GROUP OF COLLEGES

"WORKING TOWARDS BEING THE BEST"

Name of Student: ______________________

Enrolment No.: ______________________

Class: ______________________

Section: ______________________

Session: ______________________

Digital Communication Lab

[EC-502]Manual

Department of Electronics and Communication Engineering

LAKSHMI NARAIN COLLEGE OF TECHNOLOGY

Kalchuri Nagar, Raisen Road Bhopal (MP) 462023

Vision and Mission of the Department

Vision

To be recognized as Centre of Academic Excellence by imparting quality teaching and strengthening research and development activities with world class infrastructure in the field of Electronics and Communication Engineering.

Mission

- To establish a quality teaching learning process to provide application oriented, in-depth knowledge consistently.
- To establish state-of-the-art laboratories for academic excellence and to develop infrastructure through collaboration for quality research.
- To equip the students by blending theoretical knowledge and practical skills with employability and entrepreneurship traits for a bright successful career.
- To inculcate team spirit and leadership qualities to produce socially acceptable, eco-friendly and responsible citizens.

LAKSHMI NARAIN COLLEGE OF TECHNOLOGY, BHOPAL

Program Specific Outcomes (PSO's)

- PSO1: Demonstrate ability to apply basic concepts of science and engineering to undertake theoretical learning of Electronic Devices and Circuits, Analog and Digital Communication, Signals and Systems, Embedded Systems, VLSI Design etc..
- PSO2: Demonstrate application of acquired hands-on skills such as Circuit Simulation, MATLAB, HDL Programming, Embedded Systems, DSP and PCB Designing etc..
- PSO3: Work actively in teams who under take some research oriented projects, especially development projects and a few industry sponsored projects.
- PSO4: Learn extra-curricular courses such as soft-skills, personality development and groom them as responsible citizen with professional ethics blended with human values, engineering economics and sustainability to handle real life problems.

Program Educational Objectives (PEO's)

Student will be able to

- Apply knowledge of mathematics, science and engineering as appropriate in the field of Electronics and Communication Engineering as proficient learners in the domains such as Electronic Circuits, Embedded Systems, Communication Systems, Digital Signal Processing, VLSI Design, Data Networks, IOT, and Simulation etc.
- Seek admissions at Institutes of repute for higher education in Engineering and Technology and Management to the tune of 10%, seek employment in core and IT domains to the extent of 80% with remaining 10% opting for entrepreneurship.
- Use the skills, latest techniques, tools for modern engineering and ICT which are necessary to analyze industrial problems related to Electronics and Comm. Engineering with focus to Global, Economical and Environmental Issues.
- Understand engineering solutions, exhibit professionalism, ethical attitude, team work, effective written and oral communication skills to practice in their profession with high regards to societal issues and responsibilities.

Course Outcomes (CO's)

CO1. Analyze the process of converting analog signal to discrete form along with their circuits.

CO2. Analyze various Analogue to Digital conversion techniques along with various Line Coding methods.

CO3. Compare various digital transmission techniques on the base of Spectral properties.
CO4. Develop an expression for probability of error of different digital communication techniques.

CO5. Design communication systems with optimum capacity.

Code of Conducts for the Laboratory

- All bags must be left at the indicated place.
- The lab timetable must be strictly followed.
- Be **PUNCTUAL** for your laboratory session.
- Noise must be kept to a minimum.
- Workspace must be kept clean and tidy at all time.
- Handle the experiment kit and interfacing its with care.
- All students are liable for any damage to the accessories due to their own negligence.
- Students are strictly **PROHIBITED** from taking out any items from the laboratory.
- Students are **NOT** allowed to work alone in the laboratory without the Lab Supervisor
- Report immediately to the Lab Supervisor if any malfunction of the accessories, is there.
- Before leaving the lab Place the stools properly.
- Please check the laboratory notice board regularly for updates.

Rubrics for Assessment of student performance during Experiments

Area of Direct Assessment	Poor (0-2 Marks)	Fair (3-4 Marks)	Average (5-6 Marks)	Good (7-8 Marks)	Excellent (9-10 Marks)
Aim & Theory	Aim is not clear and irrelevant theory written Concept was not explained.	Aim is clear and Incomplete theory written. Concept could not be explained.	Aim is clear and Theory written but is unorganized Concept is explained.	Aim is clear and Theory written properly. Concept is explained.	Aim is clear and Theory written properly. Concept is explained with neat diagrams.
Performance and Working with Others	Did not conduct the experiment and none of the member recorded the observations.	Followed few steps to conduct the experiment. But few members recorded the observations.	Followed few steps to conduct the experiment. Few members recorded the observations.	Followed step by step method to conduct the experiment. Sufficient observations recorded by all team members.	Followed step by step method to conduct the experiment. Many observations recorded by all team members.
Safety Measures	None of the team member knew safety measures and did not followed.	Team members had knowledge of safety measures and followed few of them.	Team members had fair knowledge of safety measures and followed them.	Team members were well acquainted with safety measures and followed.	Team members were well acquainted with safety measures and followed all of them.
Result and Conclusion	No data recorded. Conclusion can not be drawn.	Analysis does not follow data the data. Conclusion can not be drawn.	Analysis as recorded somewhat lacks in insight. Results is poorly recorded to make sense. Conclusion can not be drawn.	Analysis as recorded somewhat lacks in insight. But clearly recorded as Results. Conclusion is properly drawn.	Observations are analyzed accurately and clearly recorded as Results. Conclusion is properly drawn.
Observations and Calculations	No observations recorded and no calculation done.	Insufficient number of observations recorded. So calculations are Inaccurate.	Sufficient number of observations recorded but calculations are Inaccurate.	Almost all observations recorded. Calculations are accurate and well organized.	Many observations recorded in the table. Calculations are accurate and well organized.
Internal Viva	Student does not have grasp on the experiment and could not answer the questions about the experiment.	Student mumbles incorrectly, pronouns terms and speak too quietly for teachers to hear.	Student is uncomfortable but is able to answer basic questions about the experiment.	Student is at ease and able to answer expected questions, but fails to elaborate.	Student demonstrated full knowledge by answering all questions with explanations and elaboration.

Enrolment No.:

INDEX

LAKSHMI NARAIN COLLEGE OF TECHNOLOGY, BHOPAL

INDEX

Name of Student:____________________Enrolment No.:________________________

Sl. No.	Title of the Experiment	Date of Experiment	Date of Submission	Remark
1	Generation and Detection of Sampled Signal.			
2	Generation and Detection of Time Division Multiplexed PAM.			
3	Generation and Detection of Pulse Code Modulation			
4	Generation and Detection of Delta Modulation			
5	Generation and Detection of FSK Modulated Signal.			
6	Generation and Detection of BPSK Modulated Signal.			
7	Generation and Detection of ASK Modulated Signal.			
8	Generation and Detection of DPSK Modulated Signal.			
9	Generation and Detection of QPSK Modulated Signal.			
10	Generation and Detection of Differential Pulse Code Modulation			

Date of Experiment: _______________

EXPERIMENT NO:1

AIM:

To generate the Sampled signal and analyze the effect of variations in sampling rate over the recovered message.

APPARATUSREQUIRED:

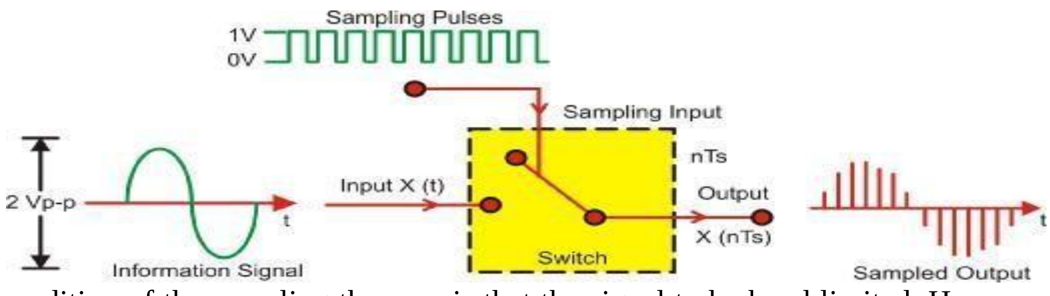
1. ST2101withpowersupplycord.
2. Oscilloscope with connecting probe.
3. Connecting cords.

THEORY:

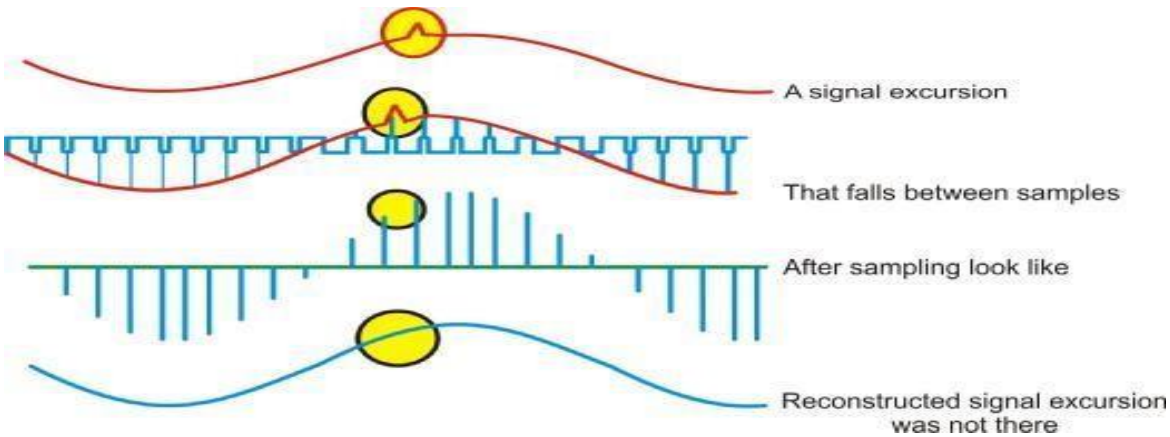
The signals used in the real world, such as our voice, are called "analog" signals .To process these signals for digital communication, there is a need to convert analog signals to "digital" form .While analog signal is continuous in both time and amplitude , a digital signal is discrete in both time and amplitude .To convert continuous time signal to discrete time signal, a process is used called as sampling. The value of the signal is measured at certain intervals in time. Each measurement is referred to as a sample.

Principle of sampling:-

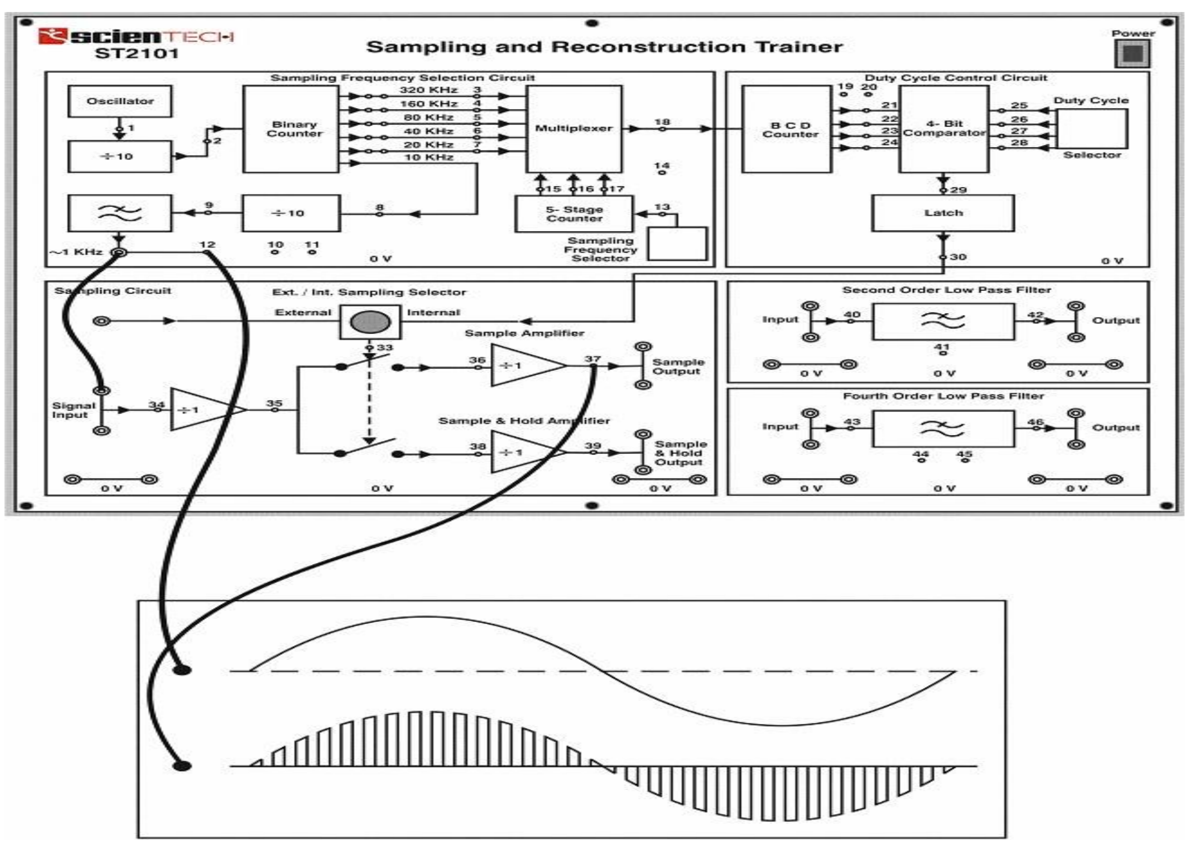
Consider an analogue signal x(t) that can be viewed as a continuous function of time, as shown in figure. We can represent this signal as a discrete time signal by using values of x(t) at intervals of nTs to form x(nTs) as shown in figure . We are “grabbing" points from the function x(t) at regular intervals of time, Ts, called the sampling period.



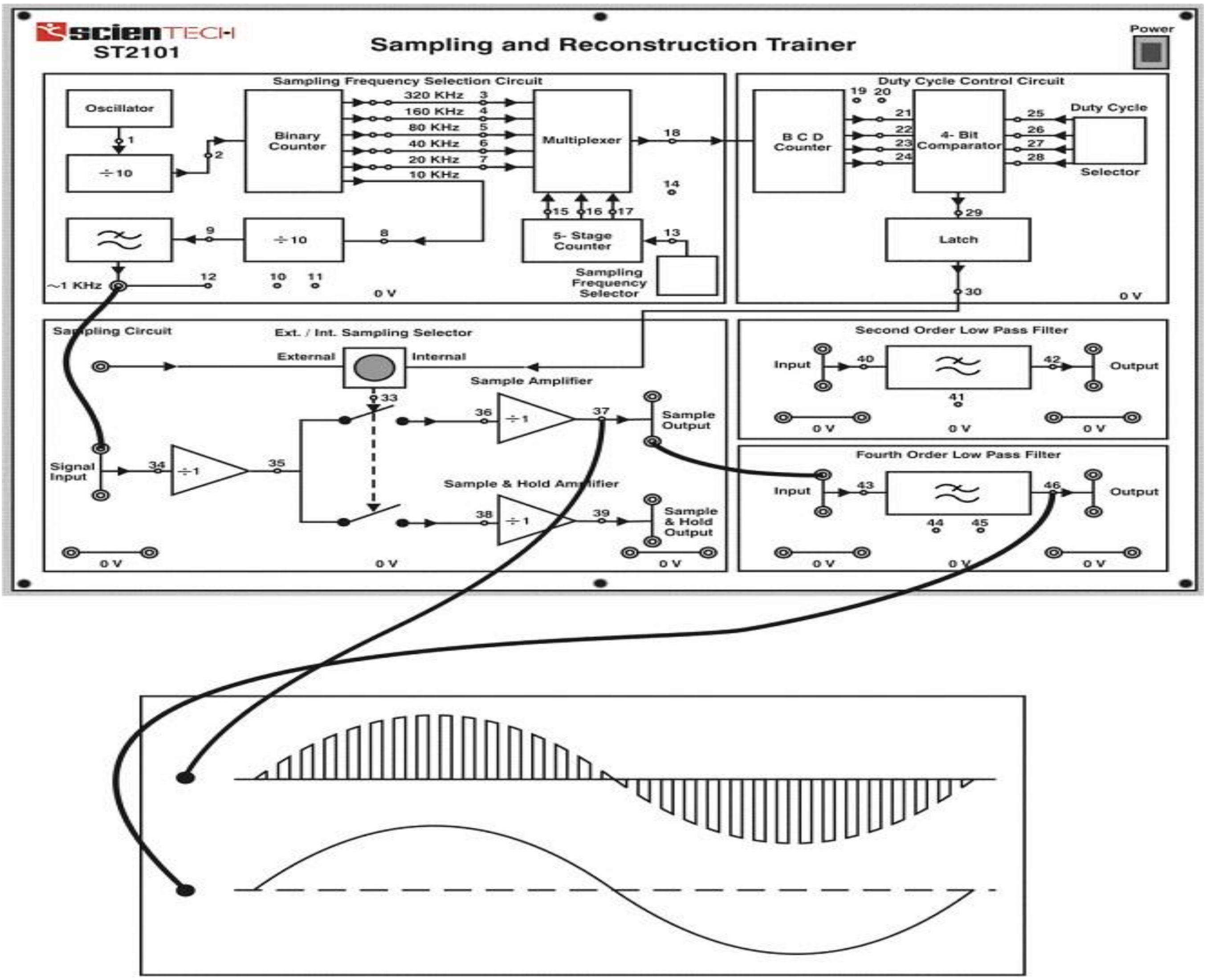
A precondition of the sampling theorem is that the signal to be band limited. However, in practice, no time-limited signal can be band limited. Since signals of interest are almost always time-limited (e.g., at most spanning the lifetime of the sampling device in question), it follows that they are not band limited. However , by designing a sampler with an appropriate guard band, it is possible to obtain output that is as accurate as necessary. Aliasing is the presence of unwanted components in the reconstructed signal. These components were not present when the original signal was sampled. In addition, some of the frequencies in the original signal may be lost in the reconstructed signal. Aliasing occurs because signal frequencies can overlap if the sampling frequency is too low. As a result , the higher frequency components roll into the reconstructed signal and cause distortion of the signal Frequencies "fold" around half the sampling frequency. This type of signal distortion is called aliasing.



CIRCUIT DIAGRAM:-



SIGNALRECONSTRUCTION:-



PROCEDURE:-

A. Setup for Sampling and reconstruction of signal .Initial setup of trainer :Duty cycle selector switch position:Position5.

B Sampling selector switch :Internal position.

1. Connect the power cord to the trainer .Keep the power switch in 'Off' position.
2. Connect1 KHz Sine wave to signal Input.
3. Switch 'ON' the trainer's power supply and Oscilloscope.
4. Connect BNC connector to the CRO and to the trainer's output port.
5. Select 320 KHz (Sampling frequency is1/10th of the frequency indicated by the illuminated LED) sampling rate with the help of sampling frequency selector switch .
6. Observe 1 KHz sine wave and Sampled Output on Oscilloscope . Connect the Sampled output to Input of Second Order and Fourth Order low pass Filter one after the other and observe the effect of filtering on reconstructed output with help of oscilloscope. The display shows the reconstructed original1KHz sine wave.
7. By successive presses of sampling Frequency Selector switch, change the sampling frequency to 2KHz, 4KHz, 8KHz, 16KHz (Sampling frequency is 1/10th of the frequency indicated by the illuminated LED).Observe how SAMPLED output changes in each cases and how the lower sampling frequencies introduce distortion into the filter's output waveform. This is due to the fact that the filter does not attenuate the unwanted frequency component significantly. Use of higher order filter would improve the output waveform.
8. 1 KHz Sine wave being sampled at 32 KHz , so there are 32 samples for every cycle of the sine wave,

Reconstruction of Analog Signal

9 Decrease the sampling rate from 32 KHz to 2 KHz. Observe the distorted waveform at filter's output. This is due to the fact that sampling rate is kept very critical amount equal to Nyquist rate This is due to the fact that the filter does not attenuate the unwanted frequency component significantly. Use of higher order filter would improve the output waveform somewhat but recovered output is same as that of original analog signal at moderate and higher sampling rates.

OBSERVATION TABLE:

Parameters of Analog Signal (v_m and f_m) :-

Sl. No.	Theoretical Sampling Rate	Observed Sampling Rate	Percentage Error	Recovered Output Voltage

RESULT:

Percentage Error between Theoretical Sampling Rate and Observed Sampling Rate is in permissible limits And message is recovered properly.

QUESTIONS :

1. What is the significance of Sampling process.
2. State NY Quist Rate.
3. Describe Aliasing effect.
4. Name the circuit which performs Sampling.
5. Discuss the types of Practical Sampling.
6. Give the purpose of Sample and hold circuit.

Date of Experiment: _______________

EXPERIMENT NO: 2

AIM:

To observe and analyze Time Division Multiplexed signal and to recover original analog signals from multiplexed form.

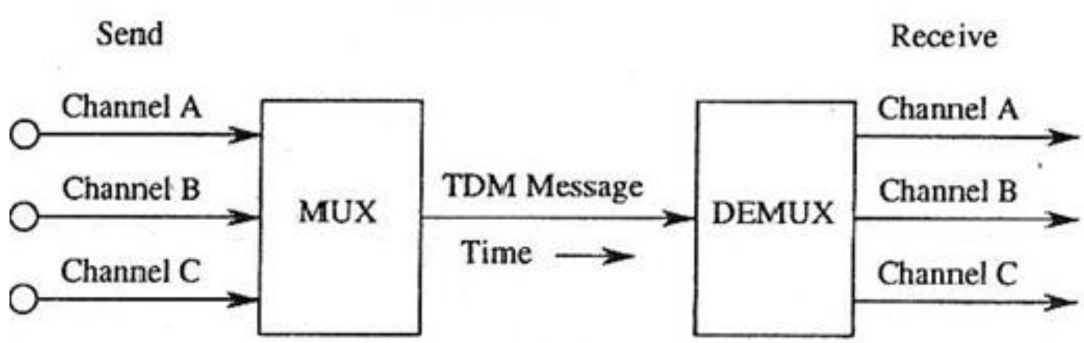
APPARATUS USED:

1.TDM Trainer ,Kit
2. C.R.O and Connecting probes.

THEORY:

An important feature of pulse-amplitude modulation is a conservation of time. That is, for a given message signal, transmission of the associated PAM wave engages the communication channel for only a fraction of the sampling interval on a periodic basis. Hence, some of the time interval between adjacent pulses of the PAM wave is cleared for use by the other independent message signals on a time-shared basis. By so doing, a time-division multiplexed signal is obtained (TDM), which enables the joint utilization of a common channel by a plurality of independent message signals without mutual interference. Each input message signal is first restricted in bandwidth by a low-pass pre-alias filter to remove the frequencies that are nonessential to an adequate signal representation.

BLOCKDIAGRAM:



Multichannel TDM System

PROCEDURE:

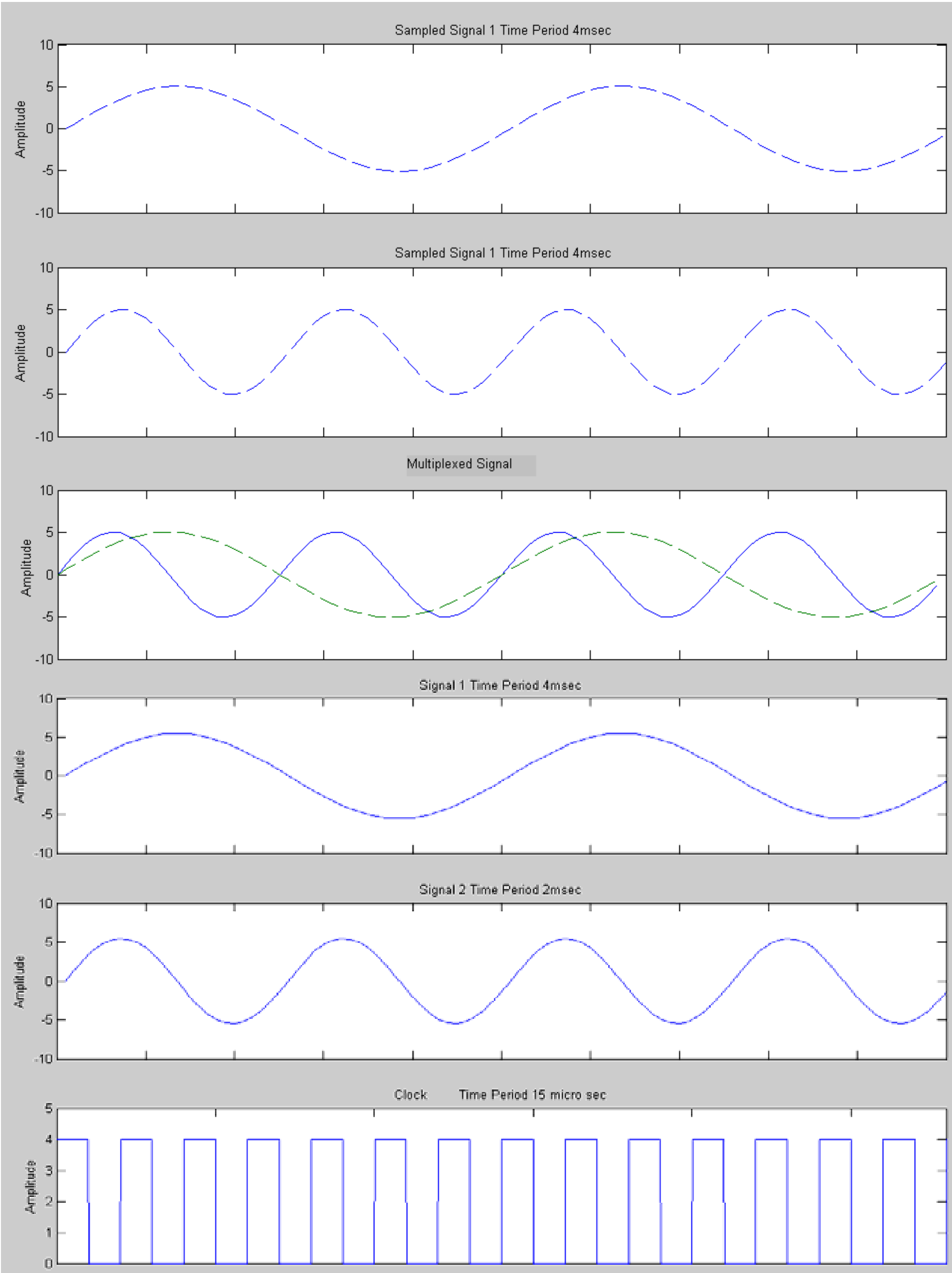
MULTIPLEXER:

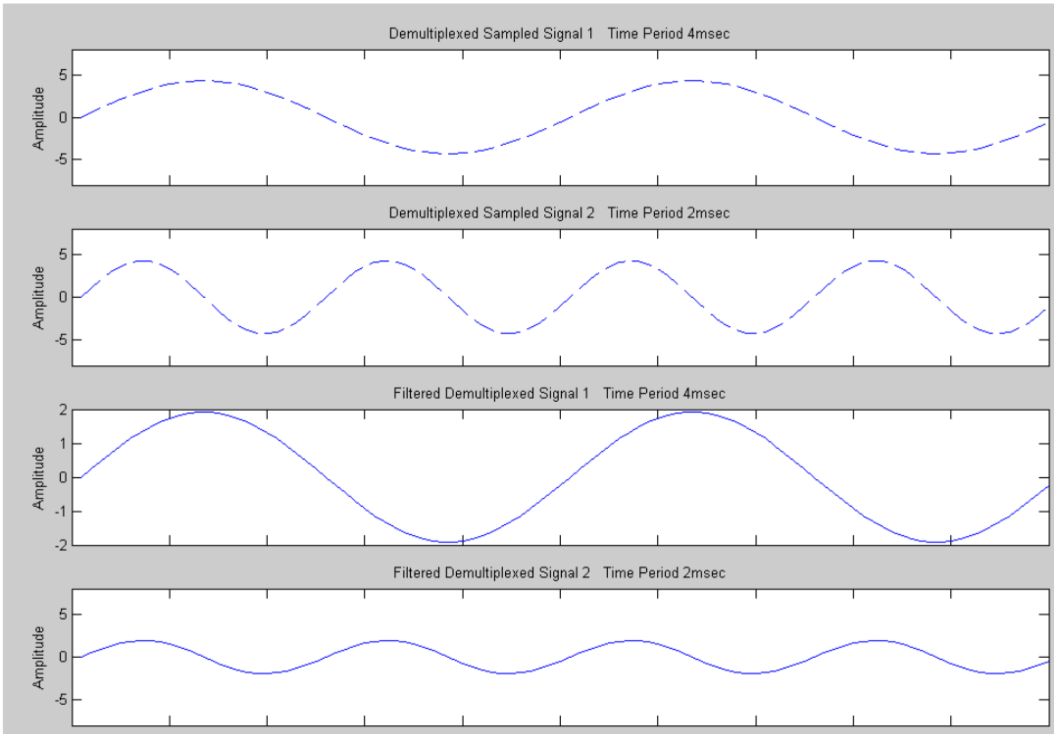
1. Observe the AFgenerator-1 output and note down the amplitude and frequency.
2. Observe the AFgenerator-2 output and note down the amplitude and frequency.
3. Observe the AFgenerator-3 output and note down the amplitude and frequency.
4. Connect the AFgenerator1, 2 and 3outputs to CH1,CH2 and CH3inputs of TDM multiplexer.
5. Observe the TDM output over the screen of cathode ray oscilloscope.

DEMULTIPLEXER:

1. Using probes connect the TDM multiplexers output to the TDM de-multiplexers input.
2. Connect the clock generator output, synchronizing pulse output of the transmitter trainer to the respective inputs of the TDM de- multiplexer.
3. Observe the de-multiplexed signals which are the outputs to low passfilteratCH.1, CH.2 and CH.3.
4. Note down the recovered output AMPLITUDE and FREQUENCY amounts.

WAVEFORMS:


Sampled Signal 1 Time Period 4msec
Amplitude
10
5
0
-5
-10
Sampled Signal 1 Time Period 4msec
Amplitude
Multiplexed Signal
Amplitude
Signal 1 Time Period 4msec
Amplitude
Signal 2 Time Period 2msec
Amplitude
Clock Time Period 15 micro sec
Amplitude
5
4
3
2
1
0



1.8. OBSERVATION

Transmitter Section		Receiver Section	
Signal 1		**Demultiplexed Signal 1**	
Amplitude	**Time Period**	**Amplitude**	**Time Period**
Signal 2		**Demultiplexed Signal 2**	
Amplitude	**Time Period**	Amplitude	**Time Period**
Transmitter Output		**Filtered Demultiplexed Signal 1**	
Amplitude	**Time Period**	**Amplitude**	**Time Period**
		Filtered Demultiplexed Signal 1	
		Amplitude	**Time Period**

RESULT:

Time Division Multiplexing System signal has been observed and analyzed , Demultiplexed signal is verified successfully.

QUESTIONS :

1. What is meant by multiplexing technique and what are the different types of Multiplexers?
2. Briefly explain about TDM and FDM?
3. What is the transmission bandwidth of a PAM/TDM signal?
4. Define crosstalk effect in PAM/TDM system?
5. What are the advantages of TDM system?
6. What are major differences between TDM and FDM?
7. Give the value of Ts in TDM system?
8. What care the applications of TDM system and give some example?
9. What is meant by signal overlapping?
10. Which type of modulation technique will be used in TDM?

EXPERIMENT NO: 3

AIM:

To analyze a PCM system and interpret the modulated and demodulated waveforms for a sampling frequency of 4 KHz.

APPARATUS:

1. PCM modulator trainer
2. PCM Demodulator trainer
3. C.R.O(30MHz)
4. Patch chords.

THEORY:

In Pulse code modulation (PCM) only certain discrete values are allowed for the modulating signals. The modulating signal is sampled, as in other forms of pulse modulation. But any sample falling within a specified range of values is assigned a discrete value. Each value is assigned a pattern of pulses and the signal transmitted by means of this code. The electronic circuit that produces the coded pulse train from the modulating waveform is termed a coder or encoder. A suitable decoder must be used at the receiver in order to extract the original information from the transmitted pulse train.

This PCM system consists of

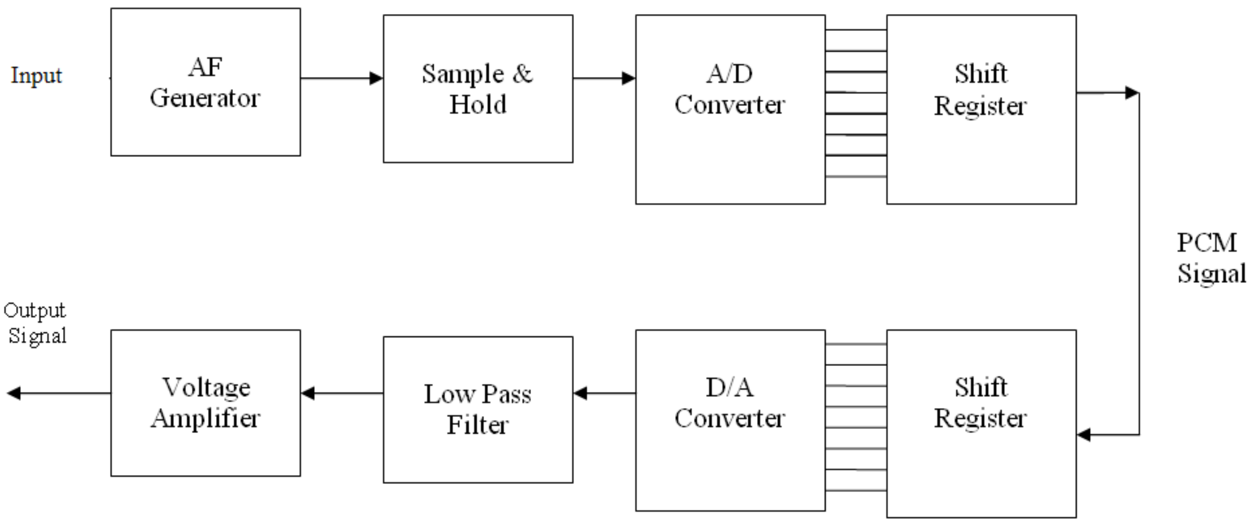
PCM Modulator

1. Regulated power supply
2. Audio Frequency signal generator
3. Sample & Hold circuit
4. 8 Bit A/D Converter
5. 8 Bit Parallel-Serial Shift register
6. Clock generator/Timing circuit
7. DC source

PCM Demodulator

1. Regulated power supply
2. 8 Bit Serial-Parallel to shift register
3. 8 Bit D/A converter
4. Clock generator
5. Timing circuit
6. Passive low pass filter
7. Audio amplifiers

BLOCK DIAGRAM: PCM MODULATOR AND DEMODULATOR



PCM Operation:

The modulating signal is applied to sample & hold circuit. This applied signal will be super imposed by +2.5V DC so that the negative portion the modulating signal will clamped to positive, this process is needed, because input of the A/D Converter should be between 0 and +5V. After level shifting is done the signal will be passed to sample &hold circuit. Sample &hold circuit will sample the input signal during on period of the clock signal and will hold the sampled output till next pulse comes. Sampling rate is 4KHz in this system.

So input of the A/D Converter is a stable voltage of certain level in between 0 and +5V. A/D converter (encoder) will give a predetermined 8 bit code for the sampled input. This entire conversion process will be made at a fast rate operating at high frequency clock i.e. 1MHz. Coded output of the A/D converter is applied to input of the parallel in serial out register through a latch. This shift register is operating at 64 KHz (sampling frequency is 4KHz, so to shift 8 bits from parallel to serial we need 64KHz). This output (PCM) is transmitted through a co-axial cable which represents a communication channel.

PCM signal from modulator (encoder) is applied to serial to parallel register. This shift register is also operating at 64KHz clock at which parallel to serial shift register is operating at PCM modulator (these both the clock signals should be in synchronized with each other in order to get proper decoded output).So the output of the serial to parallel register is a 8 bit code .This 8 bit code is applied to 8 bit D/A converter. Output of the D/A converter will be a staircase signaling between 0 and +5V. This stair case signal is applied a low pass filter. This low pass will smoothen the staircase signal so that we will get a recovered AF signal. We can use a voltage amplifier at the output of the low pass filter to amplify there covered AF signal to desired voltage level.

PROCEDURE:

PCM Operation (with AC input):

Modulation:

1. Connect AC signal of 2 V_{pp} amplitude to Sample and Hold circuit.
2. Keep the CRO in dual mode. Connect one channel to the AF signal and another channel to the Sample and Hold output. Observe and sketch the sample and hold output.
3. Connect the Sample and Hold output to the A/D converter and observe the PCM output using Storage oscilloscope.
4. Observe PCM output by varying AF signal voltage.

Demodulation:

1. Connect PCM signal to the demodulator input (S-P shift register) from the PCM modulator with the help of coaxial cable (supplied with the trainer).
2. Connect clock signal (64 KHz) from the transmitter to the receiver using coaxial cable.
3. Connect transmitter clock to the timing circuit.
4. Keep CRO in dual mode. Connect CH1 input to the sample and hold output and CH2 input to the D/A converter output .
5. Observe and sketch the D/A output.
6. Connect D/A output to the LPF input.
7. Observe the output of the LPF/Amplifier and compare it with the original modulating signal .
8. From above observation you can verify that there is no loss in information (modulating signal) in conversion and transmission process.
9. Disconnect clock from transmitter and connect to local oscillator (i.e., Clock generator output) 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

EXPECTEDWAVEFORMS:

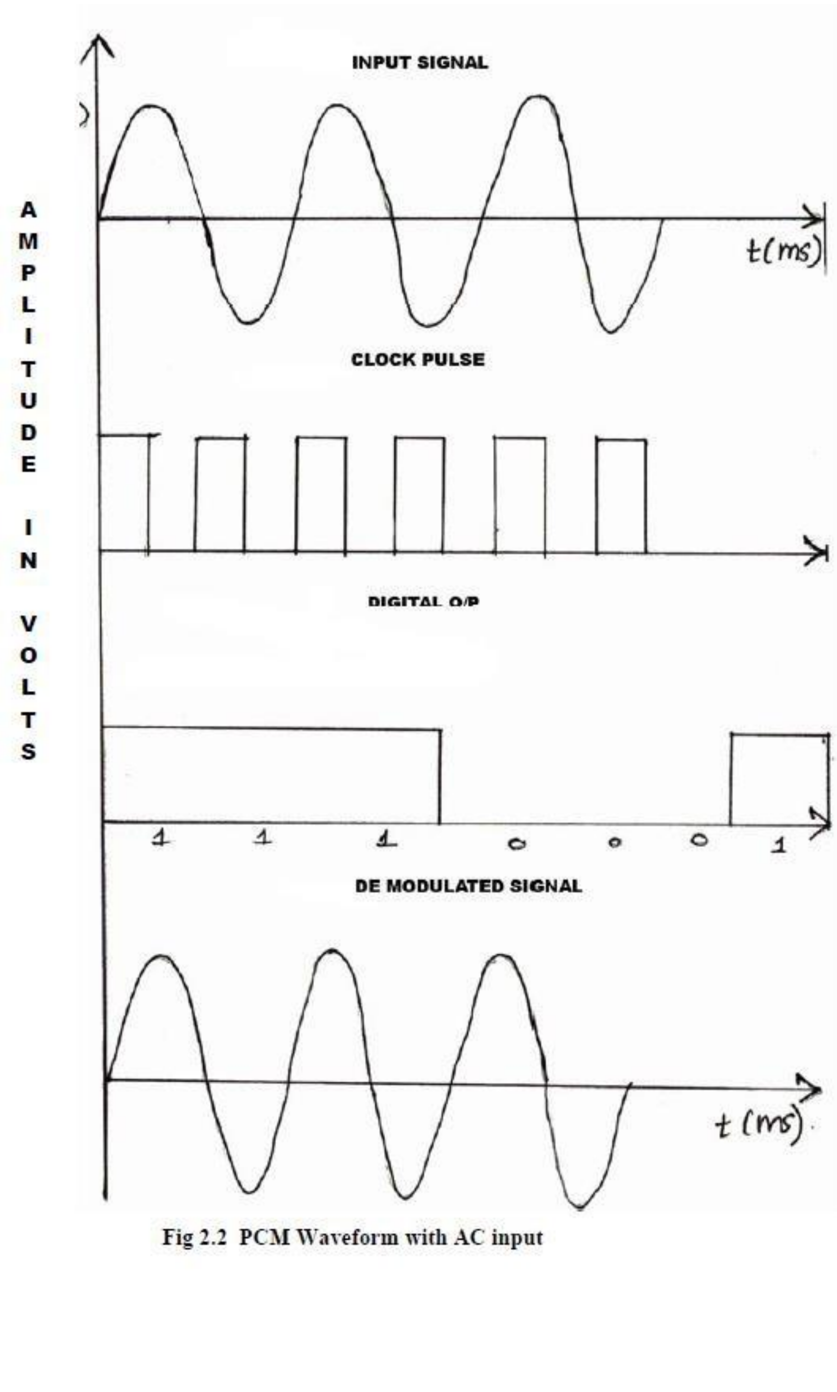


Fig 2.2 PCM Waveform with AC input

OBSERVATIONS:

PCM Modulation with AC input

	AMPLITUDE	FREQUENCY
Analog Signal input		
Sample and hold circuit		
Clock signal		
Clock signal		
PCM Output		
D/A converter output signal		
LPF output signal		
Demodulated output		

RESULT:

Binary output of Pulse Code modulator has been observed and analog message is recovered at PCM demodulator and graphs were plotted.

VIVA QUESTIONS:

1. What do you mean by quantizing process?
2. What will happen when sampling rate is greater than Nyquist rate?
3. What will happen when sampling rate is less than Nyquist rate?
4. Find the A/D Converter output for input DC voltage of 3.6V.
5. Mention some applications of PCM.
6. What is the function of Sample and Hold circuit?

Date of Experiment:_______________

EXPERIMENT NO: 4

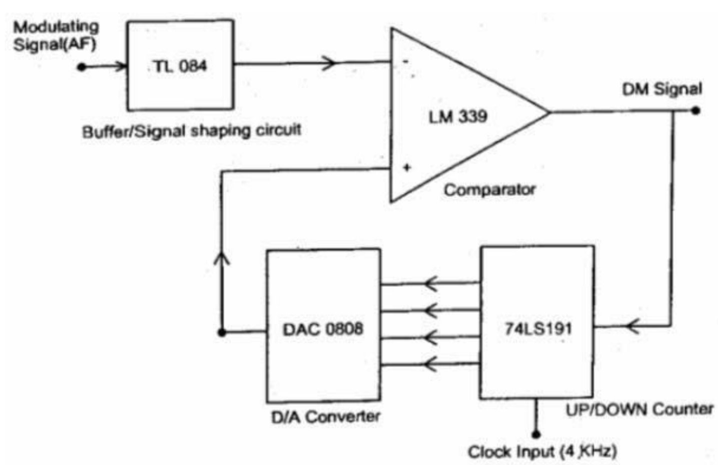
AIM:

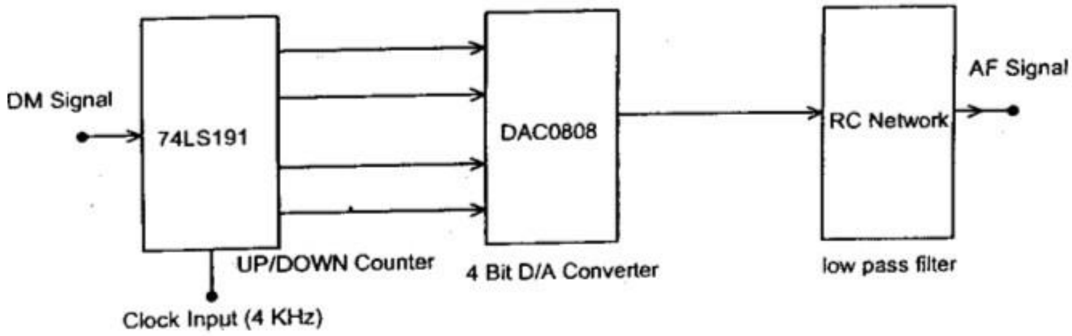
To analyze a Delta modulation system. and interpret the modulated and demodulated waveforms

APPARATUS:

1. DM Modulator and Demodulator trainer-
2. C.R.O(30MHz)
3. Patch chords.

BLOCK DIAGRAM: DELTA MODULATOR AND DEMODULATOR





THEORY:

Delta Modulation is a form of pulse modulation where a sample value is represented as a single bit. This is almost similar to differential PCM, as the transmitted bit is only one per sample justto indicate whether the present sample is larger or smaller than the previous one. The encoding, decoding and quantizing process become extremely simple but this system cannot handle rapidly varying samples. This increases the quantizing noise.

The trainer is a self sustained and well organized kit for the demonstration of delta modulation and demodulation .The system consist of :

DM Modulator trainer kit

1. Regulated power supply
2. Audio Frequency signal generator
3. Buffer/signal shaping network
4. Voltage comparator
5. 4 Bit UP/DOWN counter
6. Clock generator/Timing circuit
7. 4 Bit D/A converter
8. DC source

DM Demodulator trainer kit

1. Regulated power supply
2. 4 Bit UP/DOWN counter
3. 4 Bit D/A converter
4. Clock generator
5. Passive low pass filter
6. Audio amplifier

Regulated power supply:

This consists of a bridge rectifier followed by Capacitor filters and three terminal regulators 7805 and 7905 to provide regulated DC voltages of +-5V and +12V@ 300Ma each to the on board circuits. These supplies have been internally connected to the circuits. so no external connections are required for operation.

Audio Frequency (AF) signal generator

Sine wave signal of 250Hz, 500 Hz, 1kHz and 2KHz is generated to use as a modulating (message or information) signal to be transmitted. This is an Op-Amp based Wien bridge Oscillators is a FET. input general purpose Operational Amplifier .Amplitude control is provided in the circuit to vary the output amplitude of AF signal.

Clock generator/Timing circuit:

A TTL compatible clock signal of 4 KHz frequency is provided on board to use as a clock to the various circuits in the system. This circuit is astable multi vibrator using 555 timer followed by a buffer.

Voltage comparator:

This circuit is build with IC LM339 The LM339 series consists of four independent precision voltage comparators with an offset voltage specification as low as 2mV for all four comparators. These were designed specifically to operate from a single power supply over a wide range of voltages .Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the common mode voltage range includes ground, even though operated from a single power supply voltage. Application areas include limit comparators simple analog to digital converters: pulse, square and time delay generators. wide range VCO;MOS clock timers; multi vibrators and high voltage digital logic gates .The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, they will directly interface with MOS logic where the low power drain of the LM339 is a distinct advantage over standard comparators .For circuit connections and other operating conditions.

Sample and Hold Circuit

It is a Bi stable multi vibrator or a clocked D flip flop so as to store the output of comparator for one clock duration.

Uni polar to Polar Converter

The purpose of this converter is to convert Low bit zero voltage amounts into a specific negative amounts so that when applied to the integrator, negative saw tooth patterns are also produced.

Integrator or Low pass filter

This is a series of simple RC networks provided on receiver board to smoothen the output of the D/A converter output. RC values are chosen such that the cutoff frequency would be at 100 Hz. Also the purpose of Integrator of transmitter feedback path is to convert pulses in the form of Saw tooth signal.

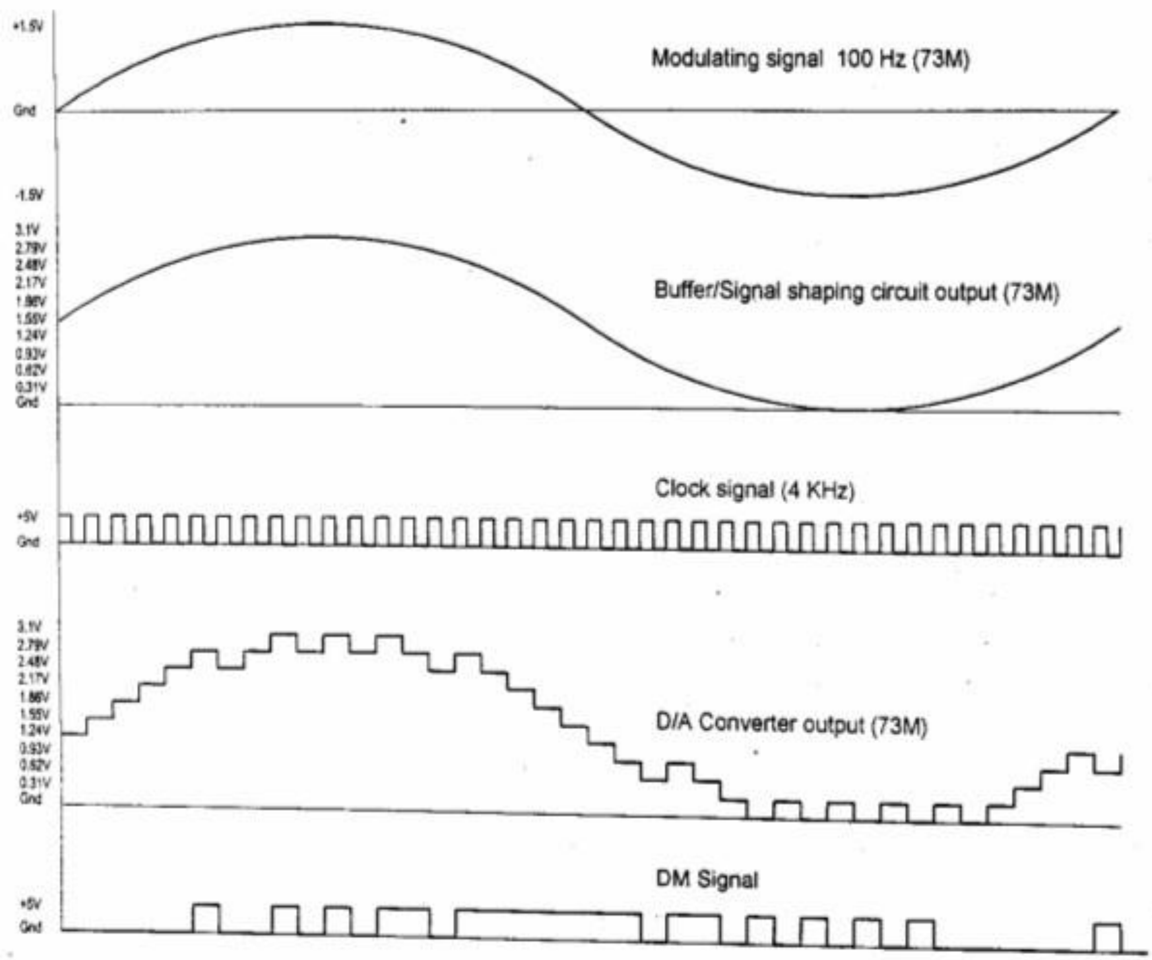
PROCEDURE:

DM Modulator:

1. Study the theory of operation
2. Connect the trainer-
3. Observe the output of Audio Frequency generator using CRO; it should be a Sine wave of 1000 Hz frequency with 3Vpp amplitude.
4. Observe the output of the clock generator it should be 4 KHz frequency of square wave with 5 V_{pp} amplitude.
5. Observe and plot the signals at D/A converter output (i.e. non-inverting input of the comparator), DM signal using CRO and compare them with the waveforms given in figure.
6. Connect DM signal to the DM input of the demodulator.
7. Connect clock (4 KHz) from modulator to the clock input of the demodulator Connect clock input of UP/DOWN counter to the clock from transmitter with the help of springs provided.
8. Observe digital output (LED indication) of the UP/DOWN counter and compare it with the output of the UP/DOWN. By this both the outputs are same noticed.
9. Observe and plot the output of the D/A converter and compare it with the waveforms given in figure.
10. Measure the demodulated signal (i.e. output of the D/A converter with the help of multi meter and compare it with the original signal. From the above observation it is noticed that both the voltages are equal and there is no loss in process of modulation ,transmission and demodulation.
11. Similarly the DM operation can be verified for different values of modulating signal.

Observe and sketch the D/A output.

12. Connect D/A output to the LPF input.
13. Observe the output of the LPF/Amplifier and compare it with the original modulating signal .
14. From the above observation you can verify that there is no loss in information in conversion and transmission process.
15. Disconnect clock from transmitter and connect to local oscillator (i.e. clock generator output with remaining setup as it is. Observe demodulated signal 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.
16. Observe and plot the signals at D/A converter output (i.e. non-inverting input of the comparator), DM signal using CRO and compare them with the waveforms given in figure.
17. Similarly the DM operation can be verified for different values of modulating signal.



EXPECTED WAVEFORMS FOR AC INPUT

OBSERVATION TABLE

SLNO.	SIGNALS AT VARIOUS STAGES	AMPLITUDE	FREQUENCY
	ANALOG INPUT SIGNAL		
	INTEGRATORS OUTPUT		
	CLOCK SIGNAL		
	DM TRANSMITTER OUTPUT		
	DM RECIVERS INPUT		
	DM RECIVERS OUTPUT		

RESULT:

Thus the Delta modulation and demodulation is performed and waveforms with readings are plotted and observed.

VIVAQUESTIONS:

1. Compare DPCM, PCM and Delta modulation.
2. How to reduce the quantization noise that occurs in DM?
3. A band pass signal has a spectral range that extends from 20 to 82 KHz. Find the acceptable sampling frequency.
4. Find the bit rate for a message when clock rate is kept 64 kHz
5. Mention the drawbacks of DM.

Date of Experiment:______________

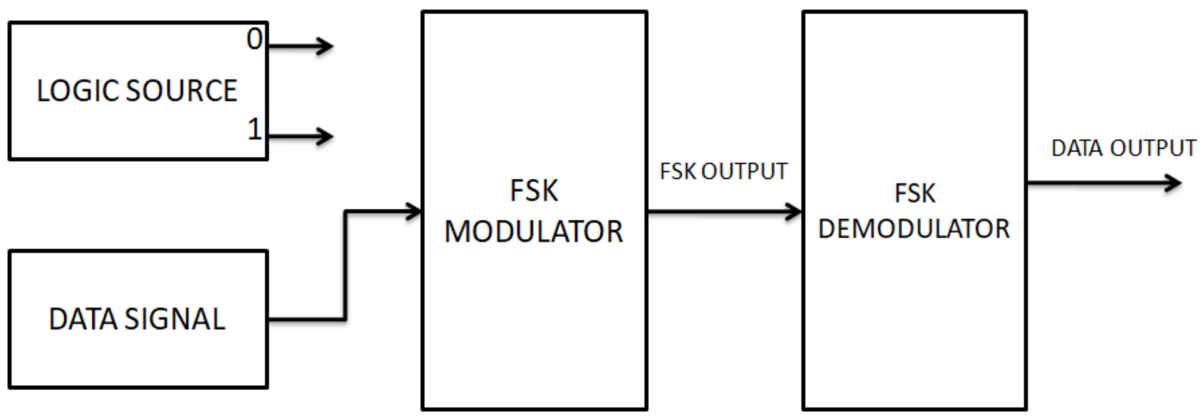
EXPERIMENT NO: 5

AIM:

To analyze a FSK modulation system and interpret the modulated and demodulated waveforms

APPRATUS:

1. FSK Trainer Kit- Scientech
2. Dual Trace oscilloscope
3. Digital Multi meter
4. C.R.O (30MHz)
5. Patch chords.



BLOCKDIAGRAM OF FSK SYSTEM

THEORY:

In Frequency shift keying, the carrier frequency is shifted (i.e. from one frequency to another) corresponding to the digital modulating signal. If the higher frequency is used to represent a data

‘1’ & lower frequency a data ‘0’, the resulting FSK waveform appears.
Thus

Data=1 High Frequency

Data=0 Low Frequency

It is also represented as a sum of two ASK signals. The two carriers have different frequencies and the digital data is inverted .The demodulation of FSK can be carried out by a PLL. As known the PLL tries to ‘lock’ the input frequency. It achieves this by generating corresponding output voltage to be fed to the VCO, if any frequency deviation at its input is encountered. Thus the PLL detector follows the frequency changes and generates proportional output voltage. The output voltage from PLL contains the carrier components. Therefore to remove this, the signal is passed through Low Pass Filter. The resulting wave is too rounded to be used for digital data processing. Also, the amplitude level may be low due to attenuation

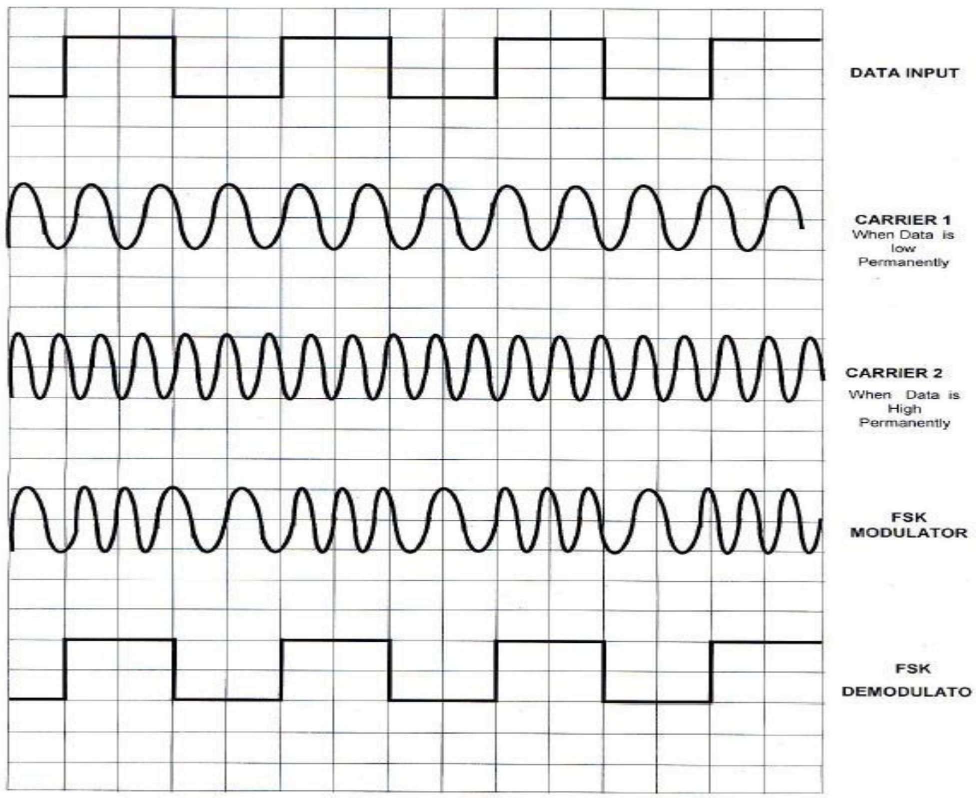
PROCEDURE:

1. Connect the trainer kit to the mains and switch ON the power supply.
2. Check internal RPS voltage (it should be 12V) and logic source voltage for logic one (it should be 12V)
3. Observe the data signal using oscilloscope. Observe the various data signals (2KHZ,4KHZ, 8 KHZ and 16KHZ) using CRO
4. Note down the parameters of Data. (Amplitude and Time Period). Time period has to match with the selected Data rate.
5. Connect the output of the logic source to data input of the FSK modulator.
6. Check the frequencies and amplitudes of the provided carrier signals.
7. See the carrier frequency of the FSK modulator as 1.2 KHz using control F0 (this represents logic 0). Then set another frequency as 2.4 KHz using control F1 (this represents logic 1)
8. Connect the data input of the FSK modulator to the output of the data signal generator. Observe the signal that comes out of FSK modulator and note down the readings.
9. Connect the FSK modulator output to the input of the FSK demodulator. Observe the waveform of FSK demodulator output using CRO and note down the readings

OBSERVATIONS:

TYPE OF SIGNAL	AMPLITUDE	FREQUENCY
BINARY DATA		
CARRIER SIGNAL (S1)		
CARRIER SIGNAL (S2)		
MODULATED SIGNAL		
MODULATED SIGNAL		
RECOVERED BINARY DATA (DEMODULATED SIGNAL)		

EXPECTED WAVEFORM:



RESULT:

Waveforms of FSK modulated and demodulated signal has been observed and readings are taken and analyzed properly

VIVA QUESTIONS:

1. What are the advantages of FSK over ASK and PSK?
2. Forthegiven8bitdata10111010drawtheFSKoutputwaveform.
3. Draw the constellation diagram of FSK.
4. What is the consumed Bandwidth of FSK?
5. Give the block diagrams of COHERENT FSK Modulator and Demodulator.

Date of Experiment:_______________

EXPERIMENT NO: 6

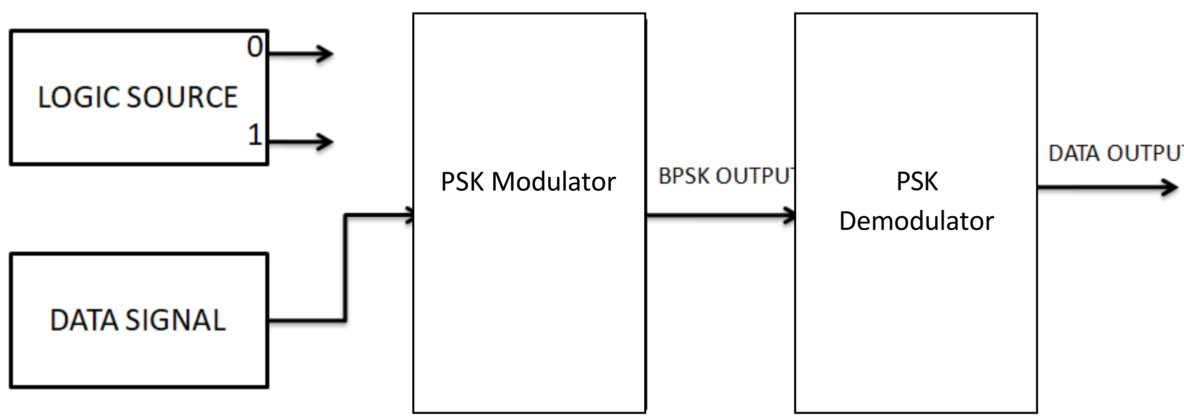
AIM:

To analyze a PSK modulation system and interpret the modulated and demodulated waveforms.

APPRATUS:

1. BPSK Trainer Kit - Scientech
2. Dual Trace oscilloscope
3. Digital Multi meter
4. C.R.O (30MHz)
5. Patch chords.

BLOCK DIAGRAM:



Theory:

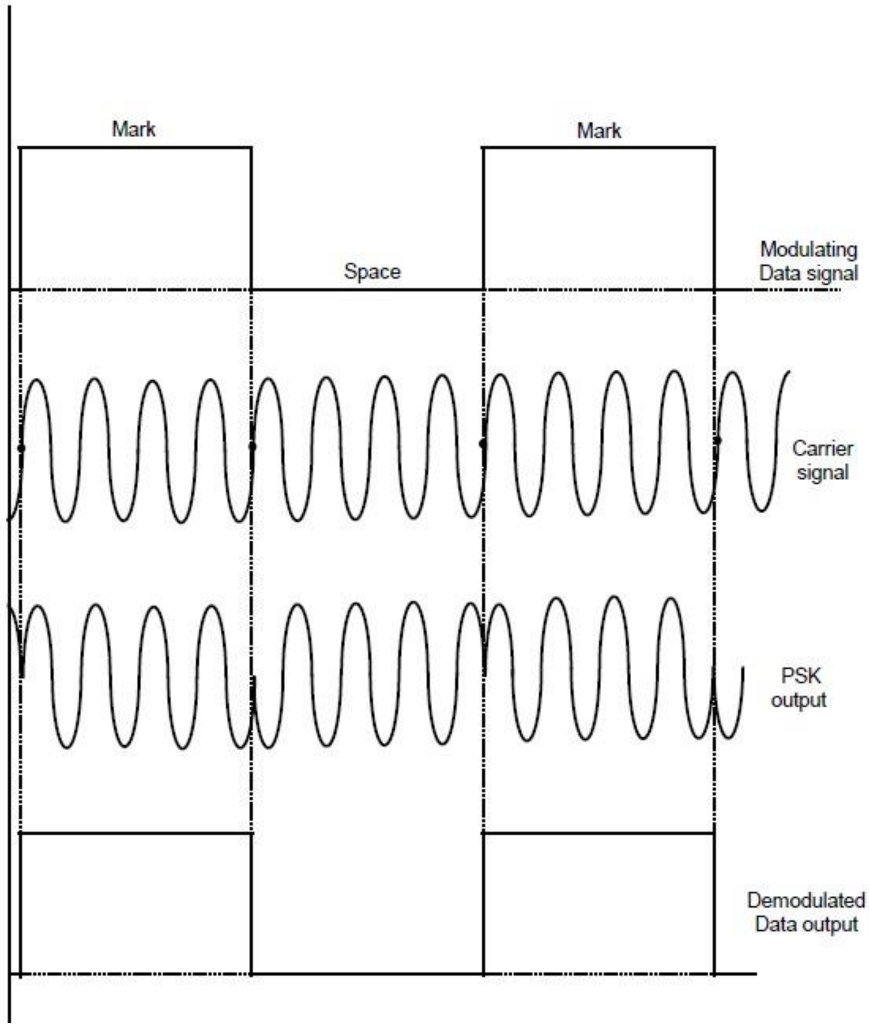
Phase shift keying is a modulation/data transmitting technique in which phase of the carrier signal is shifted between two distinct levels. In a simple PSK (ie binary PSK) un shifted carrier $V_c\cos\omega_c t$ is transmitted to indicate a 1 condition, and the carrier shifted by 180^0ie.($-V_c\cos\omega_c t$) is transmitted to indicate as 0 condition.

.

PROCEDURE:

1. Connect the trainer to mains and switch ON the power supply.
2. Measure the output of the regulated power supply ie. +5Vand -5Vwith the help of digital multi meter.
3. Observe the output of the carrier generator using CRO,
4. Observe the various data signals (2KHZ,4KHZ,8 KHZ and 16KHZ)using CRO
5. Connect data signal say 4KHZ from data source to data input of the modulator.
6. Keep CRO in dual mode and connect CH1 input of the CRO to data signal and CH2 to the output of the PSK modulator.
7. Observe the PSK output signal with respect to data signal and plot the waveforms.
8. Connect the PSK output to the PSK input of the demodulator.
9. Observe carrier to the carrier input of the PSK demodulator.
10. Keep CRO in dual mode and connect CH1 to data signal (at modulator) and CH2 to the output of the demodulator.
11. Compare the demodulated signal with the original signal. It is noticec that there is no loss in modulation and demodulation process
12. Repeat the steps 6 to12 with different data signals .

EXPECTED WAVEFORMS:



OBSERVATIONS:

TYPE OF SIGNAL	AMPLITUDE	FREQUENCY
BINARY DATA-2KHz (Theoretical Rate)		
BINARY DATA - 4 KHz (Theoretical Rate)		
BINARY DATA - 8 KHz (Theoretical Rate)		
CARRIER SIGNAL		
MODULATED SIGNAL		
RECOVERED BINARY DATA (DEMODULATED SIGNAL)		

RESULT:

Waveforms of PSK modulated and demodulated signal has been observed and readings are taken and analyzed properly

VIVAQUESTIONS:

1. What are the advantages of PSK over ASK and FSK?
2. For the given 8bit data 10111010 draw the PSK output waveform.
3. Draw the constellation diagram of PSK.
4. What is the consumed Bandwidth of PSK?
5. Give the block diagrams of NON COHERENT PSK Modulator and Demodulator.

Date of Experiment:_______________

EXPERIMENT NO: 7

AIM:

To analyze a ASK modulation system and interpret the modulated and demodulated waveforms.

APPRATUS:

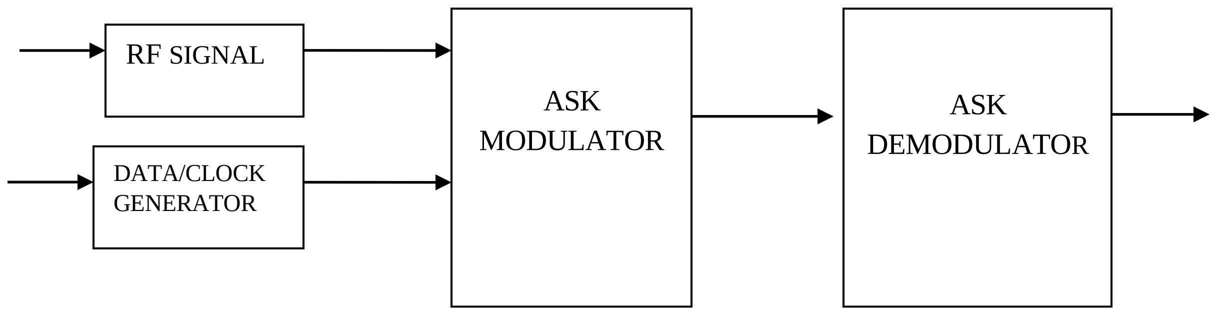
1. ASK Trainer Kit-Scientech
2. Dual Trace oscilloscope
3. Digital Multi meter
4. C.R.O (30MHz)
5 Patch chords.

THEORY:

ASK modulation involves the variation of the amplitude of the carrier waves in accordance with the data stream. The simplest method of modulating a carrier with a data stream is to change the amplitude of the carrier wave every time the data changes. This modulation technique is known as amplitude shift keying. The simplest way of achieving amplitude shift keying is 'ON' the carrier whenever the data bit is 'HIGH' & switching 'OFF' when the data bit is low i.e. the transmitter outputs the carrier for HIGH & totally suppresses the carrier for low. This technique is known as ON-OFF keying Fig. illustrates the amplitude shift keying forthe given data stream. Thus, DATA= HIGH (CARRIER TRANSMITTED)DATA = LOW (CARRIER SUPPRESSED) .The ASK waveform is generated by a balanced modulator circuit, also known as a linear multiplier, As the name suggests, the device multiplies the instantaneous signal at its two inputs, the output voltage being product of the two input voltages at any instance of time. One of the inputs is a/c coupled 'carrier' wave of high frequency. Generally the carrier wave is a sine wave since any other waveform would increase the bandwidth imparting any advantages requirement without improving or to it. The other i/p which is the information signal to be transmitted, is D.C. coupled. It is known as modulating signal

In order to generate ASK waveform it is necessary to apply a sine wave at carrier input & the digital stream at modulation input. The double balanced modulator is shown in fig.

BLOCK DIAGRAM:



The data stream applied is uniploar i.e. 0 Volt at logic LOW & +5Volts at logic HIGH. The output of balanced modulator is a sine wave, unchanged in phase when a data bit 'HIGH' is applied to it. In this case the carrier is multiplied with a positive constant voltage when the data bit LOW is applied , the carrier is multiplied by0 Volts, giving rise to 0Volt signal at modulator's o/p. The ASK modulation results in a great simplicity at the receiver. The method to demodulate the ASK waveformis to rectify it, pass it filter &'square up'the resulting waveform. The output is the original digital data stream. Fig. shows the functional blocks required in order to demodulate the ASK waveform at receiver

PROCEDURE:

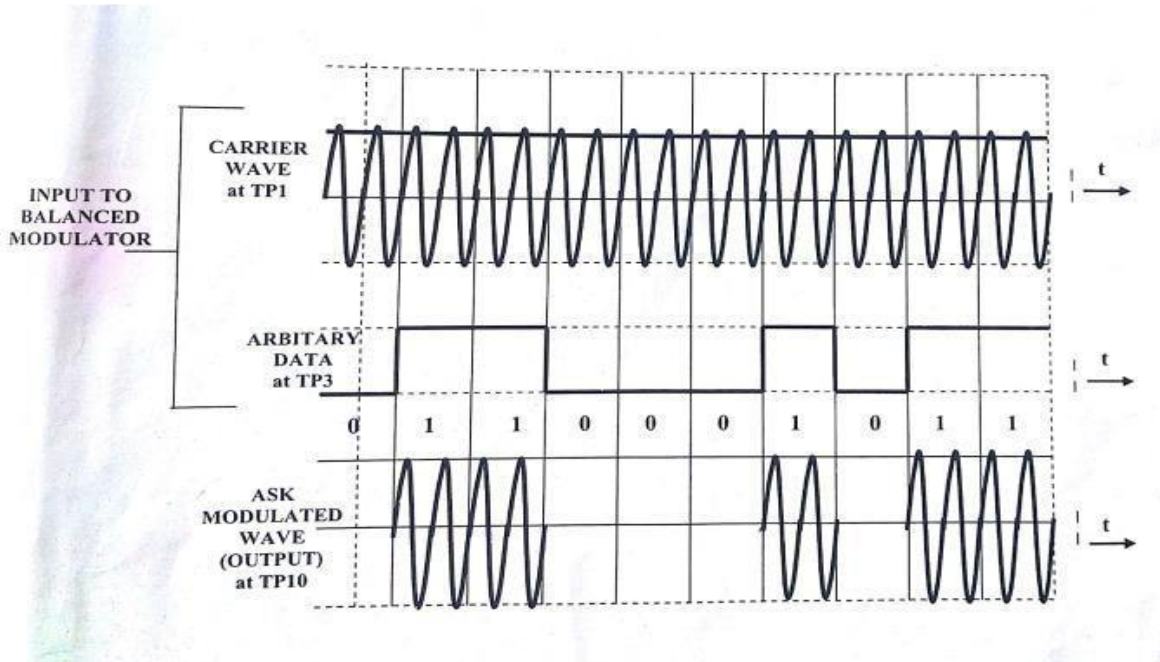
Modulation:

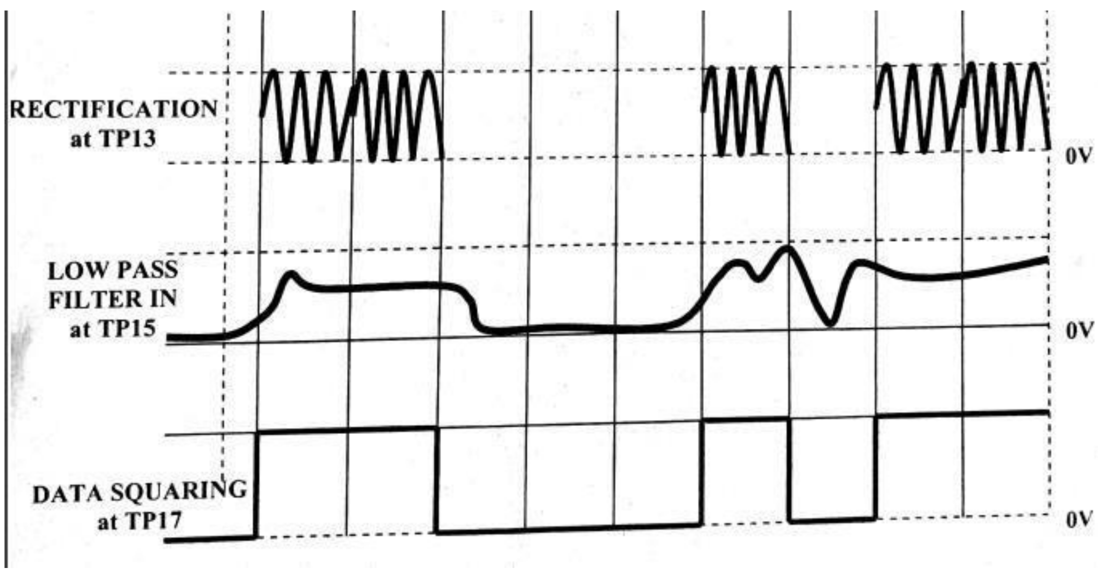
1. Connect the sine wave carrier generator to the carrier input of the modulator.
2. And also connect data clock D1 i.e., modulating signal to the modulation input
3. Switch ON the power supply.
4. Observe the modulated output.
5. By changing the data clocks D2,D3,D4 observe the output.

Demodulation:

1. Connect ASK output to the Product modulator input and observe the waveform.
2. Now connect Product modulator output to the low pass filter input and observe the output.
3. Connect LPF output to the Comparator circuit and observes the demodulated output waveform.
4. By changing the different data clocks and observe the demodulation output.

EXPECTEDWAVEFORMS:





OBSERVATIONS:

TYPE OF SIGNAL	AMPLITUDE	FREQUENCY
BINARY DATA- 2KHz(Theoretical Rate)		
BINARY DATA - 4 KHz (Theoretical Rate)		
BINARY DATA - 8 KHz (Theoretical Rate)		
CARRIER SIGNAL		
MODULATED SIGNAL		
RECOVERED BINARY DATA (DEMODULATED SIGNAL)		

RESULT:

Thus the ASK modulation and demodulation were performed and wave forms were observed along with the readings.

VIVA QUESTIONS:

1. What are the advantages of ASK over PSK and FSK?
2. For the given 8 bit data 10111010 draw the ASK output waveform.
3. Draw the constellation diagram of ASK.
4. What is the consumed Bandwidth of ASK?
5. Applications of ASK.

Date of Experiment:_______________

EXPERIMENT NO: 8

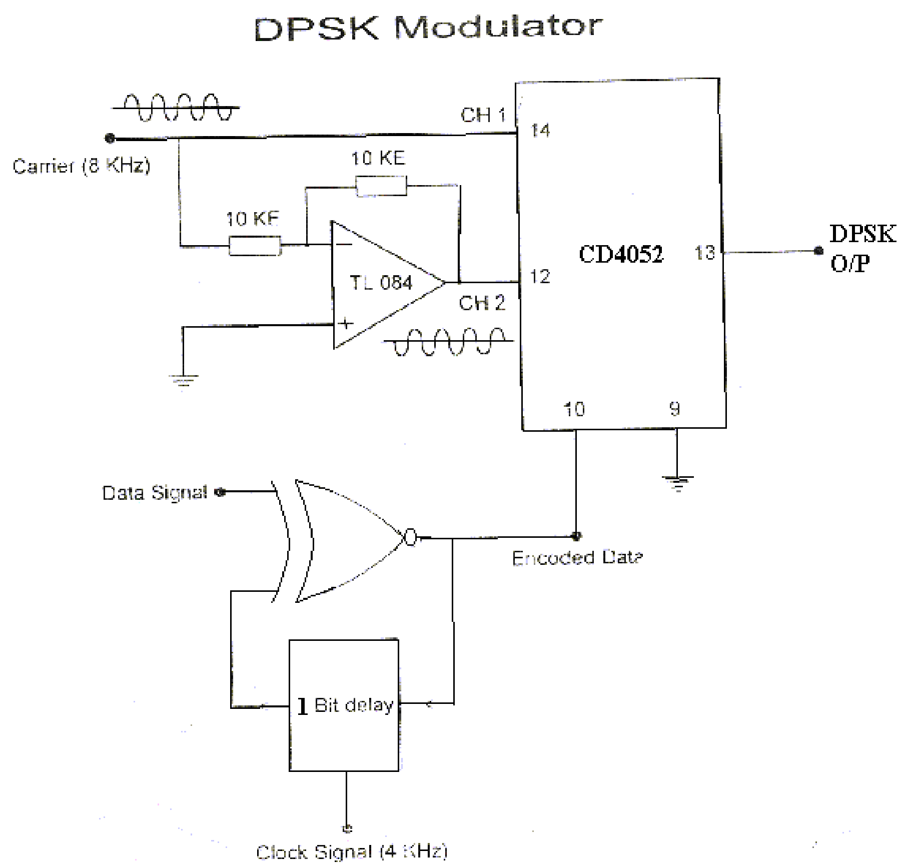
AIM:

Observe the waveforms of differential phase shift keyed modulated signal and recover the binary data

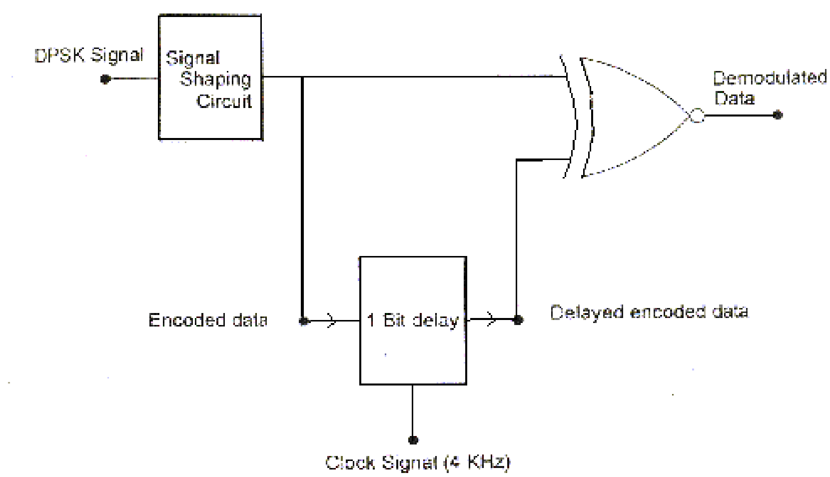
APPRATUS:

1. DPSK Trainer Kit
2. Dual Trace oscilloscope
3. Digital Multi meter
4. C.R.O (30MHz)
5. Patch chords.

BLOCK DIAGRAM:



DPSK Demodulator



THEORY:

DPSK: Phase Shift Keying requires a local oscillator at the receiver which is accurately synchronized in phase with the un-modulated transmitted carrier, and in practice this can be difficult to achieve. Differential Phase Shift Keying (DPSK) over comes the difficult 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. In other words DPSK is a non-coherent version of the PSK.

The differential encoding operation performed by the modulator is explained below Let b (t) be the binary message to be transmitted. An encoded message stream b(t) is generated from b'(t) by using a logic circuit The first bit in b(t) is arbitrary which may be chosen as 1 or 0 . The subsequent bits in b(t) are determined on the basis of the rule that when b'(t) is 1 b(t) does not change its value. In the first bit stream ,the initial bit (arbitrary) is1 and in the second bit stream, the initial bit is 0 EX-NOR gate can be used to perform this operation as its output is a 1 when both the input are same, and a 0 when the inputs are different.

b'(t)		0	1	1	0	0
b(t)	1	0	0	0	1	0
Phase	0^0	180^0	180^0	180^0	0^0	180^0

B(t)	0	1	1	1	0	1
Phase	180^0	0^0	0^0	0^0	180^0	0^0

Example for Complete DPSK operation (with arbitrary bit as 0):

Message signal (to be transmitted)		0	1	1	0	0
Encoded data (differential data)	0	1	1	1	0	1
Transmitted signal phase:	180^0	0^0	0^0	0^0	180^0	0^0
Received signal phase:	180^0	0^0	0^0	0^0	180^0	0^0
Encoded data (differential data)		0	1	1	1	0
Message signal (Demodulation)		0	1	1	0	0

DPSK Demodulator:

PROCEDURE:

MODULATOR

1. Connect carrier signal to carrier input of the PSK Modulator.
2. Connect data signal from data input of the X-NOR gate.
3. Keep CRO in dual mode.
4. Connect CH1input of the CRO to data signal and CH2 input to the encoded data (which is nothing but the output of the X-NOR gate).
5. Observe the encoded data with respect to data input. The encoded data will be in a given sequence.
6. Actual data signal: 10101101001010110100
7. Encoded data signal: 01100011011001110010
8. Now connect CH2 input of the CRO to the DPSK output and CH1 input to the encoded data. Observe the input and output waveforms and plot the same.
9. Compare the plotted waveforms with the given waveforms in fig:1.3

DEMODULATOR:

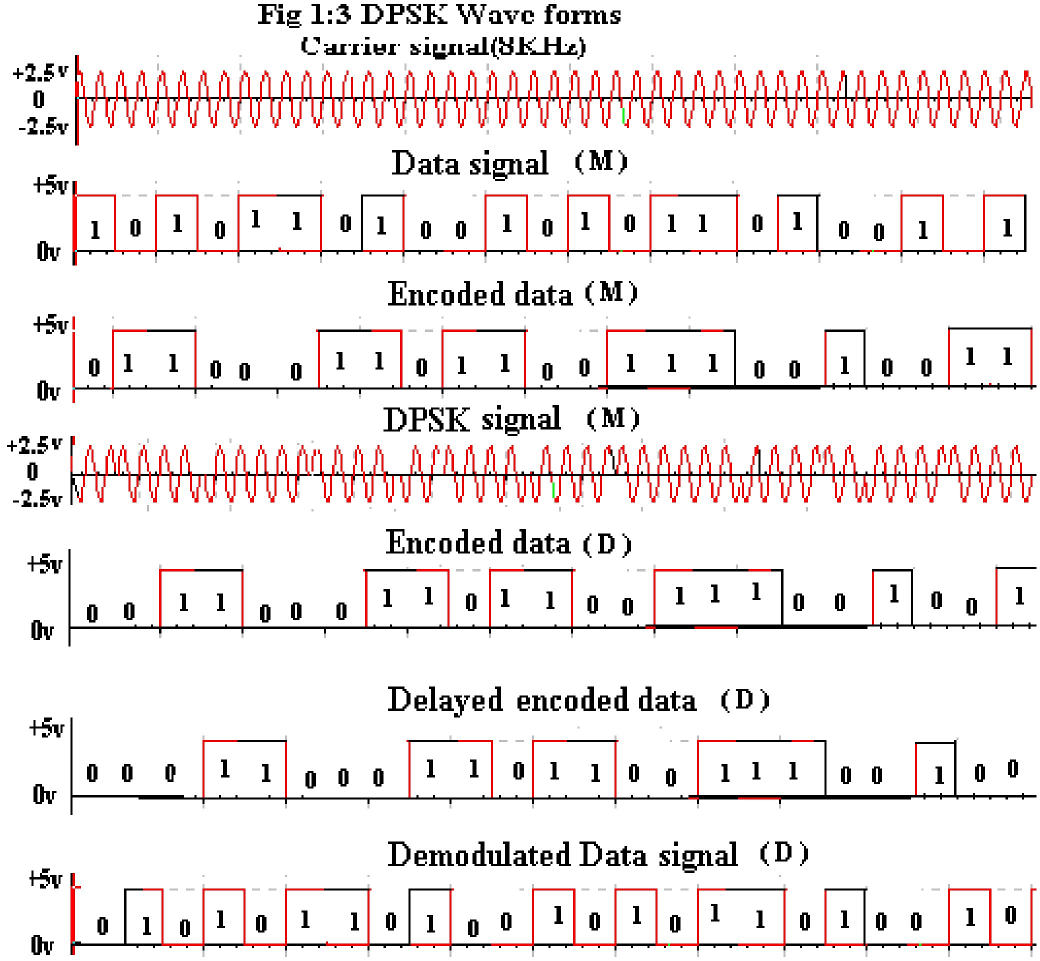
1. Connect DPSK signal to the input of the Demodulator.
2. Keep CRO in dual mode. Connect CH1 input to the encoded data (at modulator) and CH2 input to the encoded data (at demodulator).
3. Observe and plot both the waveforms and compare it with the given waveforms. It willbe noticed that both the signals are same with one bit delay.
4. Keep CRO in dual mode. Connect CH1 input to the data signal(at modulator) and CH2 input

to the output of the demodulator.

5. Disconnect clock from transmitter and connect to local oscillator clock (i.e., clock generator output from De Modulator) with remaining setup as it is. Observe demodulator output and compare it with the previous output. This signal is little bit distorted. This is because lack of synchronization between clock at modulator and clock at demodulator. We can get further perfection in output waveform by adjusting the locally generated clock frequency by varying potentiometer.

EXPECTED WAVEFORMS:

Fig 1:3 DPSK Wave forms



OBSERVATIONS:

TYPE OF SIGNAL	AMPLITUDE	FREQUENCY
BINARY DATA- 2KHz(Theoretical Rate)		
BINARY DATA - 4 KHz (Theoretical Rate)		
BINARY DATA - 8 KHz (Theoretical Rate)		
ENCODED DATA- 2KHz(Theoretical Rate) WITH VALUE		
ENCODED DATA - 4 KHz (Theoretical Rate)WITH VALUE		
ENCODED DATA -8 KHz (Theoretical Rate)WITH VALUE		
CARRIER SIGNAL		
MODULATED SIGNAL		
RECOVERED DECODED DATA RECOVERED BINARY DATA		

RESULT:

Thus the DPSK modulation and demodulation were performed and waveforms were plotted.

VIVA QUESTIONS:

1. Define DPSK?
2. Mention the advantages of DPSK?
3. Mention the disadvantages of DPSK?
4. Draw the waveforms of DPSK?
5. Compare ASK, PSK, FSK and DPSK?
6. What are the applications of DPSK?

Date of Experiment:_______________

EXPERIMENT NO: 9

AIM:

To perform modulation and demodulation of QPSK and sketch the relevant waveforms.

APPRATUS:

1. QPSK Trainer Kit
2. Dual Trace oscilloscope
3. Digital Multimeter
4. C.R.O (30MHz)
5. Patch chords.

BLOCK DIAGRAM:

QPSK MODULATOR AND DEMODULATOR

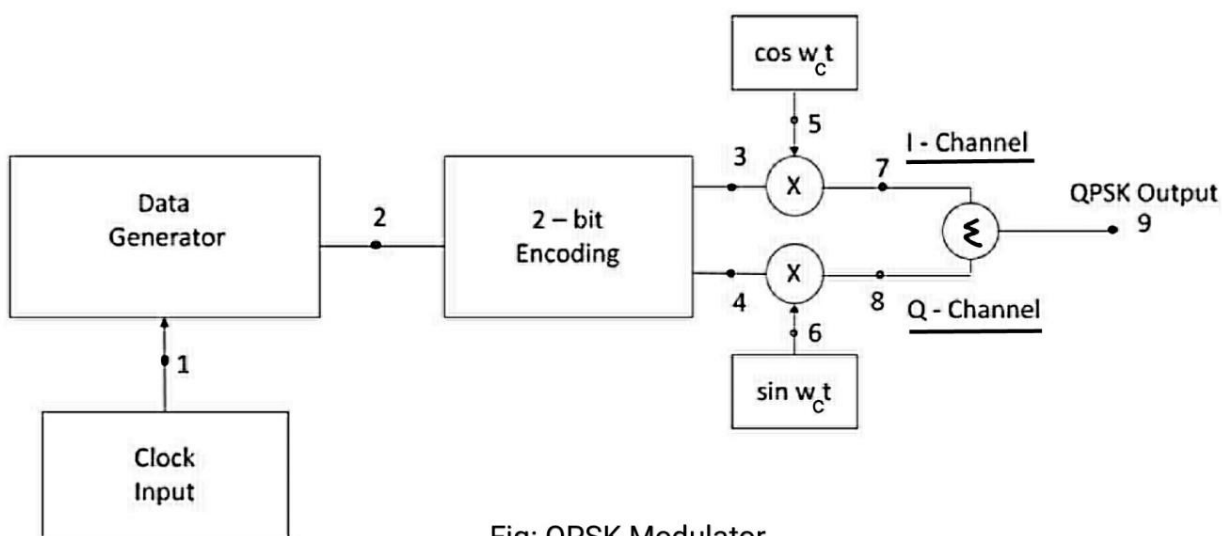


Fig: QPSK Modulator

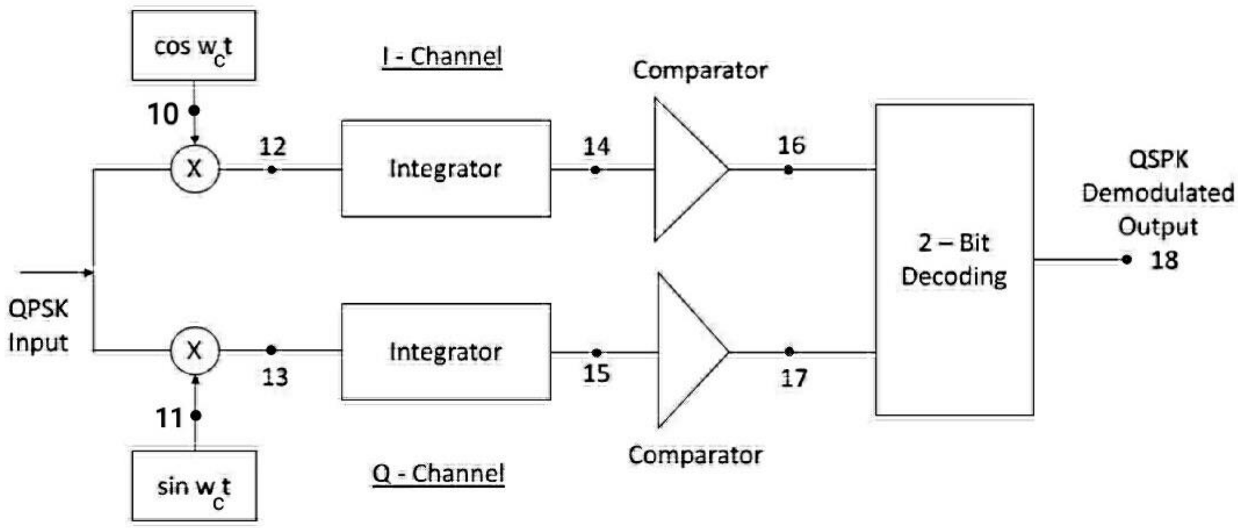


Fig: QPSK Demodulator

THEORY:

Quadrature Phase Shift Keying

Phase of the carrier takes on one of our equally spaced values such as π/4, 3π/4, 5π/4,7π/4.

$Si(t) = \sqrt{2E/Tb} \cos\{2\pi f ct + (2i - 1)\pi/4\}$, $0 \le t \le Tb$

0, ,elsewhere

Where i=1,2,3,4,and E=Tx signal energy per symbol

T_b = symbol duration

Each of the possible value of phase corresponds to a pair of bits called dibits.

Thus the gray encoded set of dibits: 10, 00, 01,11

$Si(t) = \sqrt{2E/T_b} \cos[(2i - 1)\pi/4] \cos(2\pi fct) - \sqrt{2E/T_b} \sin[(2i-1)\pi/4)] \text{Sin}(2\pi fct)$, $0 \le t \le Tb$ 0 , else where

There are two ortho nonormal basis functions

$Ø1(t) = \sqrt{2/Tb} \cos 2\pi f ct$, $0 \le t \le Tb$

$Ø2(t) = \sqrt{2/Tb} \sin 2\pi f ct, 0 \le t \le Tb$

The i/p binary sequence b(t) is represented in polar form with symbols 1 and 0 represented as $+\sqrt{E/2}$ and $-\sqrt{E/2}$ .This binary wave is Demultiplexed into two separate binary waves consisting of odd and even numbered input bits denoted by b1 (t) & b2 (t)

b1(t)andb2(t) are used to modulate a pair of quadrature carrier or orthogonal Basis function Ø1 (t) and Ø2(t).The result is two PSK waves'. These two binary PSK waves are added to produce the desired QPSK signal .

PROCEDURE:

1. Connect and switch ON the power supply.
2. QPSK is selected by default and LEDs of corresponding technique will glow.
3. Select the bit pattern using push button i.e.8 bit or 16 bit or 32 bit or 64 bit. Observe bit pattern on TP-2.
4. Select data rate using push button i.e. 2 KHz or4 KHz or 8 KHz or 16KHz.

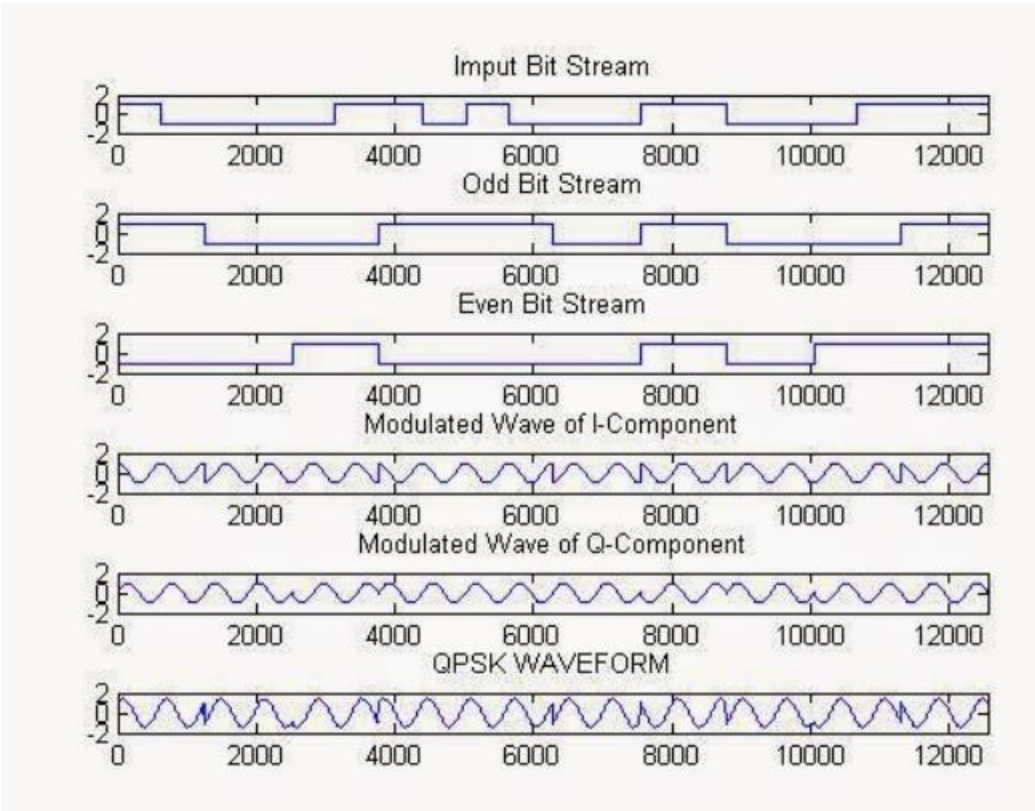
Modulation:

5. Observe the input bit pattern by varying bit pattern using respective push button.
6. Observe the data rate by varying data rate using respective push button.
7. Observe the Two-bit encoding i.e. I-Channel and Q-Channel.
8. Observe carrier signal i.e. cosine wave and sine wave .Frequency of carrier signal will change with respect to data rate.
9. Observe I-Channel and Q-Channel modulated signal.
10. Observe QPSK modulated signal.

Demodulation:

11. Apply the QPSK modulated output to the demodulator input.
12. Observe the multiplied signal of QPSK and carrier signal, cosine and also observe the multiplied signal of QPSK and carrier signal, sine.
13. Observe the integrated output at I-channel and Q-channel

EXPECTEDWAVEFORMS:



RESULT:

QPSK modulation and demodulation waveforms are observed.

VIVA QUESTIONS:

1. Draw the constellation diagram of QPSK.
2. Give some applications of QPSK modulation scheme
3. Give the Bandwidth of QPSK signal
4. What is the relationship between 4 QAM and QPSK?
5. QPSK is an example of which M-ary technique.

LAKSHMI NARAIN COLLEGE OF TECHNOLOGY, BHOPAL

Date of Experiment:_______________

EXPERIMENT NO: 10

AIM:

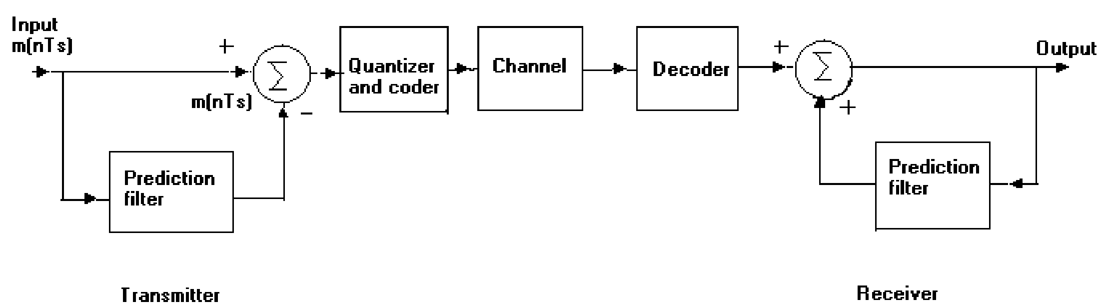
To analyze a DPCM system and to interpret the modulated and demodulated waveforms for a sampling frequency of 2KHz, 4KHz and 8 KHz.

APPRATUS:

1. DPCM Modulation and Demodulation Trainer Kit
2. Dual Trace oscilloscope
3. Digital Multi meter
4. C.R.O (30MHz)
5. Patch chords.

BLOCK DIAGRAM:

Block diagram of DPCM



THEORY:

Differential PCM is quite similar to ordinary PCM. However, each word in this system indicates the difference in amplitude, positive or negative, between this sample and the previous sample. Thus the relative value of each sample is indicated rather than, the absolute value as in normal PCM. This unique system consists of

DPCM Modulator

1. Regulated power supply
2. Audio Frequency signal generator
3. Prediction Filter

4. Sample and Hold circuit

5. A/D Converter

6. Parallel to Serial Shift register

7. Clock generator/Timing circuit

8. DC source

II. DPCM Demodulator

1. Regulated Power Supply

2. Serial to Parallel Shift registers.

3. D/A converter.

4. Clock generator

5. Timing circuit

6. Prediction filter

7. Passive low pass filter

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 AFgenerator using CRO, it should be Sine wave of 400Hz frequency with 3V pp amplitude.

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

5. Observe the output of the Clock generator using CRO, hey should be 64 KHz and 8KHz frequency of square with 5 Vpp 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 AC input):

Modulation:

1. Connect AC signal of 3VPP amplitude to positive terminal of the summer circuit.

Note :The output of the prediction filter is connected to the negative terminal of the summer circuit and can observe the waveforms at the test points provided on the board.

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

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

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

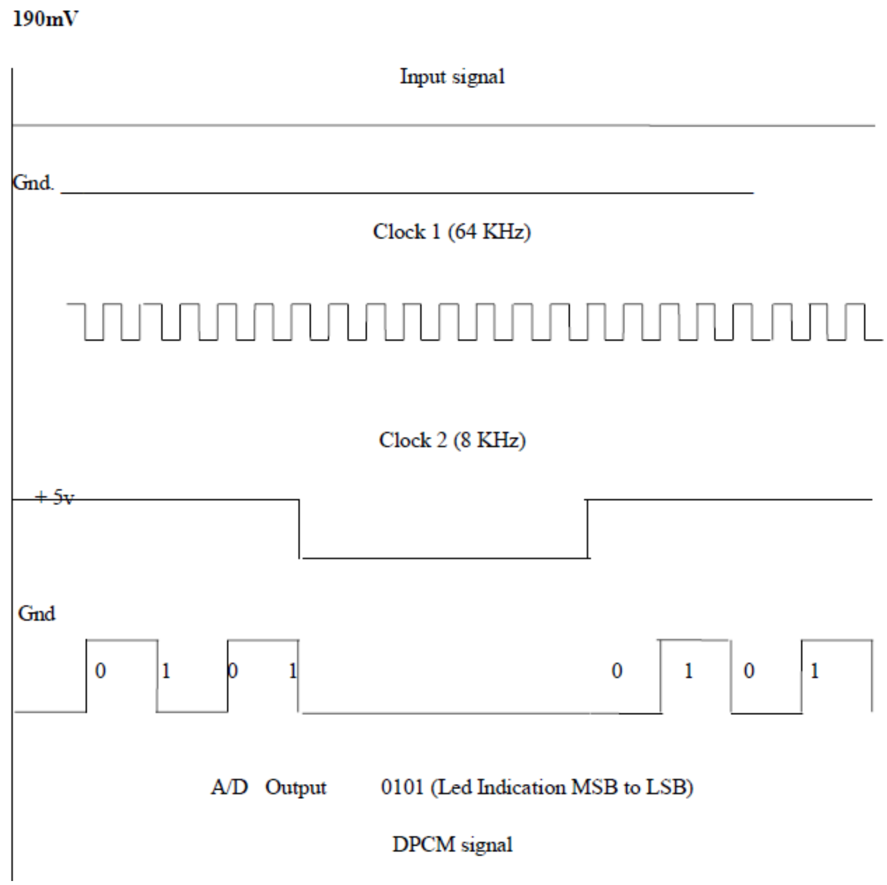
5. Observe DPCM output by varying AF signal voltage.

Demodulation:

6. Connect DPCM signal to the demodulator input (S-P shift register) from the DPCM modulator with the help of coaxial cable (supplied with trainer).
7. Connect clock signal (64KHz) from the transmitter to the receiver using coaxial cable.
8. Connect transmitter clock to the timing circuit.
9. Keep CRO in dual mode. Connect one channel to the sample and hold output and another channel to the D/A converter output.
10. Observe ands ketch the D/A output
11. Connect D/A output to the LPF input and observe the output of the LPF.
12. Observe the waveform at the output of the summer circuit.
13. Disconnect clock from transmitter and connect to the local oscillator (i.e., clock generator output from De Modulator) 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.

EXPECTEDWAVEFORMS:

The wave forms for the given AC input, corresponding binary data wave form, and for AC input sample and hold waveforms are drawn then D/A converter o/p and then reconstructed AC signal is also drawn.



OBSERVATIONS: DPCM with AC input

	Amplitude	Time period
AC Input		
Prediction Filter Output		

Sample and Hold Output		
Clock -1 output		
DPCM Output		

Demodulation:

	Amplitude	Timeperiod
DPCM Input		
D/A Converter Output		
LPF Output		
Demodulation Output		
Prediction Filteroutput		

RESULT:

Thus the Differential Pulse code modulation and demodulation were performed.

VIVAQUESTIONS:

1. For data compression says whether ADPCM or DPCM is better .Justify.
2. What is the need for compression ?Mention the types of compression.
3. List the communication standards which use DPCM.
4. Based upon the knowledge that you have gained after doing the experiment write the Functions of sample and hold circuit.
5. Name the circuit used to achieve synchronization between transmitter and receiver.