DIGITAL COMMUNICATIONS LAB/EC 362 R20

III/IV B.TECH – II SEM-R20

LABORATORY MANUAL

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BAPATLA WOMEN'S ENGINEERING COLLEGE::BAPATLA

(AFFILIATED TO ACHARYA NAGARJUNA UNIVERSITY,GUNTUR)

BAPATLA DISTRICT,ANDHRA PRADESH,INDIA ,PIN:522101

BAPATLA WOMEN'S ENGINEERING COLLEGE::BAPATLA

AN ISO 9001-2015 CERTIFIED INSTITUTION

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COLLEGE VISION AND MISSION

Vision

Bapatla Women's Engineering College has been established with forethought to organize the growing needs of higher technical education for WOMEN, in order to provide them a competative edge and a unique niche in the society.

Mission

Our mission is to impart the quality education at par with global standards to the students from all over India and in particular those from the local and rural areas. We continuously try to maintain high standards so as to make them technologically competent and ethically strong individuals who shall be able to improve the quality of life and economy of our country.

BAPATLA WOMEN'S ENGINEERING COLLEGE::BAPATLA

AN ISO 9001-2015 CERTIFIED INSTITUTION

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To produce highly professional and socially responsible women engineers through world class quality technical education and research to meet industry and Society needs in the field of Electronics and Communication Engineering.

MISSION

M1- To inculcate quality education for women through innovative learning practices with the use of modern tools.

M2- To impart professional ethics and moral values through co-curricular and extra-curricular activities as individual and team member.

M3- Empowering graduates through industrial trainings/on-job training in collaboration with industries with-a-view to life-long learning.

Programme Educational Objectives (PEO's)

PEO1: To develop and implementation of Electronics and Communication systems by imparting technical knowledge, professional leadership and communication skills as an individual and team in a multi-disciplinary stream.

PEO2: To train Graduates in solving complex problems, analyzing, designing and imparting research-based knowledge by using modern scientific tools to develop least cost-effective and innovative products.

PEO3: To produce women graduates through life-long learning, who ensure ethical and moral behavior.

Programme Specific Outcomes(PSO's)

PSO1: To understand and analyze basic concepts of electronics and communication in various areas like signal processing, VLSI, embedded systems, communications, digital and analog devices.

PSO2: Ability to design and develop computing systems using concepts of mathematics, electronics engineering and other related inter disciplines to asses and resolve societal, environmental, health safety and cultural issues with professional ethics.

Programme Outcomes (POs)

- **PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO2: Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools prediction and modelling to complex engineering activities with an understanding of the limitations.
- **PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
- **PO7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
- **PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering prac tice.
- **PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and receive clear instructions.
- **PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in team, to manage projects and in multidisciplinary environments.
- **PO12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

EC362 R20 –Digital Communication Lab

SYLLABUS

EC362R20 Digital Communication Lab **L T P C**
0 0 3 1.5

OBJECTIVES:

- ✓ To understand the deep knowledge in digital communication systems at the practical level .
- ✓ To understand different modulation and digital modulation techniques in digital communication.
- ✓ To learn the detailed analysis of TDM.
- ✓ To implement the Hamming code.

OUTCOMES:

Upon Completion of the course, the students will be able to:

- ✓ Develop time division multiplexing concepts in real applications.
- ✓ Analyze different Digital Modulation & Demodulation schemes
- ✓ Analyze different Digital shift keying Techniques
- ✓ Evaluate Error Coding Techniques

REFERENCES:

1. Simon Haykin, Digital communications, JohnWiley, 2005.
2. Taub & Schilling, "Principles of Communication Systems", Tata McGraw Hill Publication.

Course Outcomes (COs):

CO No.	Course Outcome Statement	Bloom's Taxonomy Level
C362.1	Develop time division multiplexing concepts in real applications.	CREATE
C362.2	Analyze different Digital Modulation & Demodulation schemes	ANALYZE
C362.3	Analyze different Digital shift keying Techniques	EVALUATE
C362.4	Evaluate Error Coding Techniques	APPLY

Mapping of Course Outcomes with POs and PSOs:

Mapping of course outcomes with Program outcomes (CO/ PO/PSO Matrix) Note: 1- Weak correlation 2-Medium correlation 3-Strong correlation '-' No Correlation * - Average value indicates course correlation strength with mapped PO &PSO													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO 10**	**PO11**	**PO1 2**	**PSO 1**	**PSO 2**
C362.1	3	2	2	-	2	-	-	-	-	-	-	-	2	-
C362.2	3	2	2	-	2	-	-	-	-	-	-	-	2	-
C362.3	3	2	2	-	2	-	-	-	-	-	-	-	2	-
C362.4	2	2	2	-	3	-	-	-	-	-	-	-	3	-
Avg CO	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**

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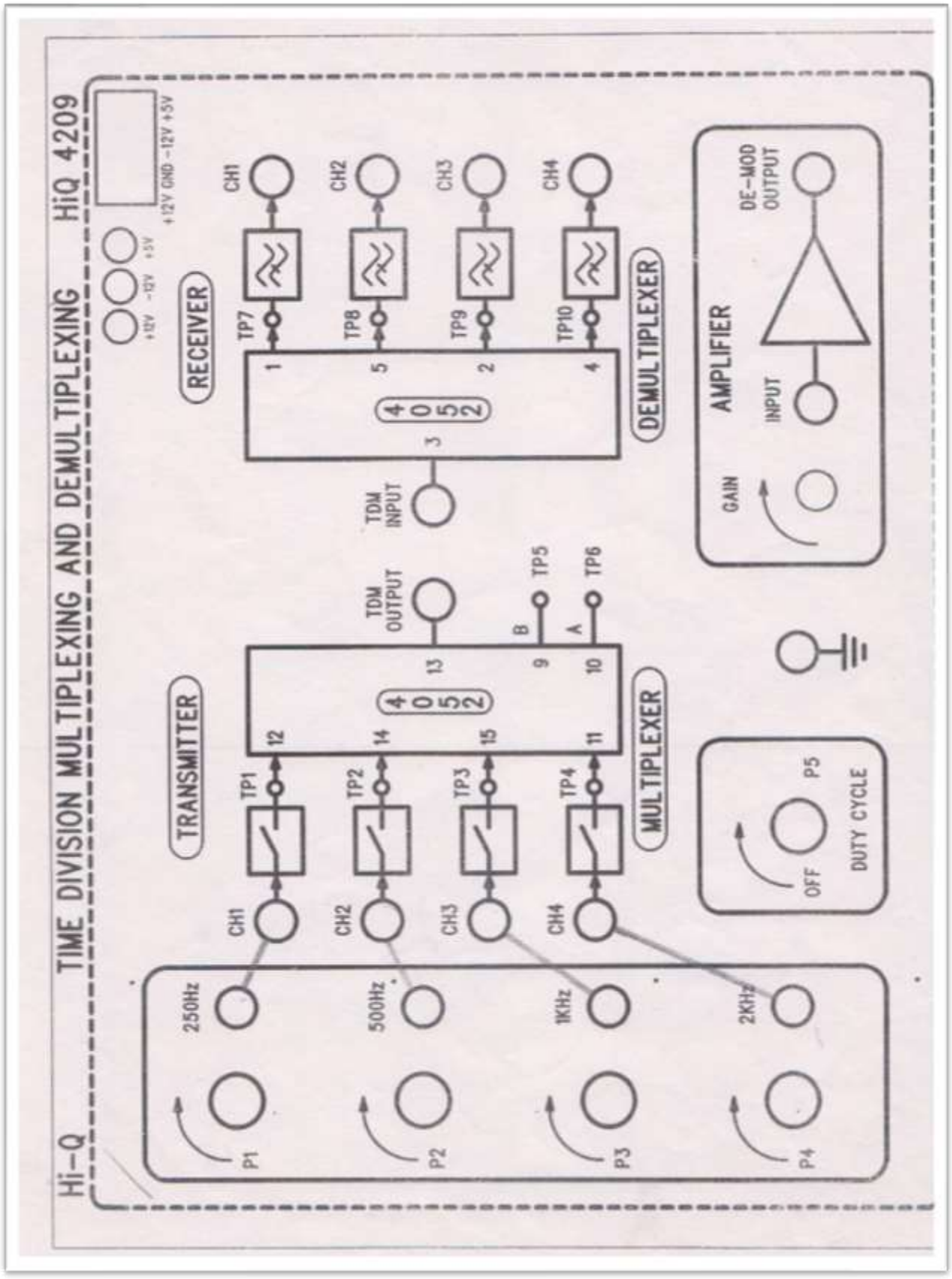
CIRCUIT DIAGRAM:



1. Generation and Detection of Time Division Multiplexing

Aim: Study of 4 channel analog multiplexing and demultiplexing techniques

Equipment: TDM Trainer Kit – HiQ-420

20MHz Dual Channel Oscilloscope

Patch Chords

Theory:

The TDM is used for transmitting several analog message signals over a communication channel by dividing the time frame into slots,one slot for each message signal.The four input signals,all band limited by the input filters are sequentially sampled,the output of which is aPAM waveform containing samples of the input signals periodically interlaced in time.The samples from adjacent input message channels are separated by T_s/M,where M is the number of input channels.A set of M pulses consisting of one sample from each of the input M-input channels is called a frame.

At the receiver the samples from individual channels are separated by carefully synchronizing and its critical path TDM.Thus samples from each channel are filter to reproduce original message signal.There are 2 levels of synchronization.Frame synchronization is necessary to establish when each group of samples begin and word synchronization is necessary to properly separate the samples within each frame.

Besides the space and frequency diversity there is a method of sending multiple analog signals on a channel using “Time division multiplexing and demultiplexing” technique.

Procedure:

Multiplexing:

1.Connect the circuit as shown in diagram 1.

2.Switch on the power supply.

3.Set the amplitude of each modulating signal as 5V P-P.

4.Monitor the outputs at test points 1,2,3,4 these are natural sampling PAM outputs.

5.Observe the outputs by varying the duty cycle pot(P5).The PAM outputs will vary with 10% to 50% duty cycle.

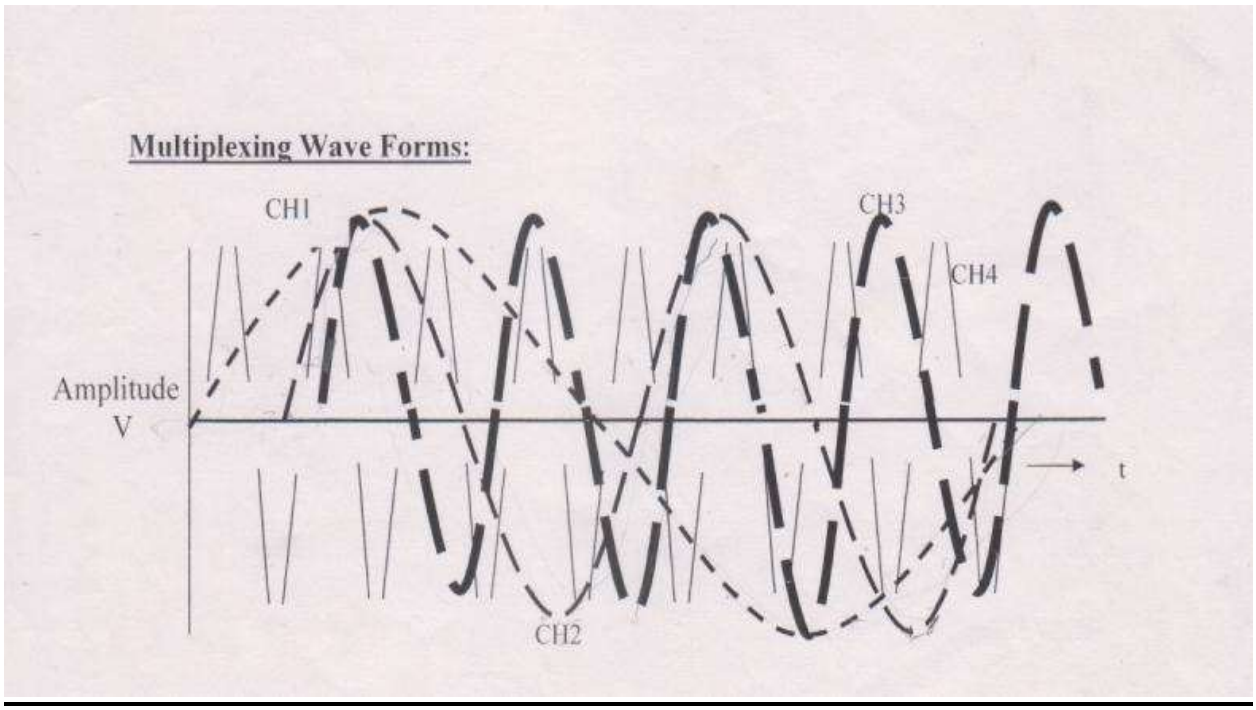
6.Try varying the amplitude of modulating signal corresponding each channel by using amplitude pots P1,P2,P3,P4 observe the effect on all outputs.

7.Observe the TDM output at pin number 13 of 4052IC all the multiplexer channels are observed during the full period of the clock (1/32 KHz).

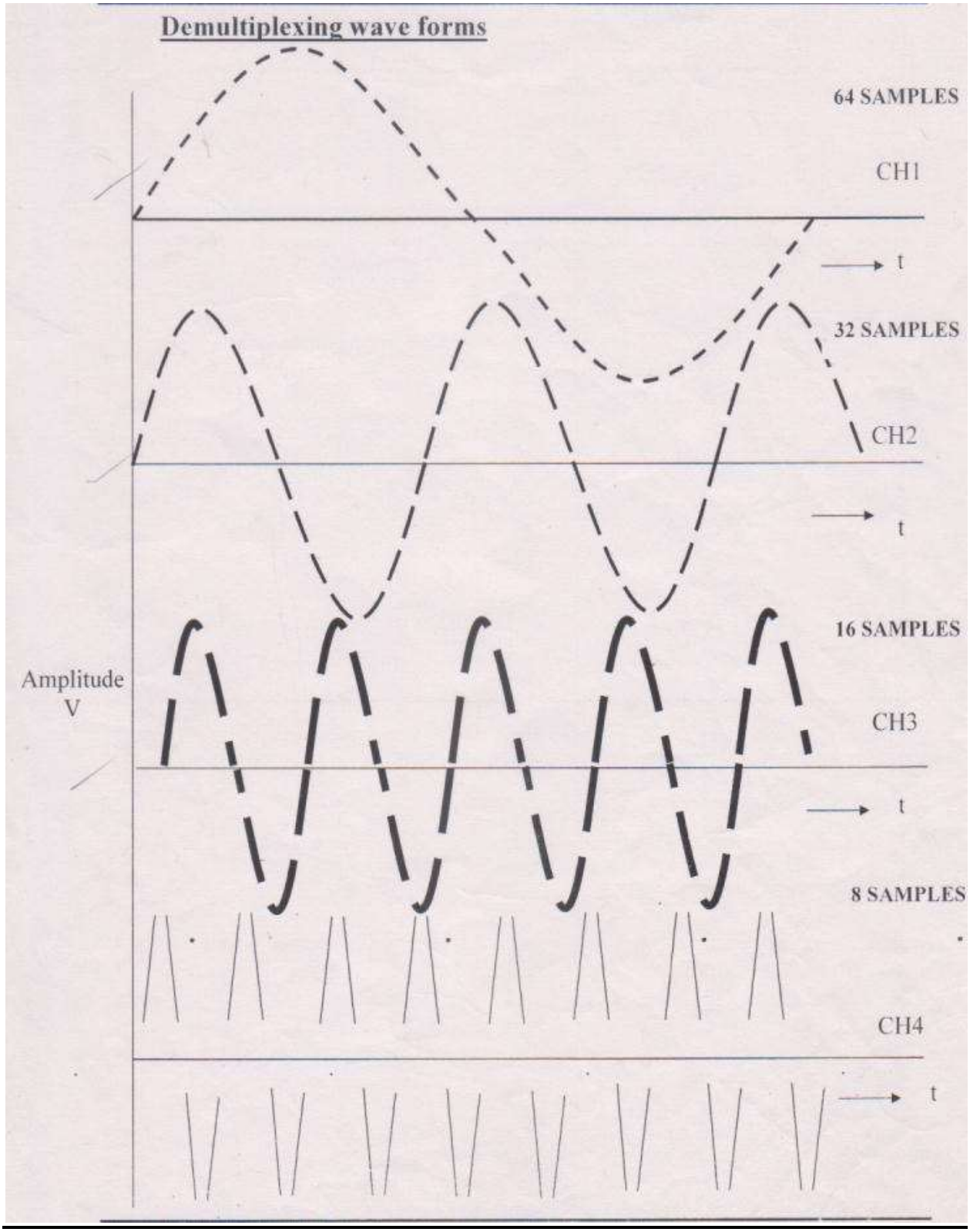
Demultiplexing:

1. Connect the circuit as shown in diagram 2.
2. Observe the demultiplexed outputs at test points 7,8,9,10 respectively.
3. Observe by varying the duty cycle pot P5 and see the effects on the outputs.
4. Observe the low pass filter outputs for CH1,CH2,CH3,CH4.These signals are true replica of the inputs.These signals have lower amplitude.
5. The low pass filter is obviously less and it is fed to the AC amplifier which comprises of a single op-amp and whose output is amplified.

Multeplixing Wavefroms:



De-Multeplixing Wavefroms:



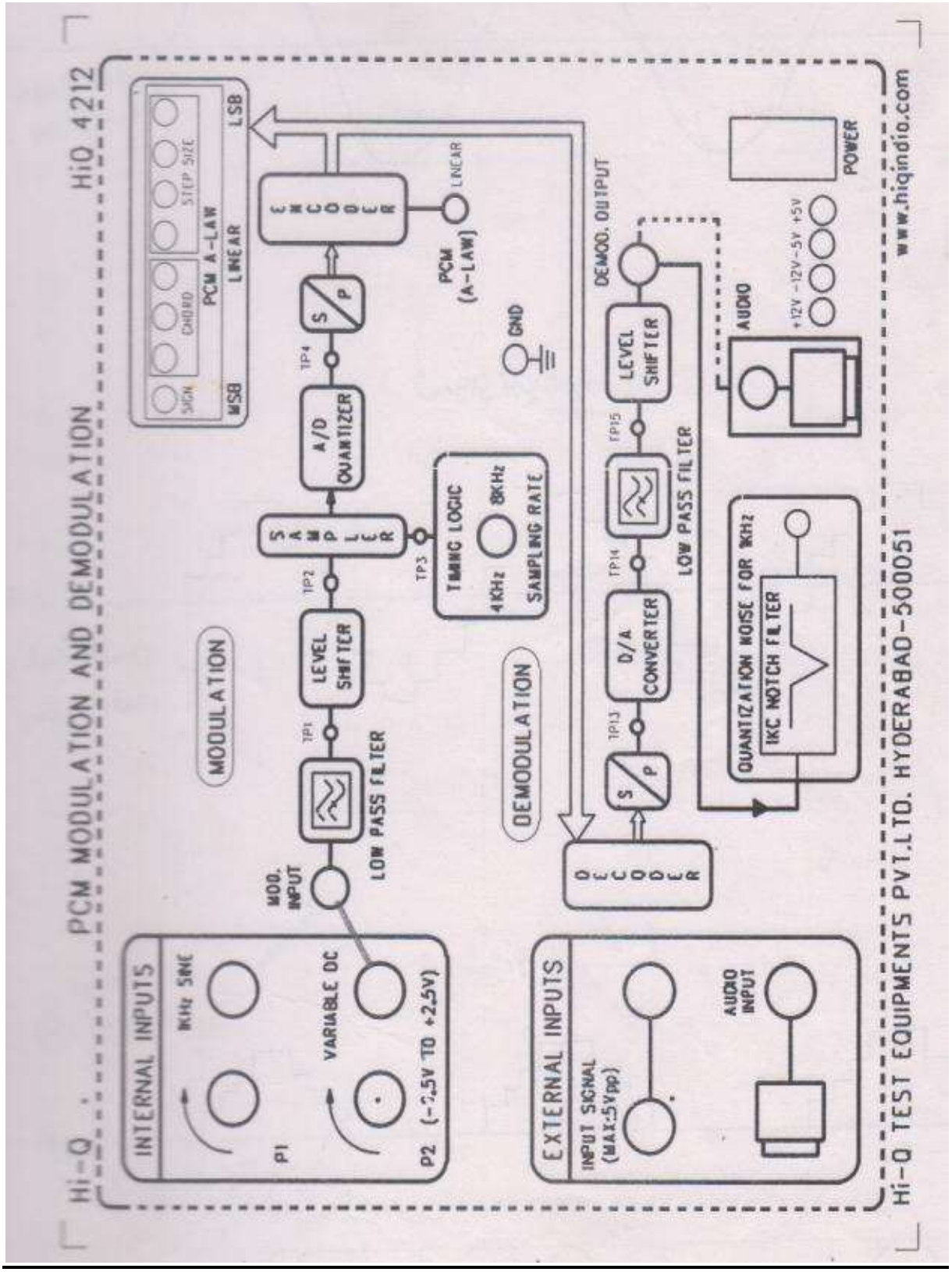
Result:

Generation and detection of Time Division Multiplexing has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

1. Define guard time & frame time?
2. How TDM differ from FDM?
3. Is the bandwidth requirement for TDM & FDM will be same?
4. Is the FDM susceptible to harmonic distortion compared to TDM?
5. In what aspects, TDM is superior to FDM?
6. Is TDM system is relatively immune to interference with in channels (inter channel cross talk) as compared to FDM?

Circuit Diagram:



2.Generation and Detection of Pulse Code Modulation

Aim:1.To study the pulse code modulation and demodulation.

2.To study the effect of A-law PCM and linear modulation by varying the input signal amplitude.

3.To study the variation of sampling frequency on the demodulation output signal and to prove the Nyquist sampling theorem.

Observing Quantizing noise at demodulation output for 1KHz sine wave input according to A-Law and linear by varying input signal amplitude.

Equipment Required:

1)Hi-Q Test Equipment Pvt.LTD

2)PCM modulation and Demodulation Trainer kit

3)20MHZ dual channel CRO

Theory:

The PCM is the simplest and low complexity speech coding technique.In the PCM the source sppech signal is sampled at 8000 samples per second ,and dynamic range of the speech is quantized into 256 quantization levels so that each sample is approximated by one of these 256 quantized levels.Therefore in the PCM 8 bits are required to code each sample.

Sampling: The process of converting filter voice information into a digitized pulse train format begins with sampling the voice signal at uniform intervals.These intervals are determined by Nyquist samping theorem,which simply states that any signal may be completely reconstructed from its representative sampling if it is sampled atleast twice the maximum frequency.The process is called Pulse amplitude modulation.

Samplin Rate: The accuracy of any digital reproduction of analog signal depends on number of samples taken using PAM and PCM can reproduce the row form exactly by taking infinite samples.According to Nyquist theorem to ensure the accurate reproduction of analog signal using PAM sampling rate must be atleast twice the highest frequency of the original signal.

Quantization: By quantization the signal is discrete in both time and amplitude.In a uniform quantizer the represented levels are uniformly spaced.In non uniform quantizer step size

increase as separation from the origin of input and amplitude characteristics is increased.The non-uniform quantizer is equivalent to baseband through the compressor (by A-law or μ law) and then to uniform quantizer.

Encoding: In the encoding system the PAM signals are quantized using a 13 segment compression characteristic known as A-law which is governed by following expression.

$$Y = \frac{(1 + \ln(AX))}{(1 + \ln(A))}$$

Where a=87.6

X=normalized compressor input voltage

Y= normalized compressor output voltage

This characteristic is made up of 7 different size segments for the positive and negative halves,with two segments around the zero point forming a single straight line segment.each segment is divided into linear steps with the segments around the zero point forming a single straight line segment.Each segment is divided into linear steps with the segments around zero point forming a single straight line segment.Each segment is divided into linear steps with the segments about the zero pont having 32 steps and the rest having 16 steps.

This results in non linear quantization of the sampled signal,which has the useful effect on the signal to quantizing noise ratio(S/Q) ratio.

Most of the information in the human voice is at the low amplitudes and segment about the zero point covers 1/64 th of the amplitude range and is divided into 32 steps.Whereas the top half of the input signal dynamic range is covered by the last 16^{th} step segment of the characteristic.

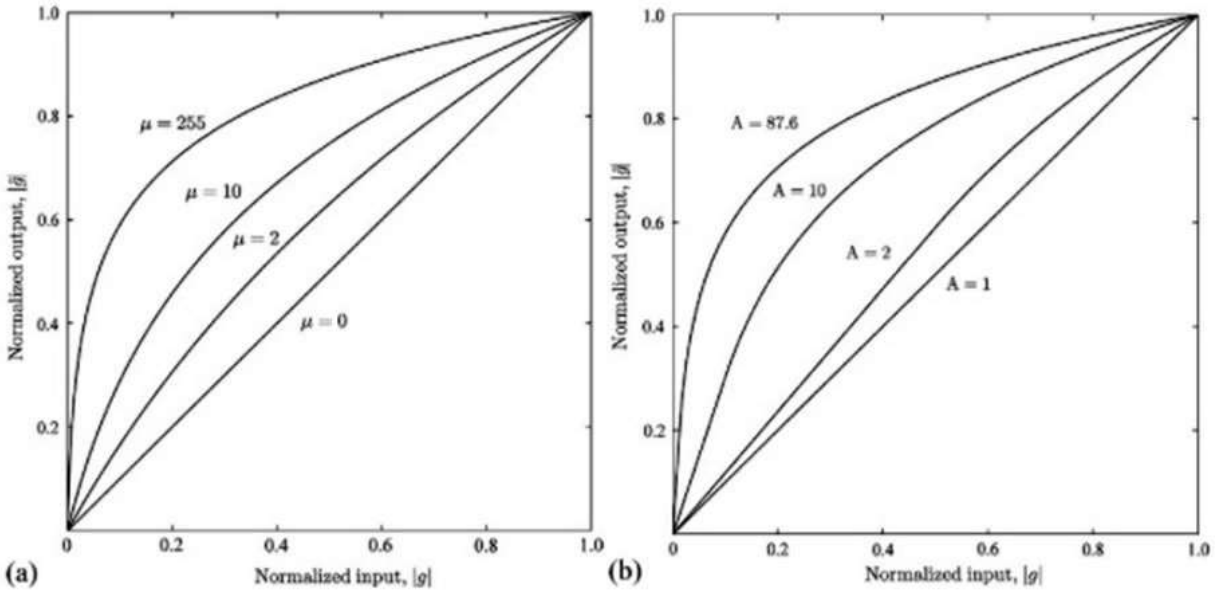
The conversion to binary PCM data for transmission involves coding of 256 quantizing intervals assigned to individual PAM samples into 8 bit binary words(7 data bits + 1sign bit).

Companding:

Compress during Modulation,expand during Demodulation.

μlaw,A-law

The PCM CODEC performs this non-uniform or non-linear quantization through μ law or A law.This process enhances lower amplitude signals to allow them to complete with system noise, and attenuates higher amplitude signals preventing them form saturating the system.This form of signal compression results in a relatively uniform signal to quantization noise ratio.



Decoding:

The cleaned pulses are regrouped in CODE words and decoded into a quantized PAM signal.In decoding process a pulse is generated whose amplitude is the linear sum of all the pulses in the code word and each pulse being weighted by place value (2,0,2,1,2,1……) in the code.

Filtering:

The final operation in the receiver is to recover the message signal by passing the decoder output through a low pass reconstruction filter having cutoff frequency equal to twice the message bandwidth W.

Experimental Procedure:

1.To study the pulse code modulation and demodulation

1. Switch on the power supply.
2. Connect the C.R.O probe at variable DC terminal and set C.R.O in DC mode then vary the pot p2,observe the variable DC voltage.
3. Observe the DC voltage at TP2,it is +2.5V.This is origin for ADC .Any input signal applied at MOD.Input shifyed to this voltage level.This voltage is indicating on output LED's when no input is applied.
4. Connect the patch chord from variable DC terminal to MOD.input.Observe the level shifter output at TP2 which is shifted by +2.5V.
5. Keep pot P2-2.5v side(fully anti clockwise),now observe all LED's OFF. Now turn p2 slowly clock wise and observe LED's glowing. Observe the serial data at TP4.
6. Connect C.R.O channel 1 probe at variable DC terminal and channel 2 probe at demod. Output vary pot P2,observe that same DC voltage should appear at two points.
7. Keep some DC voltage ,select one type of encoding method by selecting toggle switch (A-law or Linear)then observe LED's. Now change the switch position by toggle and observe LED's. Identify the bit pattern between linear and A-law modulation. The 8-bit compressed A-law values for 13-bit input values given in table number.
8. Remove DCfrom input and connect 1KHz sine wave at MOD in.
9. Observe sampling rate clock at TP3 by changing sampling rate at toggle switch (4 KHz and 8KHz).
10. Observe LPF output TP1,level shifter output at TP2 .
11. Observe the sampling clock at TP3 by changing SAMPLING RATE
    Switch and also observe A/D QUANTIZER output at TP4(serial data output).
12. Observe the Demod. Output . Identify the difference between output waveforms when sampling frequency is 4KHz and 8KHz.
13. By changing amplitude of sine wave observe Demod.outputs.

To study the effet of A-law in PCM:

1. Connect Mod. Inpiut from external input .Connect external sine wave from Function generator. Maximum amplitude of this wave form is 5Vp-p.

2. Connect C.R.O ch1 at MOD.input and ch2 at de-mod output.Set input amplitude 200mVp-p in function generator. Keep sampling rate switch in 8KHz and keep encoding switch A-law.
3. Observe Demod. Output .Now change encoding switch to Linear oserve Demod. Output.Identify difference A-lawPCM and linear modulation .In Linear modulation Demod.Output. is not same as input in shape. In A-law PCM output is same as input in shape .Repeat this process for decreasing input amplitude and varying frequency.
4. Now connect the input signal to audio input and connect a patch chord at audiom output. Connect two telephone sets to telephone sockets.
5. Keep encoding switch in A-law side. One person speaks at telephone audio input and another person listen at audio output.Observe clarity of voice. Now change encoding switch to Linear side,repeat above process. You can observe clarity of voice is better when switch position is in A-law.

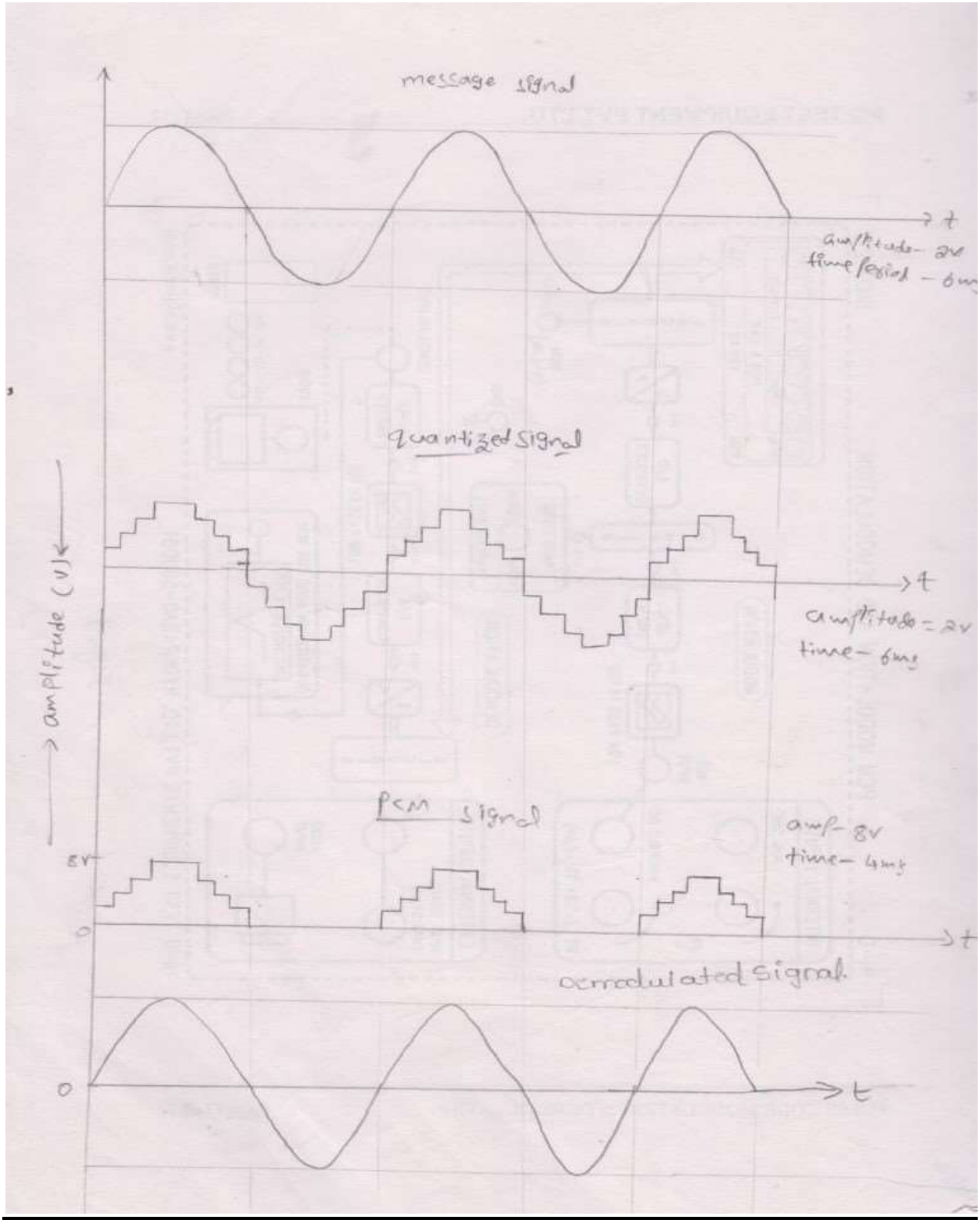
Observing Quantizing Noise for 1KHz sine:

1. Adjust the function generator to 1KHz sine . Change C.R.O ch2 to notch filter output. Keep sampling rate switch to 8 KHz.
2. Adjust the input signal amplitude to 100m Vp-p ,keep encoding switch to A-law ,and observe noise.Vary input signal amplitude to 5Vp-p,observe noise.
3. Keep encoding switch Linear and repeat above process then observe noise.

Observing nyquist theorem by changing sampling rate:

1. Keep sampling rate switch in 4KHz,give input signal 5Vp-p 1Hz to 1KHz.Observe Demod .Output.
2. Change sampling rate to 8KHz then repeat above step observe Demod .Output. Identify deference between in two cases.

Waveforms:


message signal
t
amplitude- 2V
time period - 6ms
quantized signal
amplitude (V)
t
amplitude = 2V
time- 6ms
PCM signal
amp- 8V
time- 4ms
8V
0
t
demodulated signal
0
t

Result:

Generation and Detection of Pulse Code Modulation has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

1. Define modulation?

2. What are three different processing steps in PCM?

3. Define signal – to – noise ratio?

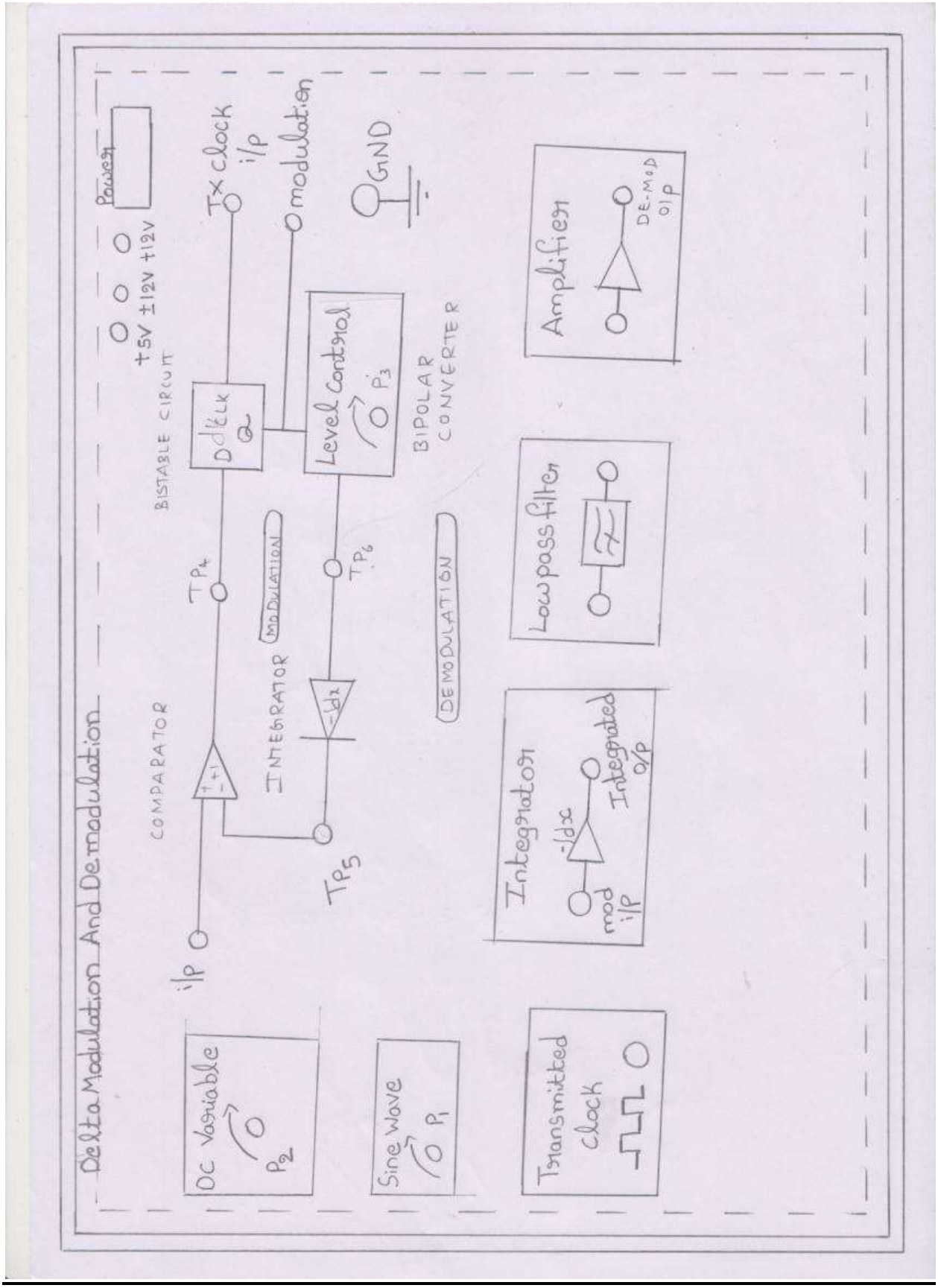
4. Define quantization error?

5.What are advantages of PCM?

6. Define White Gaussian noise?

7. Define channel and Quantization noise?

Circuit Diagram:



3.Generation and Detection of Delta Modulation & Demodulation

Aim:

To study the Delta Modulation and Demodulation.

Equipment:

1.DELTA MODULATION & DEMODULATION Trainer.

Model:HiQ-4208.

2.Oscilloscope-20MHZ dual channel,HiQ-6020A.

3.Patch chords.

Theory:

The Delta Modulation &Demodulation trainer can be configured to illustrate and study the techniques and advantages of Delta Modulation.The effective of various inputs and parameters on the particular Modulation system can be studied by varying following parameters.

a. Sampling frequency
b. Sampling step size
c. Input amplityude

These variables help in the comparing the effect of sampling frequency,quantization noise,signal to noise ratios, frequency,slope overload,amplitude overload on various modulation systems.various test points at input of every block are provided for easy observation by oscilloscope.

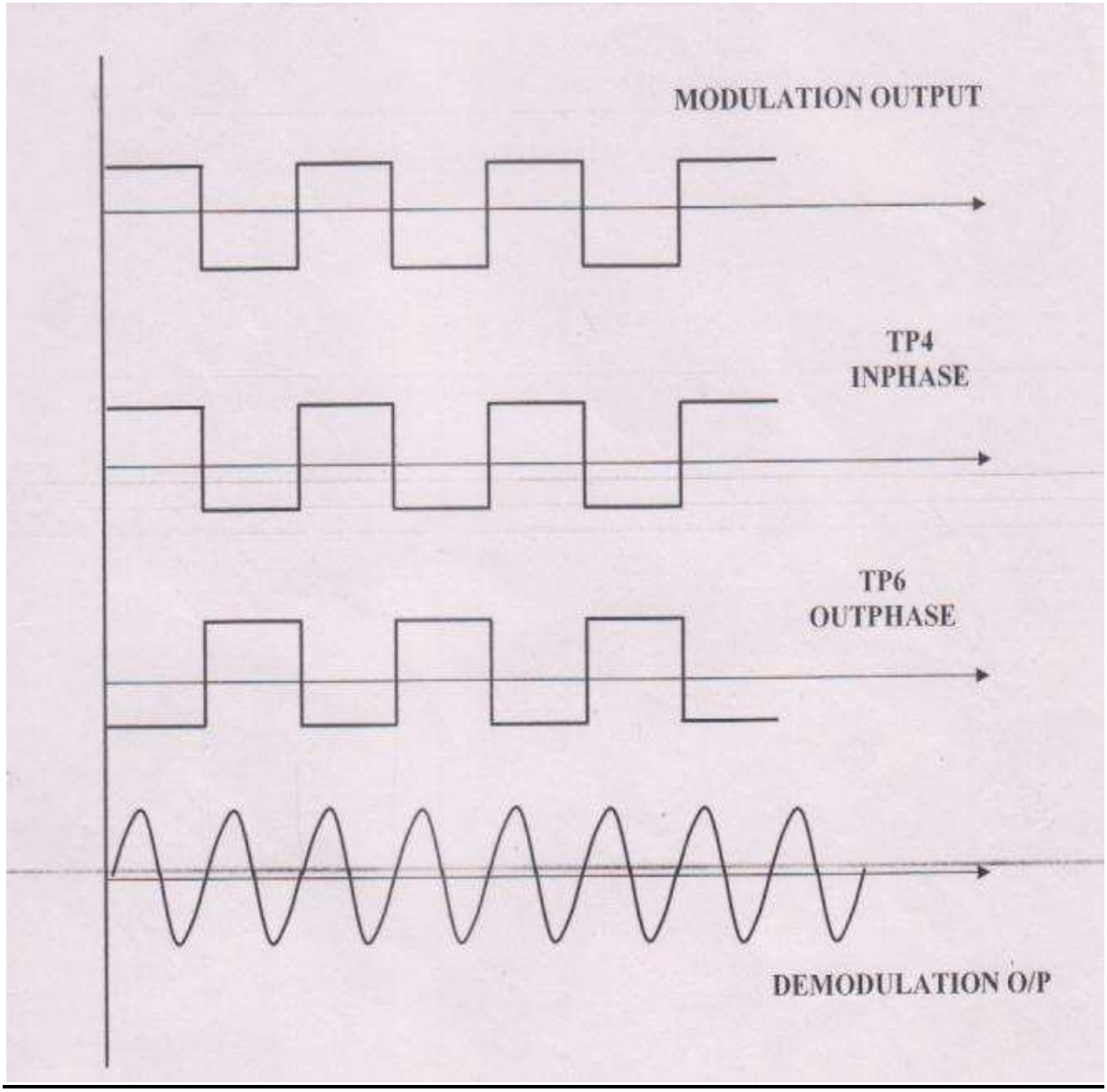
Delta modulation is a system of digital modulation developed after pulse code modulation.In this system,at each sampling time,say the k_{th} sampling time,the difference between the sample value at sampling time k and the sample value at the previous sampling time(k-1) is encoded into just a single bit.

Procedure:

1. Switch on the power supply.
2. Connect TX clock to TX clock input.The clock frequency should be 32KHz.
3. In order to ensure for correct operation of the system,we first take the input to 0V from DC variable.So connect the '+' input of the delta modulator's voltage comparator to 0V.
4. Observe the output of integrator at TP5 and the output of the level change the TP6.

5. If the trasmitter's level changer output has equal positive and negative output level,Integrator's output will be a triangle wave centered around '0' volts,as shown in fig.4 .However, if the level changer's negative level is greater than the positive level,the integrator's output will appear as shown in fig5. Should the level changer's positive output level be the greater of the two levels the integrators output will resemble that shown in fig :4.
6. The relative amplitudes of the level changer's positive and negative output levels can be varied by adjusting the level adjust present in the bistable and level changer circuit.
7. The output from the transmitter's BISTABLE circuit will now be a stream of alternate '1' and '0' 's',this is also the output of the delta modulator itself.The delta modulator is now set to be 'balanced' for correct operation.
8. Disconnect the voltage comparator's '+' input from 0V,and reconnect it to the 2KHZ sine wave.
9. Observe the integrator output by varying the amplitude.
10. Observe the Bistable output together with the analog input at TP4,and note that the 2KHz sine wavw has effectively been encoded into a stream of data bits at the Bistable's output.
11. Connect the modulation output to the integrator input and observe the output.
12. Now connect to the Low pass filter input and observe the output.
13. Connect to the amplifier input and observe the demodulation output.

Waveforms:


MODULATION OUTPUT
TP4
INPHASE
TP6
OUTPHASE
DEMODULATION O/P

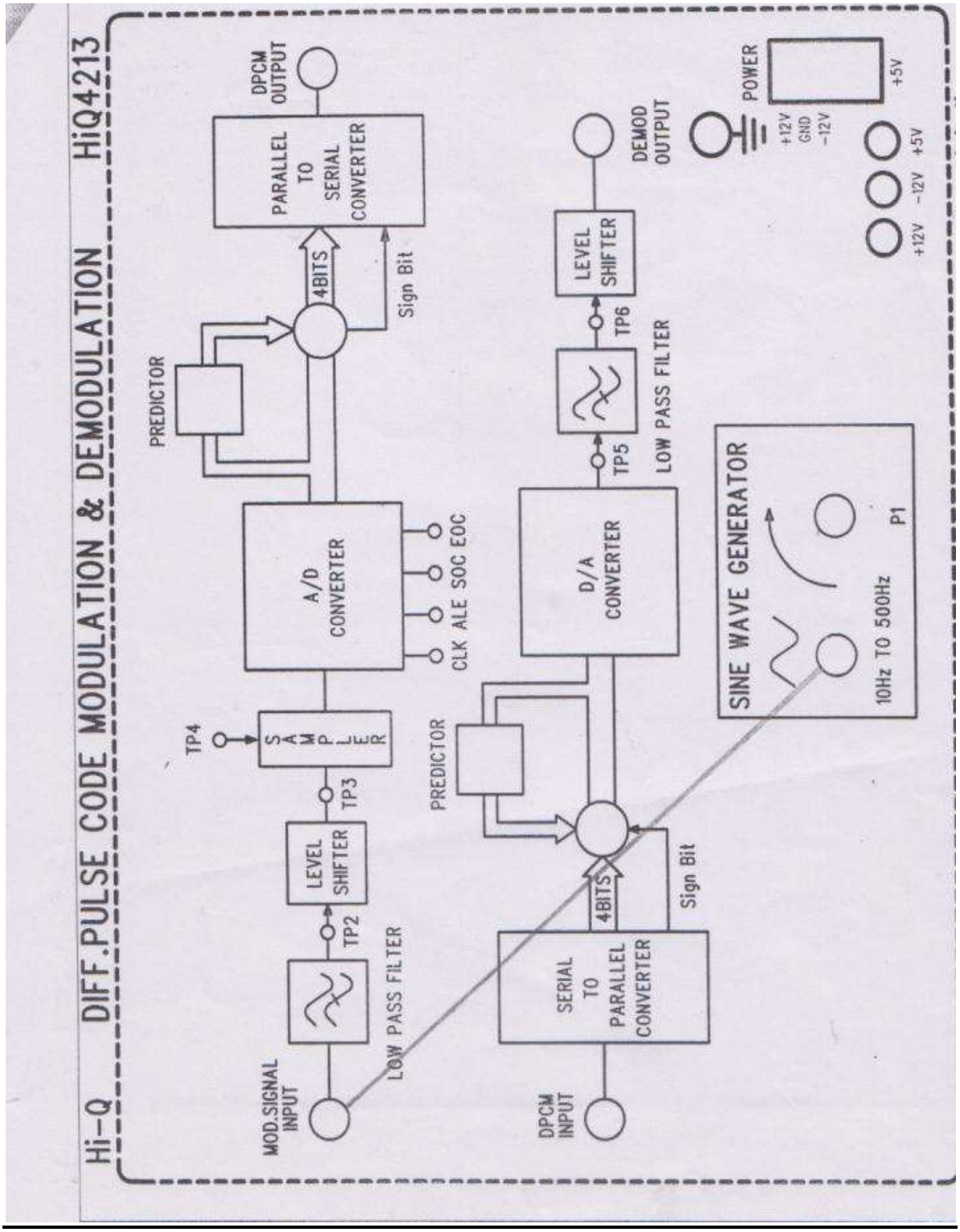
Result:

Generation and Detection of Delta modulation and Demodulation has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

1. Define Delta modulation?
2. What are two unique features of Delta modulation?
3. What are the applications of Delta modulation?
4. What is the purpose of low pass filter?
5. Define bandwidth?
6. Define quantization noise.

Circuit Diagram:



4.Generation and Detection of Differential Pulse Code Modulation & Demodulation

Aim: To Study Differential Pulse Code Modulation and demodulation by sending fixed 1KHz sine and variable frequency sine and square waves.

Equipment: 1.Differential Pulse Code Modulation and demodulation Trainer Kit

2.20MHz Dual Channel Oscilloscope

3.Patch Chords

Theory:

1.DPCM takes advantage of the high correlation between samples by encoding the difference between samples rather than the absolute sample value.

2.Can reduce rate further by using prediction based on previous samples

3.Send only the difference between predicted and actual 4 bits per sample.

4.Over time the error between the decoded signal and the differentially encoded signal increase, so periodically,a full pulse is sent rather than the difference.

5.Suffers from high quantization noise when the difference between the pulses are continually high.e.g. a strong oscillatory signal.

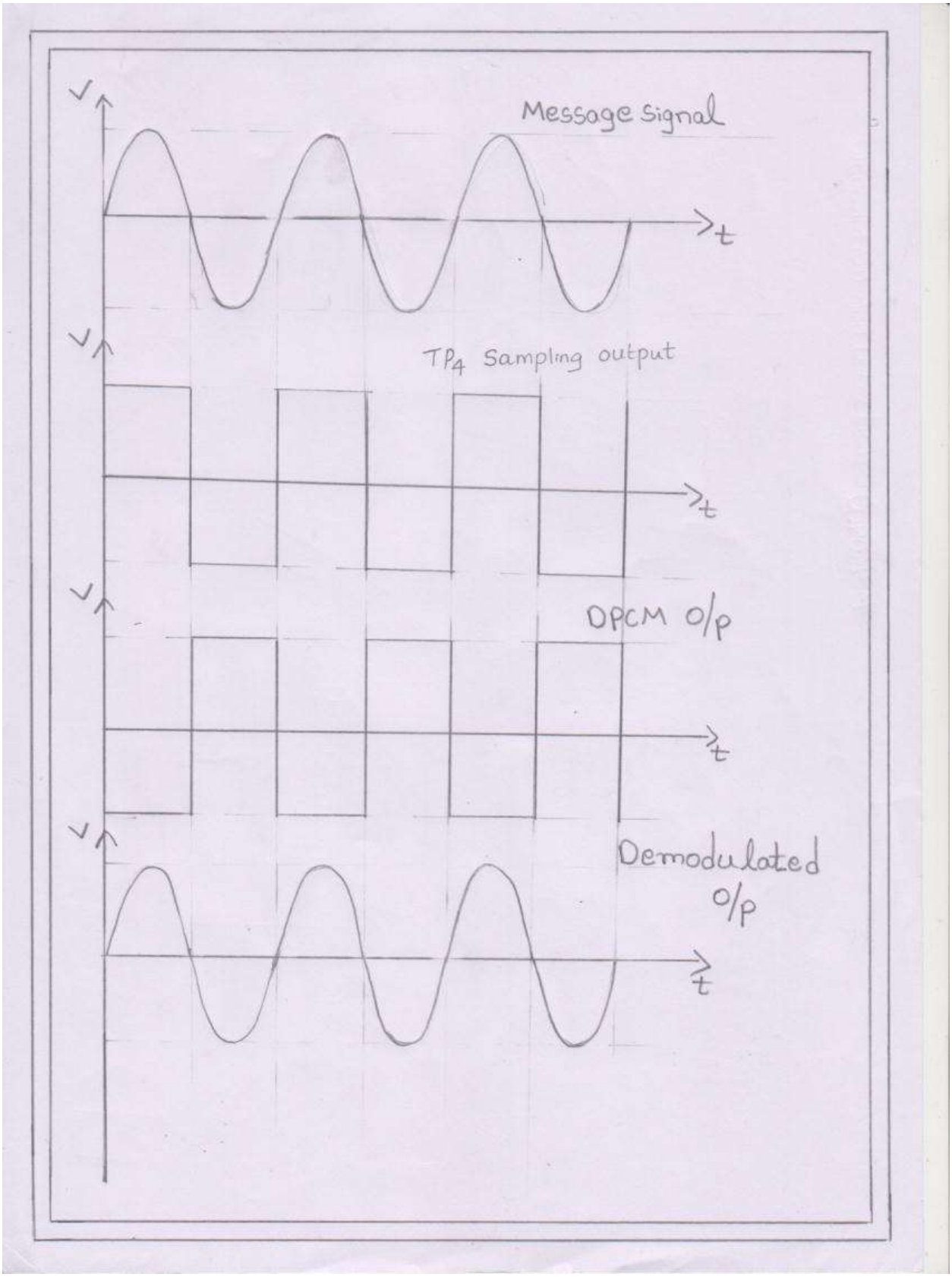
In a typical PCM-encoded speech waveform,there are often successive samples taken in which there is little difference between the amplitude of the two samples.This necessitates transmitting several identical PCM codes,which is redundant.Differential pulse code modulation is designed specifically to take advantage of the sample to redundancy in typical speech waveforms,With DPCM,the difference in amplitude of two ssuccessive samples is transmitted rather than the actual sample.Since the range of sample differences is typically less than the range of individual samples,fewer bits are required for DPCM then conventional PCM.Firstly the signal is normalized so that the maximum value of the signal is +1 to -1.This is then quantized into discrete levels so that the compression is between the quantized levels.So the next part in the system is the hold and add.This done so the last value of the signal is subtracted from the current sample to produce a code that is the difference hence the

name Differential pulse code modulation.Then the signal is transmitted to the receiver where a similar process is carried out.The only difference is that the hold signal is added to the next sample rather than subtracted.this is to add the current difference between the last and present sample to the previous value.That is the difference is added to the last value to reconstruct the input signal.

Procedure:

1. Switch on the power supply.
2. Connect the CRO probe at MOD signal INPUT and observe 1 KHZ sine wave in CRO.
3. Connect the probe at TP4 and observe the 8KHZ clock.This is the sampling rate for system then change probe to CLK,observe 2MHz clock this is the system clock for ADC.
4. Connect the patch cord between SINE WAVE and MOD.INPUT.Connect the patch cord between DPCM output and DEMOD Input.
5. Connect CRO channel 1 to sine wave and channel to Demod output.Now we can observe modulating input and demodulated output in CRO.The demodulated output amplitude is less than modulating signal.Because in DPCM we sending difference of previous sample and present sample so there is no enough time to obtain for receiver of exact input signal for 1KHz sine input.In DPCM exact amplitude of input will not obtained at receiver for high frequency inputs.
6. Connect ch1 at sine wave o/p and ch2 at demo output,observe waveforms.
7. Vary the input frequency from 20 Hz to 1KHz,observe output at demod out.We can identify the difference between low frequency then output is high amplitude than when input is high frequency.Because When input is low frequency then time period more.In this time period more differences are adding or subtracting at receiver.S output is high amplitude.When input is high frequency time period is less,in this period fewer samples are added or subtracted at receiver.

Waveforms:


Message Signal
t
TP4 Sampling output
t
DPCM o/p
t
Demodulated o/p
t

Result:

Generation and Detection of Differential Pulse Code Modulation and Demodulation has been observed and resultant graphs are plotted.

Viva-Voce Questions:

1. What are differences between DM and DPCM?

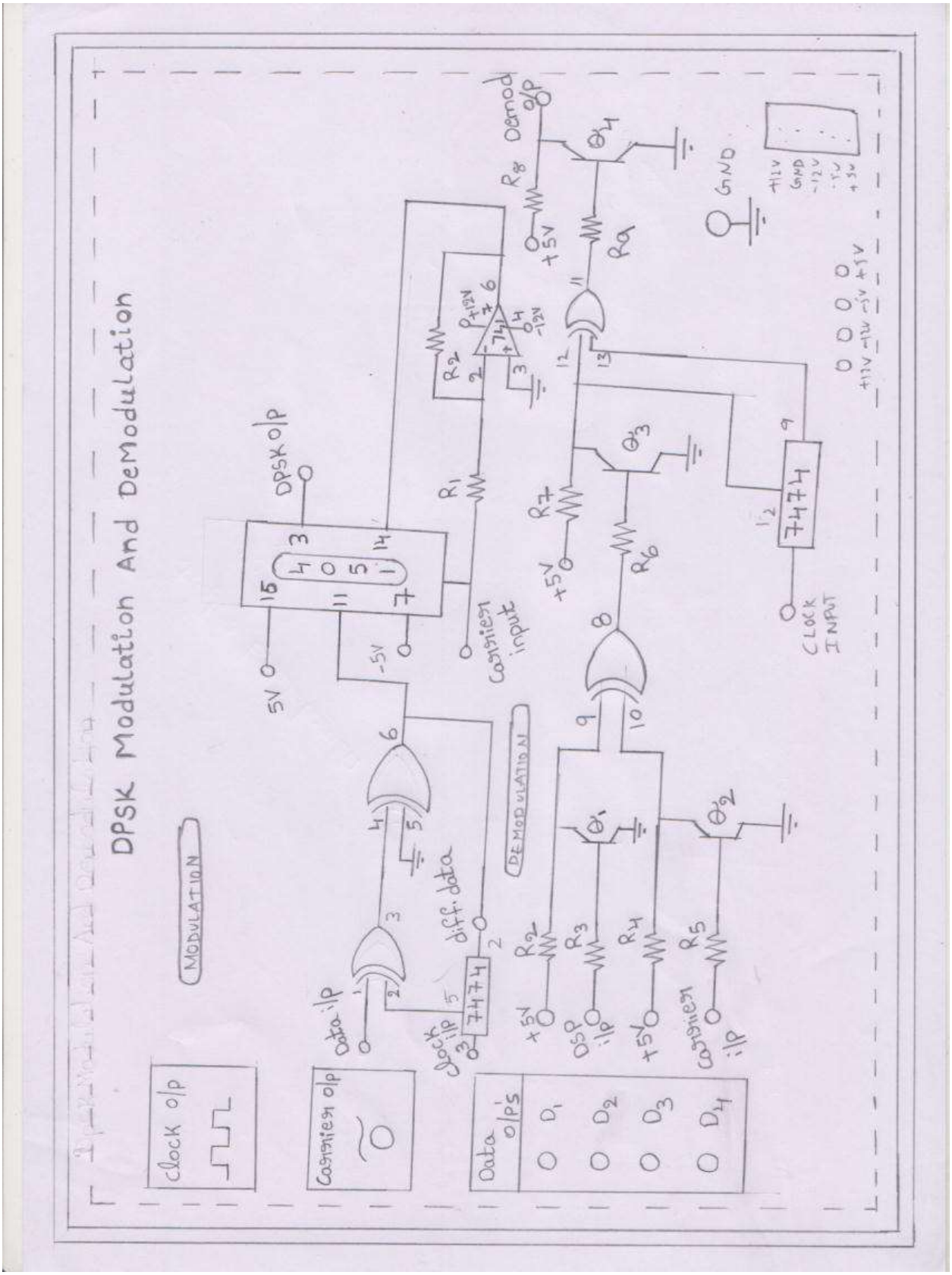
2. How does DPCM handle quantization compared to PCM?

3. Can you explain the role of prediction in DPCM encoding?

4. What is the significance of the prediction error in DPCM?

5. How does DPCM demodulation recover the original signal from the encoded signal?

Circuit Diagram:



5.Generation and Detection of Differential Phase Shift Keying Modulation & Demodulation

Aim:

To study the operation of Differential Phase Shift Keying Modulation & Demodulation techniques.

Equipment:

1. Differential Phase Shift Keying Modulation & Demodulation Trainer.

Model:HiQ-4210.

2.Oscilloscope-20MHZ dual channel.

3.Patch chords.

Theory:

To transmit the digital data from one place to another ,we have to choose the transmission medium.The simplest possible method to connect the transmitter to the receiver with a piece of wire.This works satisfactorily for short distances in some cases.But for long distance communication and in situations like communication with the aircraft,ship,vehicle this is not feasible.Here we have to opt for the radio transmission.

It is not possible to send the digital data directly over the antenna because the antenna of practiced size works on very high frequencies, much higher than our data transmission rate.

To be able to transmit the data over antenna,we have to module the signal i.e.phase,frequency or amplitude ext.is varied in accordance with the digital data.At receiver we separate the signal from digital information by the process of demodulation.After this process we are left with high frequency signal(called as carrier signal)which we discard and the digital information which we utilize.

Modulation also allows different data streams to be transmitted over the same channel.This process is called multiplexing and the result in a considerable saving in bandwidth no of channels to be used.Also it increases the channel efficiency.

The variation of particular parameter variation of the carrier wave give rise to various modulation techniques.Some of the basic modulation techniques are ASK,FSK,PSK,DPSK&QPSK.

The DPSK is a non-coherent version of PSK.In coherent detection the carrier wave's phase reference should be known for obtaining optimum error performance .

The DPSK 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

2.Phase-shift keying.

And hence the name Differential Phase-shift keying.

Procedure:

1. Now switch ON the trainer and see that the supply LED glows.
2. Connect data output from 4(D1,D2,D3,D4) data outputs to the data input of the DPSK modulator TP7.
3. Connect clock output TP1 to the clock input of the DPSK modulator TP8.
4. Now connect carrier output TP2 to the carrier input of the DPSK modulator TP10.
5. Observe the Differential Data output on the CRO at TP9 test point as shown on the front panel.
6. Observe the phase shifted DPSK output waveform on the CRO corresponding to the diffrenetial data output.
7. Connect DPSk modulator output TP11n to the DPSK input of the Demodulator TP12.
8. Connect carrier output TP2 to the carrier input of the DPSk demodulator TP13.
9. Also connect clock output TP1 to the clock input of the DPSk demodulator TP14.
10. Now observe the DPSK demodulated output waveform TP15 on the CRO.

Data Inputs are given below:

1.Data input(D1) : 1010 1010 1010

Differential data: 1100 1100 1100

2.Data input(D2) : 1100 1100 1100

Differential data: 1000 1000 0010

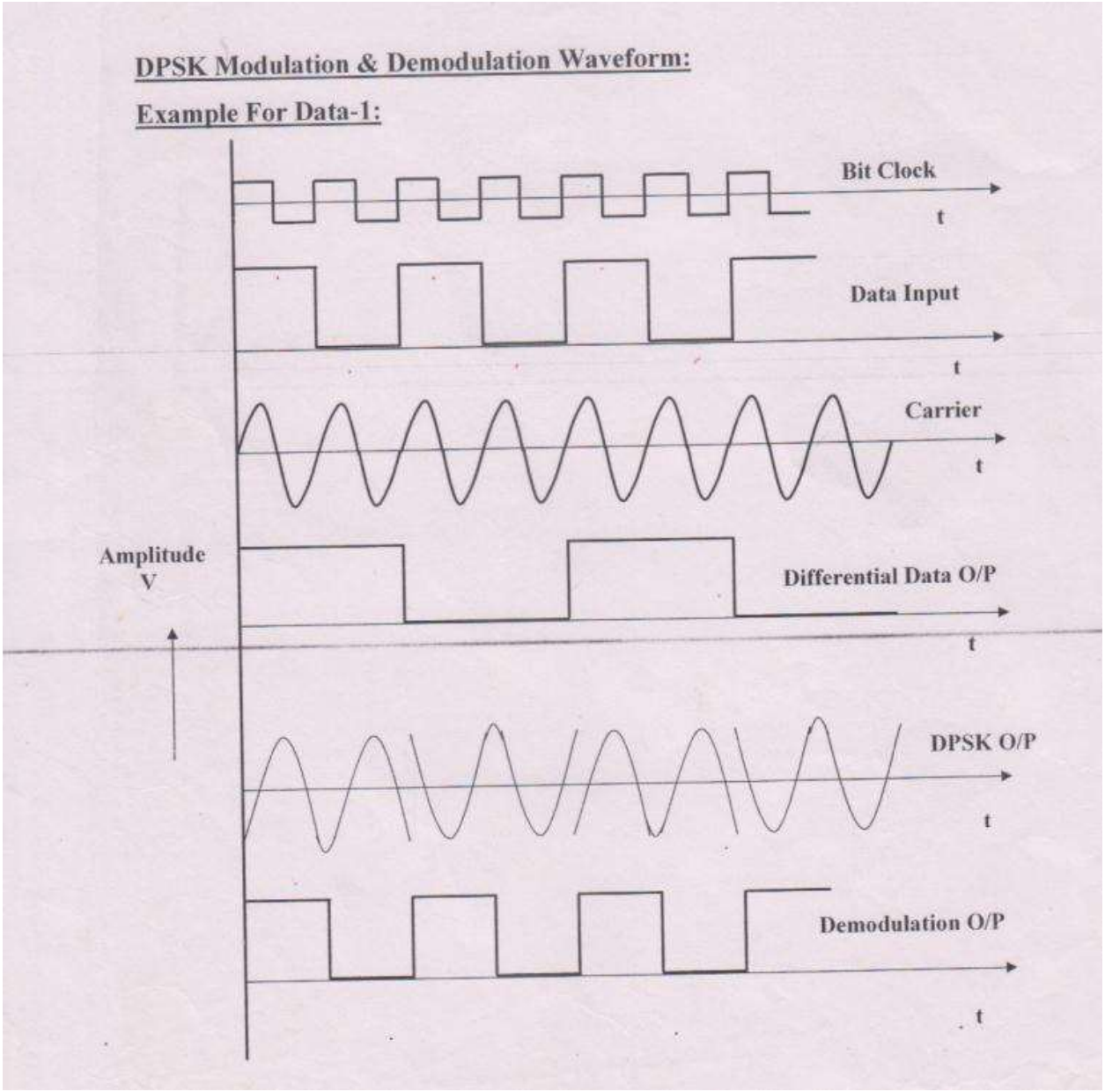
3.Data input(D3) : 1111 0000 1111

Differential data: 1010 0000 1010

4.Data input(D1) : 1100 0000 0011

Differential data: 1000 0000 0010

Waveforms:



Result:

Generation and Detection of Differential Phase Shift Keying Modulation & Demodulation has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

1. How does DPSK differ from PSK?

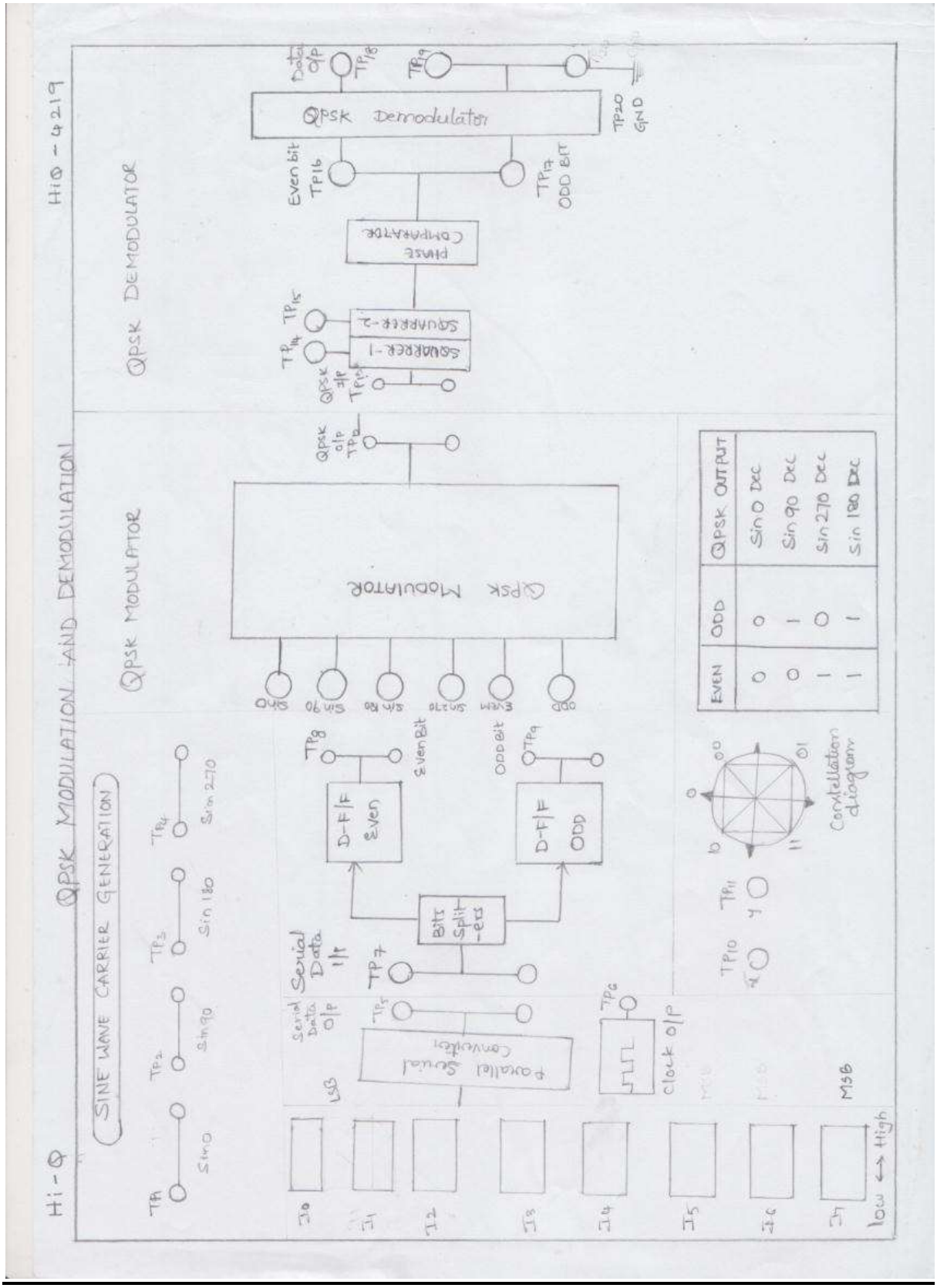
2. What is the disadvantages of DPSK.?

3. Is the error rate of DPSK is greater than PSK?

4. What is the expression for DPSK error?

5. What are the applications of DPSK?

Circuit Diagram:



6.Generation and detection of Quadrature phase shift keying Modulation and Demodulation

Aim:

To study the operation of generation of Quadrature phase shift keying modulation and demodulation.

Equipment:

1. Quadrature Phase Shift Keying Modulation & Demodulation Trainer.

Model:HiQ-4210.

2.Oscilloscope-20MHZ dual channel.

3.Patch chords.

Theory:

The purpose of analog modulation is to impress an information-bearing analog wave form onto a carrier for transmission.The purpose of digital modulation is to convert an imformation –bearing discrete –time symbol sequence into continous-time wave form (perhaps impressed on a carrier).

Key concerns- bandwidth efficiency and implementation complexicity.
These are effected by:
Baseband pulse shape
Phase transition characterics
envelope fluctuations.

Digital modulation is the process by which digital symbol are transformed into wave forms that are comnpatible with the characteristics of the channel.
Modulation can be used to minimize the effects of interference.Modulation can also be used to place a signal in frequency band where design requirements,such as filtering and amplification can be easily met.This is the case when radio frequency (RF) signals are converted to an intermediate frequency (IF) in a receiver.
In QPSK the carrier can change only once every 2T secs.If from one T interval to the next one,neither bitstream changes sign,the carrier phase remains unchanged.If one component change sign then a phase shift of $\prod$ occurs.

Figure below shows modulated wave

Sometimes known as quaternary or quadriphase PSK or 4-PSK,QPSK uses four points on the costellation diagream, equispaced around a circle. With four phases,QPSK can encode two bits per symbol,shown in the diagram with gray coding to minimize the BER-twice the rate of BPSK .analysis shows that this may be used either to double rate compared to a BPSK syatem while maintaining the bandwidth of the signal or to maintain the data-rate of BPSK but halve the bandwidth needed.

Although QPSK can be viewed as a quaternary modulation,it easier to see it as two independently modulated quadrature carriers. With this interpretation,the even (or odd) bits are used to modulate the in-phase componate of the carrier, while the odd (or even) bits are used to modulate the quadrature-phase componate of the carrier .BPSK is used on both carriers and they can be independently demodulated .

Procedure:

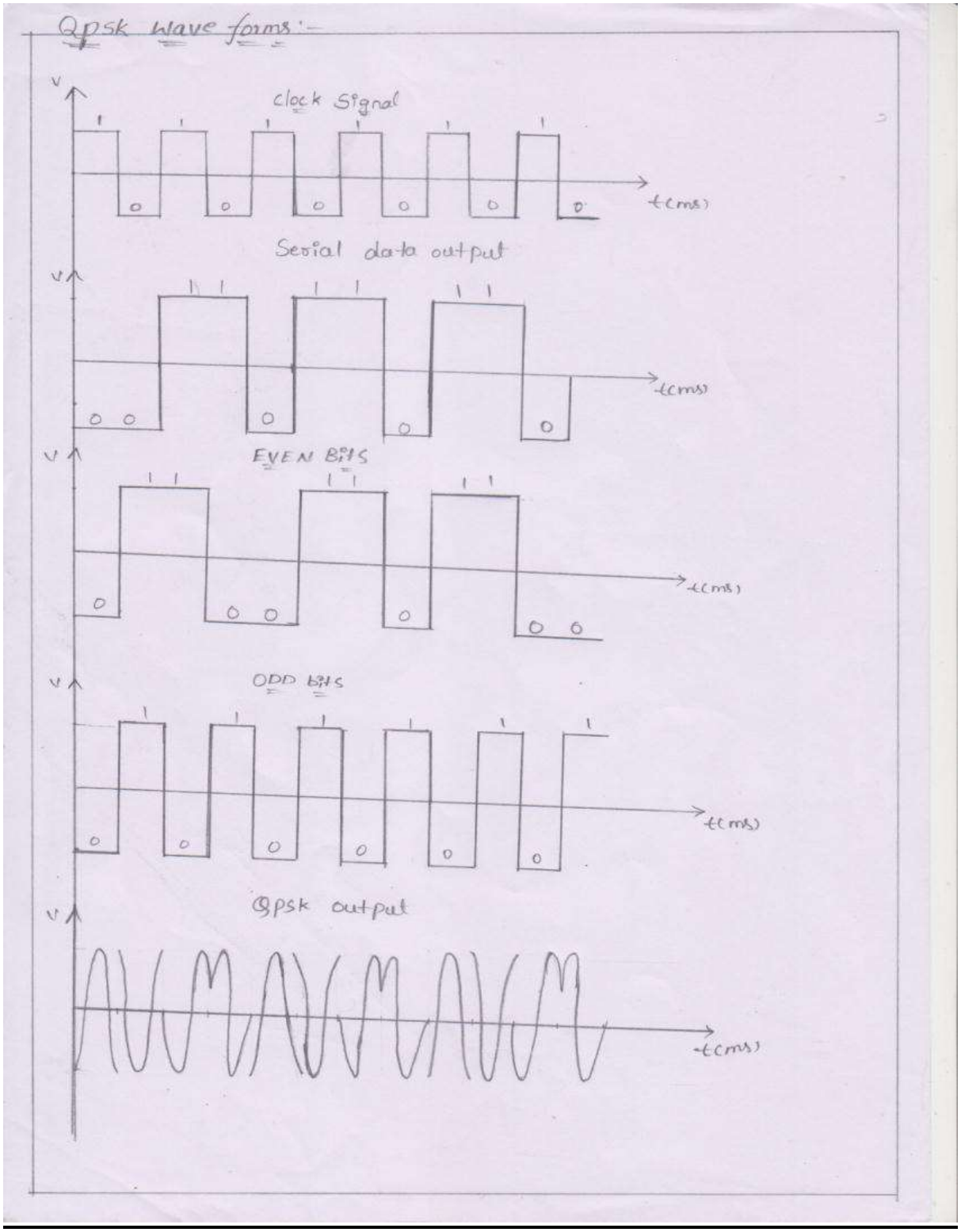
Modulation:

1. Switch ON QPSK trainer kit.(DCT-006).
2. Observe the 8 bit serial data out at (TP1 and TP2).
3. Connect the serial output data (TP2)to serial data input(TP5).
4. Observe the carrier SIN0,SIN90,SIN180 and SIN270 in TP15,TP13,TP17 And TP11 respectively.
5. Connect the SIN0(TP15) to SIN0 of QPSK Modulator (TP18).
6. Connect the SIN90(TP15) to SIN90 of QPSK Modulator (TP19).
7. Connect the SIN180(TP15) to SIN180 of QPSK Modulator (TP20).
8. Connect the SIN270(TP15) to SIN270 of QPSK Modulator (TP21).
9. Observe the Even bit s and odd bits at the (TP7)and TP9 respectively.
10. Connect the even bit (TP7) to the EVEN(TP22) of QPSK Modulator.
11. Connect the odd bit (TP9) to the EVEN(TP23) of QPSK Modulator.
12. Observe and Sketch the QPSK Modulated outpu at test point (TP25) using CRO

De-modulation:

1. Connect the QPSK modulated output (TP25) to the QPSK input (TP27).
2. Observe and sketch the SQUARRER-1 output at TP28.
3. Observe and sketch the SQUARRER-2 output at TP29.
4. Phase comparision using CD4033 phase comparator to get EVEN and Odd Bit in TP30 and TP31 respectively.
5. To combining the EVEN and ODD bits to get original data bits at the TP32.

Waveforms:


Qpsk wave forms:-
clock Signal
t(ms)
Serial data output
t(ms)
EVEN BITS
t(ms)
ODD BITS
t(ms)
Qpsk output
t(ms)

Result:

Generation and detection of Quadrature phase shift keying Modulation and Demodulation has been observed and resultant waveforms are plotted.

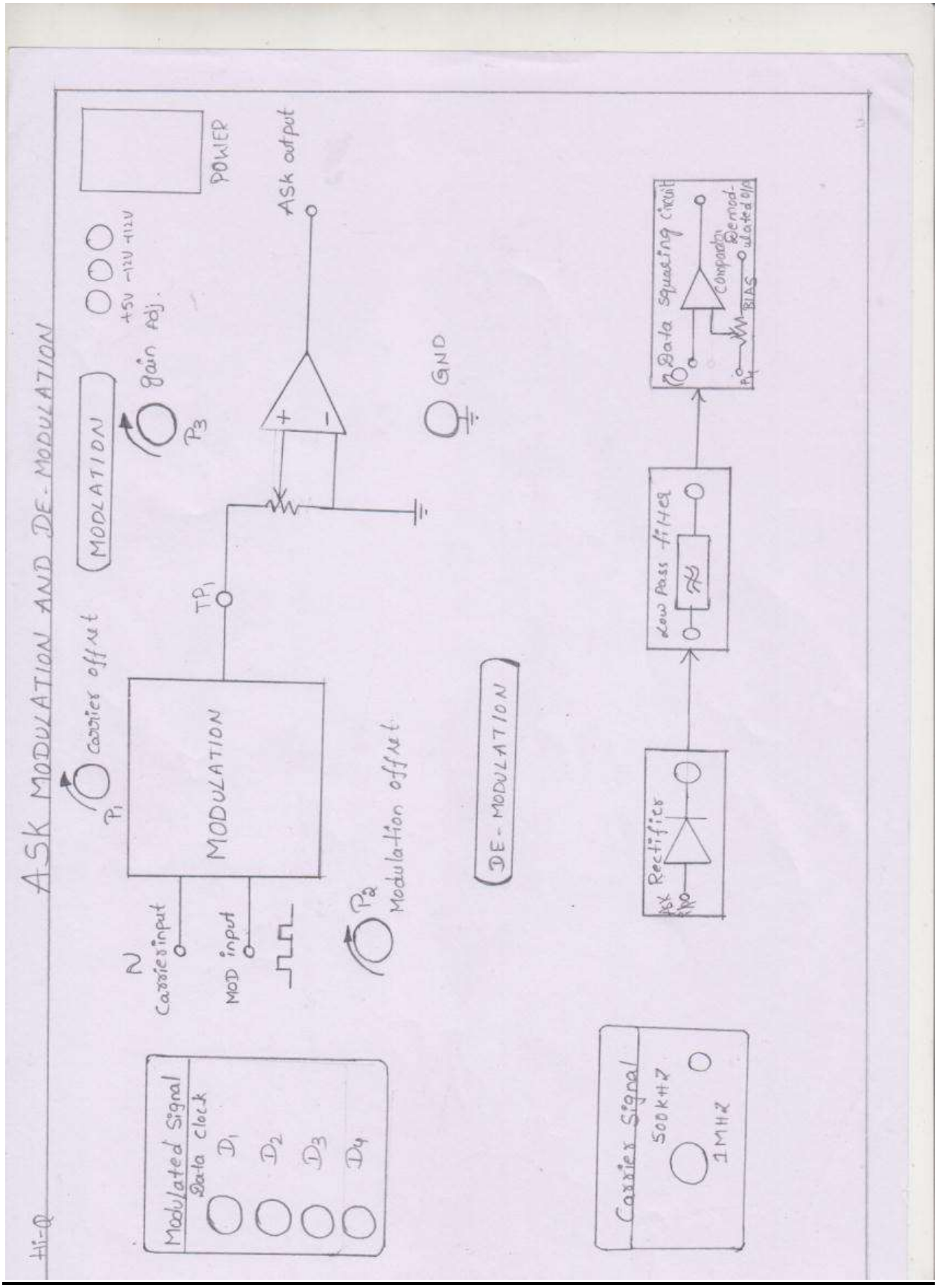
Viva-Voce Questions:

1. What is Quadrature Phase Shift Keying (QPSK)?

2. Describe the basic steps involved in demodulating a QPSK signal.

3. What are some advantages and disadvantages of using QPSK modulation for data transmission?

Circuit Diagram:



7.Generation and Detection of Amplitude Shift Keying Modulation & Demodulation

Aim:

To study the operation of Amplitude Shift Keying Modulation & Demodulation techniques.

Equipment:

1. Amplitude Shift Keying Modulation & Demodulation Trainer.

Model:HiQ-4210.

2.Oscilloscope-20MHZ dual channel.

3.Patch chords.

Theory:

Modulation also allows different data streams to be transmitted over the same channel.This process is called as Multiplexing and result in a considerable saving in bandwidth no of channels to be used.Also it increases the channel efficiency.

The variation of particular parameter variation of the carrier wave give rise to various modulation techniques.Some of the basic modulation techniques are described.

In this 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.The 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.

Thus

DATA = HIGH CARRIER TRANSMITTED

DATA = LOW CARRIER SUPPRESSED

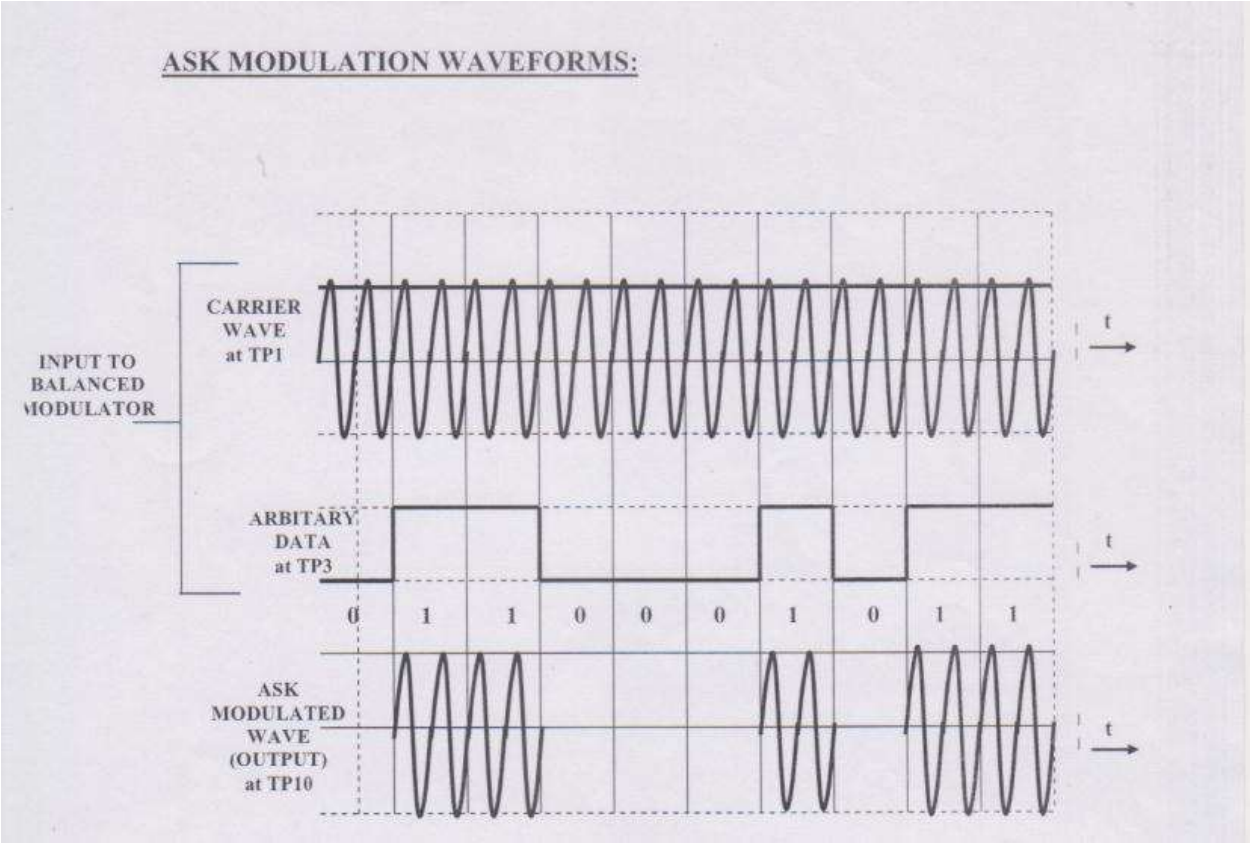
The ASK waveform is generated by a balanced modulator circuit,also known as linear multiplier,As the name suggests the device multiplies the instantaneous signal at its two inputs,the output voltage being product of the two input voltages at any instance of time.One of the input is a/c coupled 'carrier' wave of high frequency.Generally the carrier wave is a sinewave since any other waveform would increase the bandwidth imparting any advantages requirement without improving or to do it.The other input 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.

Procedure:

1. Connect the sinewave 500 KHz from the carrier generator to the carrier input of the modulator.
2. And also connect Data clock D1 i.e. modulation signal to the modulation input.
3. Switch on the power supply.
4. Observe the output.
5. By varying the gain pot P3 observe the ASK output.
6. Adjusting the carrier offset and modulation offset we can observe the ASK output.
7. By changing the carrier signal 1MHz and different data clocks D2,D3,D4 observe the output.
8. Connect ASK output to the rectifier input and observe the waveform.
9. Now connect rectifier output to the low pass filter input and observe the output.
10. Connect LPF output to the data squaring circuit input and observe the demodulation output waveform.
11. By changing the different data clocks and observe the demodulation output.

Waveforms:



Result:

Generation and Detection of Amplitude Shift Keying Modulation & Demodulation has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

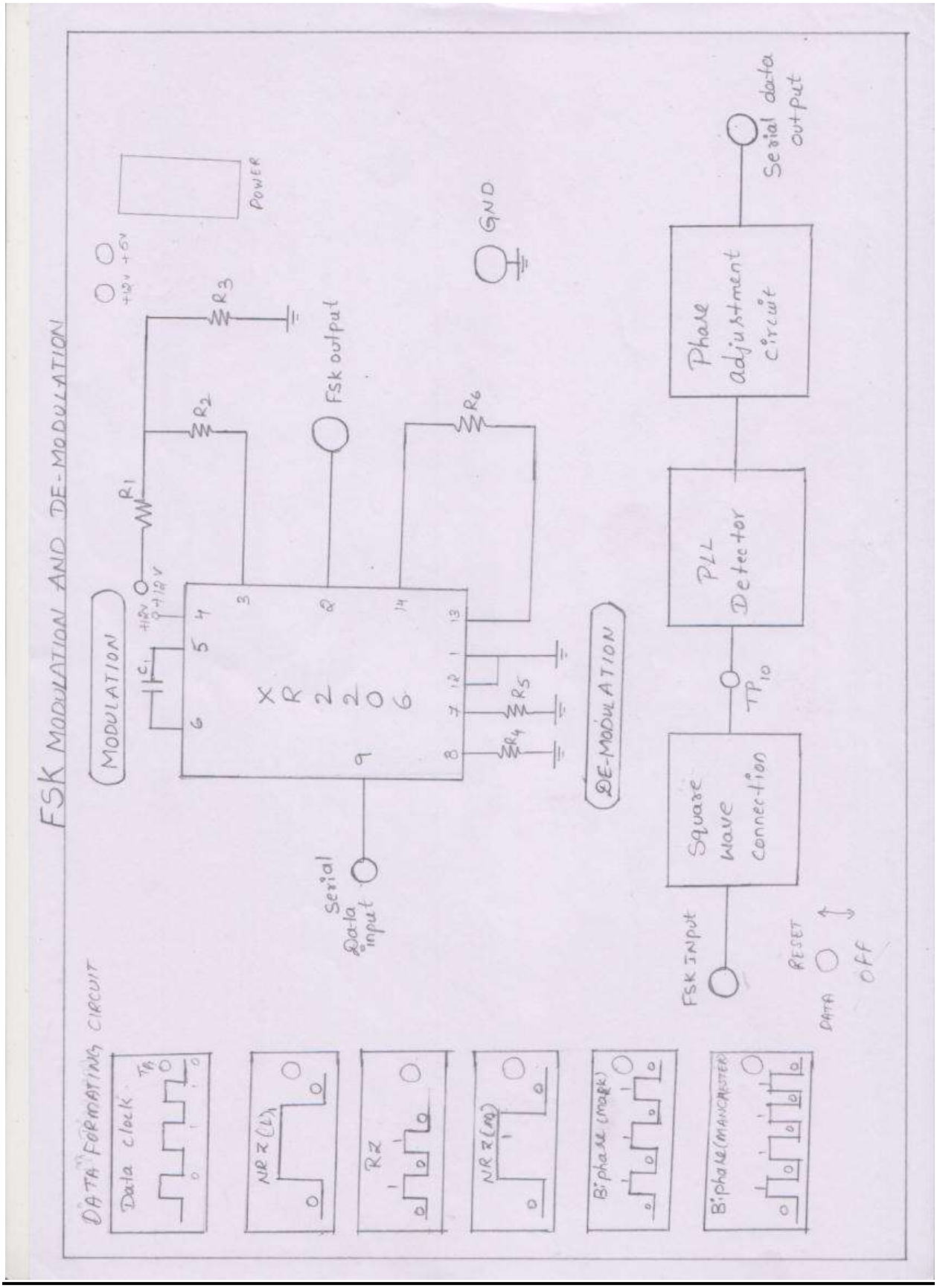
1. What is the basic principle behind Amplitude Shift Keying (ASK)?

2. How does ASK encode digital information onto a carrier signal?

3. What is the basic principle behind Amplitude Shift Keying (ASK)?

4. How does ASK encode digital information onto a carrier signal?

Circuit Diagram:



8.Generation and Detection of Frequency Shift Keying Modulation & Demodulation

Aim:

1. To generate FSK Modulation.
2. To Demodulate the FSK signals.
3. To generate NRZ(L),RZ,NRZ(M),BIPHASE(MARK), BIPHASE(MANCHESTER)

Equipment:

1. Frequency Shift Keying Modulation & Demodulation Trainer.

Model:HiQ-4210.

2.Oscilloscope-20MHZ dual channel.

3.Patch chords.

Theory:

Binary FSK is a form of constant amplitude angle modulation and the modulating signal is abinary pulse stream that varies between two discrete voltage levels but not continuous changing analog signal.In FSK,the carrier amplitude(V_c) remains constant with modulation and the carrier radian frequency(W_c) shifts by an amount equal to $\pm \Delta$ w/2.The frequency shift(Δ w/2) is proportional to the amplitude and polarity of the input binary signal.For example,a binary 1 could be +1 volt and a binary 0 could be -1 volt producing frequency shifts of $+\Delta$ w/2 and

$-\Delta$ w/2 respectively.The rate at which the carrier frequency shifts is equal to the rate of change of the binary input signal $v_m(t)$.Thus the output carrier frequency deviates(shifts) between $w_c + \Delta$ w/2 and $w_c - \Delta$ w/2 at the rate equal to f_m.

Data Formating:

A modulation code is defined as a rule by which a serial train of binary data is converted to a signal suitable for transmission.Some of the commonly used codes are listed for study in this experiment.There are a few others which are outside the scope of this experiment.

In serial data transmission a symbol is a signal level(low or high) that is held for a length of time (symbol width or symbol time).The capacity of a channel is the symbol rate (inverse of symbol time).This is the symbols per second or baud.Channel capacity has the units of symbols per second or baud.Some modulation codes require several symbols per bit of data. For example self clocking codes require two symbols per bit of data. The various codes are described below.Relative features of the codes are given in the table.The waveform diagram depicts the patterns for the serial train 11001100.

Non-return to Zero(NRZ):

This is a level type code and is one that is widely used in serial data transmission.A '0' is low level and a '1' is a high level.

Return to Zero(RZ):

This is an impulse type code where a '1' is represented by a high level that returns to zero.Its advantage is power conservation as transmission takes place only for a'1'.

Non-return to Zero(Manchester):

If the logic '0' is to be transmitted the new level is inverse of the previous level i.e, change in level occurs.If '1' is transmitted the level remains unchanged.

Biphase(Mark):

This is an edge type invertible self clocking code in which each bit cell starts with an edge and for a '0' an additional edge occurs during the middle of the bit cell.

Biphase(Manchester):

This is a level type of code in which a '1' bit cell is initially high and then has a high to low transition in the middle of the bit cell.A '0' bit cell is initially low and has a low to high transition in the middle of the bit cell.

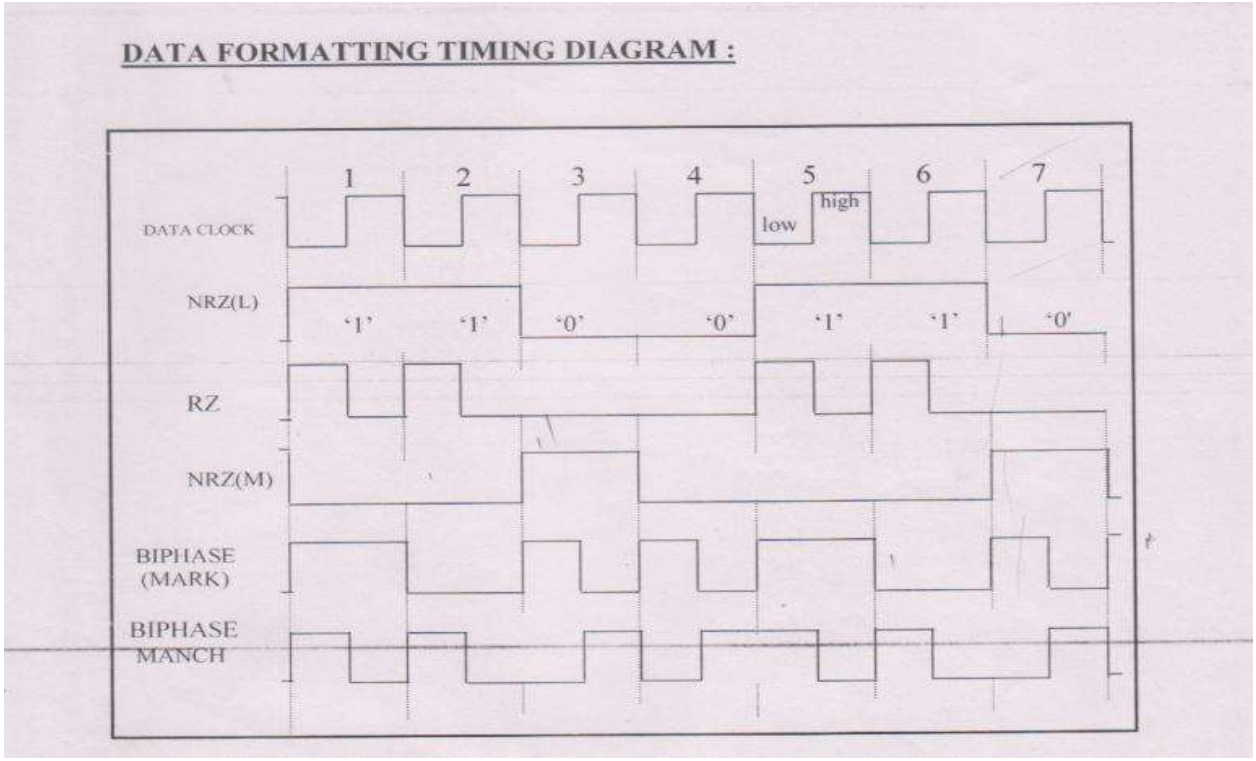
Procedure:

1. Switch ON the power supply.
2. Set the Data selection switch('DATA SELECTION') to the desired code(say 11001100).
3. Set the switch (DATA ON-OFF) ON position.Observe the 8 bit word pattern at TP12.

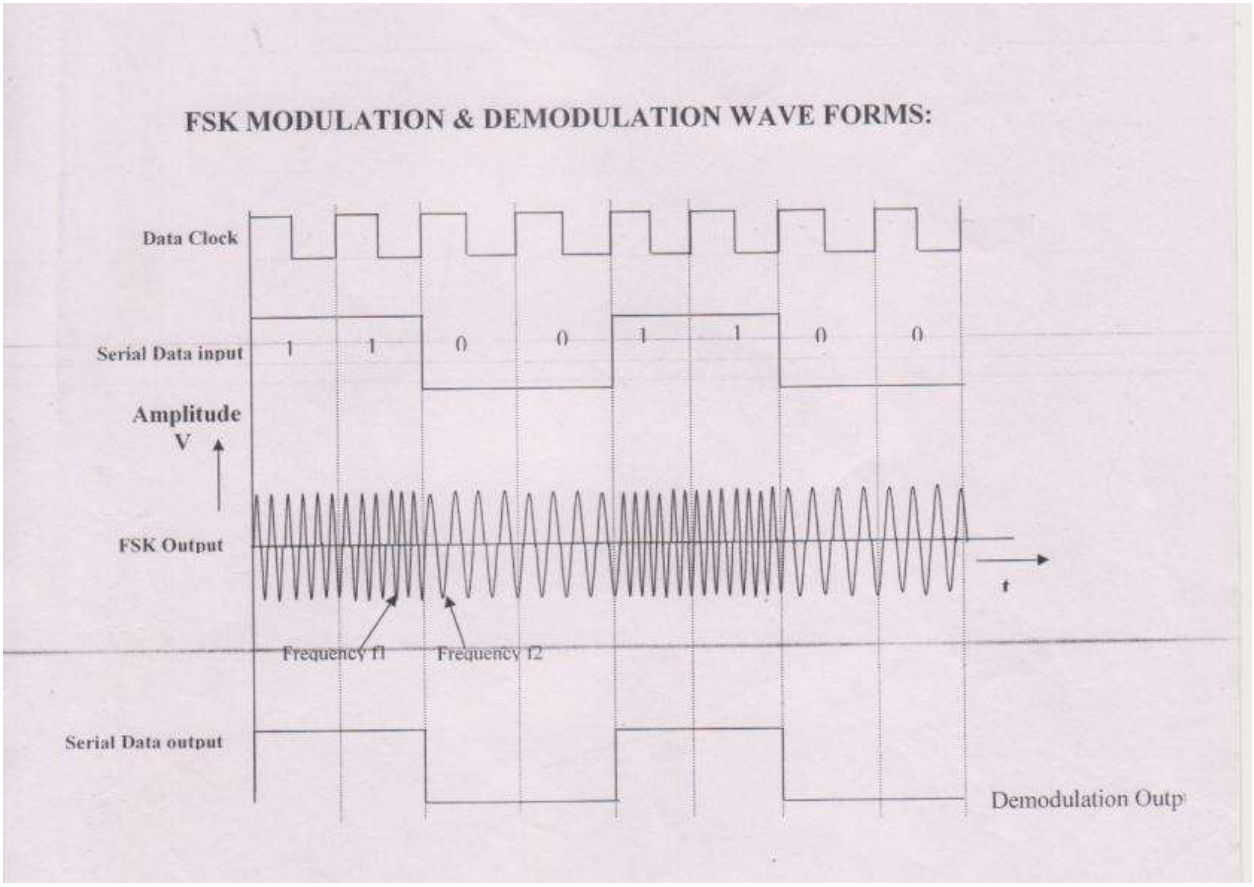
4. Observe the Data clock at TP1 and also observe the NRZ(L) at TP2,RZ at TP3,NRZ(M) at TP4,BIPHASE (MARK) at TP5,BIPHASE (MANCHESTER) at TP6.
5. Connect the patch cord as shown in diagram.Observe the corresponding FSK output at(when Data is logic '1',the frequency is high and Data is logic '0' the frequency is low)TP8.
6. Repeat the step 5 for other inputs (like NRZ(M),RZ,BIPHASE observe the corresponding FSK outputs.
7. Now change the data selection and repeat the above steps 3 to 6 and observe the corresponding FSK outputs.

Demodulation:

1. Connect the patch cords as shown in diagram 2.
2. The incoming FSK input is observed at TP9.
3. The output of 'Square wave converter ' is available at TP10.The serial Data output is available at TP11.
4. Repeat the above steps 1,2,3 for other serial data inputs and observe the corresponding serial data outputs.These outputs are true replica of the original inputs.



Waveforms:



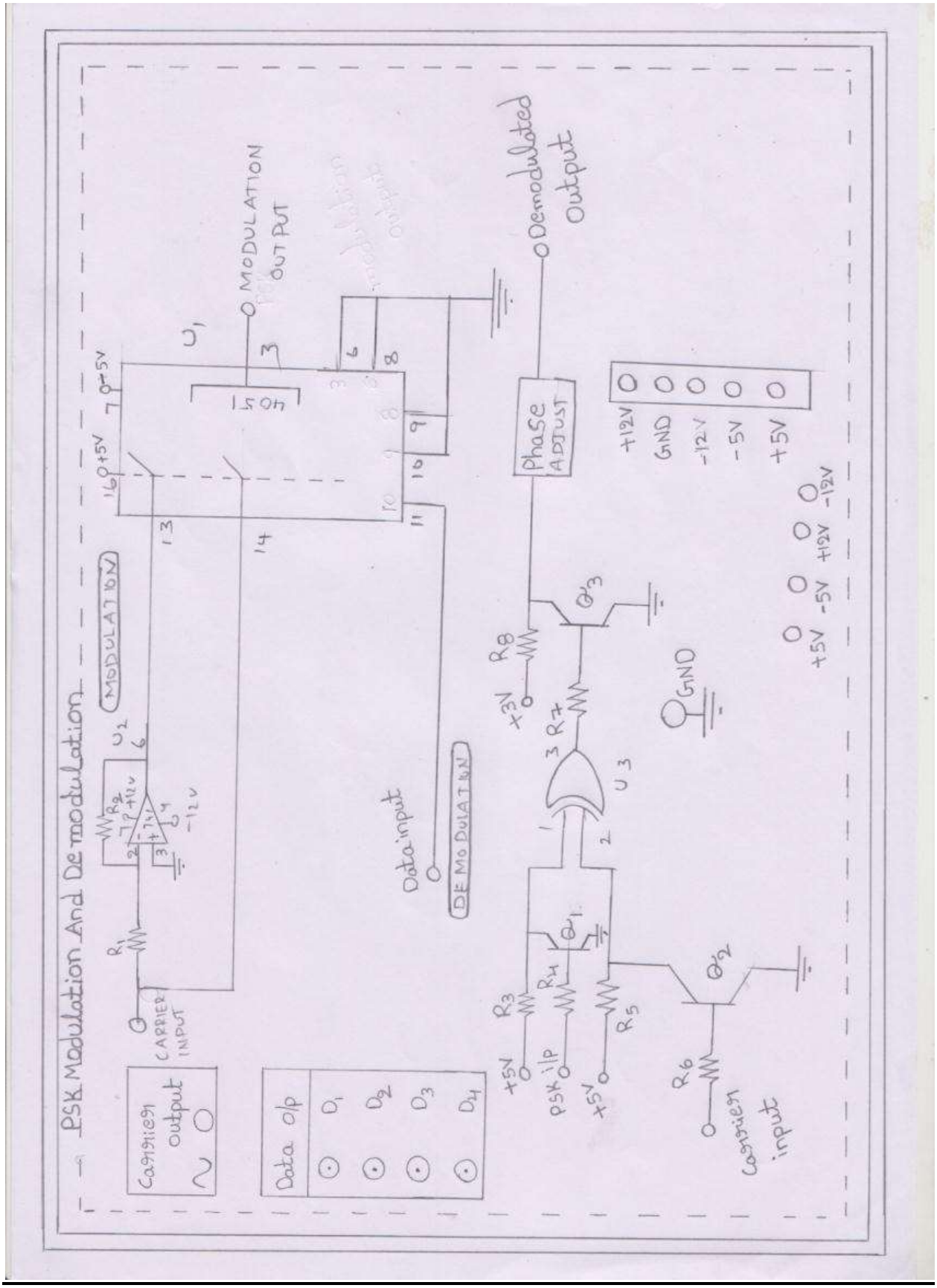
Result:

Generation and Detection of Frequency Shift Keying Modulation & Demodulation has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

1. Explain the concept of FSK?
2. Compare ASK, FSK & PSK?
3. What are the limiting factors of FSK?
4. Is the band rate & bit rate are same for FSK?

Circuit Diagram:



9.Generation and Detection of Phase Shift Keying Modulation & Demodulation

Aim:

To study the operation of Phase Shift Keying Modulation & Demodulation techniques.

Equipment:

1. Phase Shift Keying Modulation & Demodulation Trainer.

Model:HiQ-4210.

2.Oscilloscope-20MHZ dual channel.

3.Patch chords.

Theory:

To transmit the digital data from one place to another,we have to choose the transmission medium.The simplest possible method to connect the transmitter to the receiver with a piece of wire.This works satisfactorily for short distances in some cases.But for long distance communication and in situations like communication with the aircraft,ship,vehicle this is not feasible.Here we have opt for radio transmission.

It is not possible to send the digital data directly over the antenna because the antenna of practiced size works on very high frequencies,much higher than our data transmission rate.

To be able to transmit the data over antenna,we have to module the signal i.e.phase,frequency or amplitude is varied in accordance with the digital data.At receiver we separate the signal from digital information by the process of demodulation.After this process we are left with high frequency signal(called as carrier signa) which we discard and the digital information,which we utilize.

Modulation also allows different data streams to be transmitted over the same channel.This process is called as Multiplexing and result in a considerable saving in bandwidth no of channels to be used.Also it increases the channel efficiency.

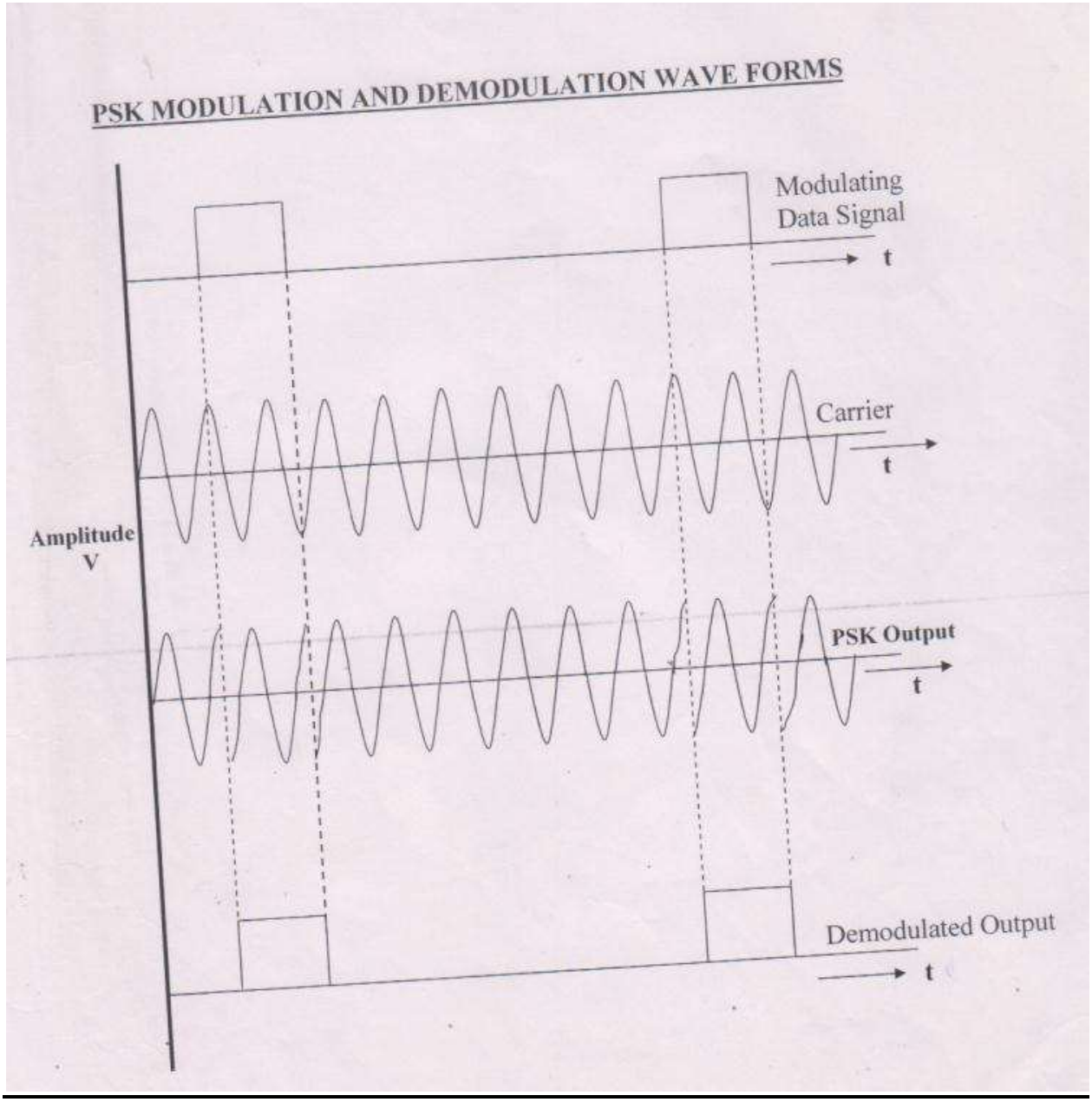
The PSK is a form of angle modulated,constant amplitude digital modulation.Digital communications because important with the expansion of the use of computers and data

processing, and have continued to develop into a major industry providing the interconnection of computer peripherals and transmission of data between distant sites.Phase Shift Keying(PSK) is relatively new system,in which the carrier may be phase shifted by +90 degrees for a mark,and by -90 degrees for a space. PSK has a number of similarities to FSK in many aspects,as in FSK,the frequency of the carrier is shifted according to the modulating square wave.

Procedure:

1. Now switch ON the trainer and see that the supply LED glows.
2. Observe the carrier output.
3. Observe the data outputs(D1,D2,D3,D4).
4. Now, connect the carrier output to the carrier input of PSK modulator using patch chord.
5. Connect the D1 to data input of PSK modulator.
6. Observe the Phase shifted PSK output waveform on CRO on channel 1 and corresponding data output on channel2.
7. Repeat the steps 4,5,6 for data outputs D2,D3,D4 and observe the PSK outputs.
8. Connect the PSK modulation output TP6 to the PSK input of demodulation TP4.
9. Connect the carrier output TP1 to the carrier input of PSK demodulation TP5.
10. Now,observe the PSK demodulated output at TP7 on CRO at channel 1 and corresponding data output on channel 2.
11. The demodulated output is true replica of data output.
12. Repeat the steps 8 to 10 for other data outputs D2,D3,D4.

Waveforms:


PSK MODULATION AND DEMODULATION WAVE FORMS
Modulating
Data Signal
t
Carrier
t
Amplitude
V
PSK Output
t
Demodulated Output
t

Result:

Generation and Detection of Phase Shift Keying Modulation & Demodulation has been observed and resultant waveforms are plotted.

Viva-Voce Questions:

1. Explain the concept of PSK?
2. Compare ASK, FSK, PSK?
3. What is the advantage of PSK over ASK, FSK?
4. What is the minimum B.W required in PSK?

10.Error Detection And Correction Using Hamming Code

Aim: To find all the code words of the (7,4) hamming code and verify that the minimum distance is equal to 3 using matlab.

Apparatus Required:

1. Pc
2. Matlab software

Program:

```
clc;
clear all;

% Input Generator Matrix
g=input('Enter The Generator Matrix: ')
disp ('G = ')
disp ('The Order of Linear block Code for given Generator Matrix is:')
[n,k] = size(transpose(g))
for i = 1:2^k
for j = k:-1:1
if rem(i-1,2^(-j+k+1))>=2^(-j+k)
u(i,j)=1;
else
u(i,j)=0;
end
end
end
u;
disp('The Possible Codewords are :')
c = rem(u*g,2)
disp('The Minimum Hamming Distance dmin for given Block Code is= ')
d_min = min(sum((c(2:2^k,:))'))

% Code Word
r = input('Enter the Received Code Word:')
```

```
p = [g(:,n-k+2:n)];
h = [transpose(p),eye(n-k)];
disp('Hammimg Code')
ht = transpose(h)
disp('Syndrome of a Given Codeword is :')
s = rem(r*ht,2)
for i = 1:1:size(ht)
if(ht(i,1:3)==s)
r(i) = 1-r(i);
break;
end
end
disp('The Error is in bit:')

i

disp(‘The Corrected codeword is’)

r
```

Output Values:

```
Enter The Generator Matrix: [1 0 0 0 1 0 1;0 1 0 0 1 1 1;0 0 1 0 1 1 0;0 0 0 1 0 1 1]
g =
1 0 0 0 1 0 1
0 1 0 0 1 1 1
0 0 1 0 1 1 0
0 0 0 1 0 1 1
G =
The Order of Linear block Code for given Generator Matrix is:
n =
7
k =
4
```

The Possible Codewords are :

c =

0 0 0 0 0 0 0

0 0 0 1 0 1 1

0 0 1 0 1 1 0

0 0 1 1 1 0 1

0 1 0 0 1 1 1

0 1 0 1 1 0 0

0 1 1 0 0 0 1

0 1 1 1 0 1 0

1 0 0 0 1 0 1

1 0 0 1 1 1 0

1 0 1 0 0 1 1

1 0 1 1 0 0 0

1 1 0 0 0 1 0

1 1 0 1 0 0 1

1 1 1 0 1 0 0

1 1 1 1 1 1 1

The Minimum Hamming Distance dmin for given Block Code is=

d_min =

3

Enter the Received Code Word:[1 0 0 0 1 0 0]

r =

1 0 0 0 1 0 0

Hammimg Code

ht =

1 0 1

1 1 1

1 1 0

0 1 1

1 0 0

0 1 0

0 0 1

Syndrome of a Given Codeword is :

s =

0 0 1

The Error is in bit:

i =

7

The Corrected Codeword is :

r =

1 0 0 0 1 0 1

Result:

The implementation verified that all code words of the (7,4) Hamming code exhibit a minimum distance of 3, confirming its efficiency in error detection and correction.

Viva-Voce Questions:

1. What is the purpose of using Hamming Code in error detection and correction?

2. How does Hamming Code detect errors in transmitted data?

3. What role do parity bits play in Hamming Code?

4. what is its significance in data transmission?

5. How does Hamming Code ensure error correction?

EXPERIMENT(S) BEYOND SYLLABUS

Amplitude Shift Keying (ASK) signal using MATLAB

Aim:

To generate the waveform of Amplitude Shift Keying (ASK) signal using MATLAB.

Software required:

1. Pc
2. Matlab software

Theory:

Generation of ASK:

Amplitude shift keying - ASK - is a modulation process, which imparts to a sinusoid two or more discrete amplitude levels. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. The data rate is a sub-multiple of the carrier frequency. Thus the modulated waveform consists of bursts of a sinusoid. The disadvantage of ASK, compared with FSK and PSK, is that it has not a constant envelope. This makes its processing (eg. power amplification) more difficult, since linearity becomes an important factor. However, it does make for ease of demodulation with an envelope detector.

ASK modulation:

1. Generate carrier signal.
2. Start FOR loop
3. Generate binary data and message signal (on-off form)
4. Generate ASK modulated signal.
5. Plot message signal and ASK modulated signal.
6. End FOR loop.
7. Plot the binary data and carrier.

Program:

```
%ASK Modulation
clc;
clear all;
close all;
%Generate Carrier Signal
```

```
Tb=1; fc=10;
t=0:Tb/100:1;
c=sqrt(2/Tb)*sin(2*pi*fc*t);
%Generate Message Signal
N=8;
m=rand(1,N);
t1=0;t2=Tb
for i=1:N t=[t1:.01:t2]
if m(i)>0.5
m(i)=1;
m_s=ones(1,length(t));
else m(i)=0;
m_s=zeros(1,length(t));
end
message(i,:)=m_s;
%product of carrier and message
ask_sig(i,:)=c.*m_s;
 t1=t1+(Tb+.01);
t2=t2+(Tb+.01);
 % Plot the message and ASK signal
subplot(5,1,2);
axis([0 N -2 2]);
plot(t,message(i,:),'r');
title('message signal');
xlabel('t--->');
ylabel('m(t)');
grid on
hold on
subplot(5,1,4);
plot(t,ask_sig(i,:));
 title('ASK signal');
xlabel('t--->');
ylabel('s(t)');
grid on
```

```
hold on
end
hold off
%Plot the carrier signal and input binary data
subplot(5,1,3);
plot(t,c);
title('carrier signal');
xlabel('t--->');
ylabel('c(t)');
grid on
subplot(5,1,1);
stem(m);
title('binary data bits');
xlabel('n--->');
ylabel('b(n)');
grid on
```

Wave Forms: The desired ASK waveforms i.e. binary data, message signal, carrier signal and output waveforms are shown in below

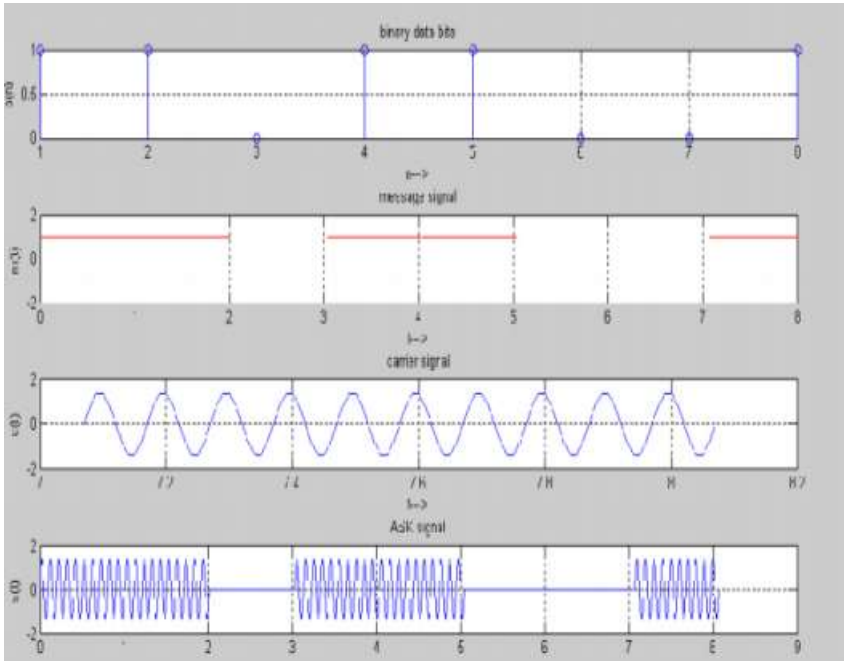


Figure: ASK waveform

Result:

The program for ASK modulation has been simulated in MATLAB and observed the desired waveforms.

waveforms.

Viva-Voce Questions:

1. What is ASK?

2. Write a MATLAB program to generate sync function

3. Differentiate plot and subplot commands in MATLAB.

4.Why it is called on-off keying.