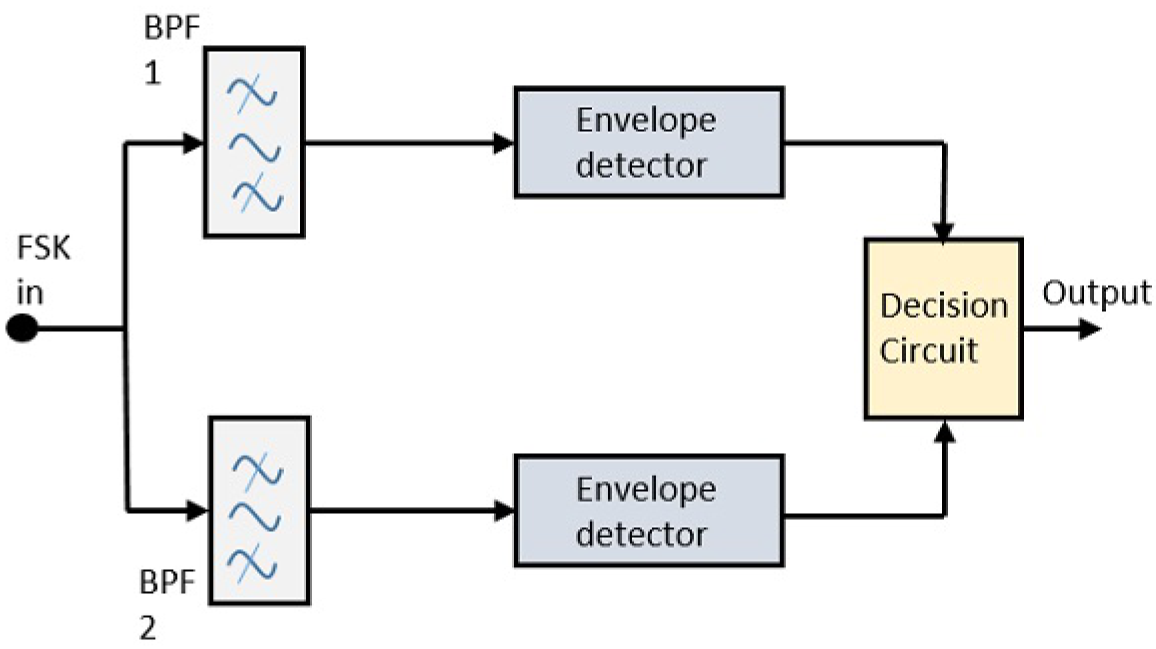
The two oscillators, producing a higher and a lower frequency signals, are connected to a switch along with an internal clock. To avoid the abrupt phase discontinuities of the output waveform during the transmission of the message, a clock is applied to both the oscillators, internally. The binary input sequence is applied to the transmitter so as to choose the frequencies according to the binary input.

FSK Demodulator

There are different methods for demodulating a FSK wave. The main methods of FSK detection are asynchronous detector and synchronous detector. The synchronous detector is a coherent one, while asynchronous detector is a non-coherent one.

Asynchronous FSK Detector

The block diagram of Asynchronous FSK detector consists of two band pass filters, two envelope detectors, and a decision circuit. Following is the diagrammatic representation.

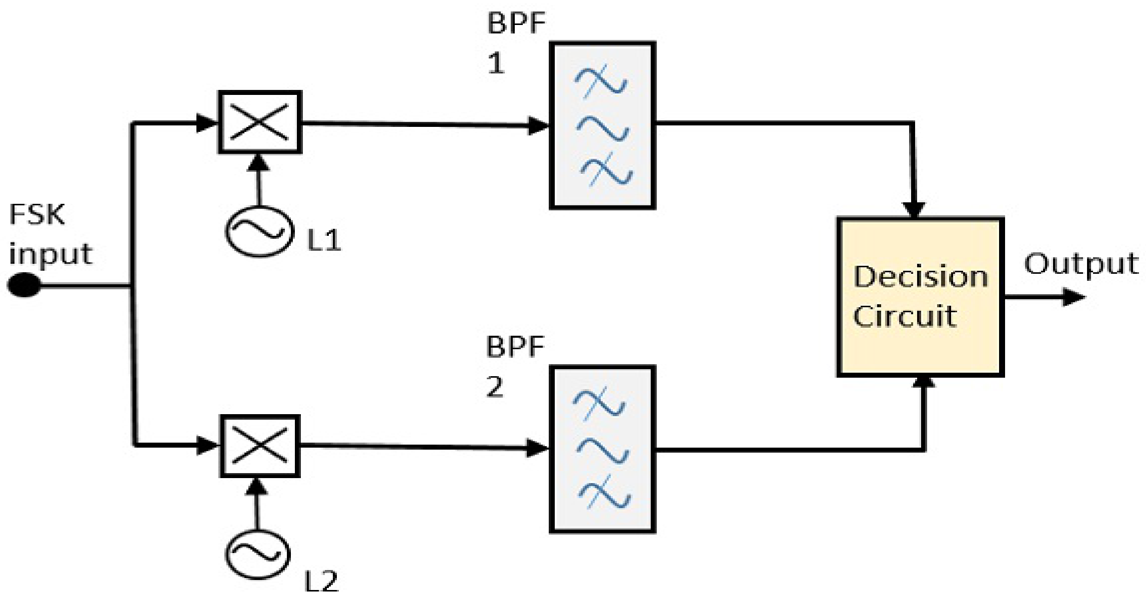


The FSK signal is passed through the two Band Pass Filters (BPFs), tuned to Space and Mark frequencies. The output from these two BPFs look like ASK signal, which is given to the envelope detector. The signal in each envelope detector is modulated asynchronously.

The decision circuit chooses which output is more likely and selects it from any one of the envelope detectors. It also re-shapes the waveform to a rectangular one.

Synchronous FSK Detector

The block diagram of Synchronous FSK detector consists of two mixers with local oscillator circuits, two band pass filters and a decision circuit. Following is the diagrammatic representation.



The FSK signal input is given to the two mixers with local oscillator circuits. These two are connected to two band pass filters. These combinations act as demodulators and the decision circuit chooses which output is more likely and selects it from any one of the detectors. The two signals have a minimum frequency separation.

For both of the demodulators, the bandwidth of each of them depends on their bit rate. This synchronous demodulator is a bit complex than asynchronous type demodulators.

CIRCUIT DESCRIPTION:

The FSK generator is formed by using a 555 as an astable multi vibrator whose fre quency is controlled by the transistor of Q_1. The output frequency of the FSK generator depends on the logic state of the digital data input. 150Hz is one of the standard frequencies at which the data are commonly transmitted. When the input is logic 1, transistor Q_1 is off. Under these conditions, the 555 works in its normal mode as an astable multi vibrator; that is capacitor C charges through R and R to 2/3 V_{CC} and discharges through R to 1/3V_{CC}. Thus capacitor C charges and discharges alternately between 2/3 V_{CC} and 1/3 V_{CC} as long as the input is at logic 1 state.

When the input signal is logic 0, Q_1 is on (Saturated), which inturn connects the resistance Rc across Ra. This action reduces the charging time of the capacitor and increases the output frequency.

The output of the 555 FSK generator is then applied to the 565 FSK demodulator. Capacitive coupling is used at the input to remove a dc level. As the signal appears at the input of the 565, the loop locks to the input frequency and tracks it between the two frequencies with a corresponding dc shift at the output. Resistor R_1 and capacitor C_1 determine the free-running frequency of the VCO, while C_2 is a loop filter capacitor that establishes the dynamic characteristics of the demodulator. Here C_2 must be choosen smaller than usual to eliminate overshoot on the output pulse. A three stage RC ladder (Low-pass) filter is used to remove the carrier component from the output. The high cutoff frequency (f_h=1/2 RC) of the ladder filter is chosen to be approximately half way between the maximum keying rate of 150Hz and twice the input frequency.

The output signal of 150Hz can be made logic compatible by connecting a voltage comparator between the output of the ladder filter and pin 6 of the PLL. The VCO frequency is adjusted with R_1, So that a slightly positive voltage is obtained at the output.

PROCEDURE:

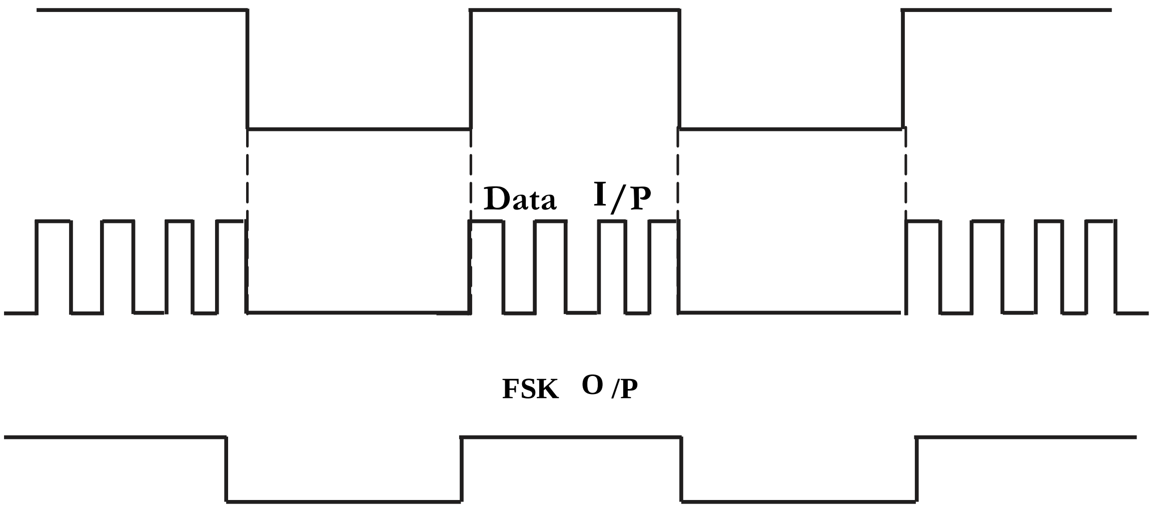
1 . Switch on Physitech’s FSK modulator & demodulator Trainer K it .

2 . Connect 150Hz square wave from function generator to Input digital data terminal.

3 . Observe FSK O/P on channel 1 of CRO.

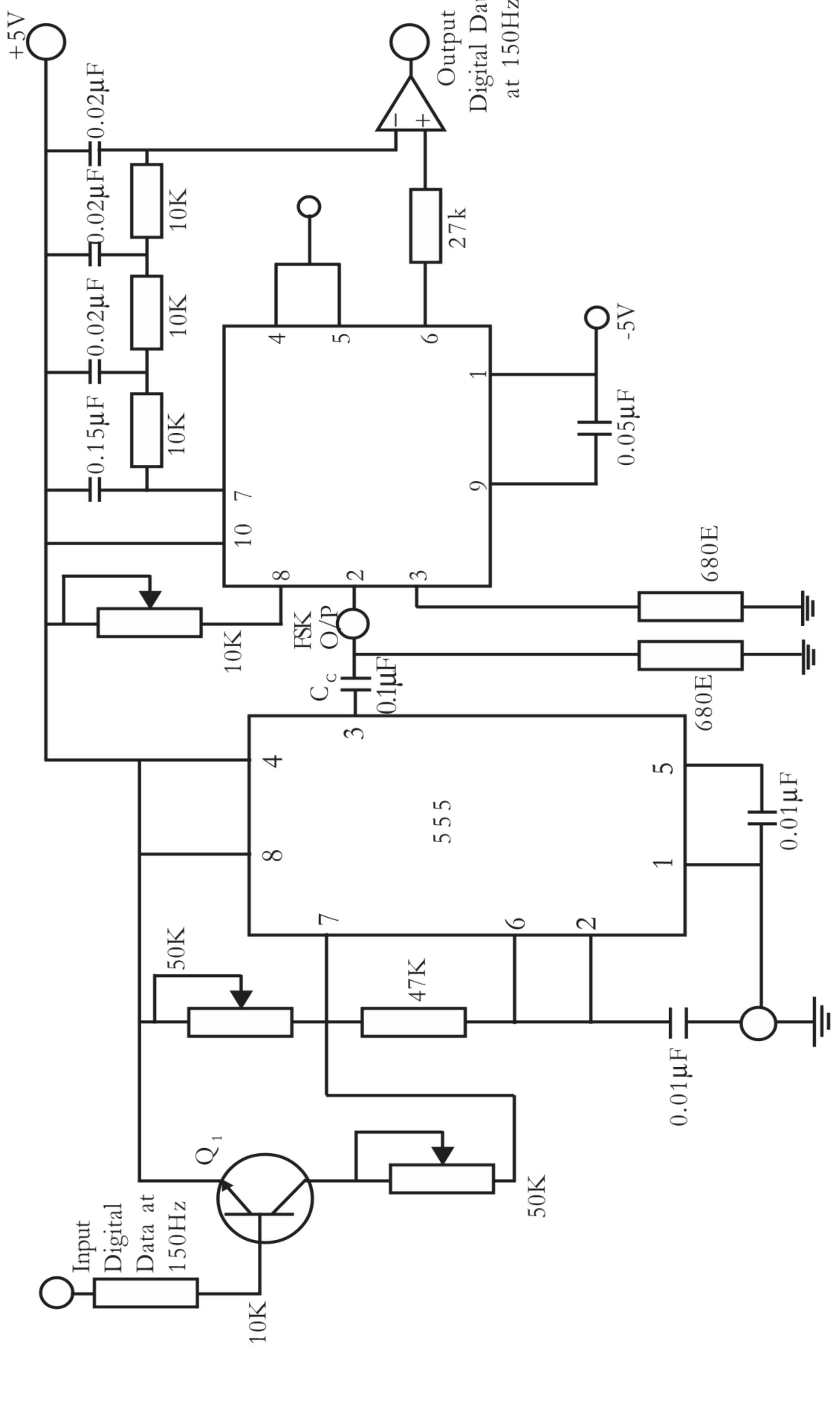
4 . Observe the demodulator output at output digital data terminal on channel 2 of CRO. To get correct waveform adjust the potentiometer knobs.

Expected Waveforms:



Demodulator O/P

Circuit Diagram :



Pre Lab Questions

1) Explain the concept of FSK?
2) Draw the waveforms of FSK?
3) What is the formula for Band Width required in FSK?

Lab Assignment

1) Explain the demodulation scheme of FSK?
2) What is the minimum B.W for an FSK signal transmitting at 2000bps(haifduplex),if carriers are separated by 3KHz?

Post Lab Questions

1) Compare ASK, FSK & PSK?
2) Is FSK more susceptible to noise than ASK?
3) What are the limiting factors of FSK?

RESULT: Hence the FSK modulation and demodulation has been studied and the modulated and demodulated wave forms were observed.

EXPERIMENT No: 9

PHASE SHIFT KEYING

AIM: To study the various steps involved in generating the phase shift keyed signal at the modulator end and recovering the binary signal from the received PSK signal.

APPARATUS:

1. Physitech's PSK Modulation & Demodulation
2. CRO
3. Connecting Wires

THEORY:

Phase Shift Keying (PSK) is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time. PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.

PSK is of two types, depending upon the phases the signal gets shifted. They are −

Binary Phase Shift Keying (BPSK)

This is also called as 2-phase PSK or Phase Reversal Keying. In this technique, the sine wave carrier takes two phase reversals such as 0° and 180°.

BPSK is basically a Double Side Band Suppressed Carrier (DSBSC) modulation scheme, for message being the digital information.

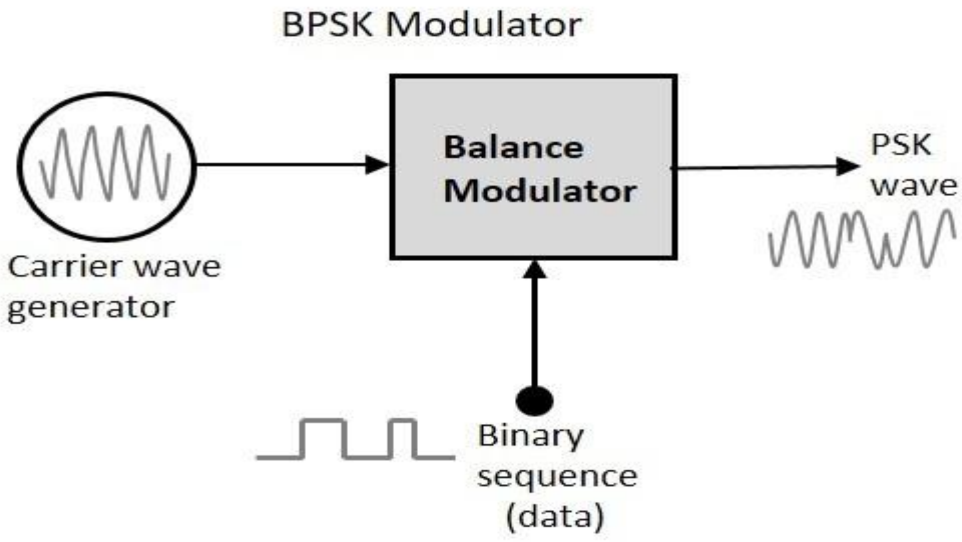
Quadrature Phase Shift Keying (QPSK)

This is the phase shift keying technique, in which the sine wave carrier takes four phase reversals such as 0°, 90°, 180°, and 270°.

If this kind of techniques is further extended, PSK can be done by eight or sixteen values also, depending upon the requirement.

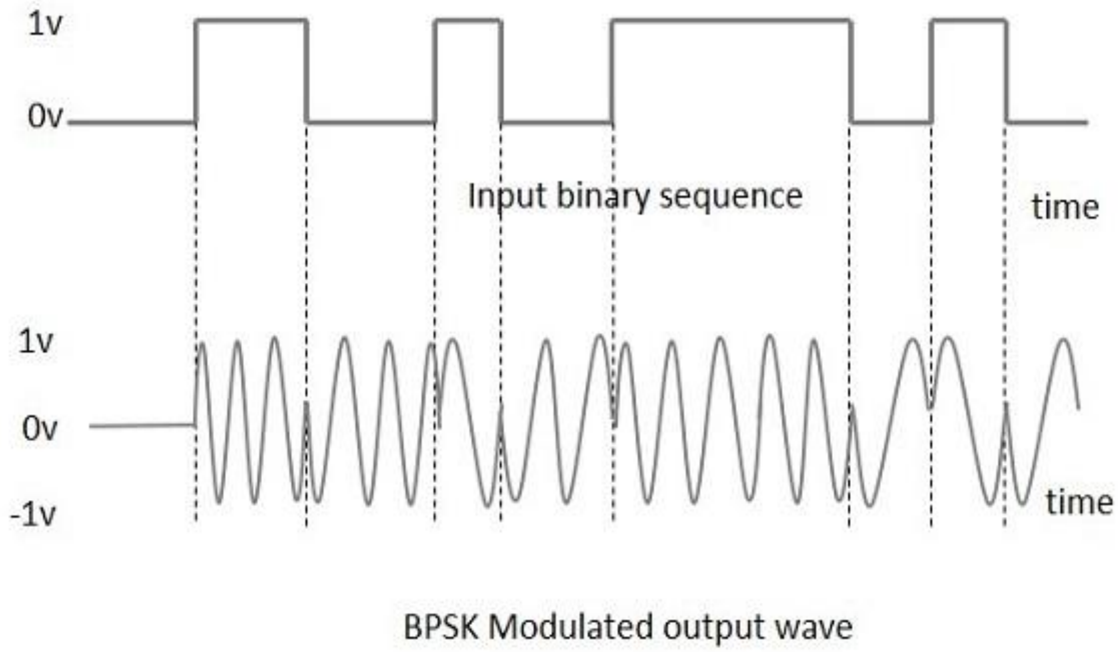
BPSK Modulator

The block diagram of Binary Phase Shift Keying consists of the balance modulator which has the carrier sine wave as one input and the binary sequence as the other input. Following is the diagrammatic representation.



The modulation of BPSK is done using a balance modulator, which multiplies the two signals applied at the input. For a zero binary input, the phase will be 0° and for a high input, the phase reversal is of 180°.

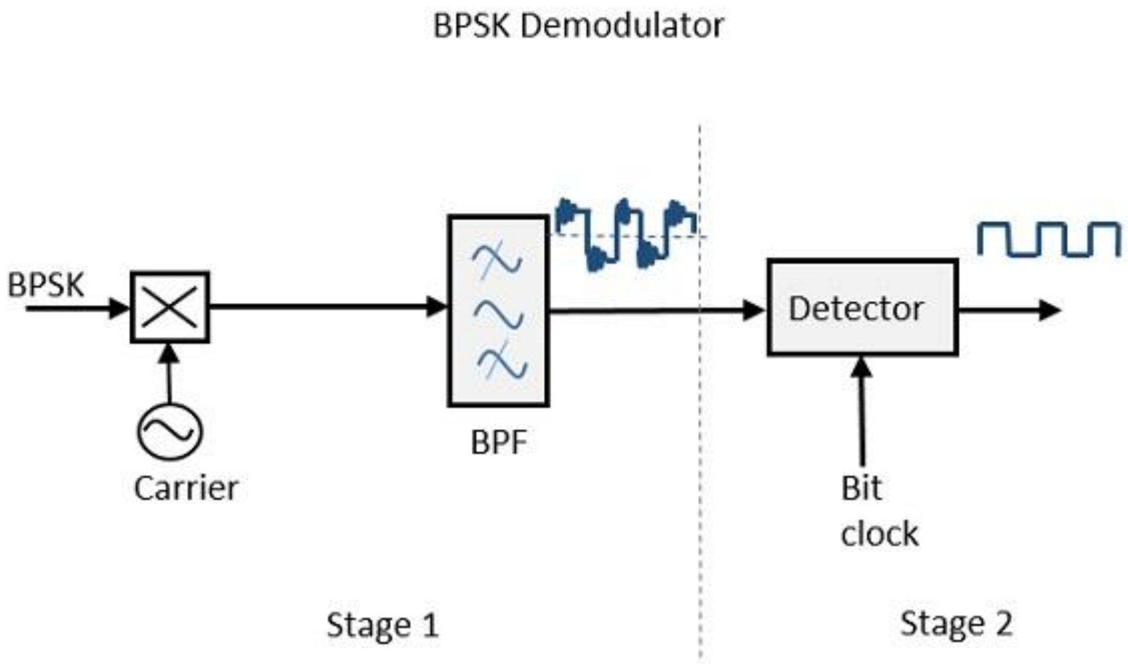
Following is the diagrammatic representation of BPSK Modulated output wave along with its given input.



The output sine wave of the modulator will be the direct input carrier or the inverted (180° phase shifted) input carrier, which is a function of the data signal.

BPSK Demodulator

The block diagram of BPSK demodulator consists of a mixer with local oscillator circuit, a bandpass filter, a two-input detector circuit. The diagram is as follows.



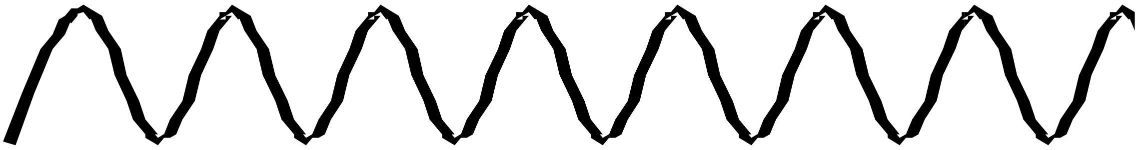
By recovering the band-limited message signal, with the help of the mixer circuit and the band pass filter, the first stage of demodulation gets completed. The base band signal which is band limited is obtained and this signal is used to regenerate the binary message bit stream.

In the next stage of demodulation, the bit clock rate is needed at the detector circuit to produce the original binary message signal. If the bit rate is a sub-multiple of the carrier frequency, then the bit clock regeneration is simplified. To make the circuit easily understandable, a decision-making circuit may also be inserted at the 2nd stage of detection.

Procedure:

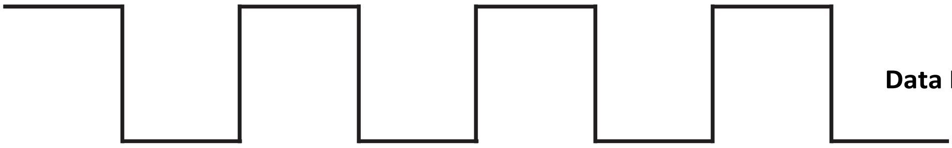
1. Switch on Physitech's PSK modulation and demodulation trainer.
2. Connect the carrier O/P of carrier generator to the carrier I/P of modulator.
3. Connect the data O/P of Data generator to the Data I/P of Modulator.
4. Compare these two signals.
5. Connect the PSK O/P of modulator to the PSK I/P of demodulator.
6. Connect the carrier O/P of carrier generator to carrier I/P of demodulator.
7. Connect CH_1 OF CRO to Data generator o/p and CH_2 tothe demodulator o/p.

PSK Expected wave forms

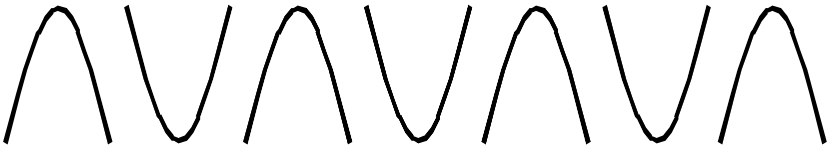


Carrier I/P

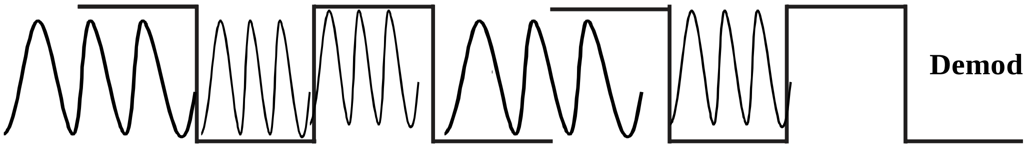
Channel: 1



Data I/P



PSK O/P



Demod O/P

Channel: 2

Data I/P

PSK O/P

Demod O/P

Pre Lab Questions

1) Explain the concept of PSK?
2) Draw the waveforms of PSK?
3) Is the maximum baud ate in PSK & ASK are same?

Lab Assignment

1) Explain the demodulation scheme of PSK?
2) What is the advantage of PSK over ASK, FSK?

Post Lab Questions

1) Compare ASK, FSK, PSK?
2) What is the minimum B.W require d in PSK?
3) Is the maximum bit rate in PSK is greater than ASK?

RESULT: Hence the PSK modulation and demodulation has been studied and the modulated and demodulated wave forms were observed.

EXPERIMENT No: 10

DPSK GENERATION AND DETECTION

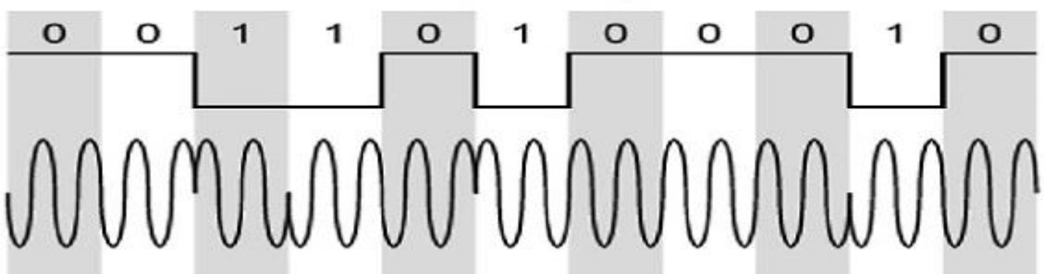
AIM: To study the various steps involved in generating differential phase shift keyed signal at the modulator end and recovering the binary signal from the DPSK signal.

APPARATUS:

1. PHYSITECH'S Differential Phase shift keying Trainer.
2. CRO
3. Connecting Wires.

THEORY:
In Differential Phase Shift Keying (DPSK) the phase of the modulated signal is shifted relative to the previous signal element. No reference signal is considered here. The signal phase follows the high or low state of the previous element. This DPSK technique doesn't need a reference oscillator.

The following figure represents the model waveform of DPSK.

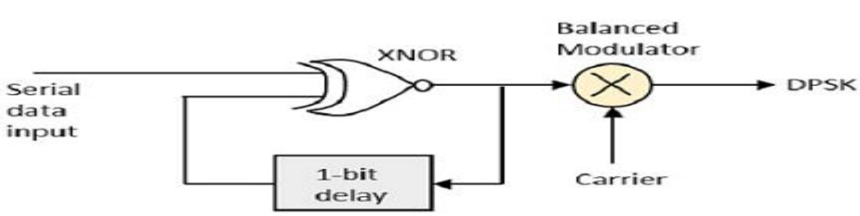


It is seen from the above figure that, if the data bit is Low i.e., 0, then the phase of the signal is not reversed, but continued as it was. If the data is a High i.e., 1, then the phase of the signal is reversed, as with NRZI, invert on 1 (a form of differential encoding).

If we observe the above waveform, we can say that the High state represents an M in the modulating signal and the Low state represents a W in the modulating signal.

DPSK Modulator

DPSK is a technique of BPSK, in which there is no reference phase signal. Here, the transmitted signal itself can be used as a reference signal. Following is the diagram of DPSK Modulator.

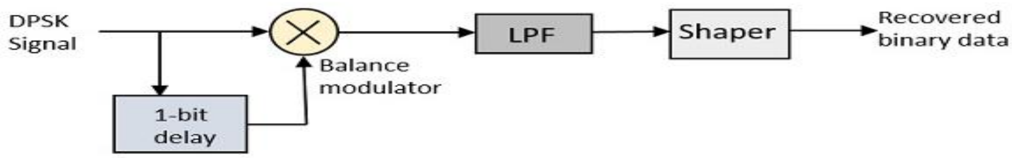


DPSK Modulator

DPSK encodes two distinct signals, i.e., the carrier and the modulating signal with 180° phase shift each. The serial data input is given to the XNOR gate and the output is again fed back to the other input through 1-bit delay. The output of the XNOR gate along with the carrier signal is given to the balance modulator, to produce the DPSK modulated signal.

DPSK Demodulator

In DPSK demodulator, the phase of the reversed bit is compared with the phase of the previous bit. Following is the block diagram of DPSK demodulator.



From the above figure, it is evident that the balance modulator is given the DPSK signal along with 1-bit delay input. That signal is made to confine to lower frequencies with the help of LPF. Then it is passed to a shaper circuit, which is a comparator or a Schmitt trigger circuit, to recover the original binary data as the output.

DPSK may be viewed as the noncoherent version of PSK. It eliminates the need for a coherent reference signal at the receiver by combining two basic operations at the transmitter:

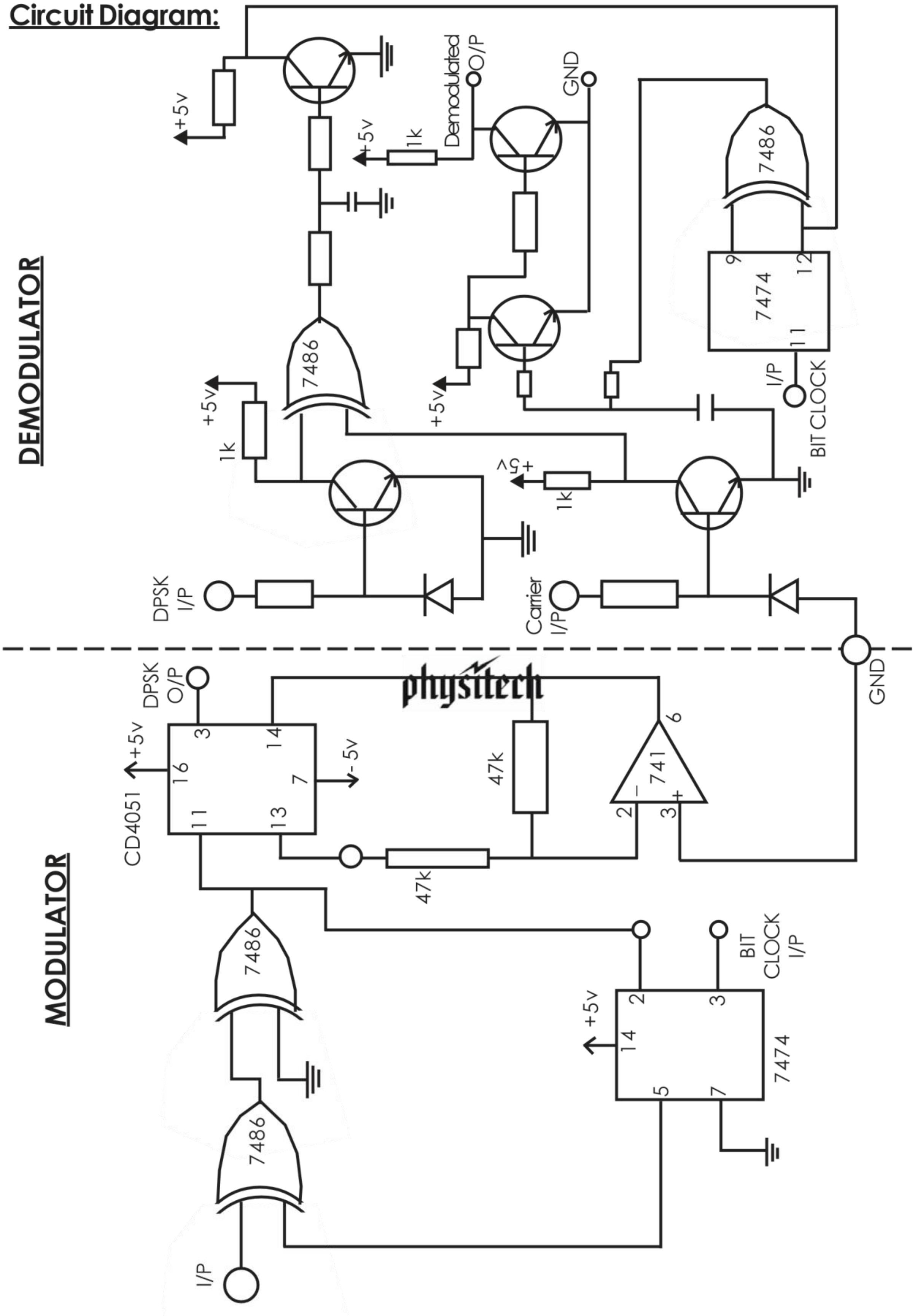
1. Differential encoding of the input binary wave and
2. Phase-Shift Keying -hence, the name, differential phase shift keying (DPSK).

In effect to send symbol 0, we phase advance the current signal waveform by 180 degrees, and to send symbol 1, we leave the phase of the current signal waveform unchanged. The receiver is equipped with a storage capability, so that it can measure the relative phase difference between the waveforms received during two successive bit intervals. Provided that the unknown phase θ contained in the received wave varies slowly, the phase difference between waveforms received in two successive bit intervals will be independent of θ.

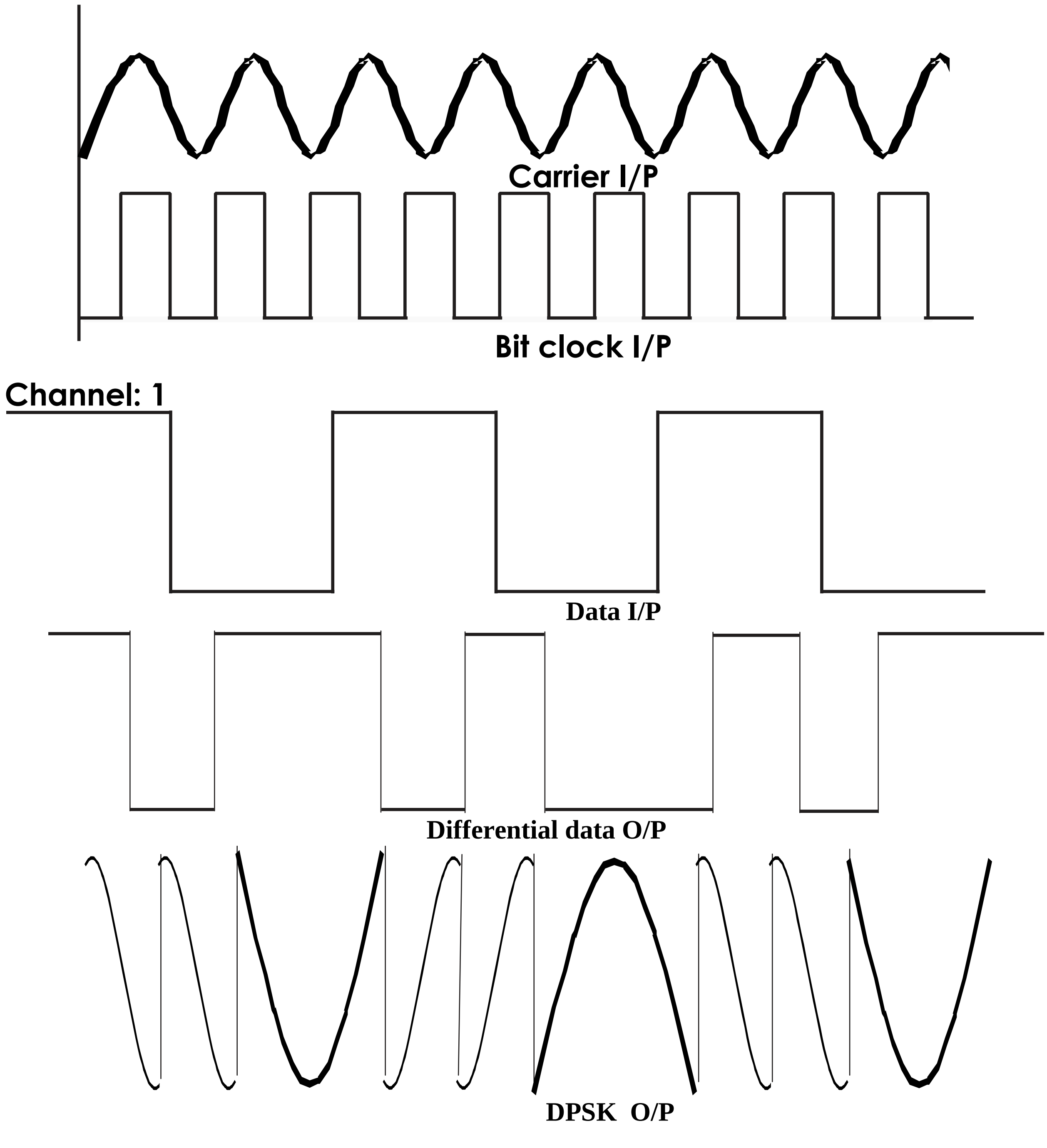
PROCEDURE:

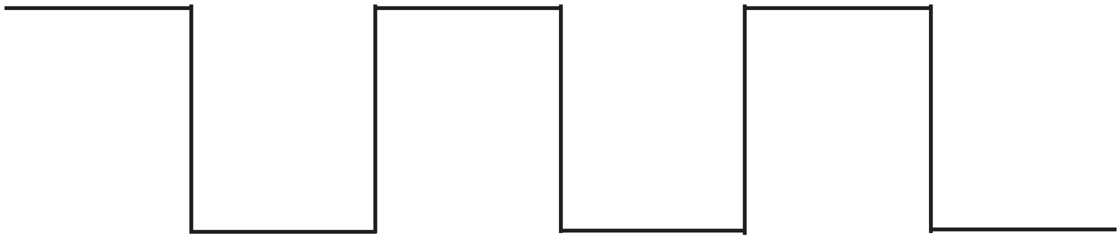
1. Switch on Physitech's differential Phase shift Keying trainer.
2. Connect the carrier output of carrier generator to the 13th pin of CD4051(Analog mux) of modulator.
3. Connect the Bit clock output to the Bit clock input at pin 3 of 7474 (8-bit converter) of modulator.
4. Connect the data output of data generator to the input of modulator circuit.
5. Connect channel 1 of CRO to the data generator.
6. Observe the differential data output at pin 2 of 7474 IC on channel -1 of CRO.
7. Observe the DPSK modulated output on channel-2 of CRO.
8. During demodulation, connect the DPSK modulated output to the DPSK I/P of Demodulator.
9. Connect the Bit clock O/P to the Bit clock I/P of Demodulator and also connect the carrier O/P to the carrier I/P of demodulator.
10. Observe the demodulated data O/P at demodulator.
11. The frequency of modulation data signal should be equal to the demodulated O/P.

Circuit Diagram:



EXPECTED WAVEFORMS:





Demodulated O/P

Pre Lab Questions

1) How does DPSK differ from PSK?
2) What is the advantage of DPSK over PSK?
3) What are the applications of DPSK?

Lab Assignment

1) What are the disadvantages of DPSK?
2) Is the error rate of DPSK is greater than PSK?

Post Lab Questions

1) Explain theoretical modulation & demodulation of DPSK using arbitrary bit sequence and assuming initial bit 0 and 1?
2) Why do we need 1 bit delay in DPSK modulator & demodulator?
3) What is the relation between carrier frequency & the bit interval T?

RESULT: Hence the Differential Phase Shift Keying Modulation and Demodulation has been studied and the modulated and demodulated output wave forms were observed.

EXPERIMENT No: 11

ASK GENERATION AND DETECTION

AIM: To study the various steps involved in generating amplitude phase shift keyed signal at the modulator end and recovering the binary signal from the ASK signal.

APPARATUS:

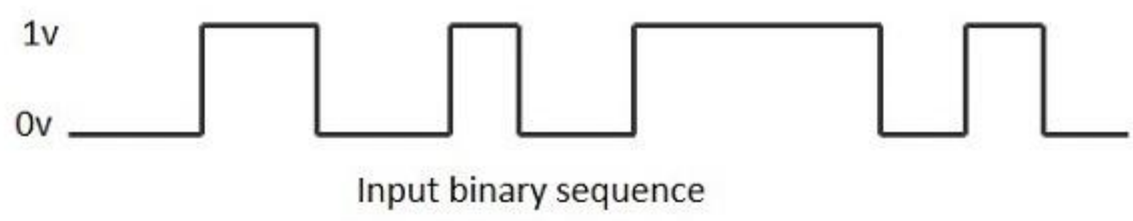
1. Physitech's Amplitude shift keying Trainer Kit
2. CRO
3. Connecting Wires.

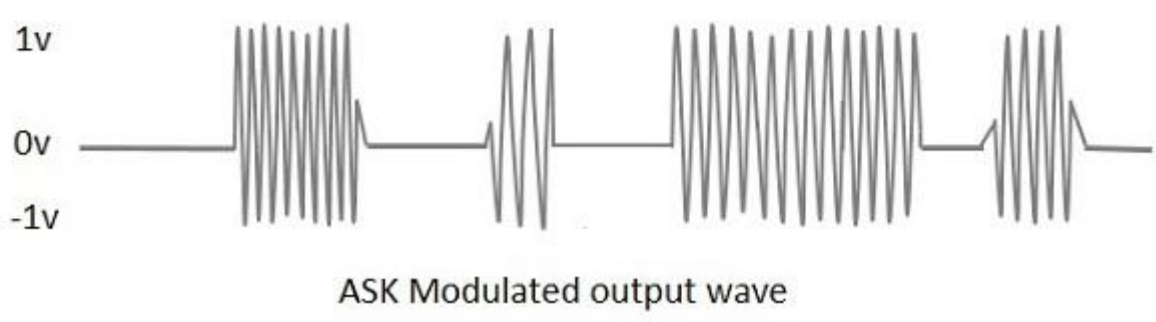
THEORY

Amplitude Shift Keying (ASK) is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal.

Any modulated signal has a high frequency carrier. The binary signal when ASK modulated, gives a zero value for Low input while it gives the carrier output for High input.

The following figure represents ASK modulated waveform along with its input.

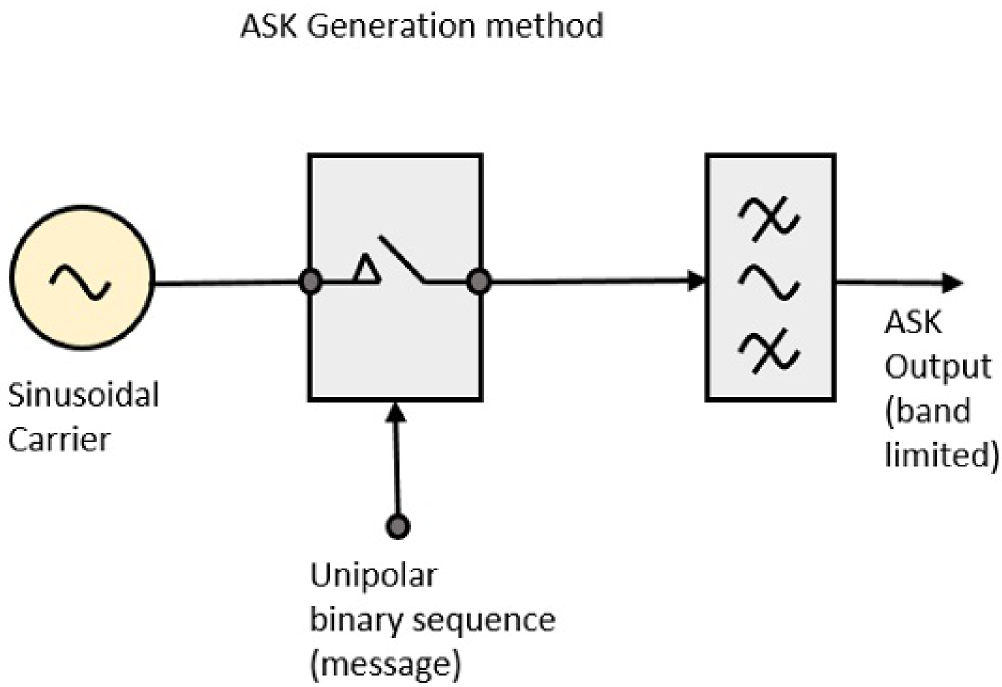




To find the process of obtaining this ASK modulated wave, let us learn about the working of the ASK modulator.

ASK Modulator

The ASK modulator block diagram comprises of the carrier signal generator, the binary sequence from the message signal and the band-limited filter. Following is the block diagram of the ASK Modulator.



The carrier generator, sends a continuous high-frequency carrier. The binary sequence from the message signal makes the unipolar input to be either High or Low. The high signal closes the switch, allowing a carrier wave. Hence, the output will be the carrier signal at high input. When there is low input, the switch opens, allowing no voltage to appear. Hence, the output will be low.

The band-limiting filter, shapes the pulse depending upon the amplitude and phase characteristics of the band-limiting filter or the pulse-shaping filter.

ASK Demodulator

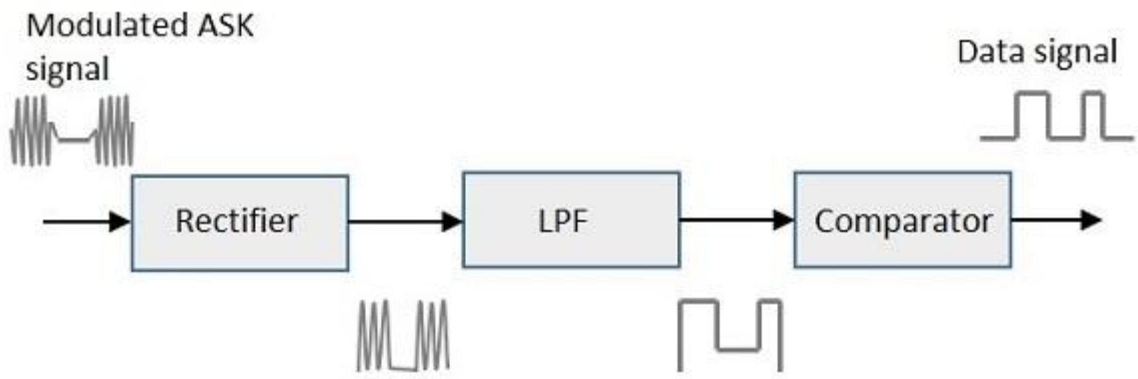
There are two types of ASK Demodulation techniques. They are −

- Asynchronous ASK Demodulation/detection
- Synchronous ASK Demodulation/detection

The clock frequency at the transmitter when matches with the clock frequency at the receiver, it is known as a Synchronous method, as the frequency gets synchronized. Otherwise, it is known as Asynchronous.

Asynchronous ASK Demodulator

The Asynchronous ASK detector consists of a half-wave rectifier, a low pass filter, and a comparator. Following is the block diagram for the same.

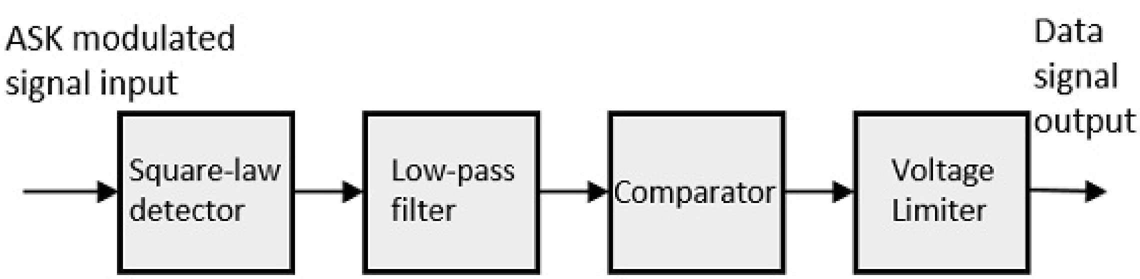


Asynchronous ASK detector

The modulated ASK signal is given to the half-wave rectifier, which delivers a positive half output. The low pass filter suppresses the higher frequencies and gives an envelope detected output from which the comparator delivers a digital output.

Synchronous ASK Demodulator

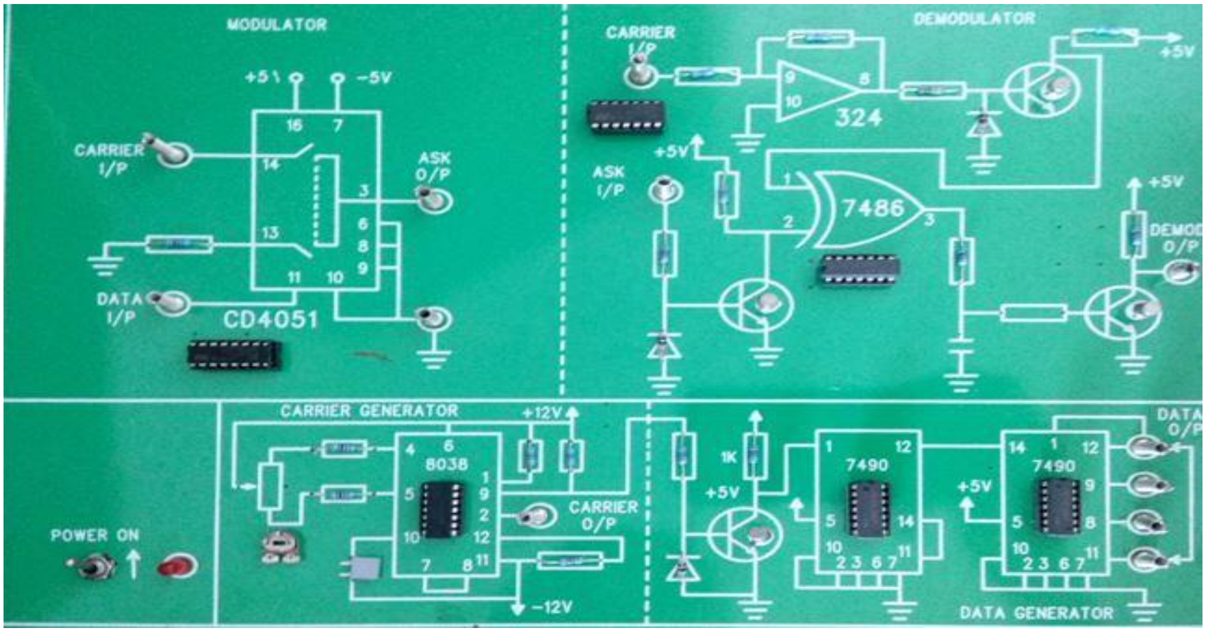
Synchronous ASK detector consists of a Square law detector, low pass filter, a comparator, and a voltage limiter. Following is the block diagram for the same.



Synchronous ASK detector

The ASK modulated input signal is given to the Square law detector. A square law detector is one whose output voltage is proportional to the square of the amplitude modulated input voltage. The low pass filter minimizes the higher frequencies. The comparator and the voltage limiter help to get a clean digital output.

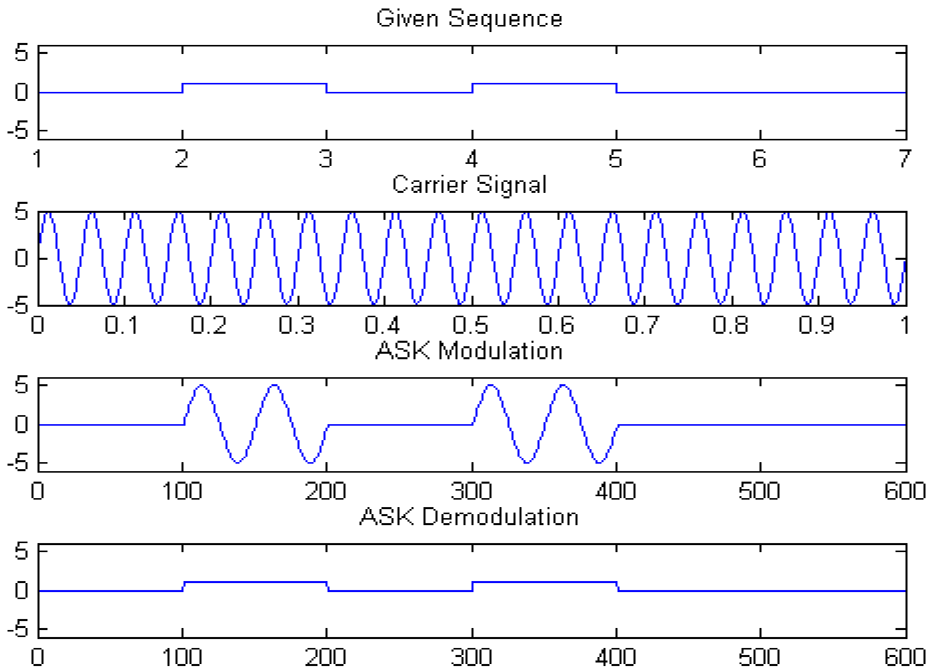
Circuit Diagram



Procedure:

1. Switch on Physitech’s ASK shift Keying trainer.
2. Connect the carrier output of carrier generator to the modulator.
3. Connect the data output of data generator to the input of modulator circuit.
4. Connect channel 1 of CRO to the data generator.
5. Observe the ASK modulated output on channel-2 of CRO.
6. During demodulation, connect the ASK modulated output to the ASK I/P of Demodulator.
7. Observe the demodulated data O/P at demodulator.

Model Waveforms:



Pre Lab Questions

1) How does ASK differ from PSK, FSK?

2) What are the applications of ASK?

Lab Assignment

3) What is the disadvantages of ASK?

4) Is the error rate of ASK is greater than PSK?

Post Lab Questions

4) Explain theoretical modulation & demodulation of ASK using arbitrary bit sequence and assuming initial bit 0 and 1?

5) What is the relation between carrier frequency & the bit interval T?

RESULT: Hence the Amplitude Shift Keying Modulation and Demodulation has been studied and the modulated and demodulated output wave forms were observed.

EXPERIMENT No: 12

QUADRATURE PHASE SHIFT KEYING

AIM: Study of carrier modulation Techniques by Quadrature phase shift keying method.

APPARATUS:

1. CRO
2. Connecting Wires.
3. QPSK Trainer kit

Theory :

In this modulation called quadrature PSK (QPSK) or PSK the sine carrier takes 4 phase values, separated of 90 deg, and determined by combinations of pair (Dibit) of the binary data signal. The data are coded in to dibit by a circuit generating.

A data signal 1 (in phase consisting in voltage levels corresponding to the values of the first bit of the considered pair, for duration equal to 2 bit intervals.

A data signal Q (in quadrature) consisting in voltage levels corresponding to the value of the second bit of the considered pair, for duration equal to w bit intervals.

Four 500 KHz sine carriers, shifted between them of 90deg, are applied to modulator. The data ((signal I & Q) reach the modulator form the dibit generator. The instantaneous value of 1 and Q data bit generates a symbol.

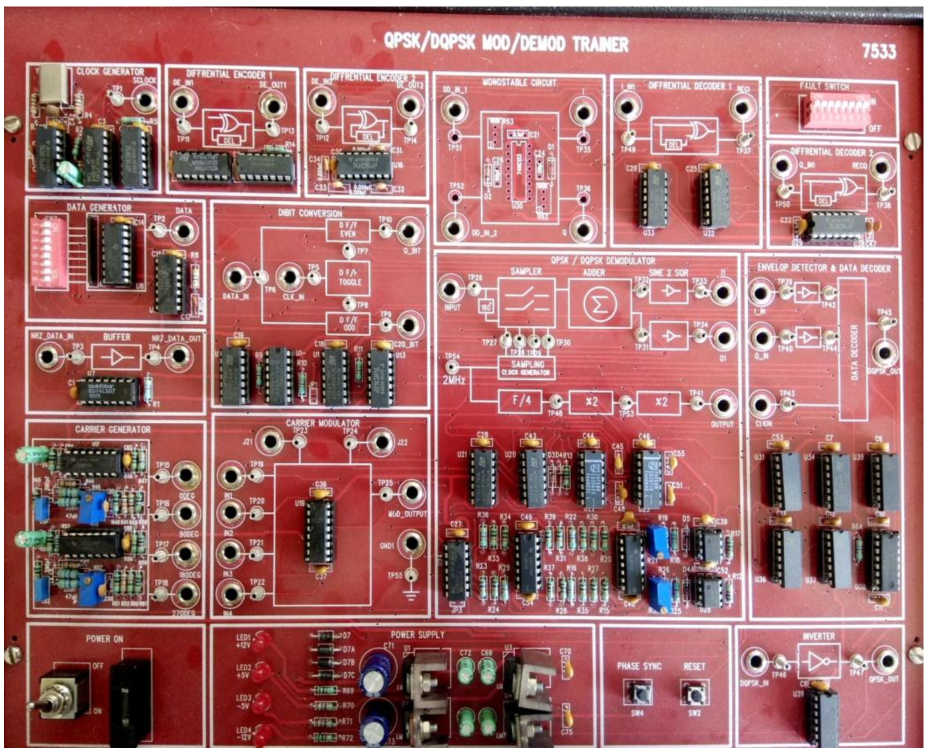
Since I and Q can take either 0 or 1 value, maximum four possible symbols can be generated (00, 01, 10,11). According to the symbol generated one of the four sine carrier will be selected. The relation between the symbol generated and sine carrier is shown in table.

DIBIT	PHASE SHIFT
00	180 deg.
01	90 deg.
10	270 deg.
11	0 deg.

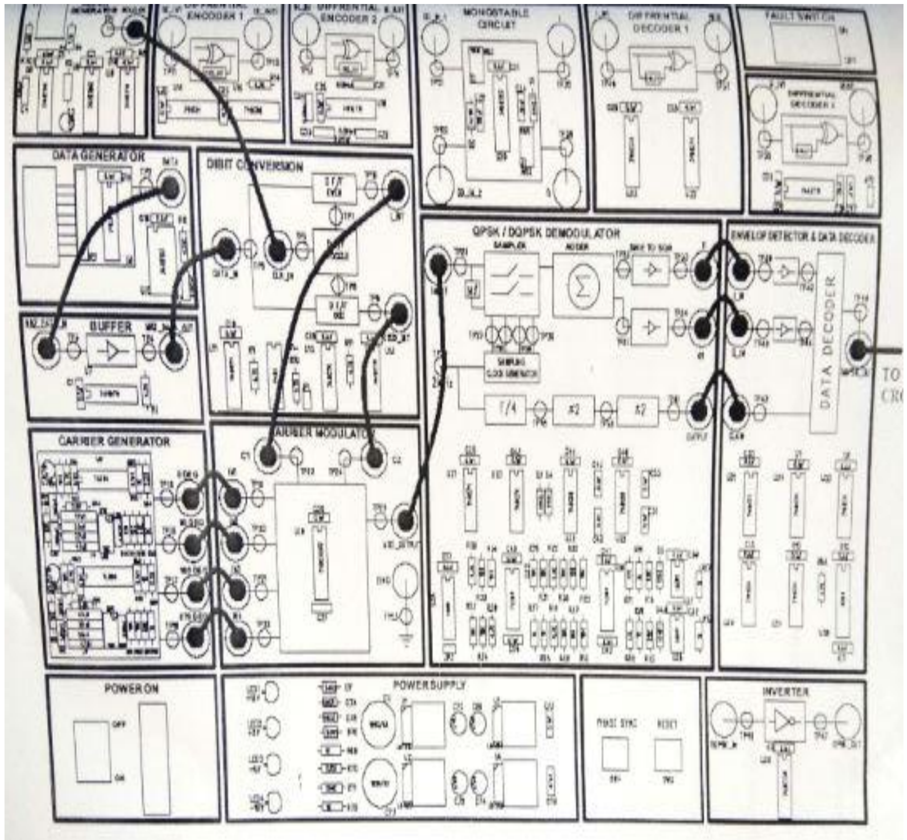
A receiver for the QPSK signal is shown in fig. synchronous detection is required and hence its necessary to locally regenerate the carriers. The scheme for regeneration is similar to that employed in BPSK. In that earlier case we squared the incoming the signal, extracted the wave form a twice the carrier frequency by filtering and recovered the carrier by frequency dividing by two. In the present case, it is required that incoming signal be raised to the fourth power after which filtering recovers a waveforms at four time the carrier.

The incoming signal also applied to the sampler followed by adder and envelope detectors. Two adders of the sampled QPSK signal, sampled by the clock having different phases. At the output of adder the signals consisting the envelope corresponds to I & Q bit. Envelope detector then filters the high frequency components and recovers I & Q bit. These recovered I & Q having exactly same phase & frequency compared to transmitter I & Q bit. These I & Q bits then applied to data decoder logic to recover the original NRZ-L data pattern.

Circuit Diagram:



:



PRODECURE:

1. Connect the AC supply to the kit.
2. Ensure that all faults are in normal position
3. Make connections as shown in above figure.
4. Select data pattern of simulated data using switch SW1 as ‘11000000’
5. Observe the following waveforms on oscilloscope.
   a) NRZ-DATA output (TP4)
   b) CARRIER SIGNALS (SINE1 to SINE4) (TP15, TP16, TP17, TP18)
   c) Dibit pair generated 1 Bit and Q BIT (TP10, TP9)
   d) QPSK modulator MOD output(TP23)
   e) SAMPLING CLOCK output (TP27, TP29, TP28, TP30)
   f) ADDER output(TP31, TP32)
   g) REC I and REC Q output (TP33, TP34)
   h) Envelop detector output (TP42, TP44)
   i) DATA DECODER output (TP45)

6. Compare above waveforms with given waveforms.
7. Repeat this above procedure for below data input and observes corresponding waveform.

- 11001100
- 10101010
- 11110000

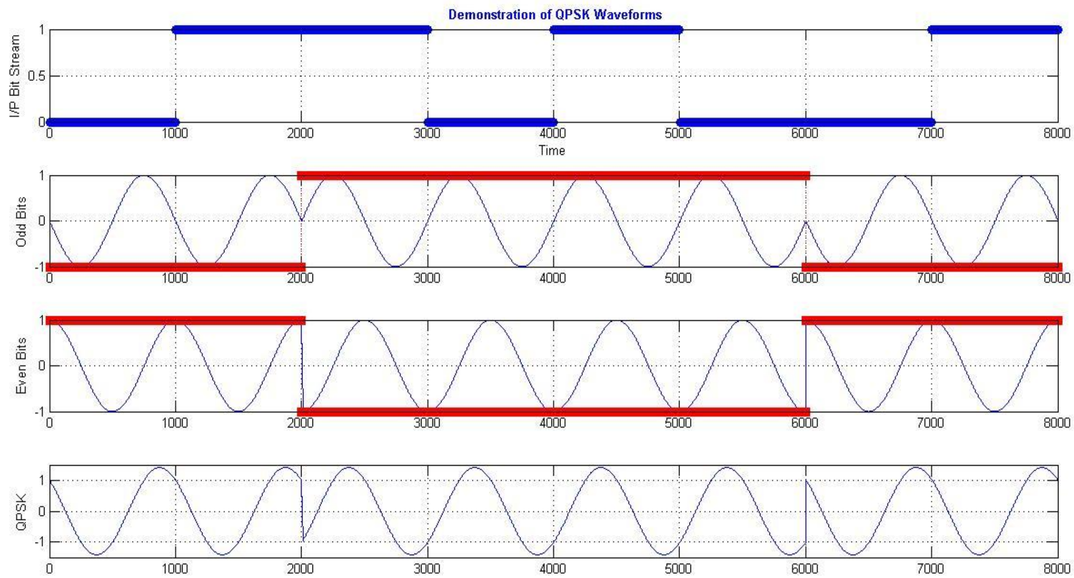
NOTE:

1) Demodulation on output may get out of phase with input for that time you can use inverter block.
2) After changing input first press RESET switch.
3) If you don’t get proper output press PHASE SYNC switch.

EFFECT OF FAULT SWITCH:

- Put switch 4 of SW1 in OFF position. This will open carrier capacitor for filtering of SIN1. Thus amplitude of SN1 and SIN3 gets disturbed.
- Put switch 3 of SW1 in OFF position. This will disable control signal C1 going to data modulator. Modulator will not able to modulate the signal properly.
- Put switch 2 of SW1 in OFF position. This will open the input of EX-Or gate used in differential encoder1. Due to this random data is generated at the output of differential encoder1.
- Put switch 1 of SW1 in OFF position. This will remove the clock signal (125 KHz-180deg) in the generation of 1 bit data. This disable the generation of 1 bit data at the output of dibit conversion.
- Put switch 5 of SW1 in OFF position. This will remove pull up resistor from envelope detector of 1 BIT. 1 BIT generation gets disabled.
- Put switch 7 of SW1 in OFF position. This will remove one of the sampling clocks to sampler. Thus QPSK signal doesn’t get sampled properly and to this QPSK demodulated data also gents disturbed.
- Put switch of 6 of SW1 in OFF position. This removes one of the sampling outputs of sample. So 1 BIT cannot be observed and recovered data also gets disturbed.

Model Waveforms:



Result:

Hence QPSK modulation and demodulation is verified using Trainer kit.

EXPERIMENT No: 13

QPSK AND DPSK USING MATLAB

AIM: To perform QPSK and DPSK using MATLAB and Simulink models.

APPARATUS:

1. MATLAB R2015 a

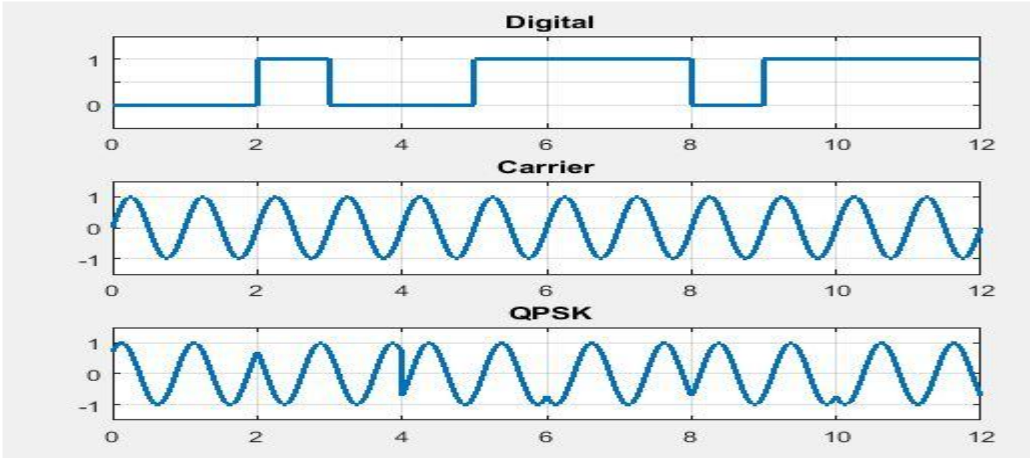
MATLAB CODE FOR QPSK

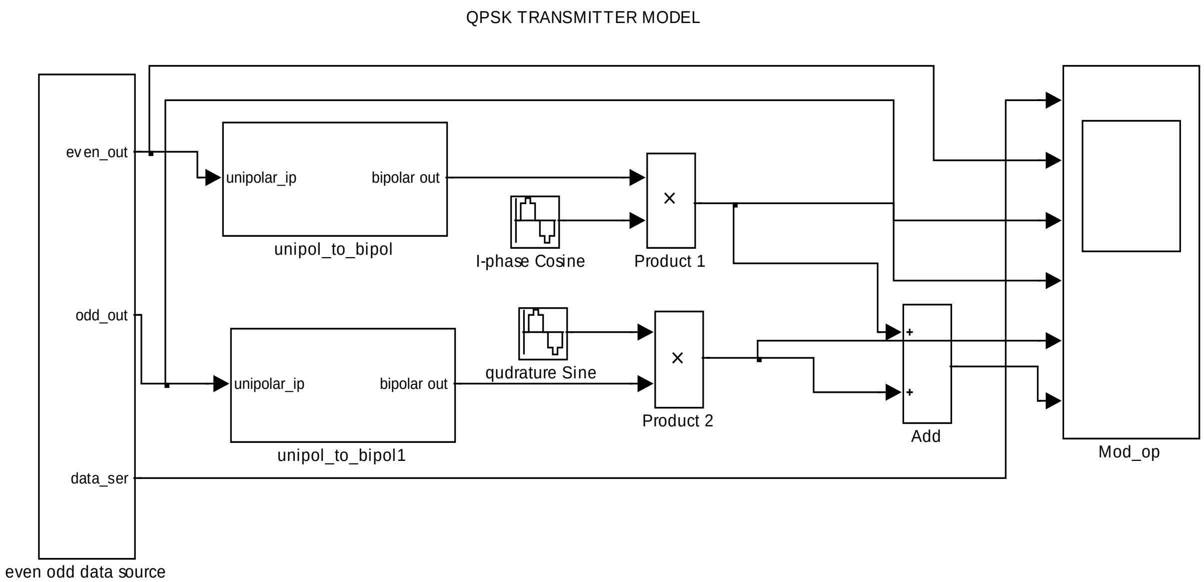
```
clc;
clear all;
close all;
bits=[0,0,1,0,0,1,1,1,0,1,1,1];
%Offset OPSK
P1=pi/4; % 45 degrees
P2=0.75*pi; % 135
P3=1.25*pi; % 225
P4=1.75*pi; % 315
%Definition of Frequencies and periods
f=1;
fs=100;
t=0:1/fs:1; % Period for the digital signal and carrier
t1=0:1/fs:2; %  the period of  QPSK
%Definition of variable to use
tiempo=[];
tiempo1=[];
Digital=[];
Portadora=[];
QPSK=[];
% Sequence of data
for i=1:1:length(bits)
   if bits(i)==0
      z=zeros(1,length(t));
      Digital = [Digital z];
   end

   if bits(i)==1
      o=ones(1,length(t));
      Digital = [Digital o];
   end
   % Carrier
   Portadora=[Portadora (sin(2*pi*f*t))];
   tiempo=[tiempo t];
   t= t+1;
end
%know QPSK
for ii=1:2: length(bits)
```

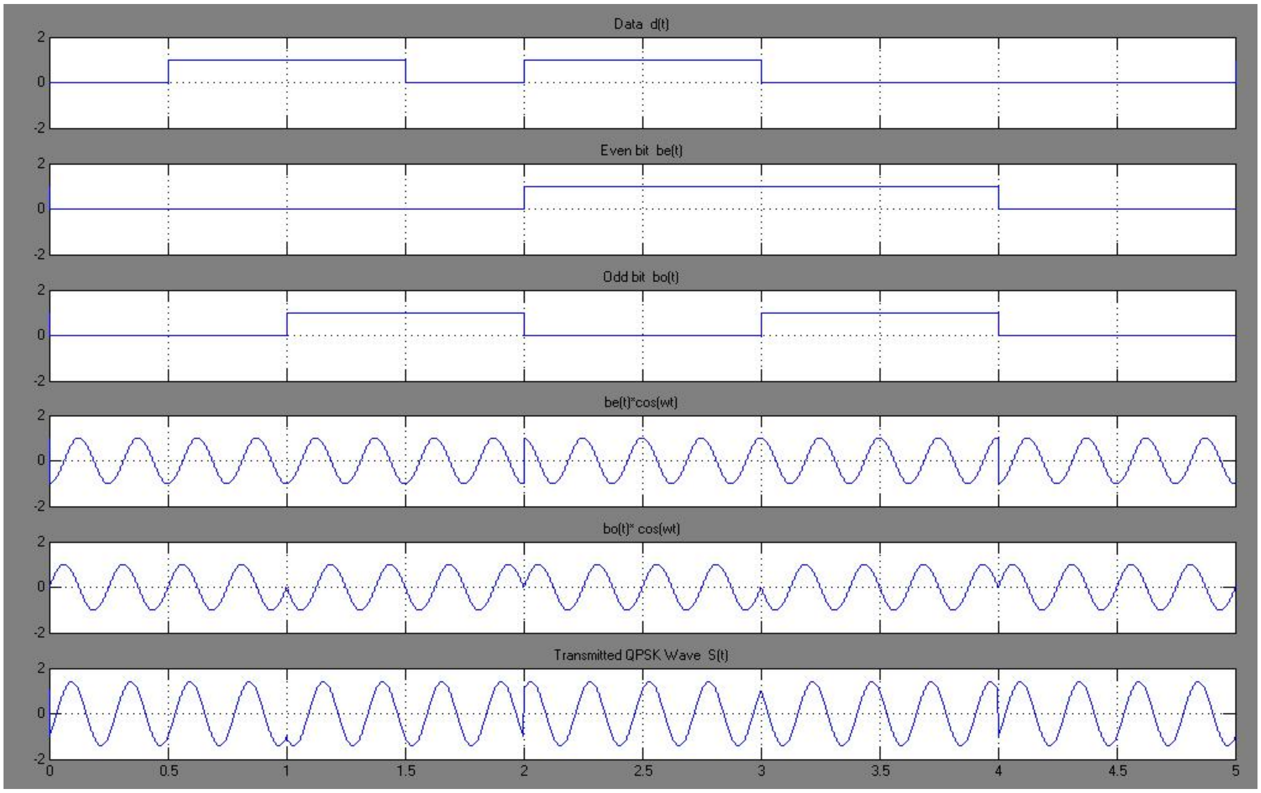
```
    % Caso 1 = 00 Offset of 45
    if bits(ii)==0 && bits(ii+1)==0
        bits00= sin(2*pi*f*t1 + P1);
        QPSK=[QPSK (bits00)];
    end
    % Caso 2 = 01 Offset of 135
    if bits(ii)==1 && bits(ii+1)==0
        bits10= sin(2*pi*f*t1 +P2);
        QPSK=[QPSK (bits10)];
    end
    % Caso 3 = 10 Offset of 225
    if bits(ii)==1 && bits(ii+1)==1
        bits11= sin(2*pi*f*t1 +P3);
        QPSK=[QPSK (bits11)];
    end
    % Caso 4 = 11 Offset of 315
    if bits(ii)==0 && bits(ii+1)==1
        bits01= sin(2*pi*f*t1 +P4);
        QPSK= [QPSK (bits01)];
    end
    tiempo1= [tiempo1 t1];
    t1=t1+2;
end
   % Representation of signals
   Subplot(3,1,1);
    plot(tiempo, Digital,'lineWidth',2.5);
    title(' Digital');
    axis([0 12 -0.5 1.5]);
     grid on;
   subplot(3,1,2);
    plot(tiempo,Portadora,'lineWidth',2.5);
    title('Carrier');
    axis([0 12 -1.5 1.5]);
     grid on;
   subplot(3,1,3);
    plot(tiempo1,QPSK,'lineWidth',2.5);
    title('QPSK');
    axis([0 12 -1.5 1.5]);
     grid on;
```

Simulation Results

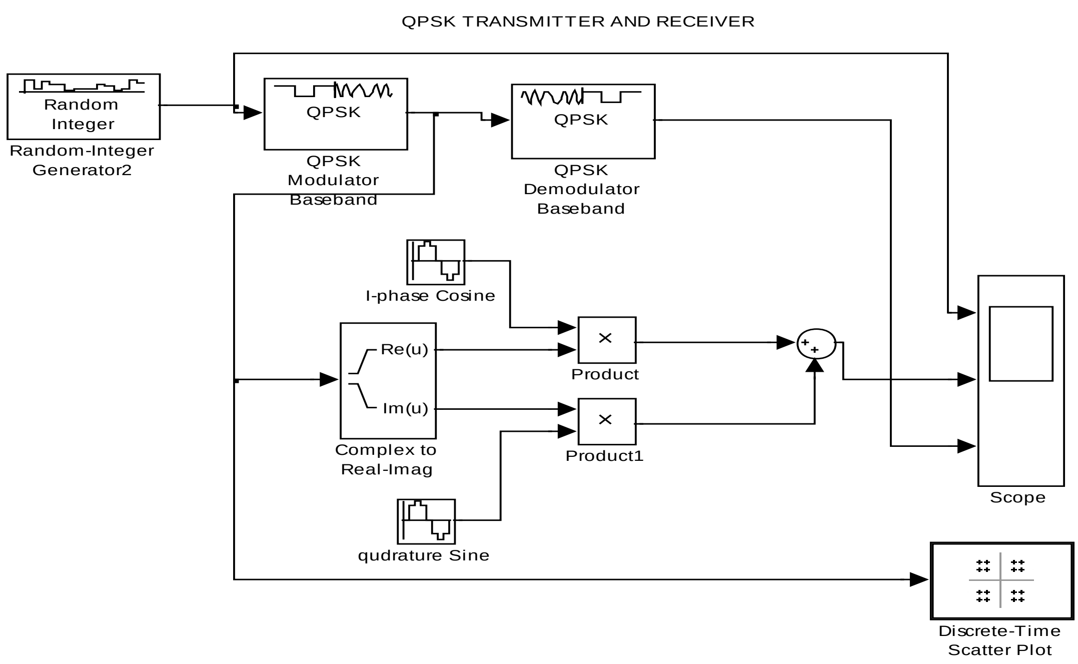




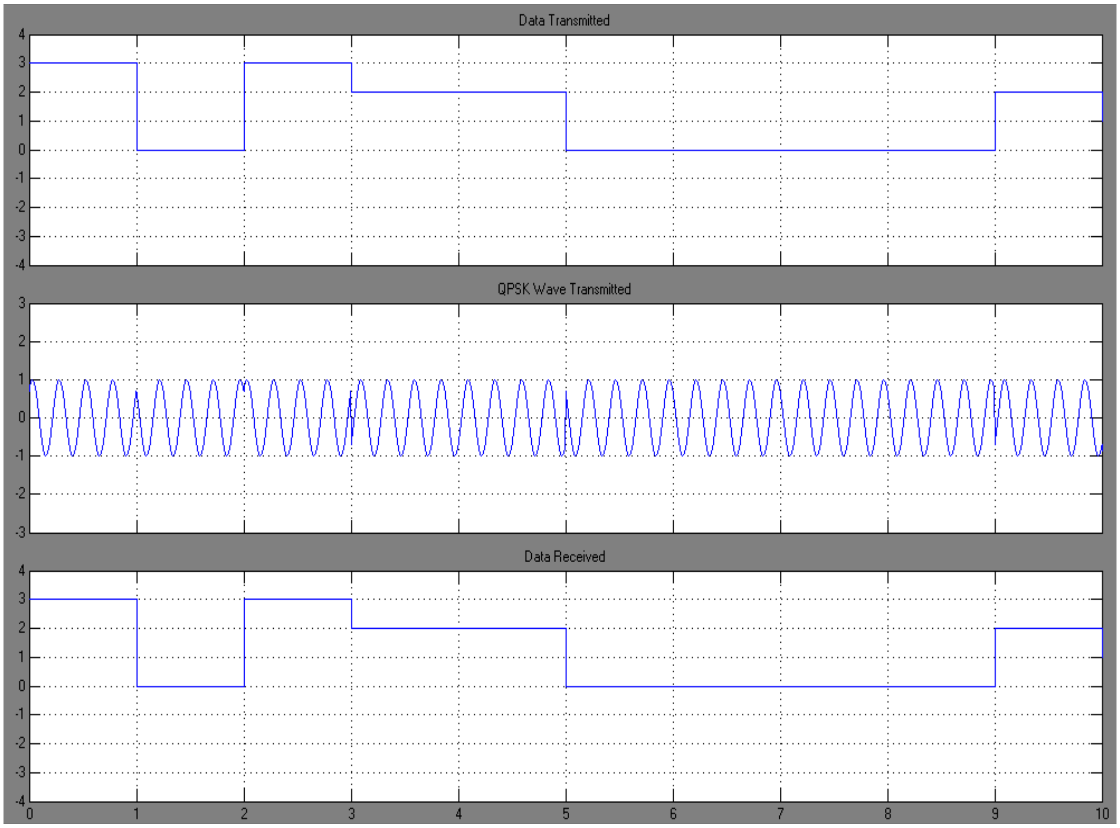
QPSK Transmitter using Simulink Model



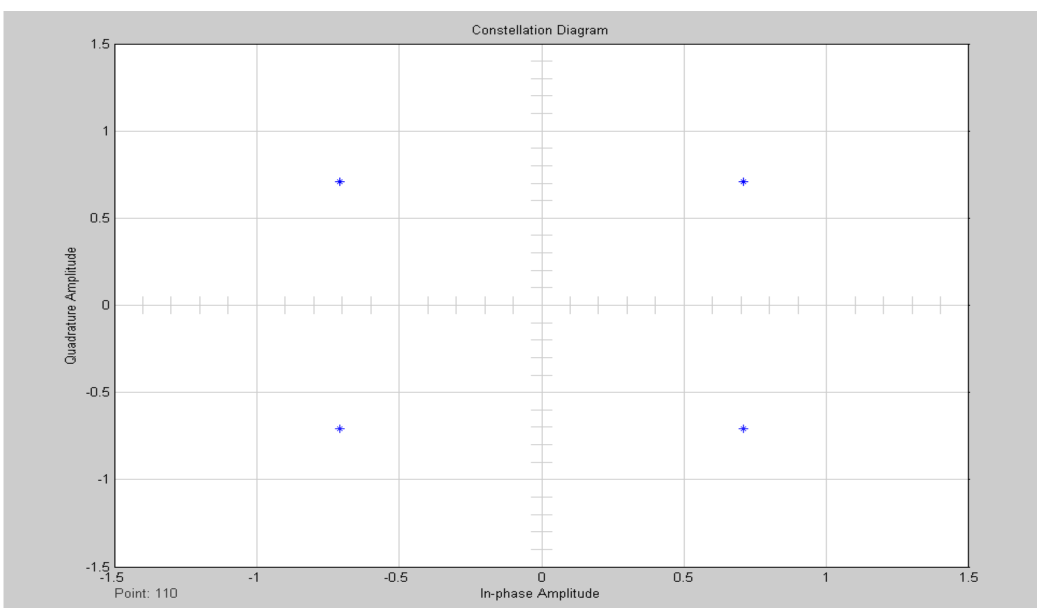
Simulation Results of QPSK for even and odd sequence of bits.



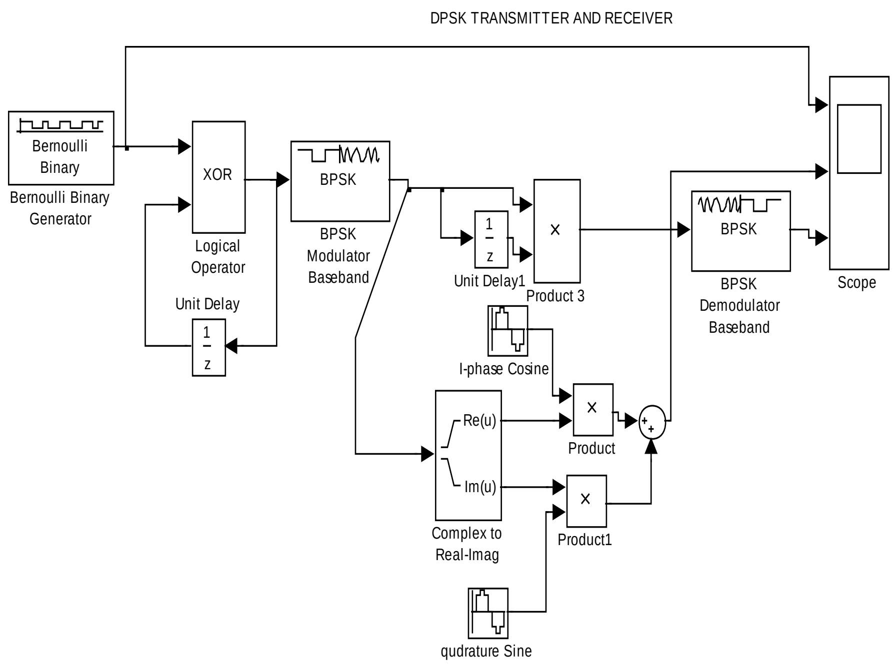
QPSK Tx and Rx using Simulink Model



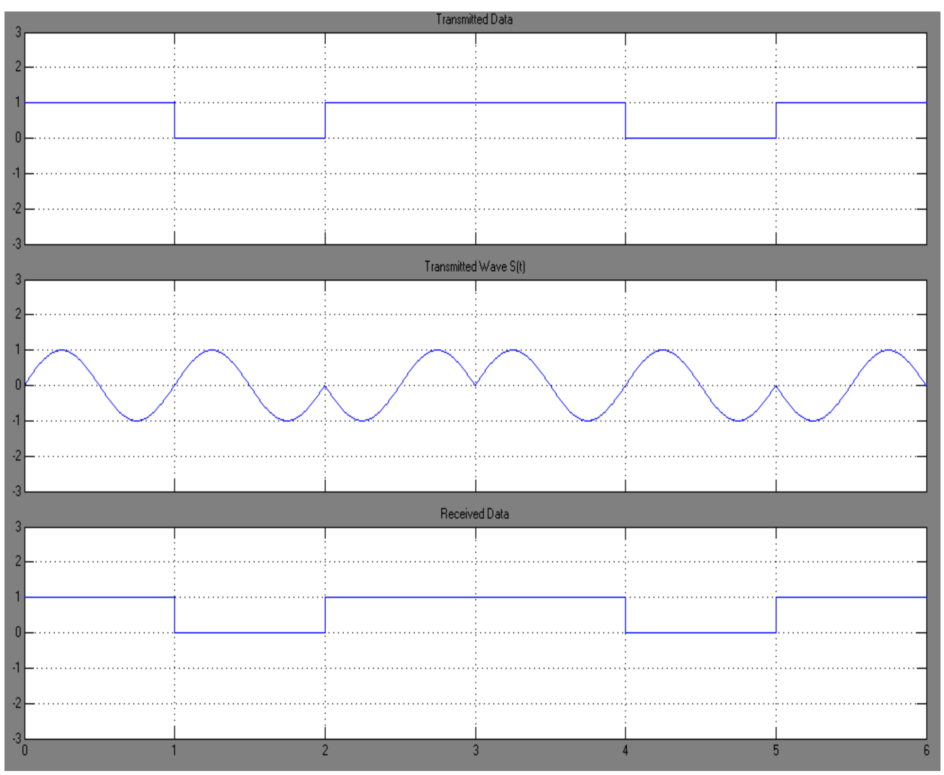
Simulation Results of QPSK Tx and Rx



QPSK Constellation Diagram



Simulink Model for DPSK Tx and Rx



Simulation Results of DPSK signal