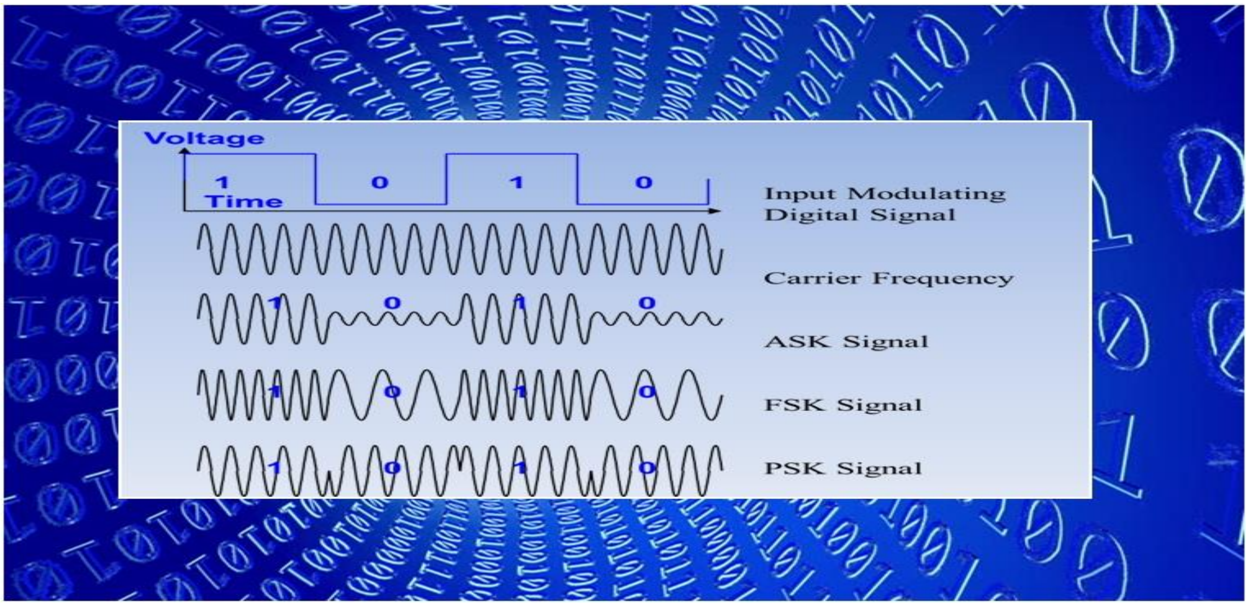
COMMUNICATION SYSTEMS LAB MANUAL



Department of Electronics & Communication Engineering

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

COMMUNICATION SYSTEMS LAB MANUAL

Name:____

H.T.No:____

Year/Semester:_______________________________________

Department of Electronics & Communication Engineering

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

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VEMU Institute of Technology
Dept. of Electronics and Communication Engineering

Vision of the institute

To be one of the premier institutes for professional education producing dynamic and vibrant force of technocrats with competent skills, innovative ideas and leadership qualities to serve the society with ethical and benevolent approach.

Mission of the institute

Mission_1: To create a learning environment with state-of-the art infrastructure, well equipped laboratories, research facilities and qualified senior faculty to impart high quality technical education.
Mission_2: To facilitate the learners to inculcate competent research skills and innovative ideas by Industry-Institute Interaction.
Mission_3: To develop hard work, honesty, leadership qualities and sense of direction in learners by providing value based education.

Vision of the department

To become a centre of excellence in the field of Electronics and Communication Engineering and produce graduates with Technical Skills, Research & Consultancy Competencies, Life-long Learning and Professional Ethics to meet the challenges of the Industry and Society.

Mission of the department

Mission_1: To enrich Technical Skills of students through Effective Teaching and Learning practices for exchange of ideas and dissemination of knowledge.

Mission_2: To enable the students with research and consultancy skill sets through state-of-the art laboratories, industry interaction and training on core & multidisciplinary technologies.

Mission_3: To develop and instill creative thinking, Life-long learning, leadership qualities, Professional Ethics and social responsibilities among students by providing value based education.

Programme Educational Objectives (PEOs)

PEO 1: To prepare the graduates to be able to plan, analyze and provide innovative ideas to investigate complex engineering problems of industry in the field of Electronics and Communication Engineering using contemporary design and simulation tools.

PEO-2: To provide students with solid fundamentals in core and multidisciplinary domain for successful implementation of engineering products and also to pursue higher studies.

PEO-3**:** To inculcate learners with professional and ethical attitude, effective communication skills, teamwork skills, and an ability to relate engineering issues to broader social context at work place

Programme Outcomes (POs)

PO-1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**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.
PO-4	**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.
PO-5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**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.
PO-7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**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 give and receive clear instructions.
PO-11	**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 a team, to manage projects and in multidisciplinary environments.
PO-12	**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.

Programme Specific Outcomes (PSOs)

PSO_1	**Higher Education:** Qualify in competitive examinations for pursuing higher education by applying the fundamental concepts of Electronics and Communication Engineering domains such as Analog & Digital Electronics, Signal Processing, Communication & Networking, Embedded Systems, VLSI Design and Control Systems etc...
PSO_2	**Employment:** Get employed in allied industries through their proficiency in program specific domain knowledge, specialized software packages and Computer programming or become an entrepreneur.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

II B.Tech-II Sem (ECE)

(20A04402P) COMMUNICATION SYSTEMS LABORATORY

Course Objectives:

- To understand the basics of analog and digital modulation techniques.
- To integrate theory with experiments so that the students appreciate the knowledge gained from the theory course.
- To design and implement different modulation and demodulation techniques and their applications.
- To develop cognitive and behavioral skills for performance analysis of various modulation techniques.

Course Outcomes (CO):

CO1: **Understand** the usage of equipment/components used to conduct the experiments in analog and digital modulation techniques.

CO2: **Conduct** the experiments in Modulation and Demodulation schemes to find the important metrics of the communication system experimentally.

CO3: **Analyze** the performance of a given Modulation and Demodulation scheme to find the important metrics of the system theoretically.

CO4: **Draw** the relevant graphs between important metrics of the system from the observed measurements.

CO5: **Compare** the experimental results with that of theoretical ones and infer the conclusions.

List of Experiments

Design the circuits and verify the following experiments taking minimum of six from each section shown below.

Section-A

1. AM Modulation and Demodulation
2. DSB-SC Modulation and Demodulation
3. Frequency Division Multiplexing
4. FM Modulation and Demodulation
5. Radio receiver measurements
6. PAM Modulation and Demodulation
7. PWM Modulation and Demodulation
8. PPM Modulation and Demodulation

Section-B

1. Sampling Theorem
2. Time Division Multiplexing
3. Delta Modulation and Demodulation
4. PCM Modulation and Demodulation
5. BASK Modulation and Demodulation
6. BFSK Modulation and Demodulation
7. QPSK Modulation and Demodulation
8. DPSK Modulation and Demodulation

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Dept. of Electronics and Communication Engineering

(20A04402P) COMMUNICATION SYSTEMS LABORATORY

II B.Tech- II Sem

LIST OF EXPERIMENTS TO BE CONDUCTED

Section-A

1. AM Modulation and Demodulation
2. DSB-SC Modulation and Demodulation
3. Frequency Division Multiplexing
4. FM Modulation and Demodulation
5. PAM Modulation and Demodulation
6. PWM Modulation and Demodulation
7. PPM Modulation and Demodulation

Section-B

1. Sampling Theorem
2. Time Division Multiplexing
3. Delta Modulation and Demodulation
4. PCM Modulation and Demodulation
5. BASK Modulation and Demodulation
6. BFSK Modulation and Demodulation
7. QPSK Modulation and Demodulation
8. DPSK Modulation and Demodulation

Additional experiments

1. Pre-emphasis and De-emphasis
2. Noise power spectral density

CONTENTS

S. NO.	NAME OF THE EXPERIMENT	PAGE NO
PART-A		
1	AM Modulation and Demodulation	2-6
2	DSB-SC Modulation and Demodulation	7-10
3	Frequency Division Multiplexing	11-16
4	FM Modulation and Demodulation	17-21
5	PAM Modulation and Demodulation	22-25
6	PWM Modulation and Demodulation	26-30
7	PPM Modulation and Demodulation	31-34
PART-B		
8	Sampling Theorem	36-47
9	Time Division Multiplexing	48-52
10	Delta Modulation and Demodulation	53-57
11	PCM Modulation and Demodulation	58-63
12	BASK Modulation and Demodulation	64-67
13	BFSK Modulation and Demodulation	68-71
14	QPSK Modulation and Demodulation	72-76
15	DPSK Modulation and Demodulation	77-80
ADDITIONAL EXPERIMENTS		
16	Pre-emphasis and De-emphasis	82-85
17	Noise power spectral density	86-88

DOS & DONTS IN LABORATORY

1. While entering the Laboratory, the students should follow the dress code (Wear shoes, White Apron & Female students should tie their hair back).
2. The students should bring their observation note book, practical manual, record note book, calculator, necessary stationary items and graph sheets if any for the lab classes without which the students will not be allowed for doing the practical.
3. All the equipments and components should be handled with utmost care. Any breakage/damage will be charged.
4. If any damage/breakage is noticed, it should be reported to the instructor immediately.
5. If a student notices any short circuits, improper wiring and unusual smells immediately the same thing is to be brought to the notice of technician/lab in charge.
6. At the end of practical class the apparatus should be returned to the lab technician and take back the indent slip.
7. Each experiment after completion should be written in the observation note book and should be corrected by the lab in charge on the same day of the practical class.
8. Each experiment should be written in the record note book only after getting signature from the lab in charge in the observation note book.
9. Record should be submitted in the successive lab session after completion of the experiment.
10. 100% attendance should be maintained for the practical classes.

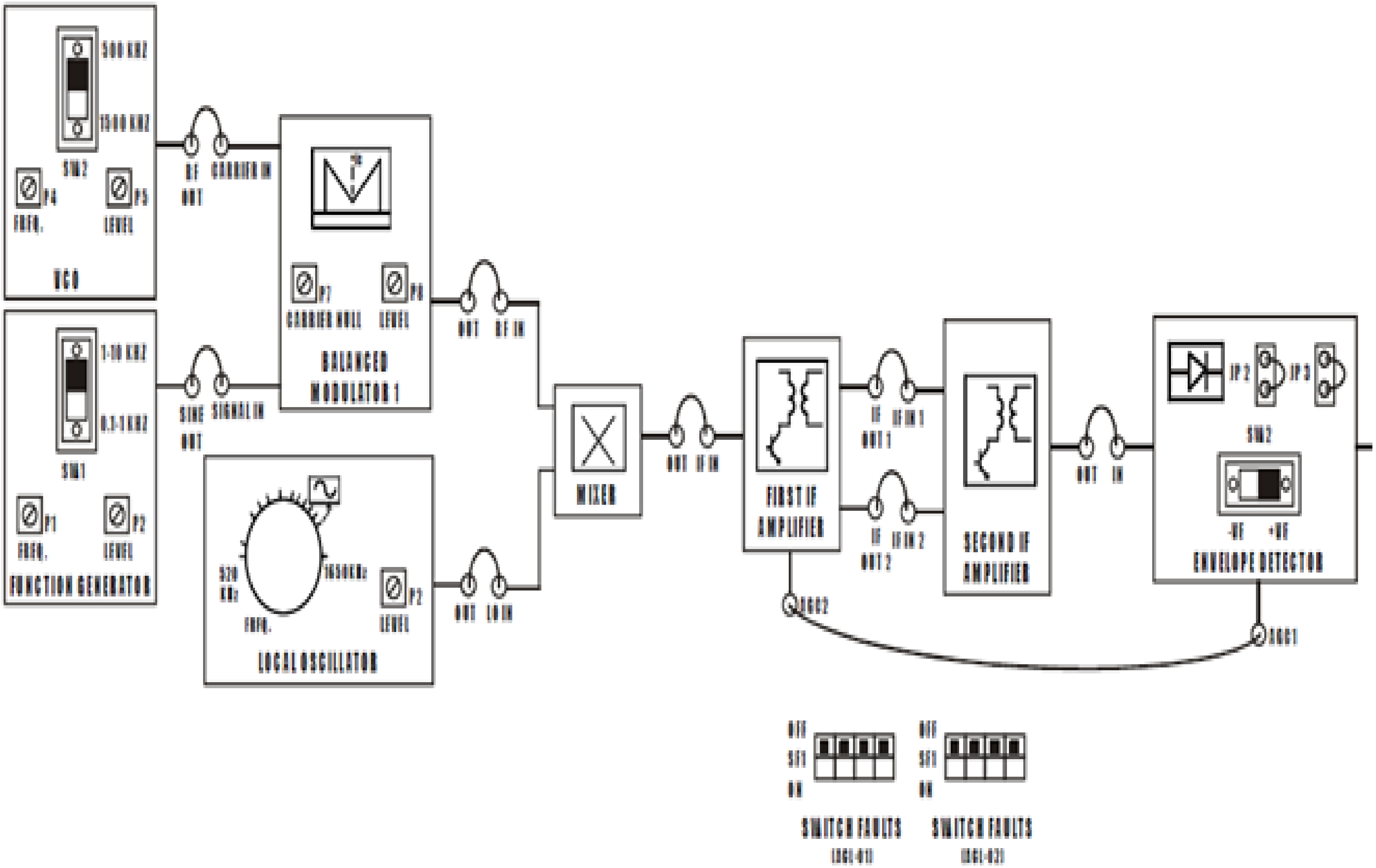
SCHEME OF EVALUVATION

S NO	NAME OF EXPERIMENT	DATE	MARKS AWARDED				TOTAL (30M)
			Record (10M)	Observation (10M)	Viva voce (5M)	Attendance (5M)	
HARDWARE EXPERIMENTS							
1	AM Modulation and Demodulation						
2	DSB-SC Modulation and Demodulation						
3	Frequency Division Multiplexing						
4	FM Modulation and Demodulation						
5	PAM Modulation and Demodulation						
6	PWM Modulation and Demodulation						
7	PPM Modulation and Demodulation						
SOFTWARE EXPERIMENTS							
8	Sampling Theorem						
9	Time Division Multiplexing						
10	Delta Modulation and Demodulation						
11	PCM Modulation and Demodulation						
12	BASK Modulation and Demodulation						
13	BFSK Modulation and Demodulation						
14	QPSK Modulation and Demodulation						
15	DPSK Modulation and Demodulation						
Additional Experiments							
16	Noise power spectral density						
17	Pre-emphasis and De-emphasis						

Signature of Lab In-charge

PART A

Block Diagram for AM modulation and Demodulation:



Exp .No: 1 **Date:**

AMPLITUDE MODULATION & DEMODULATION

Aim:

(a) To generate Amplitude modulated signal and determine the modulation index

(b) To demodulate a Amplitude Modulated signal using AM detector.

Apparatus required:

S.NO	Apparatus	Ranges	Quantity
1	ACL-AM, ACL-AD	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

PROCEDURE:

1. Connect o/p of FUNCTION GENERATOR section (ACL-AM) OUT post to the i/p of Balance Modulator1 (ACL-AM) SIGNAL IN post.
2. Connect o/p of VCO (ACL-AM) OUT post to the input of Balance modulator 1 (ACL-AM) CARRIER IN post.
3. Connect the power supply with proper polarity to the kit ACL-AM& ACL -AD, While connecting this, ensure that the power supply is OFF.
4. Switch on the power supply and Carry out the following presetting:

FUNCTION GENERATOR: Sine **LEVEL** about 0.5 Vpp; FREQ. about 1 KHz.**VCO: LEVEL** about 2Vpp; **FREQ.** about 850 KHz, Switch on 1500KHz.

BALANCED MODULATOR

1. CARRIER NULL completely rotates clockwise or counter clockwise, so that the modulator is “unbalanced” and an AM signal with not suppressed carrier is obtained across the output: adjust Outlevel to obtain an AM signal across the output whose amplitude is about 100mVpp
2. Connect local oscillator OUT post to LO IN of the mixer section.
3. Connect balance modulator1 out to RF IN of mixer section in ACL-AD.
4. Connect mixer OUT to IF IN of 1st IF AMPLIFIER in ACL-AD.

5. Connect IF OUT1 of 1st IF to IF IN 1 and IF OUT2 of 1st IFto IFIN 2 of 2ND IF AMPLIFIER.
6. Connect OUT post of 2nd IF amplifier to IN post of envelope detector.
7. Connect post AGC1to post AGC2and jumper position as per diagram.
8. Observe the modulated signal envelope, which corresponds to the waveform of the modulating signal at OUT post of the balanced modulator1 of ACL-AM. Connect the oscilloscope to the IN and OUT post of envelope detector and detect the AM signal and the detected one (FIG. 2E) If the central frequency of the amplifier and the carrier frequency of the AM signal and local oscillator frequency coincides, you obtain two signals similar to the ones of
9. Check that the detected signal follows the behavior of the AM signal envelope. Vary the frequency and amplitude of the modulating signal, and check the corresponding variations of the demodulated signal.

Calculations:

$$\% \text{ of Modulation} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} \times 100$$

$$\text{or Modulation factor} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

Result:

AF INPUT:

Amplitude____________ V_{P-P} & Frequency _______________KHz.

RF INPUT:

Amplitude____________ V_{P-P} & Frequency _______________KHz.

Band Width=_______________KHz.

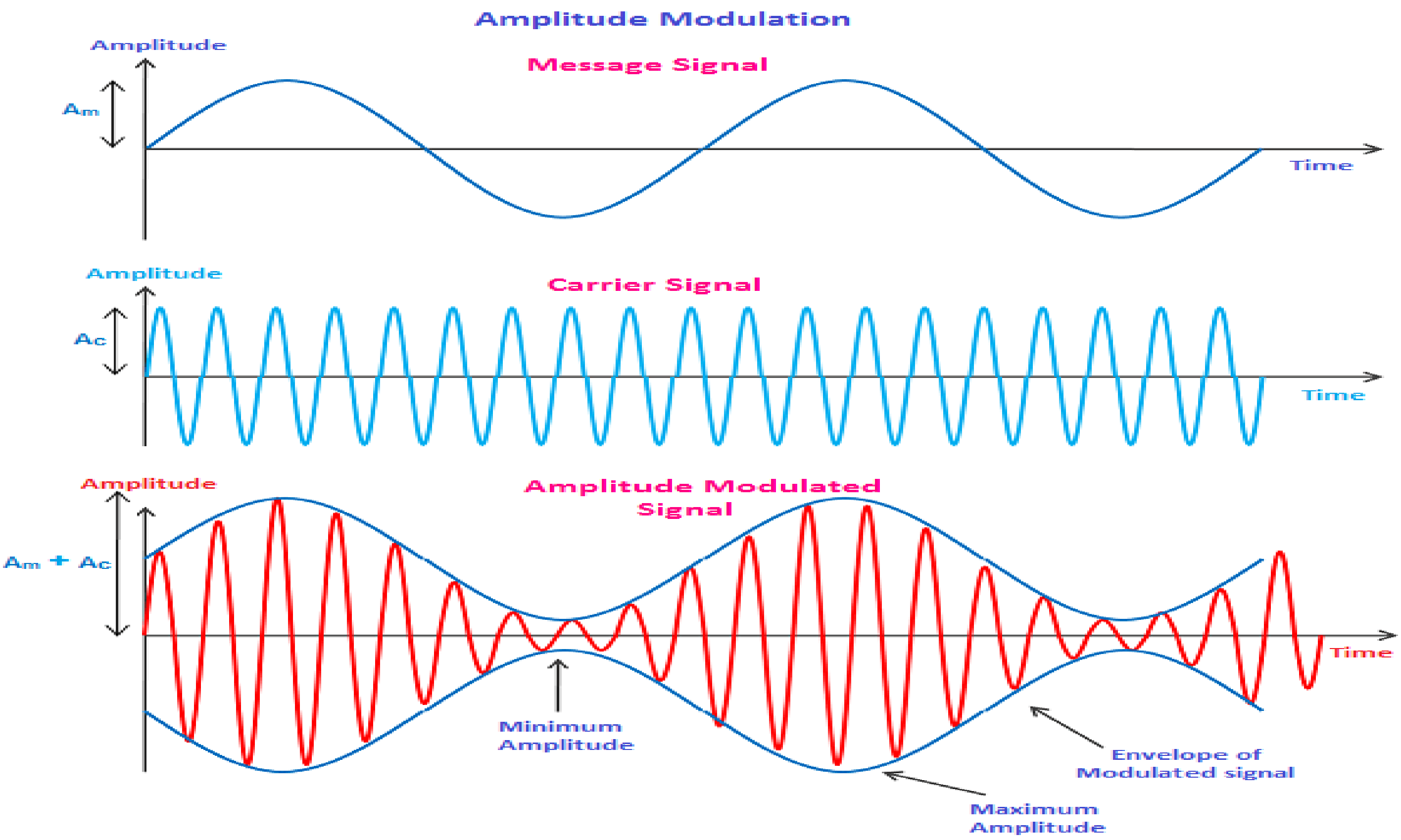
MODULATION INDEX:

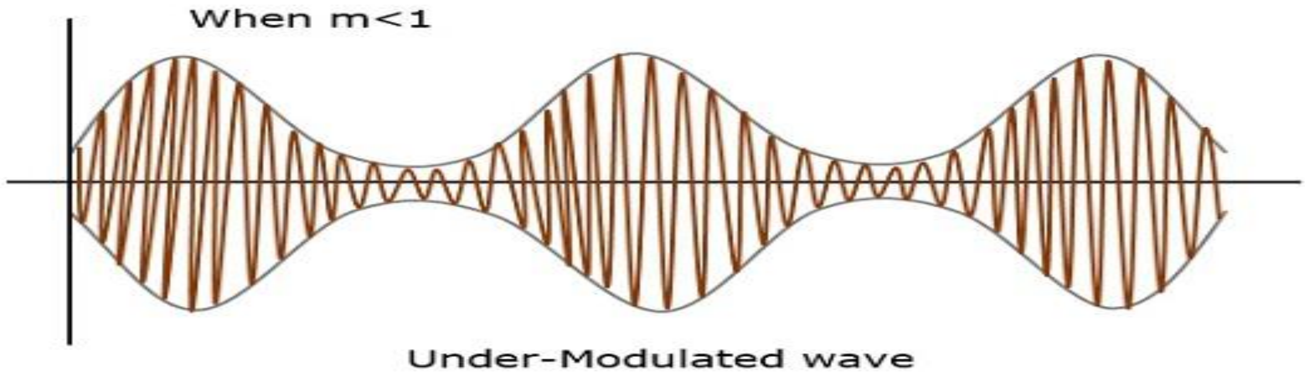
Case I: In Under modulation m_{a}=____________

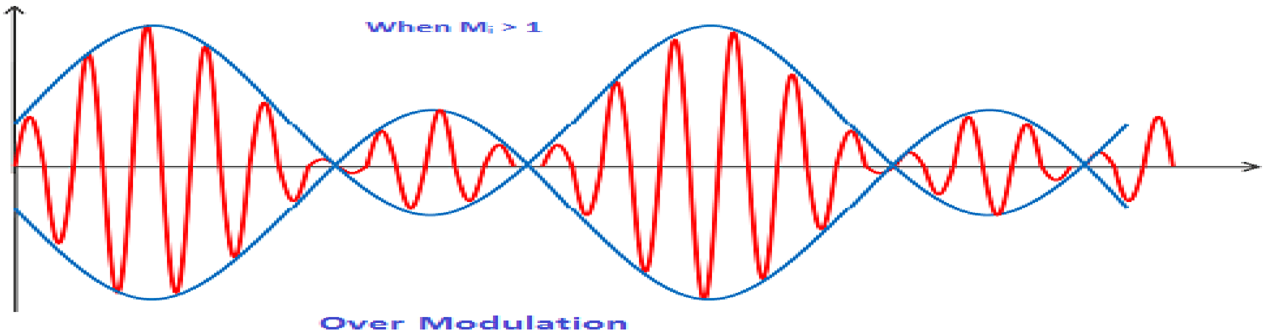
Case II: In perfect modulation m_{a}= _____________

Case III: In over modulation m_{a}= _____________

EXPECTED WAVE FORMS:







Conclusions:

1.

2.

Viva questions:

1. **Write the expression of AM signal?**
2. **Write the expression for power of AM signal?**
3. **Define modulation index?**
4. **Draw the frequency spectrum and Phasor of AM signal?**
5. **What are the advantages of AM over other modulating systems?**

Block Diagram for DSB-SC Modulation Signal:

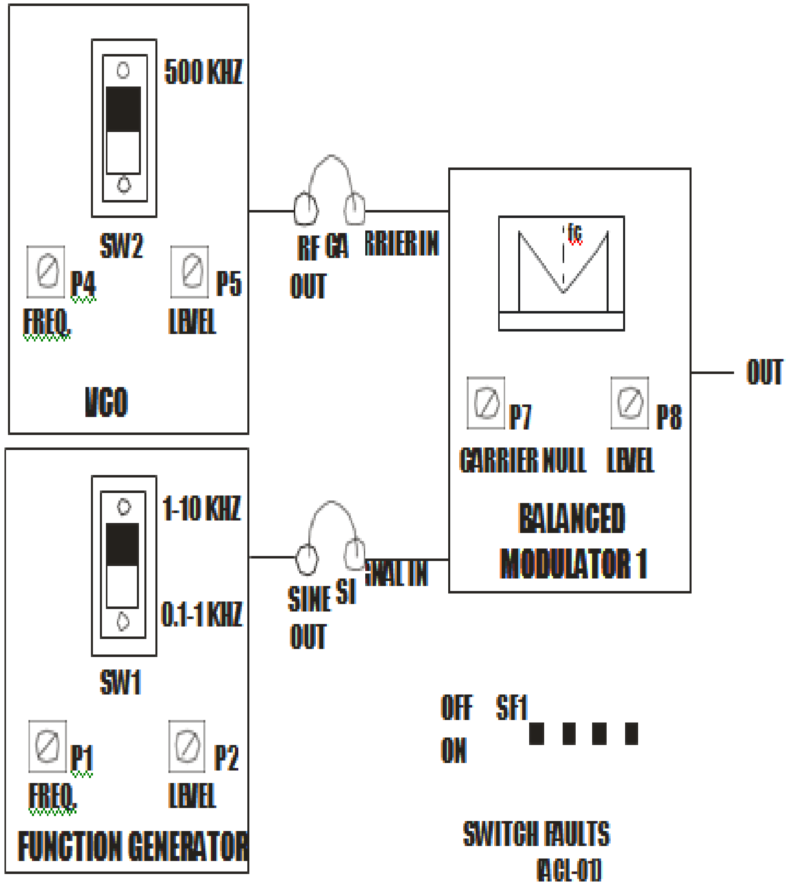
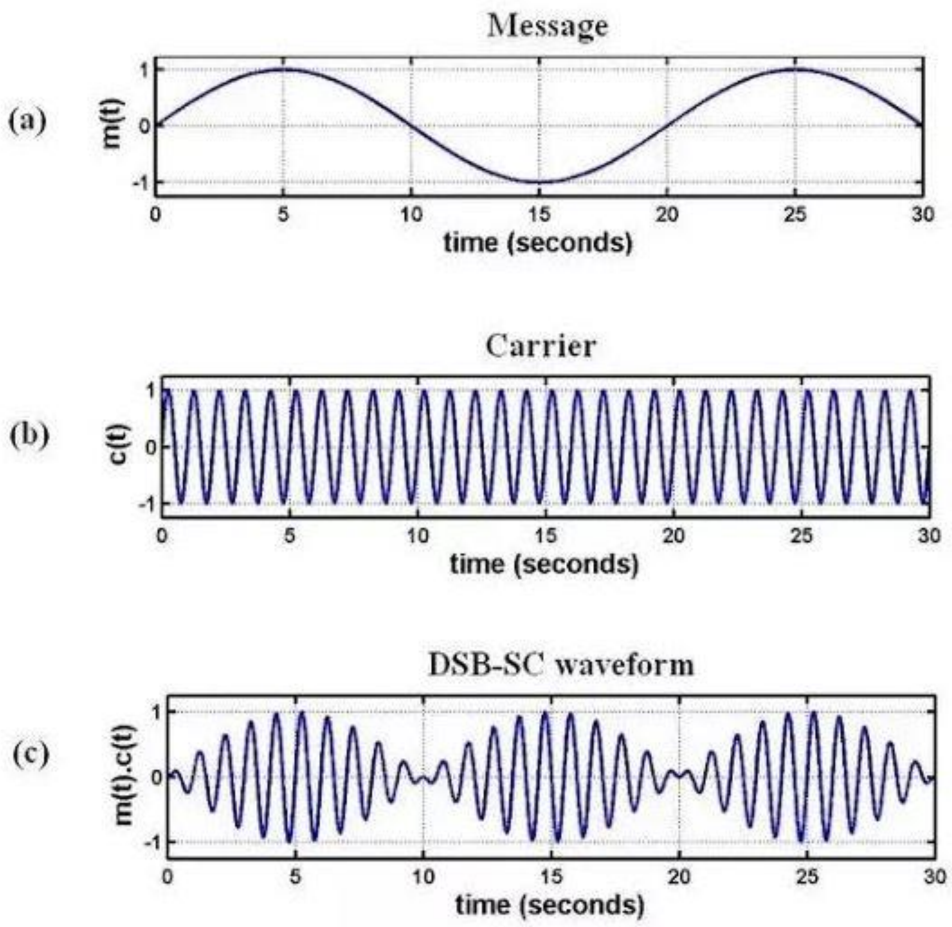


FIG. 1. BLOCK DIAGRAM FOR STUDY OF DSB AM GENERATION

Expected Wave Forms:



Exp .No: 2 **Date:**

DSB-SC MODULATION AND DE MODULATION

Aim: To generate DSB-SC Modulation Signal and extract base band signal

Apparatus Required:

S.NO	Apparatus	Ranges	Quantity
1	ACL-AM, ACL-AD	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

PROCEDURE:

1. Connect o/p of FUNCTION GENERATOR section (ACL-AM) OUT post to the i/p of Balance Modulator1 (ACL-AM) SIGNAL IN post.
2. Connect o/p of VCO (ACL-AM) OUT post to the input of Balance modulator 1 (ACL-AM) CARRIER IN post.
3. Connect the power supply with proper polarity to the kit ACL-AM& ACL -AD, While connecting this, ensure that the power supply is OFF.
4. Switch on the power supply and Carry out the following presetting:

FUNCTION GENERATOR: Sine **LEVEL** about 0.5 Vpp; **FREQ.** about 1 KHz.**VCO: LEVEL** about 2Vpp; **FREQ.** about 850 KHz, Switch on 1500KHz.

BALANCED MODULATOR:

1. CARRIER NULL completely rotates clockwise or counter clockwise, so that the modulator is “unbalanced” and an AM signal with not suppressed carrier is obtained across the output: adjust Out level to obtain an AM signal across the output whose amplitude is about 100mVpp.
2. Connect local oscillator OUT post to LO IN of the mixer section.
3. Connect balance modulator1 out to RF IN of mixer section in ACL-AD.
4. Connect mixer OUT to IF IN of 1st IF AMPLIFIER in ACL-AD.
5. Connect IF OUT1 of 1st IF to IF IN 1 and IF OUT2 of 1st IF to IFIN 2 of 2ND IF AMPLIFIER.
6. Connect OUT post of 2nd IF amplifier to IN post of envelope detector.
7. Connect post AGC1to post AGC2and jumper position as per diagram.

8. Observe the modulated signal envelope, which corresponds to the waveform of the modulating signal at OUT post of the balanced modulator1 of ACL-AM. Connect the oscilloscope to the IN and OUT post of envelope detector and detect the AM signal and the detected one (FIG. 2E) If the central frequency of the amplifier and the carrier frequency of the AM signal and local oscillator frequency coincides, you obtain two signals similar to the ones of
9. Check that the detected signal follows the behavior of the AM signal envelope. Vary the frequency and
10. amplitude of the modulating signal, and check the corresponding variations of the demodulated signal.

Observations:

Signals	**Amplitude(V)**	**Time Period(s)**
Message Signal		
Carrier Signal		
DSB-SC		
de modulation		

Result:

Conclusions:-

1.

2.

Viva Questions: -

1. **What is linear modulation technique?**

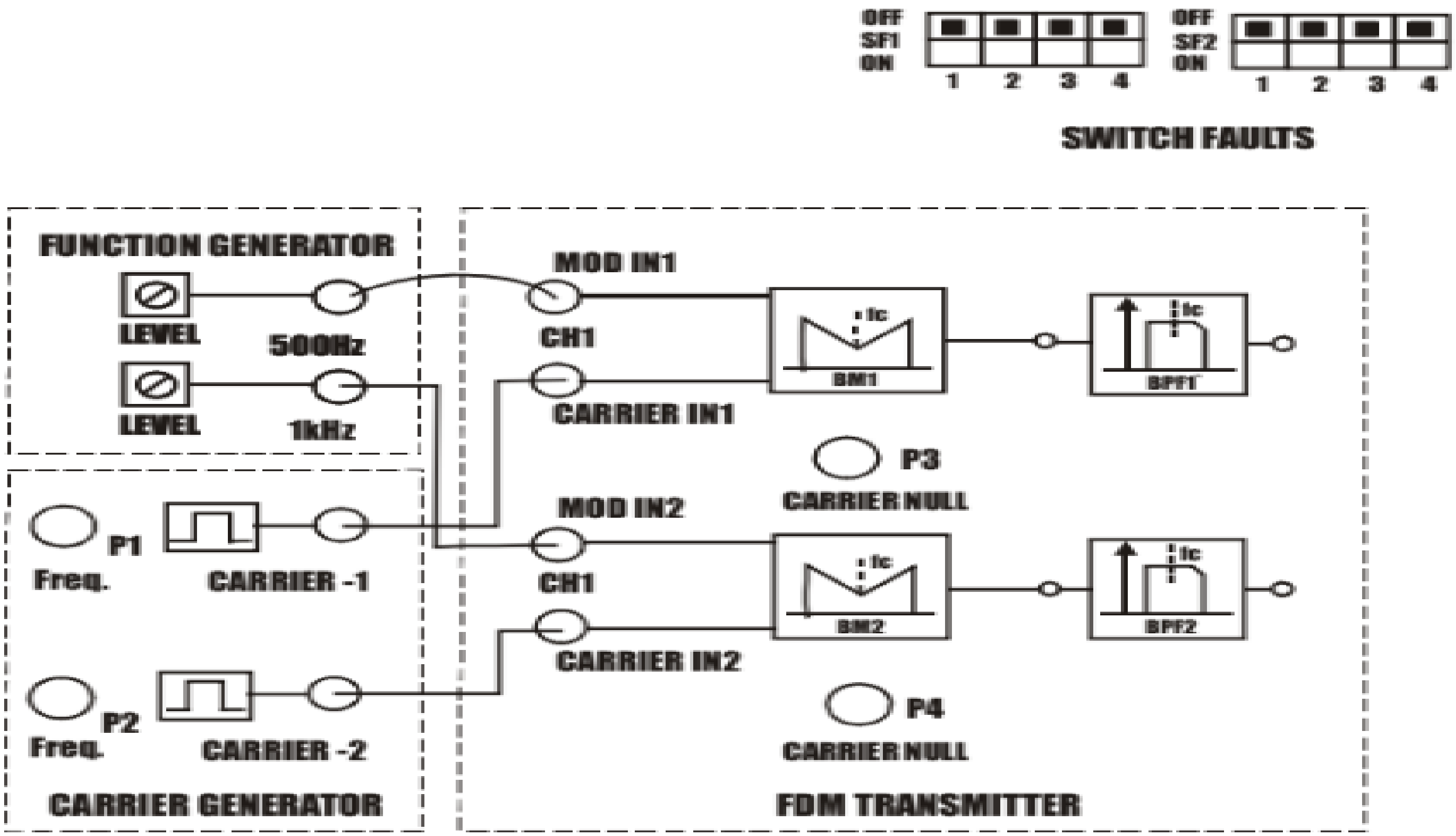
2. **What expression for DSB-SC signal multi tone modulating signal?**

3. **Write the expression for power of DSB-SC signal with multi tone modulating signal?**

4. **Give some examples for both linear and non linear modulations?**

5. **Write modulation property of Fourier transform?**

Block diagram for frequency division multiplexing:



Exp .No: 3 **Date:**

FREQUENCY DIVISION MULTIPLEXING

Aim: To generate FDM signal

Apparatus required:

S.NO	Apparatus	Ranges	Quantity
1	ACL-FDM Kit	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	Dual Channel Function Generator	(0-5MHz)	1
5	BNC Probes	50Ω	2

Procedure:

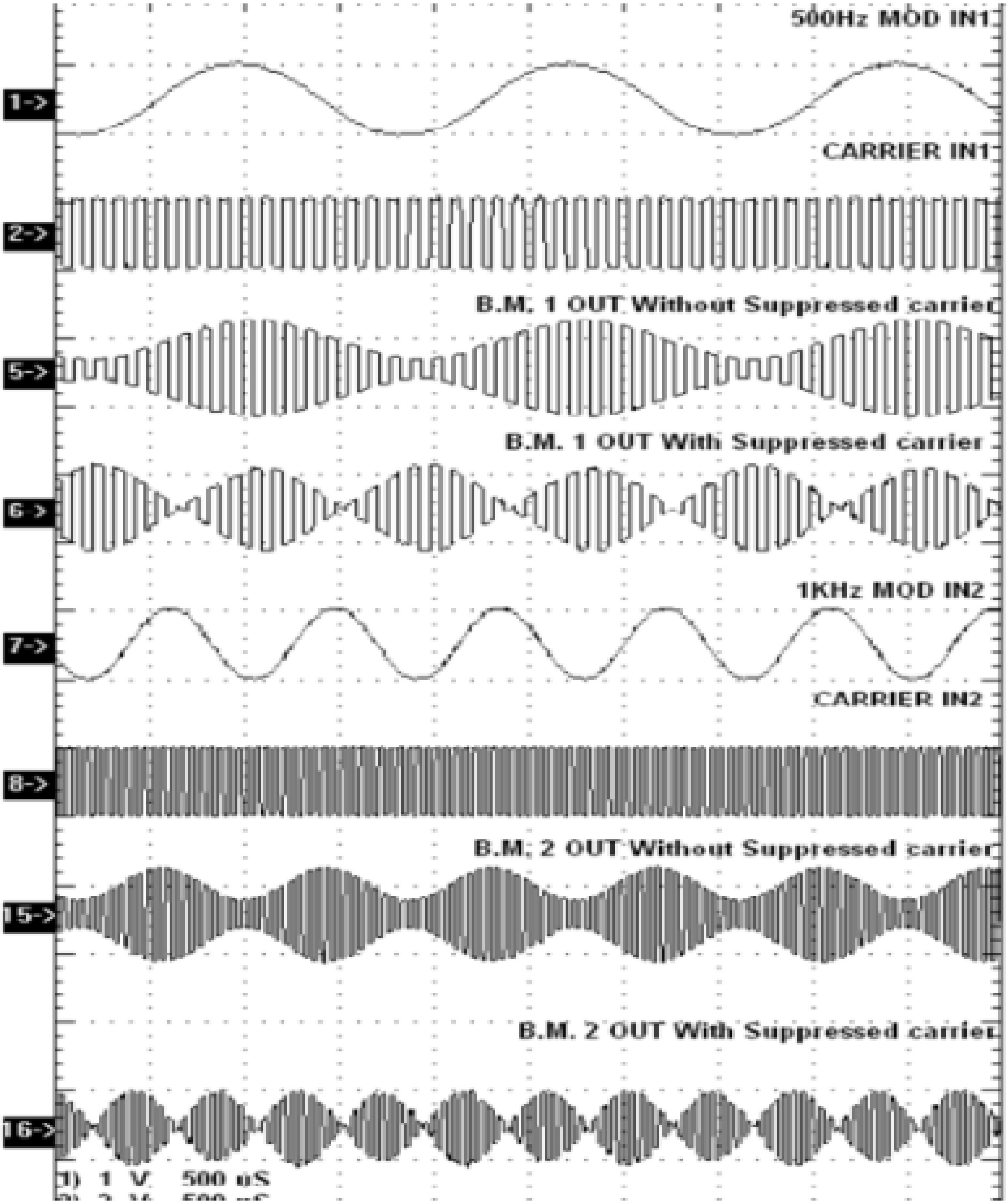
1. Refer to the block diagram and carry out the following connections and switch settings.
2. Connect the power supply cables with proper polarity to ACL-FDM kit. While connecting this, ensure that the power supply is OFF.
3. Switch on the power supply.
4. Connect the 500Hz, 1Vpp Signal from external function generator to the MOD IN 1 post of ACL-FDM.
5. Connect the 1 KHz, 1Vpp Signal from external function generator to the MOD IN 2 post of ACL-FDM.
6. Set carrier frequency CARRIER 1 to 9KHz using pot P1, set carrier frequency CARRIER 2 to 20 KHz using pot P2.
7. Connect the CARRIER 1 post of the Carrier Generator to the CARRIER IN1 post of FDM Transmitter and also connect CARRIER 2 post of the Carrier Generator to the CARRIER IN2 post of FDM Transmitter.
8. Keep the CARRIER NULL at center position by rotating the pot P3 and P4, so that both the modulators are "balanced" and an AM signal with suppressed carrier, as shown in waveform, is obtained across the output whose amplitude is about 1Vpp.
9. Observe the signal at the given out put test point of BM1 and BM2 as shown in fig.
10. Observe the Band Pass Filter-1 output at the given output test point, as shown in waveform. There should be maximum signal transmission at center frequency (fc) of about 9KHz.

11. Observe the Band Pass Filter-2 output at the given output test point, as shown in waveform. There should be maximum signal transmission at center frequency (fc) of about 20KHz.
12. Observe the FDM signal at the OUT post of the FDM Transmitter block. Observe the waveform, which is frequency division multiplexed at frequency 256 KHz of pilot carrier.

Observations:

Signals	Amplitude(V)	Time Period(s)
Carrier Signal		
B.M 1 out with Suppressed Carrier		
BPF 1 OUT		
B.M 2 out with Suppressed Carrier		
BPF 2 OUT		
FDM OUT		

Expected Waveforms:



Result:

Carrier

Amplitude_____________ V_{P-P} & Frequency ________________KHz

B.M 1 out with Suppressed Carrier

Amplitude_____________ V_{P-P} & Frequency ________________KHz

BPF 1 OUT

Amplitude_____________ V_{P-P} & Frequency ________________KHz

B.M 2 out with Suppressed Carrier

Amplitude_____________ V_{P-P} & Frequency ________________KHz

BPF 2 OUT

Amplitude_____________ V_{P-P} & Frequency ________________KHz

FDM OUT

Amplitude_____________ V_{P-P} & Frequency ________________KHz

Conclusion

1.

2.

Viva-Questions

1. **What is the difference between FDM and TDM?**

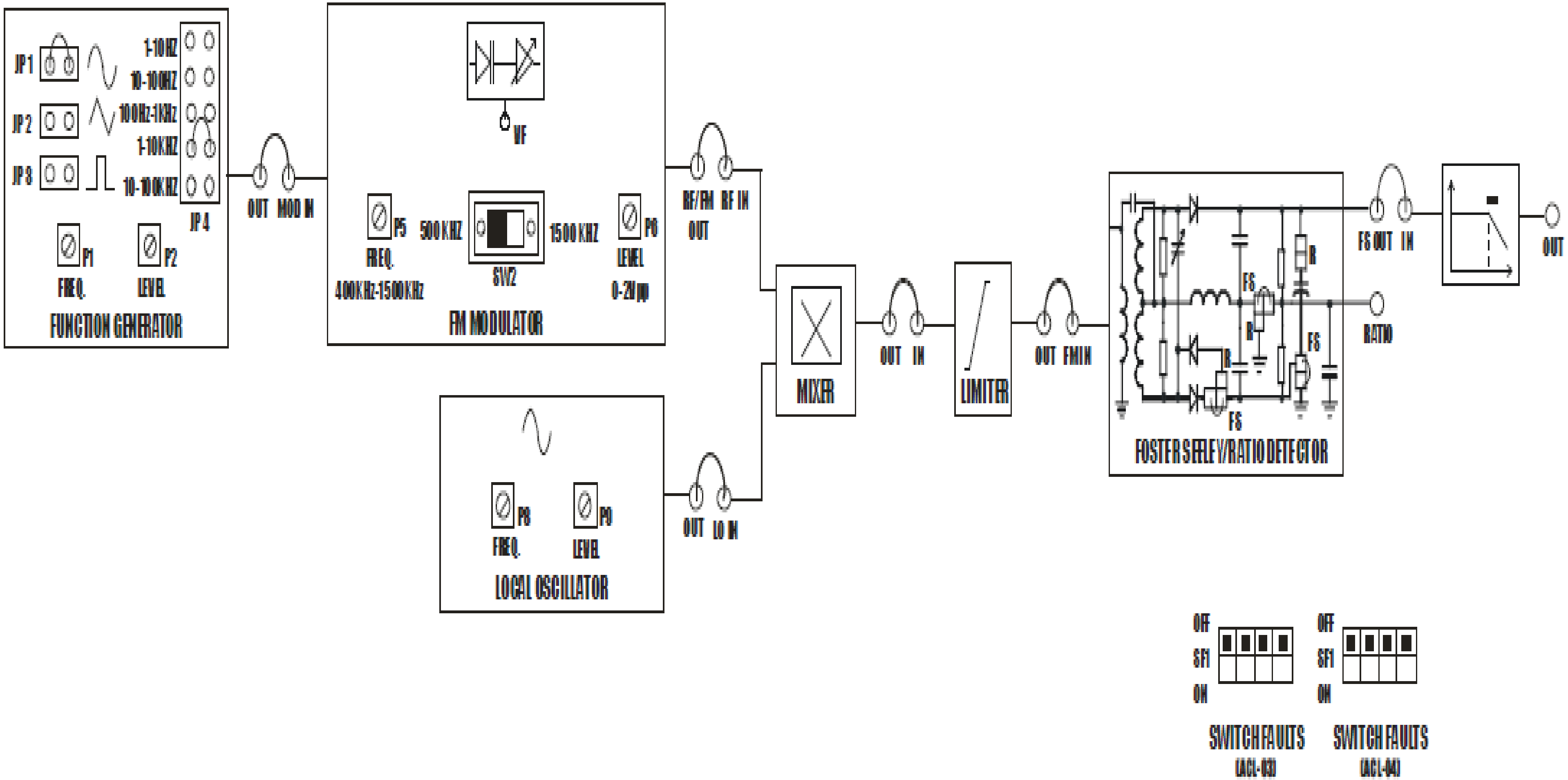
2. **What are the advantages and disadvantages of FDM?**

3. **What are the applications of FDM?**

4. **Why FDM is used in analog signals?**

5. **What is the concept of frequency division multiplexing?**

Block Diagram for Frequency Modulation and Demodulation:



Exp .No: 4 **Date:**

FREQUENCY MODULATION & DEMODULATION

Aim: To generate Frequency modulated signal, calculate modulation index and reconstruct the base band signal.

Apparatus required:

S.NO	Apparatus	Ranges	Quantity
1	ACL-FM & ACL-FD kits	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

(a) FM Modulation

1. Connect the power supply with proper polarity to the kit ACL-FM. While connecting this, ensure that the power supply is OFF.
1. Switch ON the power supply and Carry out the following presetting as shown in fig.
2. FREQUENCY MODULATOR: LEVEL about 2Vpp; FREQ. to the minimum; switch on 1500 KHz connect the oscilloscope and frequency meter to the output of the modulator FM/RF OUT.
3. The frequency deviation ΔF can be calculated as follows.From the oscilloscope evaluate FM and Fm, detecting the periods of the respective sine waves. The frequency deviation ΔF is defined as: $\Delta F = (FM - Fm)/2$
4. You can note that if the modulator operates in a linear zone so FM and Fm are over and under the central frequency F of the same quantity ΔF, otherwise this does not occur.The value of the modulation index mf is calculated by the relation.

$$mf = \Delta F / f, \text{ where f is the frequency of the modulating signal.}$$

(b) FM De-Modulation

1. Connect the o/p of Function Generator (ACL-FM) **OUT** post to the **MOD IN** (ACLFM) post.
2. Connect the o/p of FREQUENCY MODULATOR **FM/RF OUT** post to the I/p of RF IN of mixer in ACL-FM.
3. Connect the power supply with proper polarity to the kit ACL-FM&ACL-FD, while connecting this; ensure that the power supply is OFF.
4. Switch ON the power supply and Carry out the following presetting: **Frequency demodulator in Foster-Seeley mode (jumpers in FS position).**
5. Function Generator: Sine wave (JP1); LEVEL about 100mVpp; FREQ. about 1 KHz.
6. Local Oscillator: LEVEL about 1 Vpp; FREQ. About1000 KHz on (Center).
7. Connect the LOCAL OSCILLATOR OUT to the LO IN of the MIXER and MIXER OUT to the LIMITER IN post with the help of shorting links.
8. Then connect the LIMITER OUT post to the FM IN of FOSTER- SEELEY DETECTOR and FS OUT to the IN of LOW PASS FILTER.

Result:

Amplitude____________ V_{P-P} & Frequency _______________KHz.

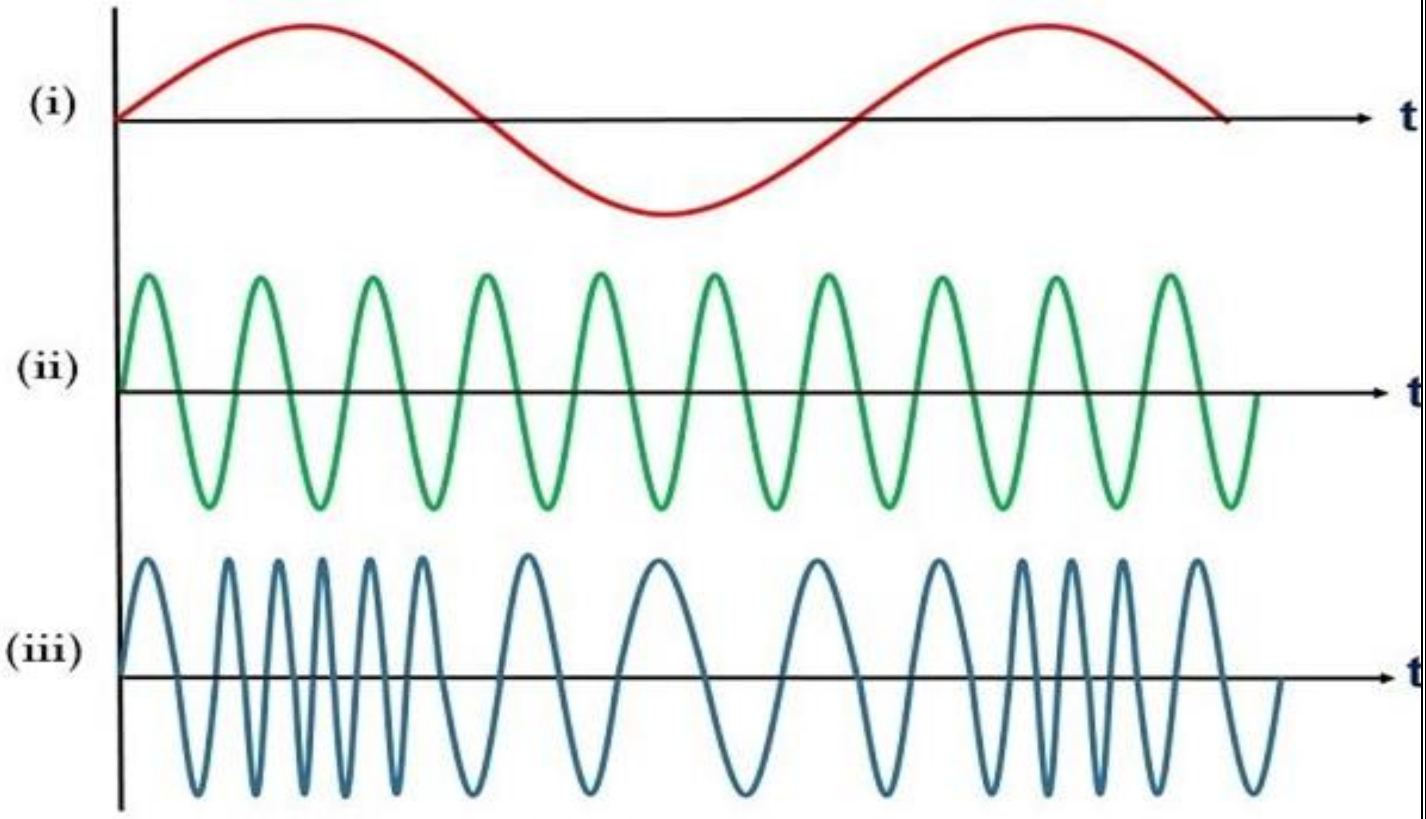
RF INPUT:

Amplitude____________ V_{P-P} & Frequency _______________KHz.

Depth of Modulation=_______________

Bandwidth of FM=_______________

Expected wave forms:



(i) Modulating signal
(ii) Carrier waveform
(iii) Frequency modulated signal

Observations:

Signals	Amplitude(V)	Time Period(s)
Message Signal		
Carrier Signal		
FM Signal		
De Modulation		

Conclusions:

1.

2.

Viva questions:

1. **Write the expression for WBFM and NBFM signal?**

2. **Write the expression for power of WBFM and NBFM signal?**

3. **Draw the frequency spectrum of WBFM & NBFM?**

4. **Compare NBFM and WBFM?**

5. **What are the advantages of FM over other modulating systems?**

Block Diagram for PULSE AMPLITUDE MODULATION AND DEMODULATION:

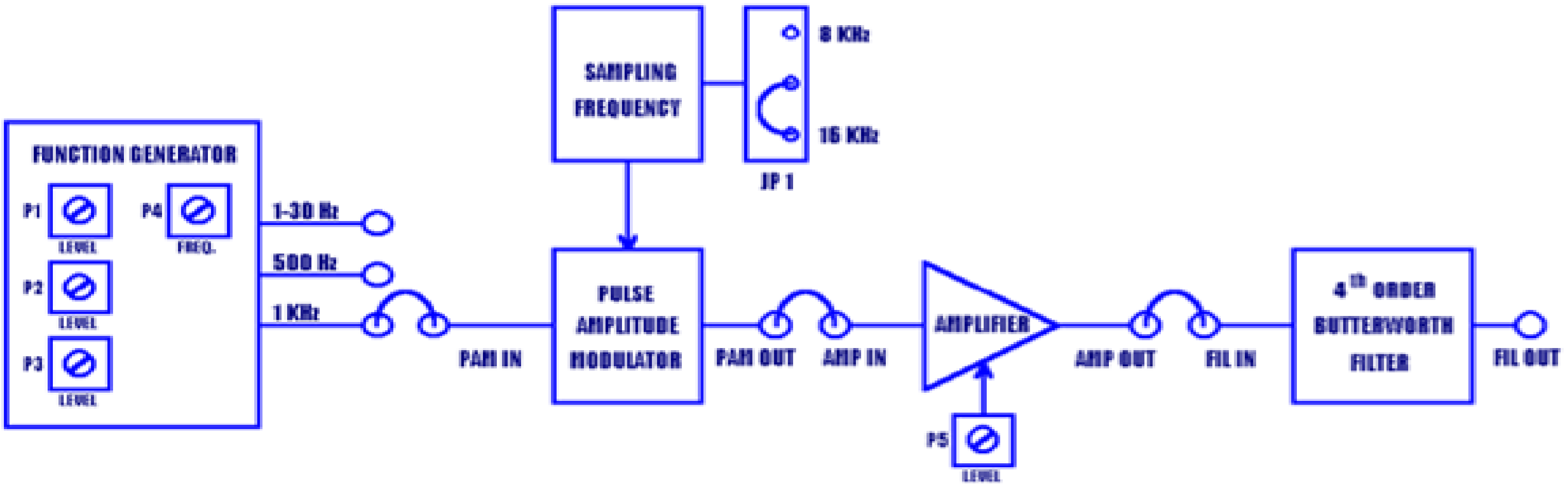
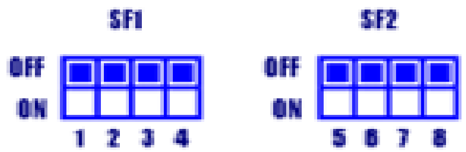


FIG.1 BLOCK DIAGRAM FOR PULSE AMPLITUDE MODULATION AND DEMODULATION



SWITCH FAULTS SELECTION SWITCH

Exp .No: 5 **Date:**

PULSE AMPLITUDE MODULATION AND DEMODULATION

Aim: To generate the Pulse Amplitude modulated signal and degenerate base band signal.

Apparatus required:

S.NO	Apparatus	Ranges	Quantity
1	Pulse amplitude modulation trainer	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

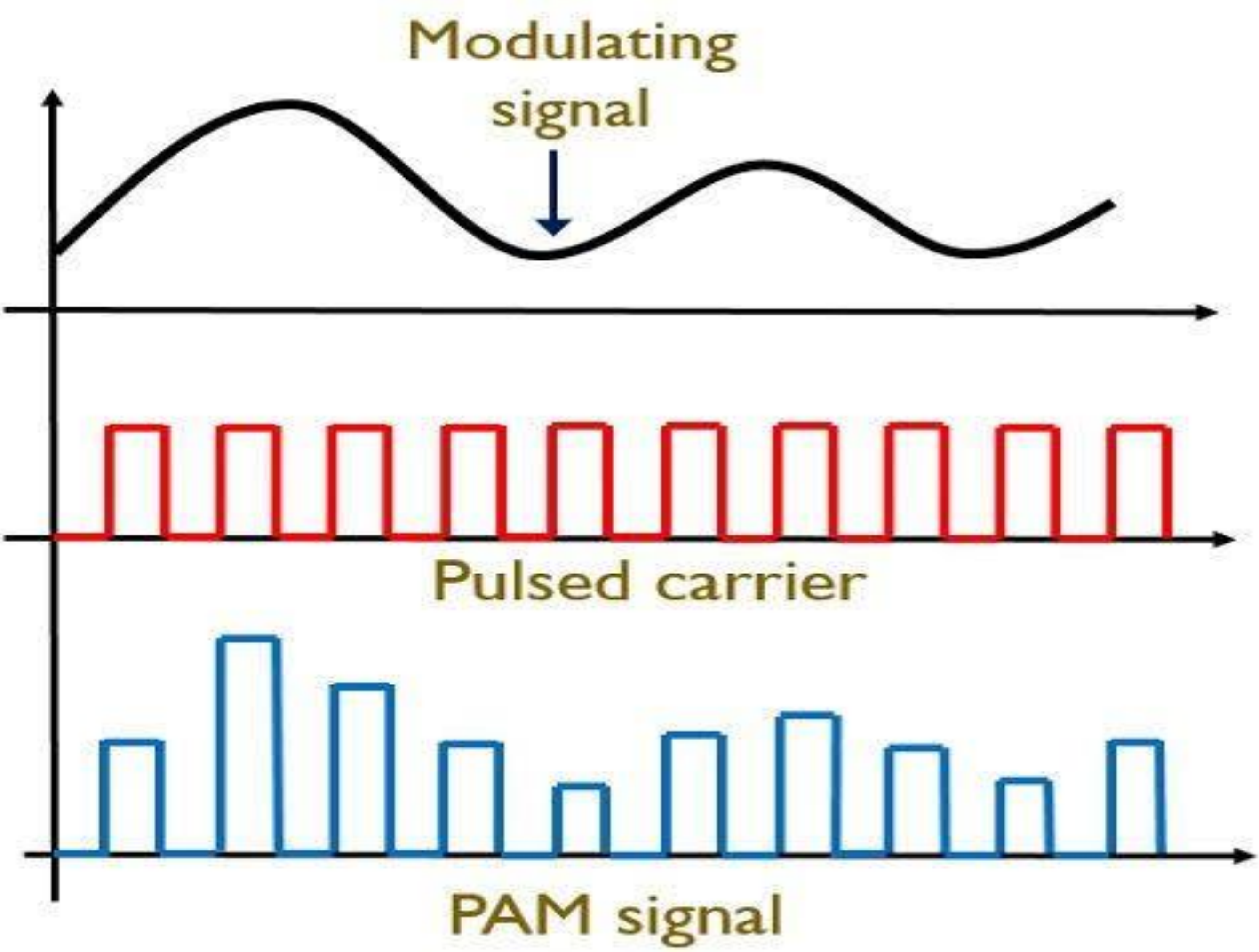
Procedure:

1. Refer to the block diagram and carry out the following connections and switch settings.
2. Connect the Power Supply with proper polarity to the kit DCL-08 and switch it on.
3. Select 16 KHz sampling frequency by jumper JP1.
4. Connect the 1 KHz, 2Vp-p sine wave signal generated onboard to PAM IN Post.
5. Observe the Pulse Amplitude Modulation output at PAM OUT Post.
6. Short the following posts with the Connecting chords provided as shown in block diagram.
7. PAM OUT and AMP IN
8. AMP OUT and FIL IN
9. Keep the amplifier gain control potentiometer **P5** to maximum completely clockwise.
10. Observe the Pulse Amplitude Demodulated signal at **FIL OUT**, which is same as the input signal.

Observations:

Signals	Amplitude(V)	Time Period(s)
Message Signal		
Carrier Signal		
PAM Signal		
De Modulation		

Model waveforms:



Result:

Message Signal:

Amplitude_______________V $_{P-P}$ & Frequency______________KHz

Carrier Signal:

Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz

PAM Signal:

Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz

Demodulated Signal:

Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz

Conclusions:

1.

2.

Viva questions:

1. **What is the practical and theoretical bandwidth of PAM signal?**

2. **What are the different types of sampling and draw the frequency spectrums?**

3. **What are the advantages and disadvantages of PAM system over other systems?**

4. **What is the minimum sampling frequency required to generate PAM?**

5. **What are the applications of PAM?**

Block Diagram for PULSE WIDTH Modulation and Demodulation:

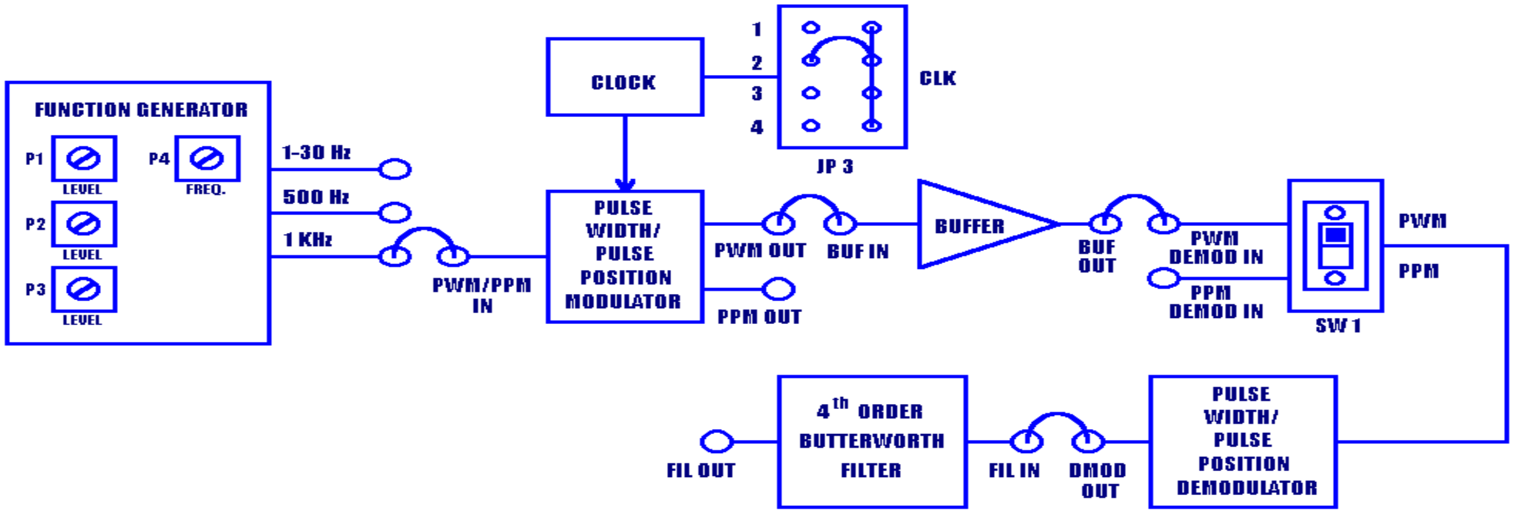


FIG.2 BLOCK DIAGRAM FOR PULSE WIDTH MODULATION AND DEMODULATION

SWITCH FAULTS SELECTION SWITCH

Exp .No: 6 **Date:**

PULSE WIDTH MODULATION AND DEMODULATION

Aim: To generate the pulse width modulated and demodulated signals

Apparatus required:

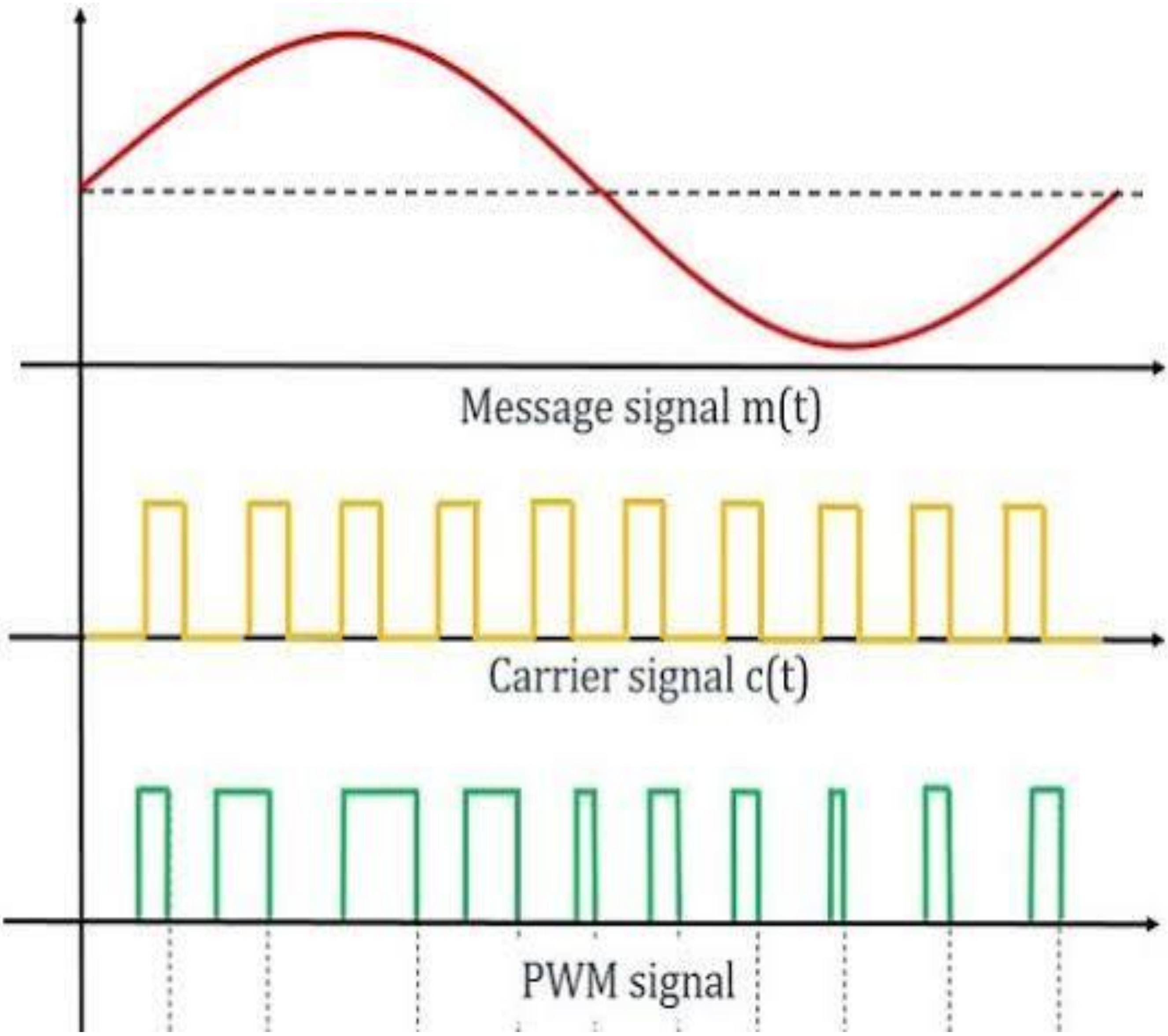
S.NO	Apparatus	Ranges	Quantity
1	Pulse width modulation and Demodulation Trainer.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

Modulation:

1. Refer to the block diagram and carry out the following connections and switch settings.
2. Connect the Power Supply with proper polarity to the kit DCL-08 and switch it on.
3. Put jumper JP3 to 2nd position.
4. Select 1KHZ 1v-pp sine wave signal generated onboard.
5. Connect this signal to PWM/PPM IN.
6. Observe the Pulse Width Modulated output at PWM OUT post. Note that since the sampling frequency is high, only blurred band in waveform will be observed due to persistence of vision. In absence of input signal only square wave of fundamental frequency and fixed on time will be observed and no width variation are present. To observe the variation in pulse width, apply 1-30Hz sine wave signal to PWM/PPM IN post. Vary the frequency from 1-30 Hz.
7. Short the following posts with the Connecting chords provided as shown in block diagram for demodulation section.
8. PWM OUT and BUF IN
9. BUF OUT and PWM DMOD IN
10. DMOD OUT and FIL IN
11. Observe the Pulse Width Demodulated output at FIL OUT.
12. Repeat the experiment for different input signal and different sampling clocks with the help of jumper JP3.

Expected wave forms:



Observations:

Signals	Amplitude(V)	Time Period(s)
Message Signal		
Carrier Signal		
PWM Signal		
De Modulation		

Result:

Message Signal:

Amplitude_______________V $_{P-P}$ & Frequency______________KHz

Carrier Signal:

Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz

PWM Signal:

Amplitude_______________ V $_{P-P}$

Demodulated Signal:

Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz

Conclusions:

1.

2.

Viva questions:

1. **What is the bandwidth of PWM signal?**

2. **Draw the frequency spectrum of PWM signal?**

3. **What is the minimum sampling frequency needed to generate PWM signal?**

4. **Compare PAM, PPM &PWM?**

5. **What are the applications of PWM?**

Block Diagram for PULSE POSITION Modulation and Demodulation:

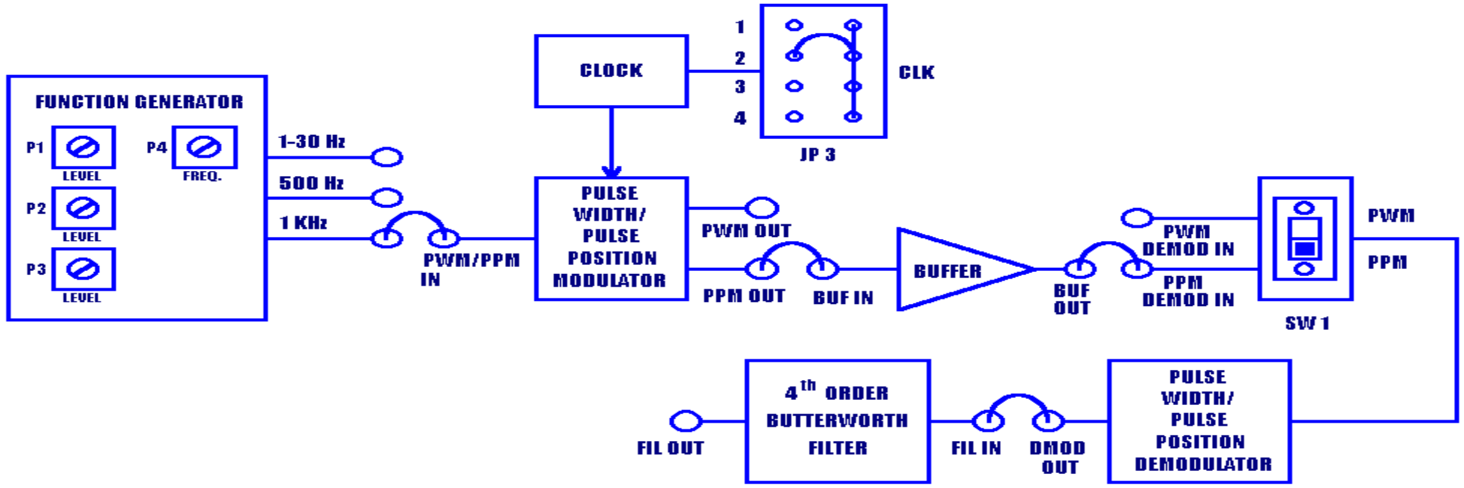


FIG.3 BLOCK DIAGRAM FOR PULSE POSITION MODULATION AND DEMODULATION

SWITCH FAULTS SELECTION SWITCH

Exp .No: 7 **Date:**

PULSE POSITION MODULATION & DEMODULATION

Aim: To generate pulse position modulation and demodulation signals and to study the effect of amplitude of the modulating signal on output.

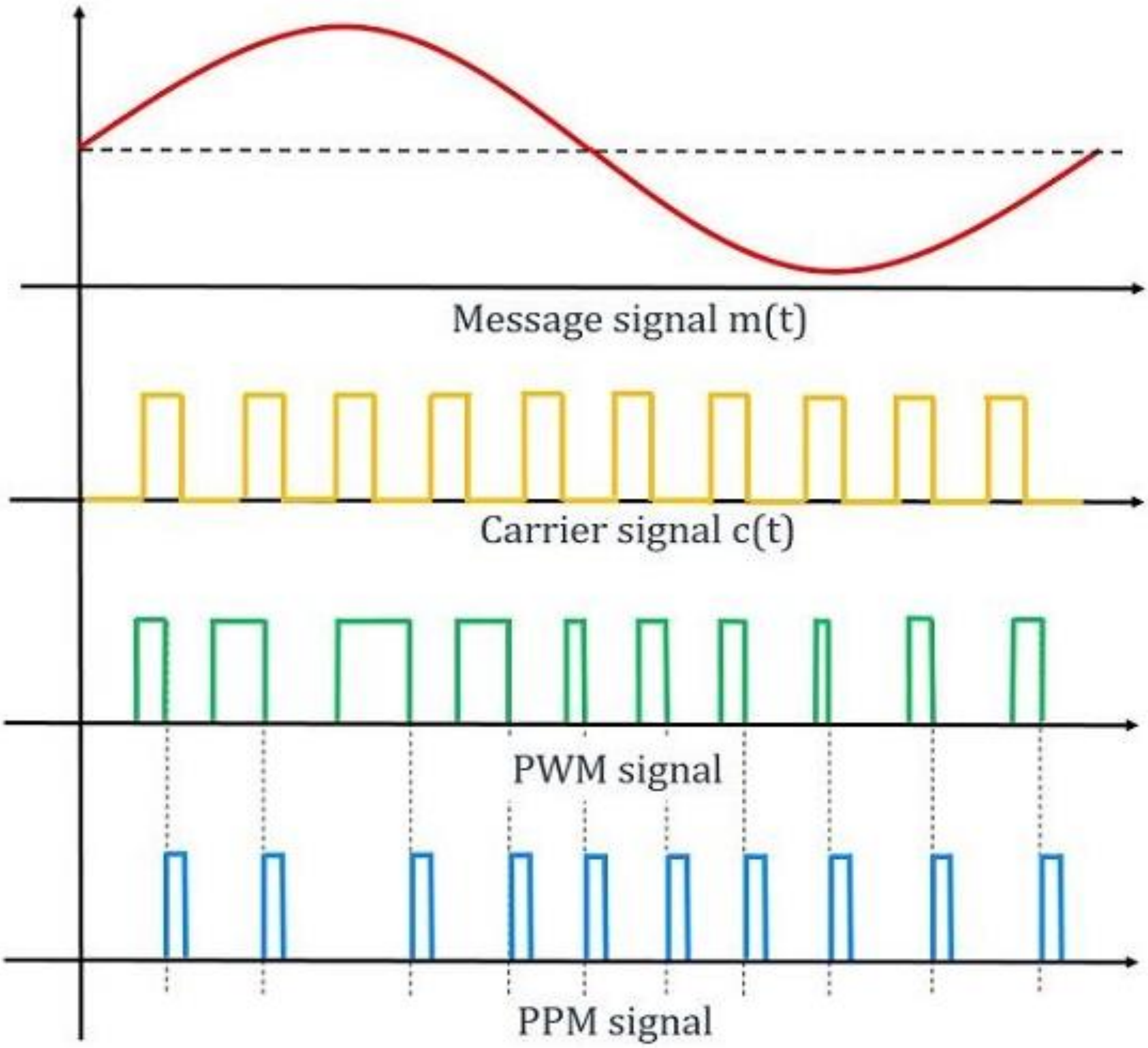
Apparatus required:

S.NO	Apparatus	Ranges	Quantity
1	Pulse position modulation and demodulation trainer.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Refer to the block diagram and carry out the following connections and switch settings.
2. Connect the Power Supply with proper polarity to the kit **DCL-08** and switch it on.
3. Put jumper **JP3** to 2nd position.
4. Select **1KHZ**, 1v-pp sine wave signal generated onboard.
5. Connect the selected signal to the **PWM/PPM IN.**
6. Observe the Pulse Position Modulated output at **PPM OUT** post with shifted position on time scale. Please note amplitude and width of pulse are same and there is shift in position which is proportional to input Analog signal.
7. To observe the variation in pulse positions, apply 1-30Hz sine wave signal to **PWM/PPM IN** post vary the frequency from 1-30 Hz and observe the signal on oscilloscope in dual for posts **PPM OUT** and **PWM OUT** simultaneously.
8. Then short the following posts with the link provided as shown in block diagram for Demodulation section.
    a. **PPM OUT** and **BUFIN**
    b. **BUFOUT** and **PPM DMOD IN**
    c. **DMOD OUT** and **FIL IN**
9. Observe the Pulse Position Demodulated signal at **FIL OUT**.
10. Repeat the experiment at different input signal and different sampling frequencies.

Expected wave forms:



Observations:

Signals	**Amplitude(V)**	**Time Period(s)**
Message Signal		
Carrier Signal		
PPM Signal		
De Modulation		

Result:

Message Signal:
Amplitude_______________V $_{P-P}$ & Frequency______________KHz
Carrier Signal:
Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz
PPM Signal:
Amplitude_______________ V $_{P-P}$
Demodulated Signal:
Amplitude_______________ V $_{P-P}$ & Frequency______________ KHz

Conclusions:

1.

2.

Viva questions:

1. **Define PPM?**
2. **What is the minimum sampling frequency is needed to generate PPM?**
3. **Draw the frequency spectrum of PPM signal?**
4. **What are the applications of PPM?**
5. **What are the advantages and disadvantages of PPM system over other systems?**

PART B

(Fig 1.1)-Block Diagram for NATURAL SAMPLING

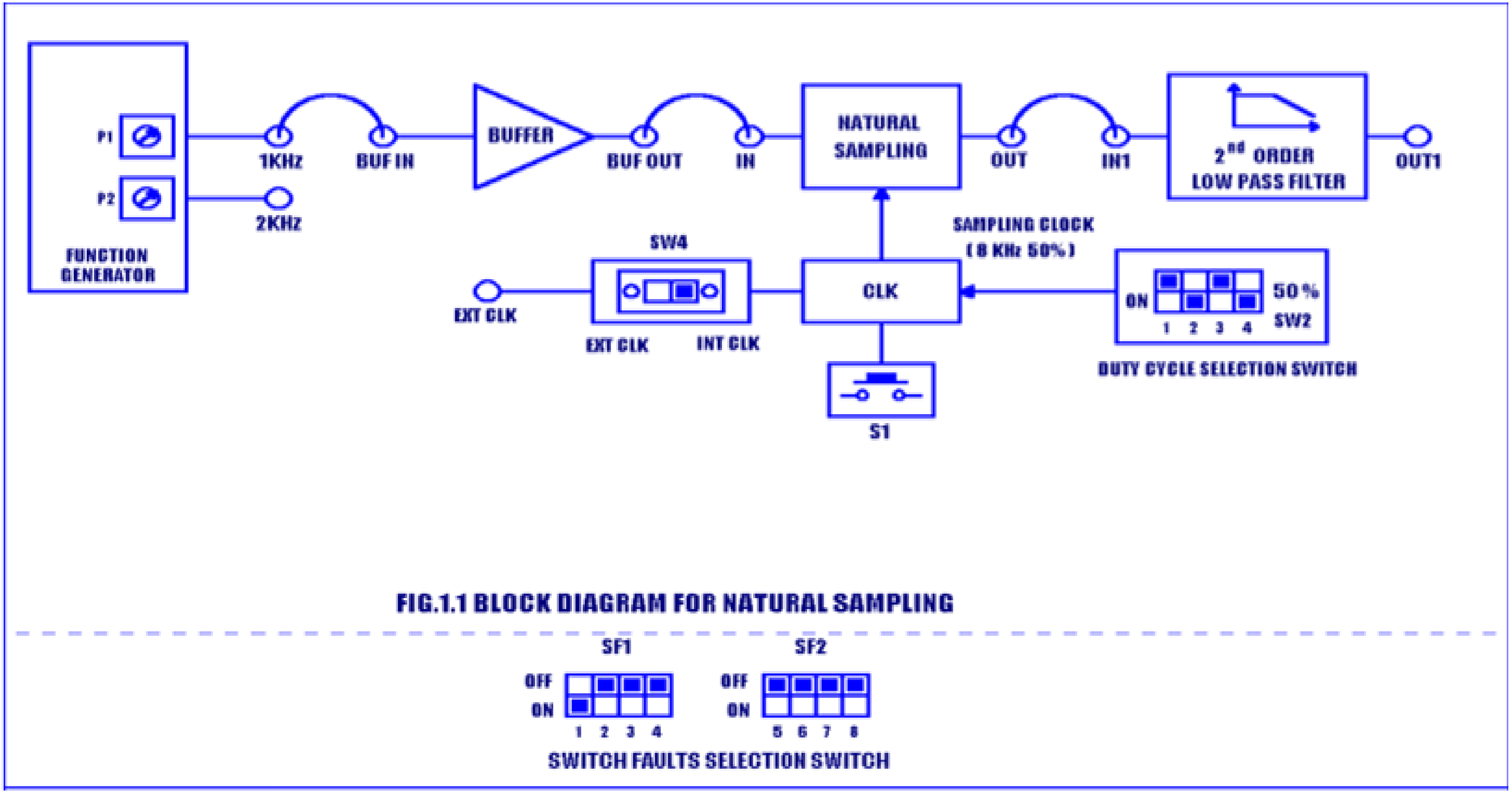


FIG.1.1 BLOCK DIAGRAM FOR NATURAL SAMPLING

(Fig 1.2)-Block Diagram for SAMPLE & HOLD

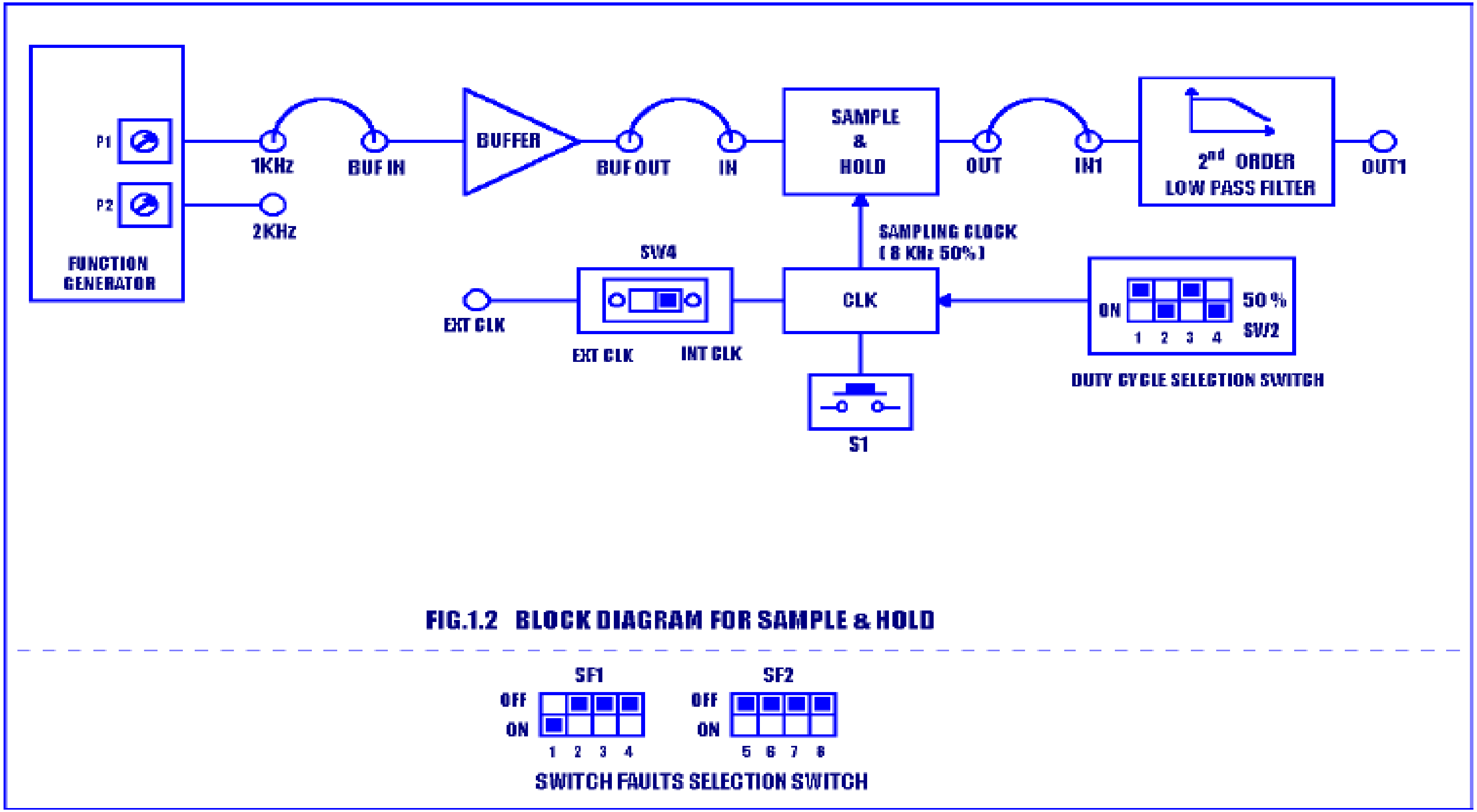


FIG.1.2 BLOCK DIAGRAM FOR SAMPLE & HOLD

(Fig 1.3)-Block Diagram for FLAT-TOP SAMPLING

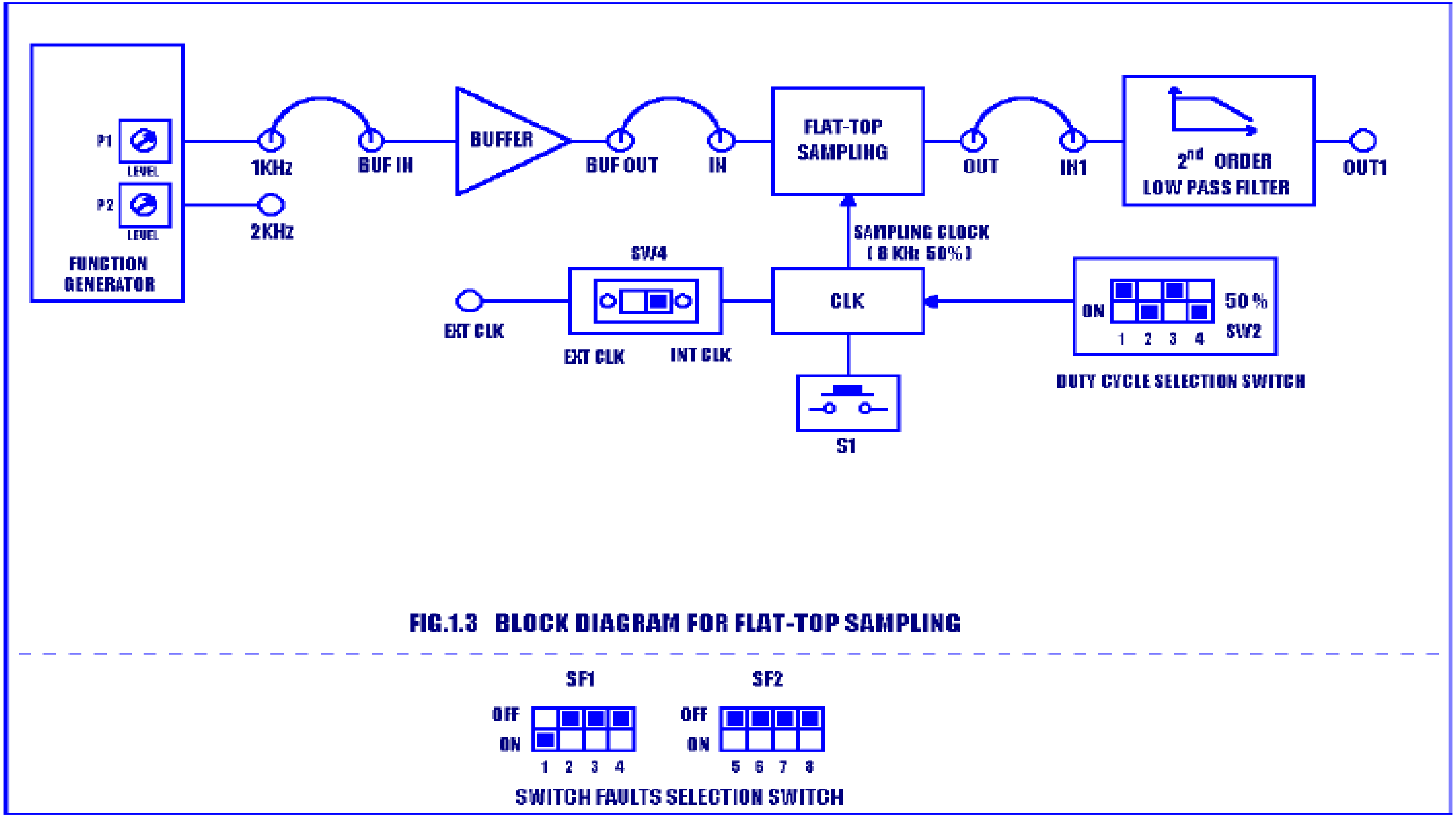


FIG.1.3 BLOCK DIAGRAM FOR FLAT-TOP SAMPLING

Exp .No: 1 **Date:**

SAMPLING THEORM

Aim: To study different types of signal samplings and its reconstruction.

1. Natural sampling. 2. Sample and hold. 3. Flat top sampling.

Equipment Required:

S.No	Apparatus	Ranges	Quantity
1	Experimenter kit DCL-01.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

1. Natural sampling:

Procedure:

1. Refer to the block diagram (Fig 1.1) & carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kit DCL-01 & switch it on.
3. Connect the 1KHz, $5V_{PP}$ Sine wave signal, generated onboard, to the BUF IN post of the BUFFER to the IN post of the Natural Sampling block by means of the Connecting chords provided.
4. Connect the sampling frequency clock in the internal mode INT CLK using switch (SW4).
5. Using clock selector switch (S1) select 8KHz sampling frequency.
6. Using switch SW2 select 50% duty cycle.
7. Connect the OUT post of the Natural sampling block to the input IN1 post of the 2nd Order Low Pass Butterworth Filter and take necessary observation as mentioned below.
8. Repeat the procedure for the 2KHz sine wave signal as input.

Observations:

Observe the following waveforms in order for every setting and plot it on the paper.

a. 1KHz Analog Input waveform.
b. Sampling frequency waveform.
c. Natural sampling signal and its corresponding reconstructed output of 2^{nd} order Low Pass Butterworth Filter.

Switch faults:

Note: Keep the connections as per the procedure. Now switch corresponding fault switch button in ON condition & observe the different effect on the output. The faults are normally used one at a time.

1. Put switch **6** of **SF2** in Switch Fault section to **ON** position. This will open B1 bit from the B input (4-bit DIP switch output) of the comparator. This introduces the fault in duty cycle section. With effect, change in duty cycle will not be observed for (10%, 40%,50%,80% and 90% settings).
2. Put switch **7** of **SF2** in switch fault section to **ON** position. This will open the bypass capacitor of the 2^{nd} order low pass butter worth filter, which results in the induction of ripples at the filter output.
3. Put switch **8** of **SF2** in switch fault section to **ON** position. This removes the capacitor (c6) used in the generation of 1KHz sine wave. Which makes the sine wave signal very distorted. The observation can be made on this signal by changing the sampling frequencies and the duty cycle.

2. Sample and hold and its reconstruction:

Procedure:

1. Refer to the block diagram (Fig 1.2) & carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kit **DCL-01** & switch it on.
3. Connect the **1KHz**,$5V_{PP}$ Sine wave signal, generated onboard, to the **BUF IN** post of the BUFFER to the **IN** post of the Sample and hold block by means of the Connecting chords provided.

4. Connect the sampling frequency clock in the internal mode **INT CLK** using switch **(SW4).**
5. Using clock selector switch **(S1)** select **8KHz** sampling frequency.
6. Using switch **SW2** select **50%** duty cycle.
7. Connect the **OUT** post of the Sample and hold block to the input **IN1** post of the 2nd Order Low Pass Butterworth Filter and take necessary observation as mentioned below (fig 1.5)
8. Repeat the procedure for the 2KHz sine wave signal as input.

Observations:

Observe the following waveforms in order for every setting and plot it on the paper.

a. 1KHz Analog Input waveform.
b. Sampling frequency waveform.
c. Sample and hold signal and its corresponding reconstructed output of 2nd order Low Pass Butterworth Filter.

By changing the position of the switch in the SF1 you are changing the capacitance value of the Sample and Hold circuit, you can find the variation accordingly at the output of the Sample and Hold circuit.

1. Put switch**2** of **SF1** in Switch Fault section to **ON** position, the capacitor C10 (1.5Pf) is at the output of sample and hold circuit.
2. Put switch**3** of **SF1** in Switch Fault section to **ON** position, the capacitor C9 (0.22µf) is at the output of sample and hold circuit.

Switch faults:

1. Put switch **6** of **SF2** in Switch Fault section to **ON** position. This will open B1 bit from the B input (4-bit DIP switch output) of the comparator. This introduces the fault in duty cycle section. With effect, change in duty cycle will not be observed for (10%,40%,50%,80% and 90% settings).
2. Put switch **7** of **SF2** in switch fault section to **ON** position. This will open the bypass capacitor of the 2nd order low pass butter worth filter, which results in the induction of ripples at the filter output.

3. Put switch **8** of **SF2** in switch fault section to **ON** position. This removes the capacitor (c6) used in the generation of 1KHz sine wave. Which makes the sine wave signal very distorted. The observation can be made on this signal by changing the sampling frequencies and the duty cycle.

3. Flat top Sampling and its reconstruction:

Procedure:

Refer to the block diagram (Fig 1.3) & carry out the following connections and switch settings.

1. Connect power supply in proper polarity to the kit **DCL-01** & switch it on.
2. Connect the **1KHz**,5V_{PP} Sine wave signal, generated onboard, to the **BUF IN** post of the BUFFER to the **IN** post of the Flat top Sampling block by means of the Connecting chords provided.
3. Connect the sampling frequency clock in the internal mode **INT CLK** using switch **(SW4).**
4. Using clock selector switch **(S1)** select **8KHz** sampling frequency.
5. Using switch **SW2** select **50%** duty cycle.
6. Connect the **OUT** post of the Flat top Sampling block to the input **IN1** post of the 2nd Order Low Pass Butterworth Filter and take necessary observation as mentioned below (Fig 1.6)
7. Repeat the procedure for the 2KHz sine wave signal as input.

Observations:

Observe the following waveforms in order for every setting and plot it on the paper.

a. 1KHz Analog Input waveform.
b. Sampling frequency waveform.
c. Flat top signal and its corresponding reconstructed output of 2nd order Low Pass Butterworth Filter.

In this manner we observe all the three types of sampling, which can be compared with the waveforms at the end of this experiment.

We observe that, during the ON time of sampling frequency the analog signal is transmitted. During the OFF time, the sample output signal drops towards zero. Whereas for Sampled and

Hold output, the signal maintains the voltage level i.e. the sample is held at last sampled value until next sample arrives. For flat top sampling first switching portion from sample & hold signal is dropped and next switching portion is taken as pulse output, i.e, only hold portion from sample & hold signal is taken at flat top sampling output.

Switch faults:

1. Put switch **5** of **SF2** in Switch Fault section to **ON** position. This will open the capacitor C12 of the Flat Top sampling circuit, which makes the flat top sample output appears to be slant.
2. Put switch **6** of **SF2** in Switch Fault section to **ON** position. This will open B1 bit from the B input (4-bit DIP switch output) of the comparator. This introduces the fault in duty cycle section. With effect, change in duty cycle will not be observed for (10%,40%,50%,80% and 90%)will not be observed as expected.
3. Put switch **7** of **SF2** in switch fault section to **ON** position. This will open the bypass capacitor of the 2nd order low pass butter worth filter, which results in the induction of ripples at the filter output.
4. Put switch **8** of **SF2** in Switch Fault section to **ON** position. This will removes the capacitor(C6) used in the generation of 1KHz sine wave. Which makes the sine wave signal very distorted. The observation can be made on this signal by changing the sampling frequencies and the duty cycle.

Model Graphs:

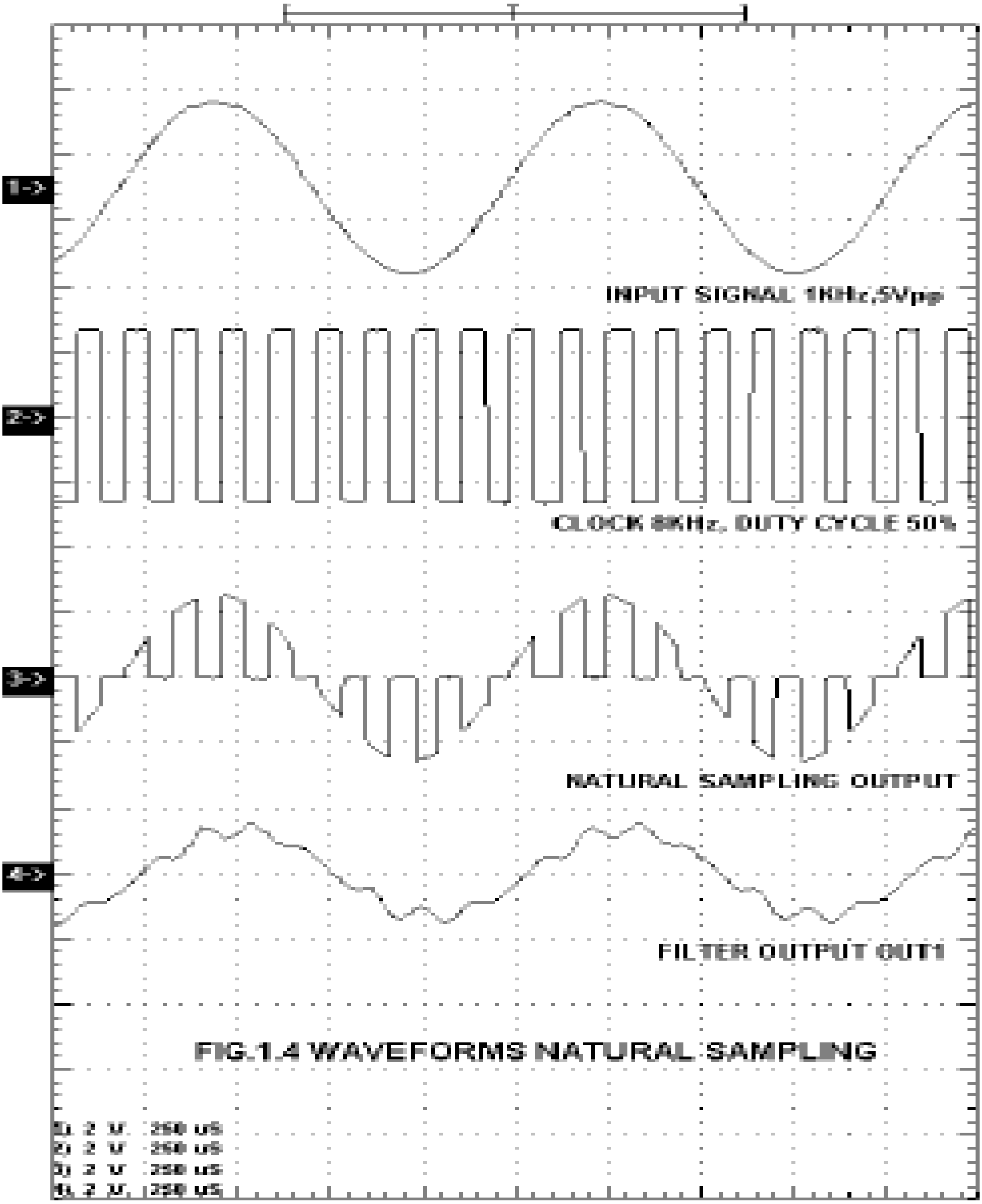


FIG.1.4 WAVEFORMS NATURAL SAMPLING

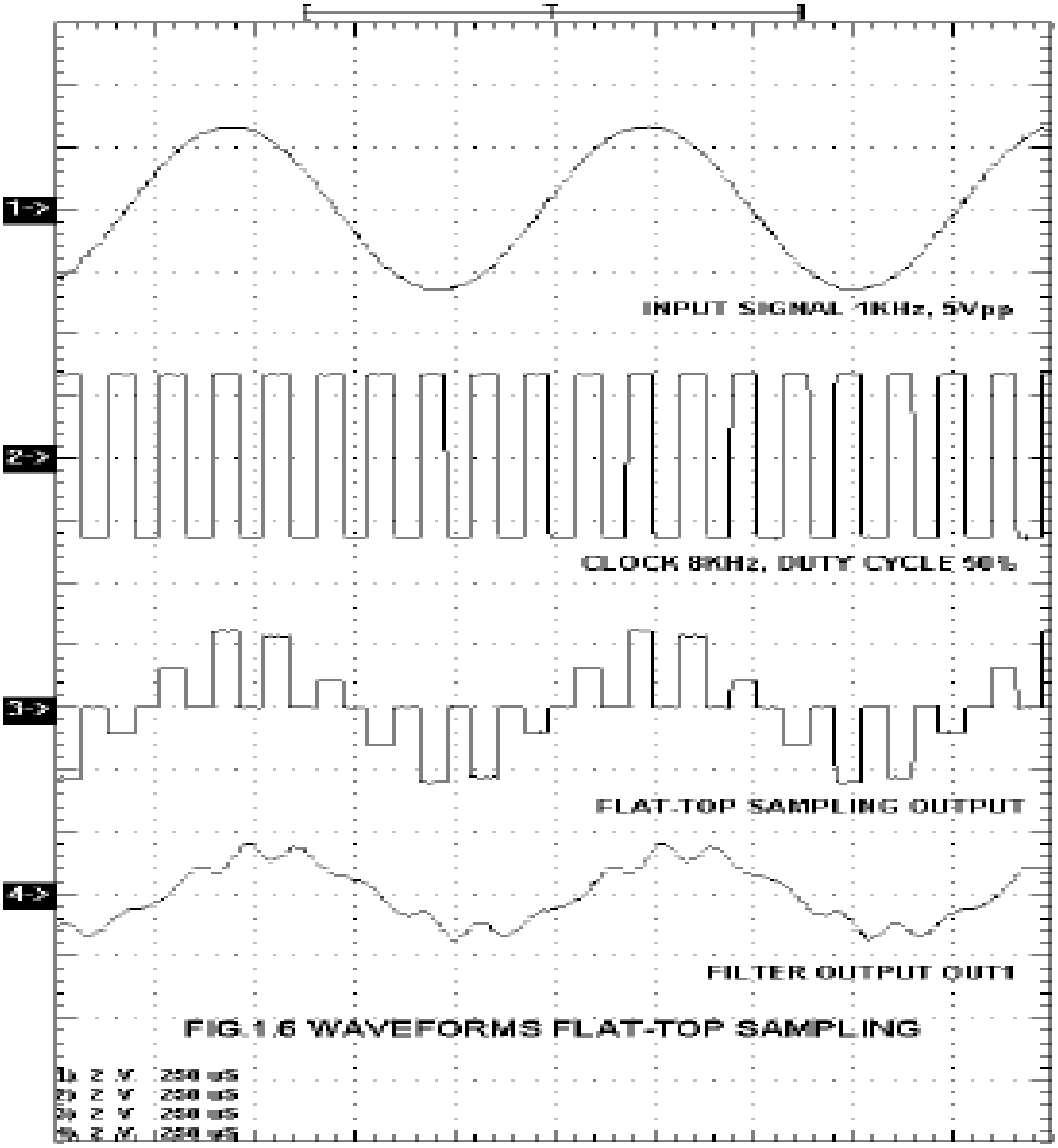


FIG.1.6 WAVEFORMS FLAT-TOP SAMPLING

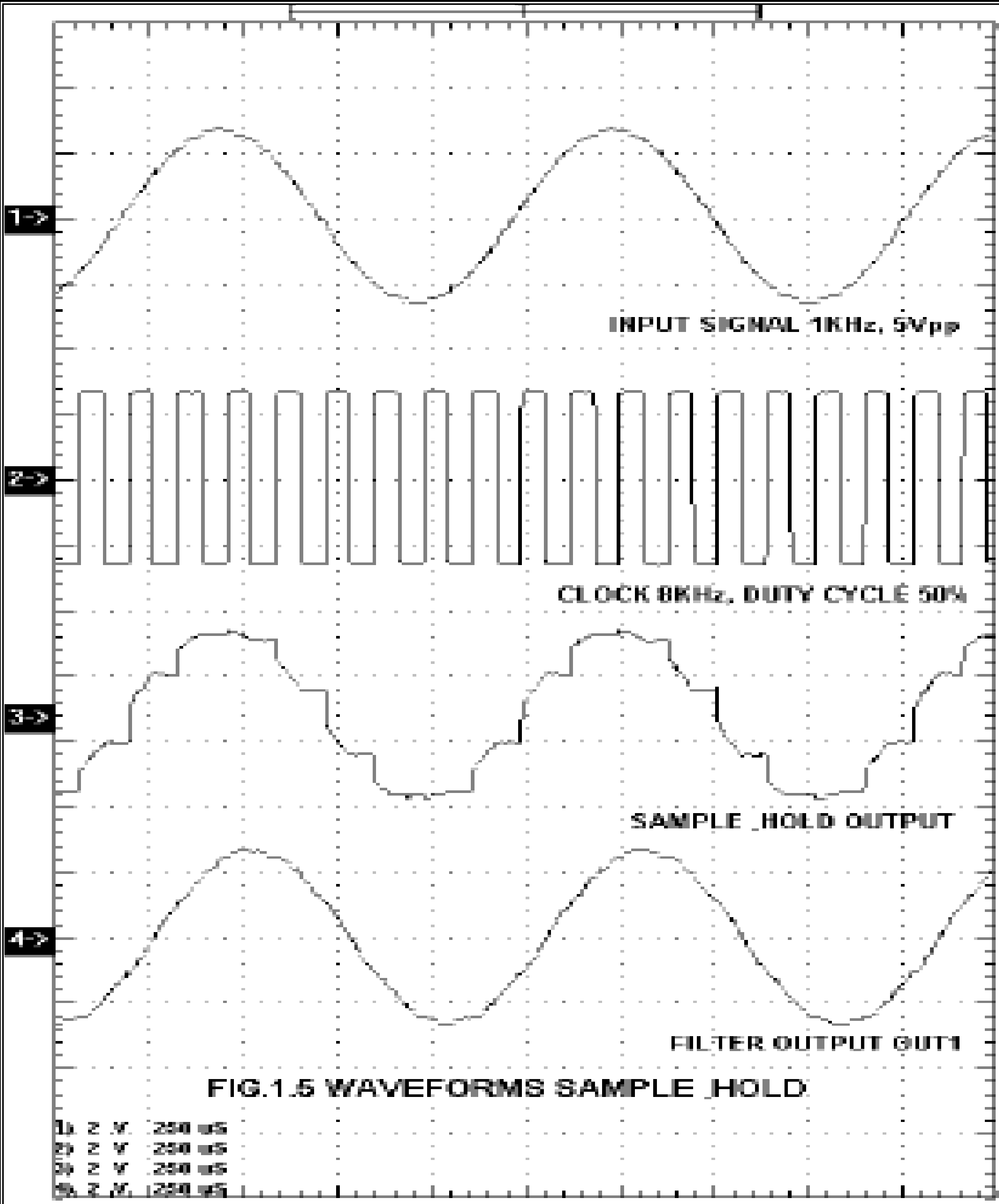


FIG.1.5 WAVEFORMS SAMPLE _HOLD

Result:

Conclusion:

Viva-voce:

1. **Define sampling theorem?**

2. **What is nyquist rate?**

3. **What is aliasing effect? How to overcome it?**

4. **Draw the frequency spectrum of sampled signal for sampling frequency above, below and equal to twice the modulating signal frequency?**

5. **Compare natural, sample and hold and flat-top sampling?**

Block Diagram for Time Division Multiplexing

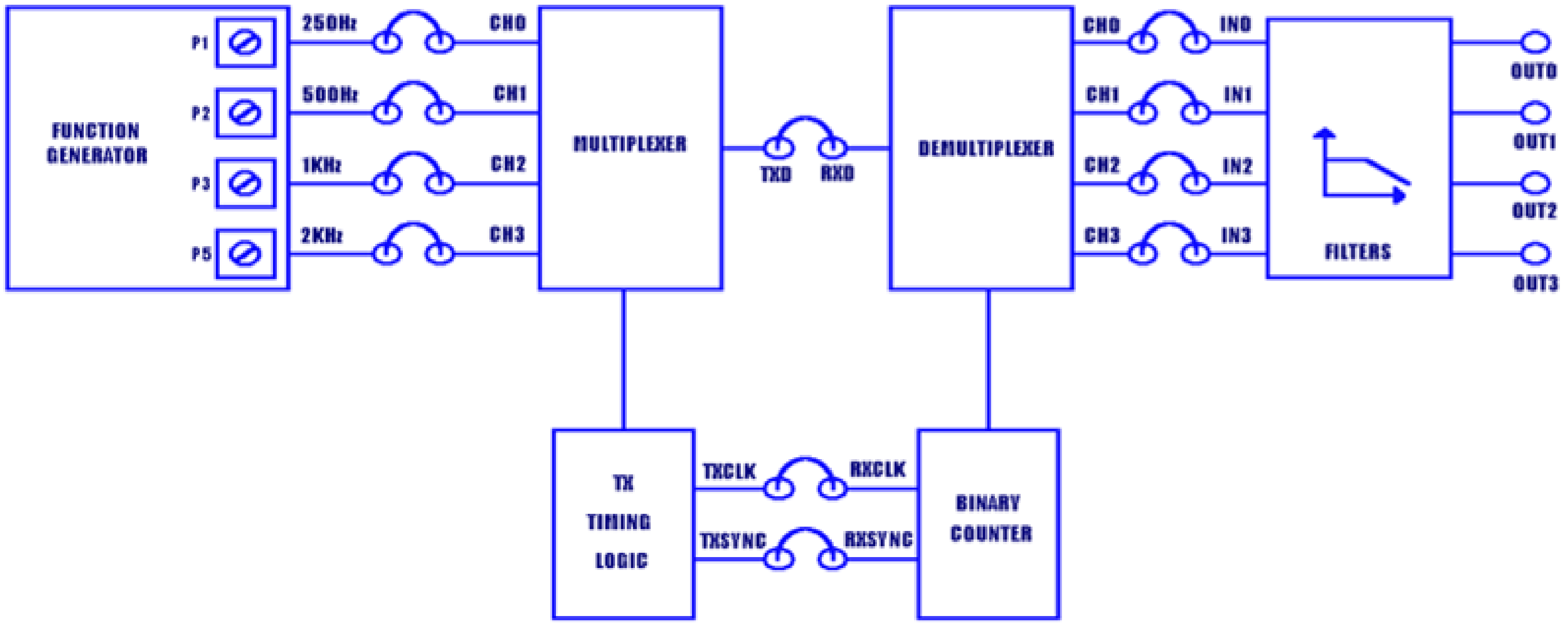
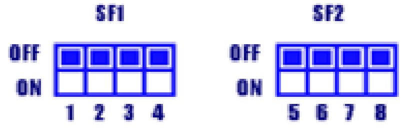


FIG.1 BLOCK DIAGRAM FOR EXP.1



SWITCH FAULTS SELECTION SWITCH

Exp .No: 2 **Date:**

TIME DIVISION MULTIPLEXING

Aim: To verify the functionality of time division multiplexing and demultiplexing circuit practically.

Equipments Required:

S.No	Apparatus	Ranges	Quantity
1	Experimenter kit DCL-02.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Refer the block diagram and carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kit DCL-02 & switch it in.
3. Connect 250 Hz, 500 Hz, 1 KHz, and 2 KHz sine wave signal from the function generator to the multiplexer input channel CH0, CH1, CH2, CH3 by means of the connecting chords provided.
4. Connect the multiplexer output TXD of the transmitter section to the demultiplexer input RXD to the receiver section.
5. Connect the output of the receiver section CH0, CH1, CH2, CH3 to the IN0, IN1, IN2, IN 3 of the filter section.
6. Connect the sampling clock TX CLK and channel identification Clock TXSYNC of the transmitter section to the corresponding RX CLK and RXSYNC of the receiver section respectively.
7. Set the amplitude of the input sine wave as desired.
8. Take the observation as mentioned below.

Model Graphs:

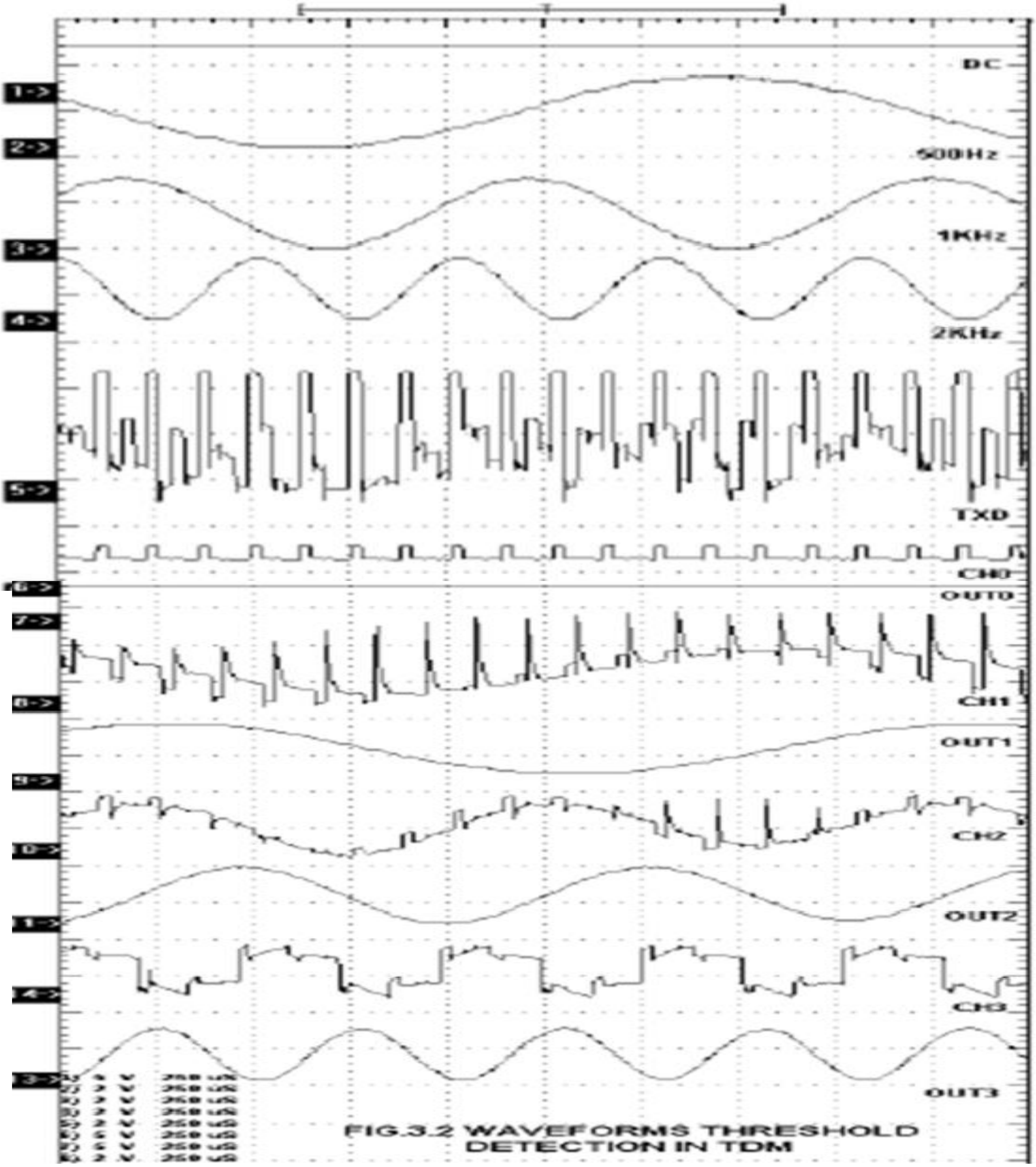


FIG.3.2 WAVEFORMS THRESHOLD DETECTION IN TDM

Observations:

Signals	Amplitude(V)	Time Period(s)
250Hz		
500HZ		
1 KHz		
2 KHz		
TX CLK		
RX CLK		
TXD		
RXD		
CH0		
CH1		
CH2		
CH3		
OUT0		
OUT1		
OUT2		
OUT3		

Result:

Conclusion:

Viva-voce:

1. **What is Time Division Multiplexing?**

2. **What is the primary advantage of TDM?**

3. **What are the differences between TDM and FDM? Which one is better?**

4. **What is the bandwidth requirement of TDM and FDM?**

5. **What is the drawback of sampling process that can be overcome by TDM?**

BLOCK DIAGRAM FOR DELTA MODULATION

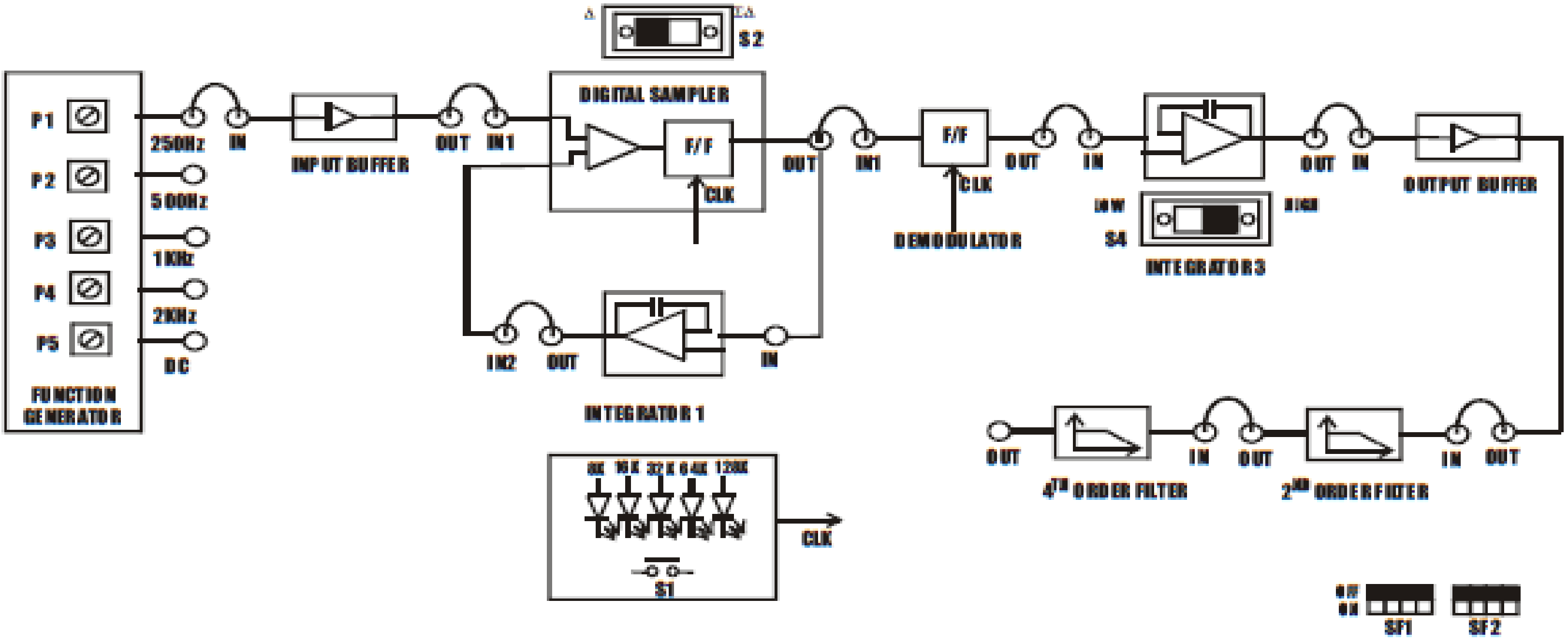


FIG.1.3 BLOCK DIAGRAM FOR DELTA MODULATION AND DEMODULATION

Exp .No: 3 **Date:**

DELTA MODULATION AND DEMODULATION

Aim: To verify the operation of Delta modulation and demodulation practically.

Equipment Required:

S.No	Apparatus	Ranges	Quantity
1	DCL-07 Kit.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Refer to the block diagram and carry out the following connections and switch techniques.
2. Connect power supply in proper polarity to the kit DCL-07 and switch it ON.
3. Select sine wave input 250Hz of 0V through pot P1 and connects post 250Hz to post IN of input buffer.
4. Connect output of buffer post OUT to digital sampler input post IN1.
5. Then select clock rate of 8KHz by pressing switch S1 selected clock is indicated by LED glow.
6. Keep switch S2 in delta position.
7. Connect output of Digital sampler post OUT to input post IN of integrator 1.
8. Connect output of integrator 1 post OUT to input post IN2 of digital sampler.
9. Then observe the delta modulated output at output of digital sampler post OUT and compare it with the clock rate selected. It is half the frequency of clock rate selected.
10. Observe the integrator output test point. It can be observe that as the clock rate is increased amplitude of triangular waveform decreases. This is called minimum step size. These waveforms are as shown below. Then increase the amplitude of 250Hz sine wave up to 0.5v. signal approximating 250Hz is available at the integrator output. This signal is obtained by integrating the digital output resulting from delta modulation.
11. Then go on increasing the amplitude of selected signal through the respective pot from 0 to 2V. it can be observed that the digital high makes the integrator output to go upward

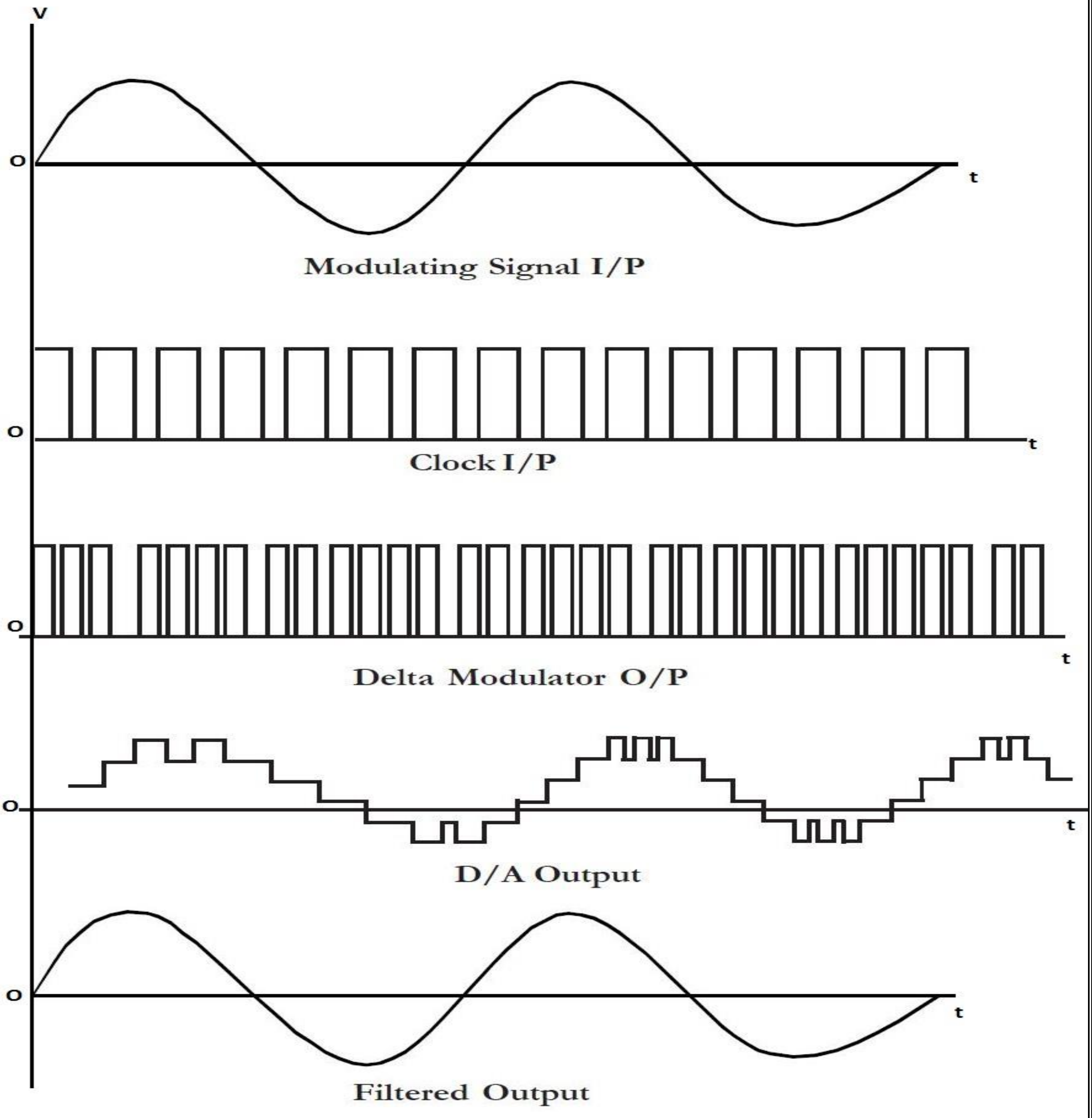
and digital low makes the integrator output to go downwards. Observe that the integrator output follow the input signal. The waveforms are as shown in fig. observe the waveforms at various test-points in the delta modulator section.

12. Increase the amplitude of 250Hz sine wave through pot P1 further high and observe that the integrator output cannot follow the input signal. state the reason.
13. Repeat the above mention procedures with different signal sources and selecting the different clock rates and observe the response of delta modulator.
14. Connect delta modulated output post OUT of digital sampler to the input of delta demodulator section post IN of demodulator.
15. Connect output of Demodulator post OUT to the input of integrator 3 post IN.
16. Connect output of integrator 3 post OUT to the input of output buffer post IN.
17. Connect output of output buffer post OUT to the input of 2nd order filter post IN.
18. Connect output of 2nd order filter post OUT to the input of 4th order filter post IN.
19. Keep switch S4 in HIGH position.
20. Then observed various tests points in delta demodulator section and observe the reconstructed signal through 2nd order filter and 4th order filter. Observe the waveforms as shown in fig.

Observations:

Signals	**Amplitude(v)**	**Time period(s)**
250 Hz		
Digital Sampler Output		
Integrator 3 Output		
Filter Output		

Model Graphs:



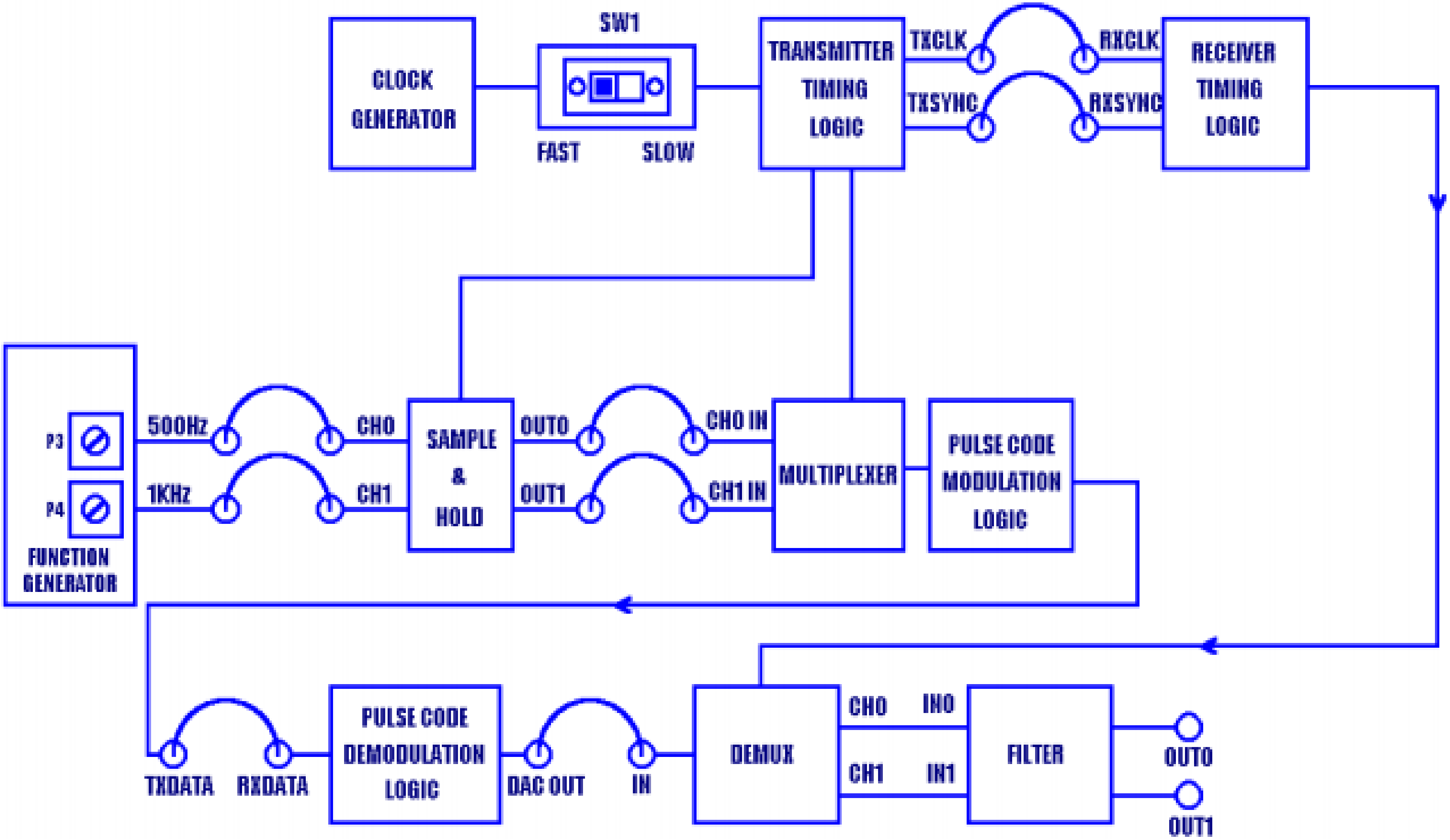
Result:

Conclusion:

Viva-voce:

1. **Write the expression for bandwidth of DM signal?**
2. **What are the advantages & disadvantages of DM over PCM?**
3. **How many no. of quantization levels are used in DM?**
4. **Write the expression for both quantization and channel noise in DM systems?**
5. **What are the drawbacks in DM and how they are reduced?**

Block diagram of PCM modulation & Demodulation



Exp .No: 4 **Date:**

PCM MODULATION AND DEMODULATION

Aim: To verify the functionality of each block in pulse code modulation and demodulation system practically.

Equipment Required:

S.No	Apparatus	Ranges	Quantity
1	PCM Modulator and Demodulator trainer kit	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Refer the block diagram and carry out the following connections.
2. Connect power supply in proper polarity to the kit DCL-03 and DCL-04 & switch it in.
3. Connect 500 Hz and 1 KHz sine wave signal from the function generator to the input channel CH0 and CH1of the sample and hold logic.
4. Connect OUT 0 to CH0 IN and OUT 1 to CH1 IN.
5. Set the speed selection switch SW1 to FAST mode.
6. Connect TXDATA, TXCLK and TXSYNC of the transmitter section DCL-03 to the corresponding RXDATA, RXCLK, and RXSYNC of the receiver section DCL-04.
7. Connect posts DAC OUT to IN post of demultiplexer section on DCL-04.
8. Take the observations as mentioned below.

Observations:

Signals	Amplitude(V)	Time Period(s)
500 Hz		
1 HZ		
OUT 0		
OUT 1		
CLK 1		
CLK 2		
MUX OUT		
DAC OUT		
CLK 1		
CLK 2		
CH 0		
CH 1		
OUT0		
OUT1		

Model waveforms:

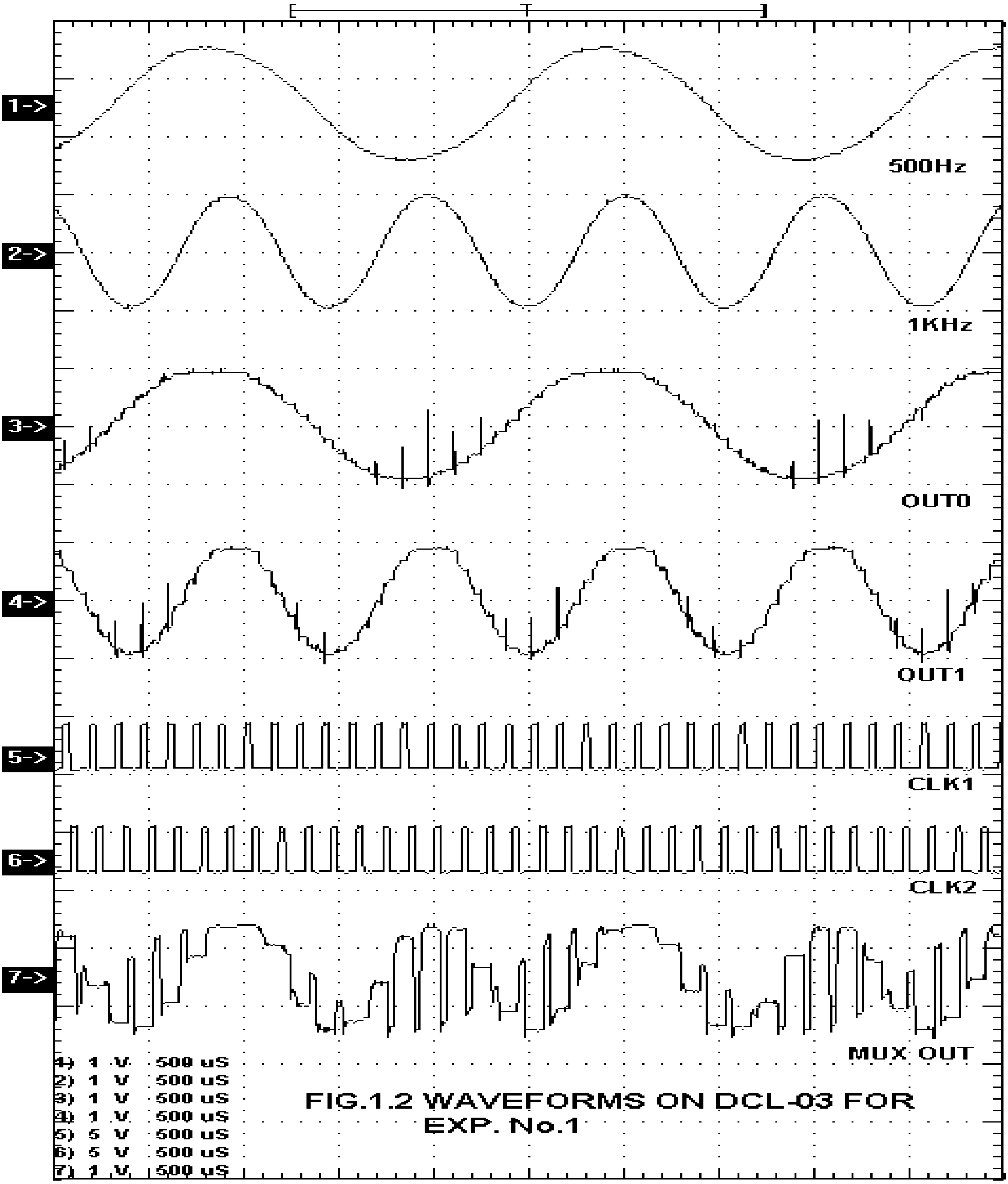


FIG.1.2 WAVEFORMS ON DCL-03 FOR EXP. No.1

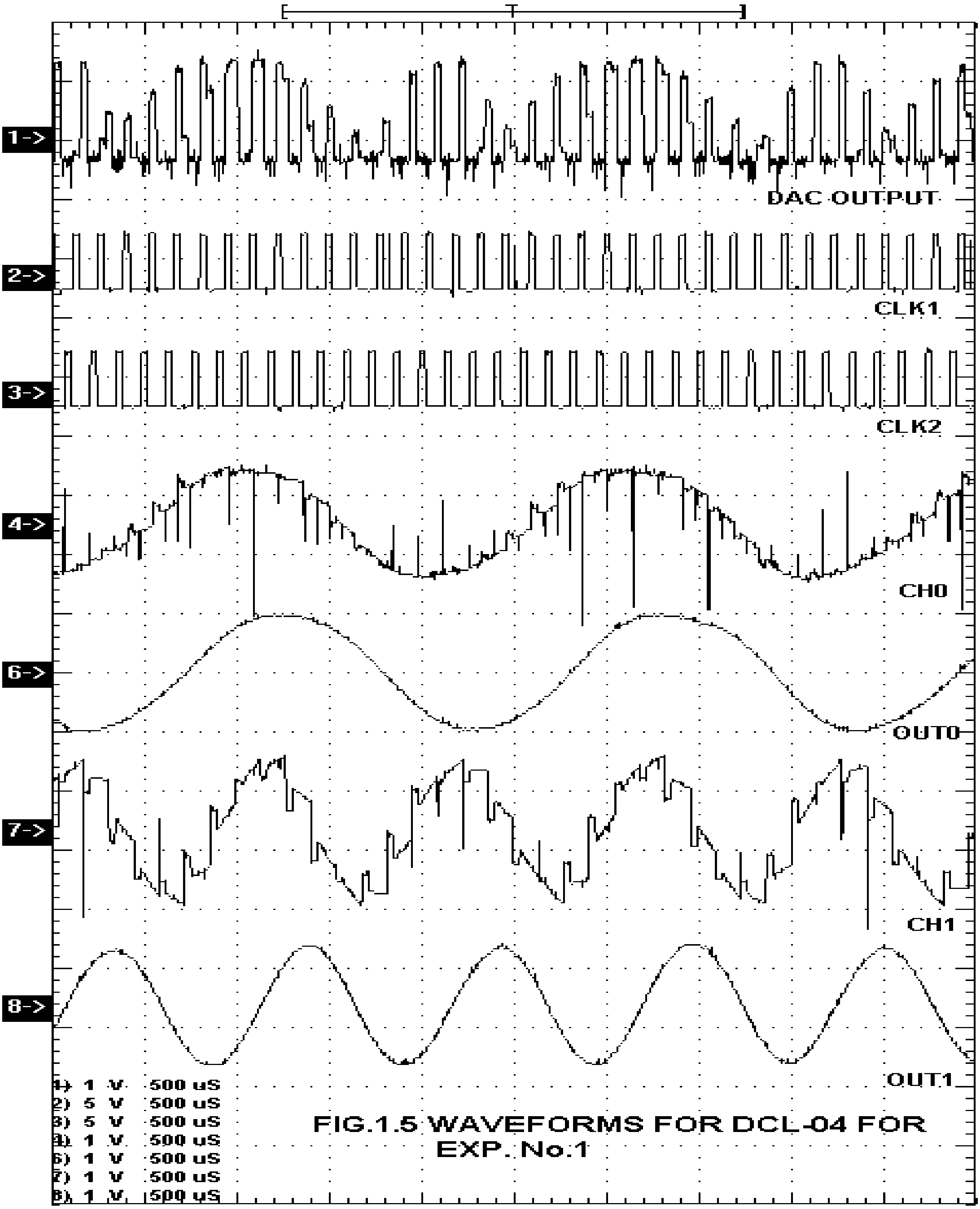


FIG.1.5 WAVEFORMS FOR DCL-04 FOR EXP. No.1

Result:

Conclusion:

Viva-voce:

1. **What is meant by PCM?**

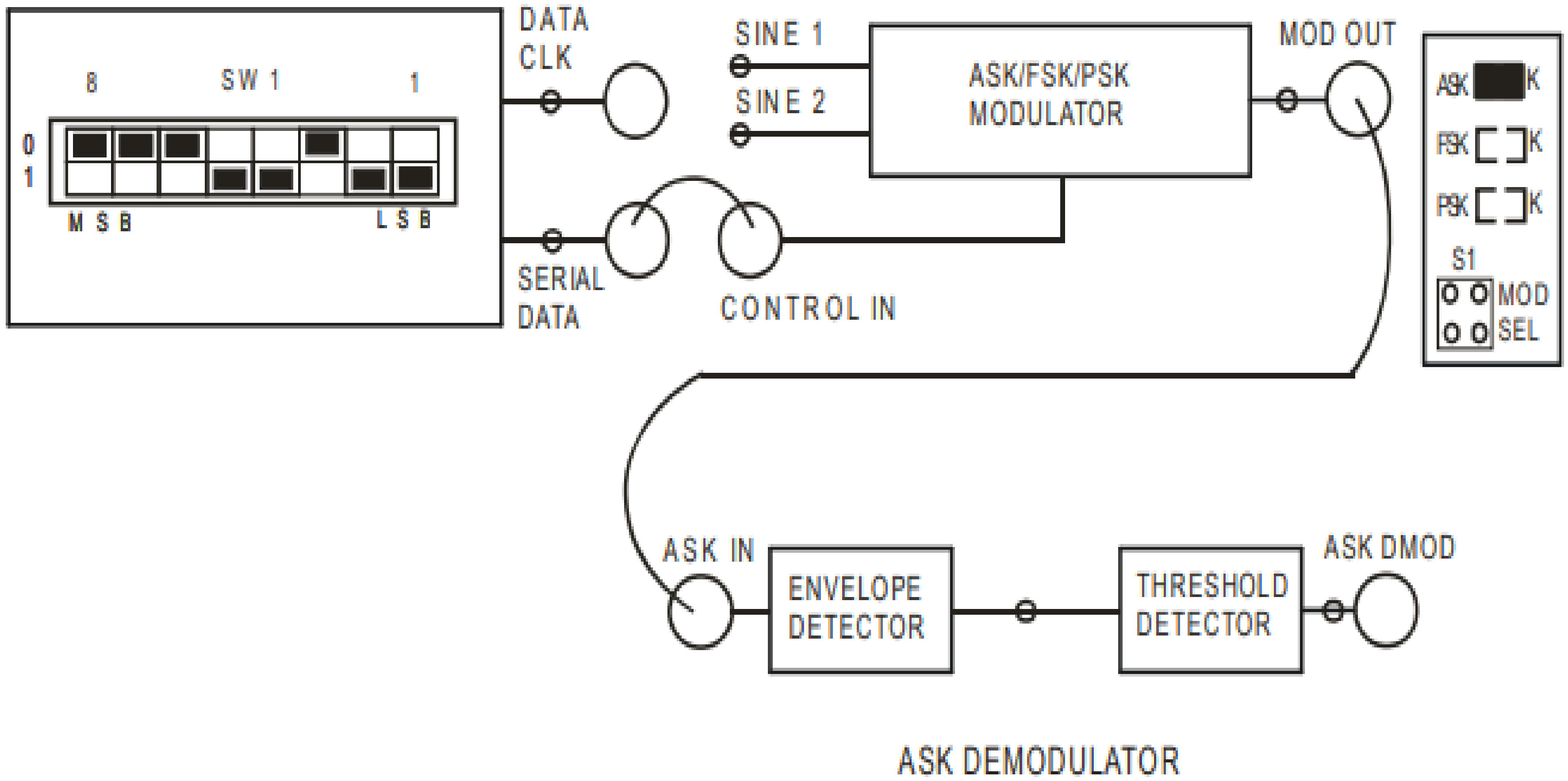
2. **What is meant by Sampler, quantizer and encoder?**

3. **What are the advantages and disadvantages of PCM over DM?**

4. **What are the applications of PCM?**

5. **What is the improvement in S/N ratio in PCM if no. of bits allocated for sample is incremented by one?**

Block diagram for BASK Modulation and Demodulation technique



Exp .No: 5 **Date:**

BASK MODULATION AND DEMODULATION

Aim: To design and verify the working principle of BASK modulation and demodulation with suitable setup.

Equipments:

S.No	Apparatus	Ranges	Quantity
1	Experimental Kit DCL-06.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kit DCL-06 and switch it on.
3. Connect SERIAL DATA generated on board to CONTROL IN of CARRIER MODULATOR.
4. Select ASK modulation using switch S1, the ASK LED will glow.
5. Observe the waveforms at SINE1, SINE2 and MOD OUT. DCL-06: ASK / PSK / FSK MODULATION /DEMODULATION KIT V-17.0 - 22 - DIGITAL COMMUNICATION LAB
6. Connect ASK modulated signal MOD OUT to the ASK IN of the ASK DEMODULATOR.
7. Observe various waveforms as mentioned below.

Observations:

Observe the following signal on the oscilloscope and plot it on the paper.

1. SERIAL DATA with respect to DATA CLK. FIG. 5.2(a)
2. SINE 1(1.024 MHz) and SINE 2 (no signal i.e. grounded). FIG. 5.2(b)
3. ASK modulated signal MOD OUT with respect to CONTROL IN. FIG. 5.2(c)
4. Output of ENVELOPE DETECTOR with respect to ASK IN. FIG. 5.2(d)
5. ASK DMOD with respect to CONTROL IN. FIG. 5.2(e)

Model graphs:

CH 1: DATA CLK (256 KHz) &
CH 2: SERIAL DATA (00011011)

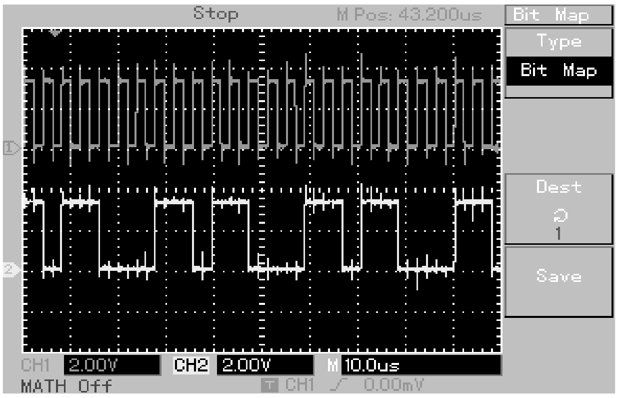


Fig. 5.2(a)

CH 1: SINE 1 (1.024MHz, 0°) &
CH 2: SINE 2 (GND)

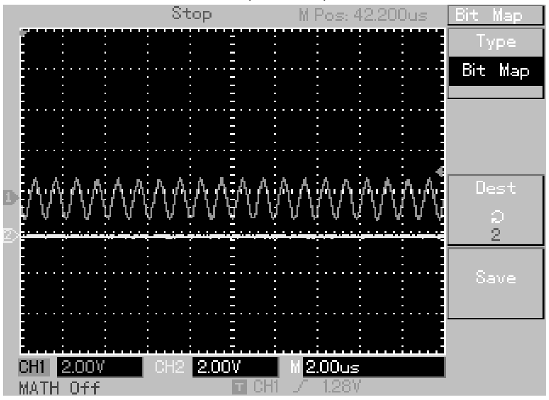


Fig. 5.2(b)

CH 1: CONTROL IN &
CH 2: MOD OUT (ASK)

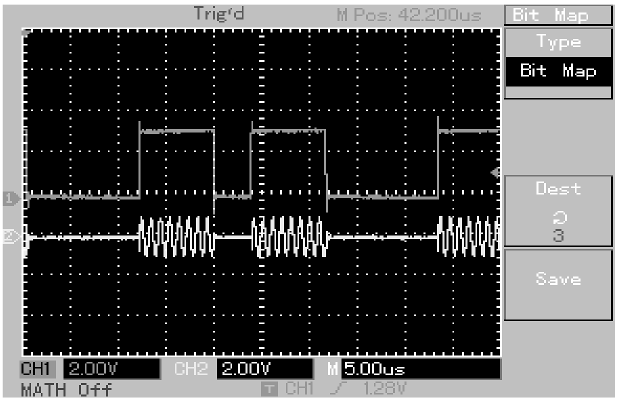


Fig. 5.2(c)

CH 1: ASK IN &
CH 2: Output of ENVELOPE DETECTOR

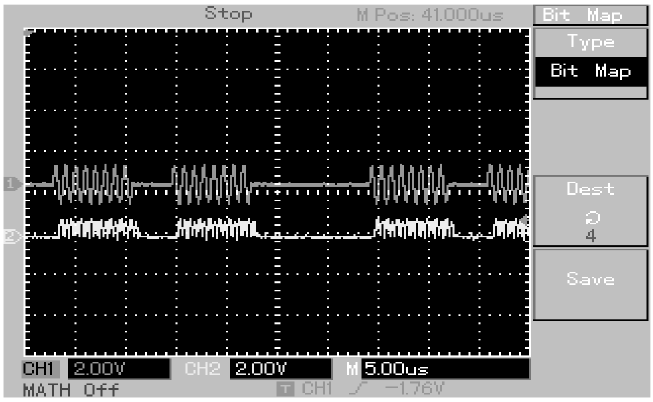


Fig. 5.2(d)

CH 1: CONTROL IN & CH 2: ASK DMOD

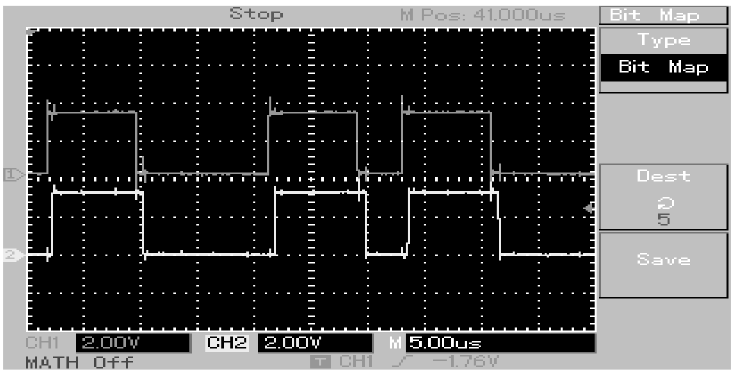


Fig. 5.2(e)

Result:

Conclusion:

Viva-voce:

1. **What is the difference between Base Band and Pass Band Data Transmission system?**

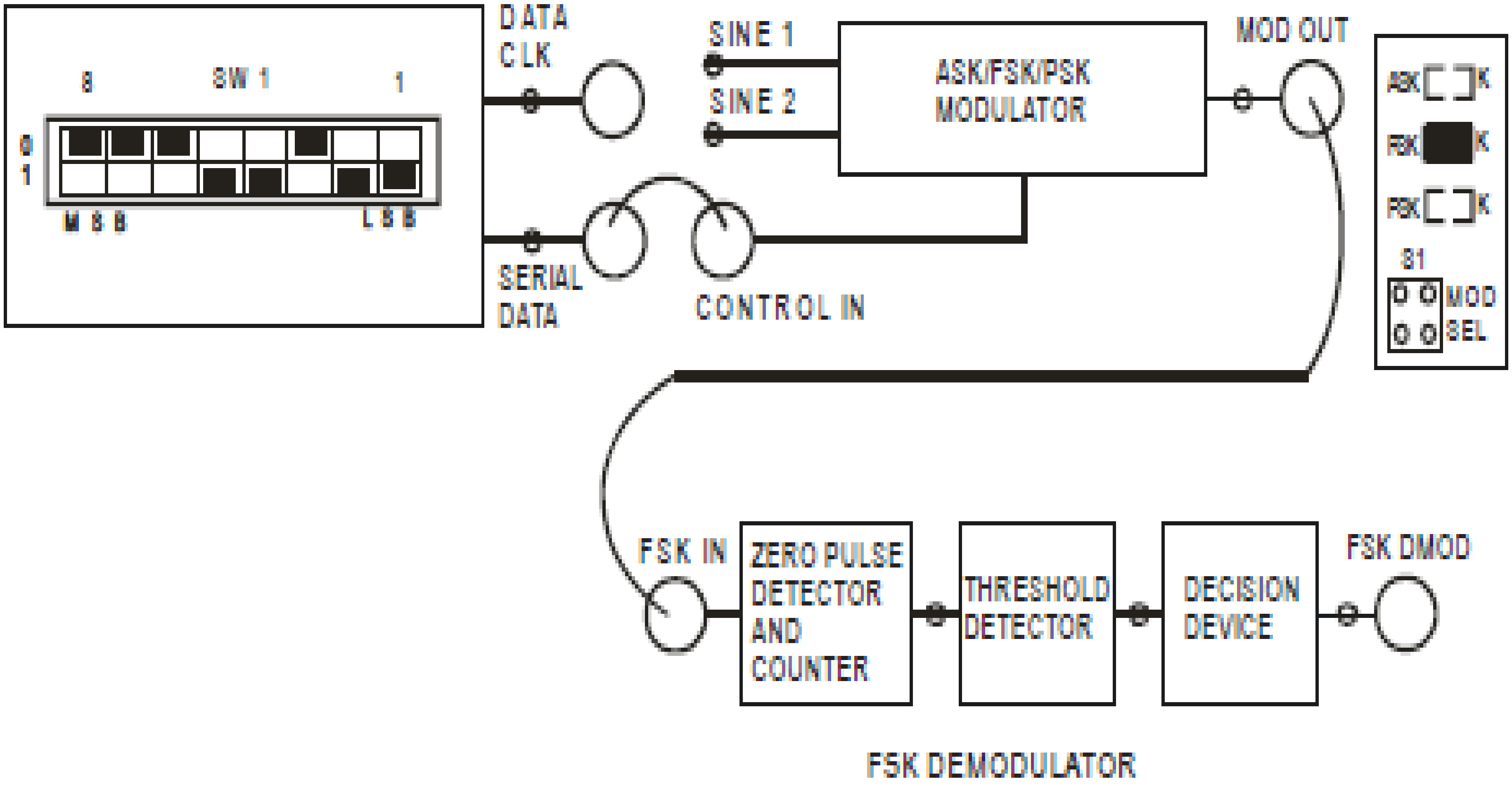
2. **What is meant by BASK?**

3. **What are the advantages and disadvantages of BASK when compared with other digital carrier modulation techniques?**

4. **Write the expression for bit probability and bandwidth of BASK signal?**

5. **Why is ASK called as ON-OFF keying?**

BLOCK DIAGRAM FOR BFSK MODULATION AND DEMODULATION



Exp .No: 6 **Date:**

BFSK MODULATION AND DEMODULATION

Aim: To design and verify the working principle of BFSK modulation and demodulation with suitable setup.

Equipments Required:

S.No	Apparatus	Ranges	Quantity
1	Experimental Kit DCL-06.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kit **DCL-06** and switch it on.
3. Connect **SERIAL DATA** generated on board to **CONTROL INPUT** of **CARRIER MODULATOR.**
4. Select FSK modulation using switch S1, the FSK LED will glow.
5. Observe the waveforms at SINE 1,SINE 2 and MOD OUT.
6. Connect FSK modulated signal **MOD OUT** to the **FSK IN** of the **FSK DEMODULATOR**.
7. Observe various waveforms as mentioned below.

Observations:

Observe the following signal on the oscilloscope and plot it on the paper.

1. **SERIAL DATA** with respect to **DATA CLK**. **FIG. 6.2(a)**
2. **SINE 1**(1.024 MHz) **and SINE 2** (512 KHz). **FIG. 6.2(b)**
3. **FSK** modulated signal **MOD OUT** with respect to **CONTROL IN**. **FIG. 6.3(c)**
4. Output of Zero Pulse Detector at its test point with respect to **FSK IN**. **FIG. 6.2(d)**
5. Output of Threshold Detector at its test point with respect to **FSK IN**. **FIG. 6.2(e)**
6. **FSK DMOD** with respect to **CONTROL IN**. **FIG. 6.2(f)**

Model graphs:

CH 1: DATA CLK (256 KHz) &
CH 2: SERIAL DATA (00011011) &

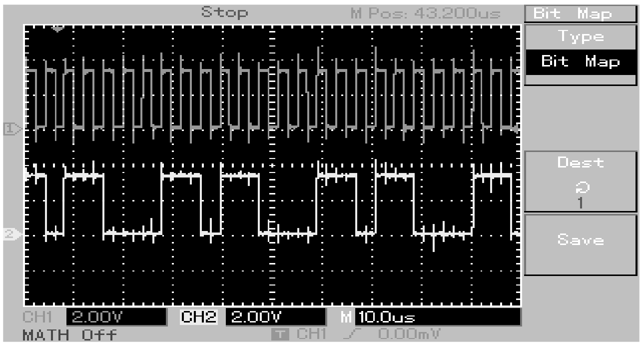


Fig. 6.2(a)

CH 1: SINE 1 (1.024MHz, 0°)
CH 2: SINE 2 (512 KHz, 0°)

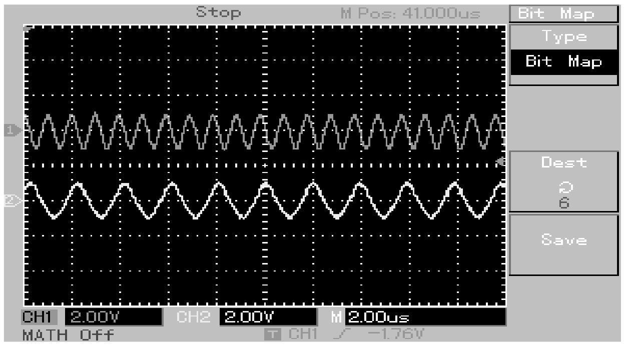


Fig. 6.2(b)

CH 1: CONTROL IN &
CH 2: MOD OUT (FSK)

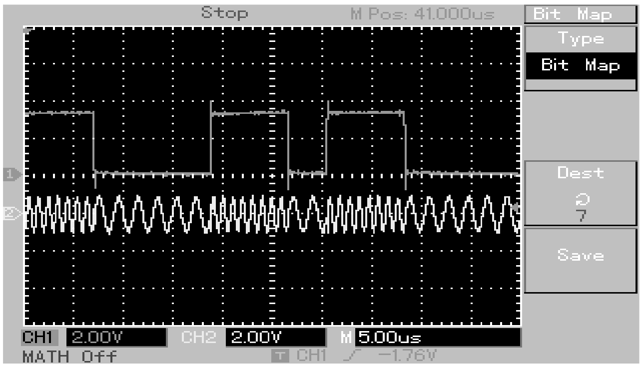


Fig. 6.2(c)

CH 1: FSK IN &
CH 2: ZERO PULSE DETECTOR OUT

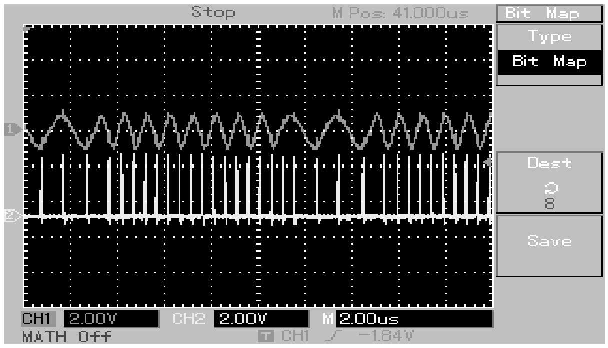


Fig. 6.2(d)

CH 1: ZERO PULSE DETECTOR OUT &
CH 2: THRESHOLD DETECTOR OUT

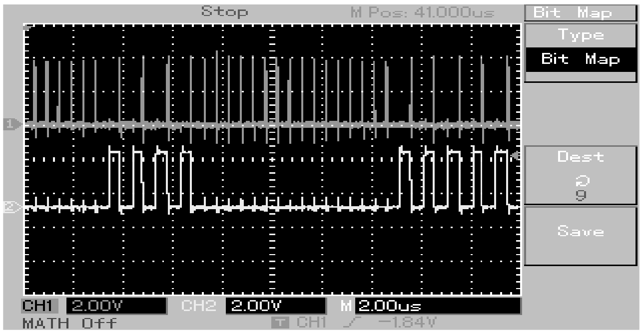


Fig. 6.2(e)

CH 1: CONTROL IN &
CH 2: FSK DMOD

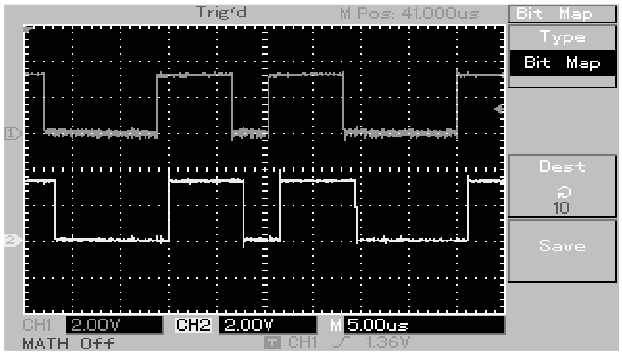


Fig. 6.2(f)

Result:

Conclusion:

Viva-voce:

1. **What is meant by BFSK?**

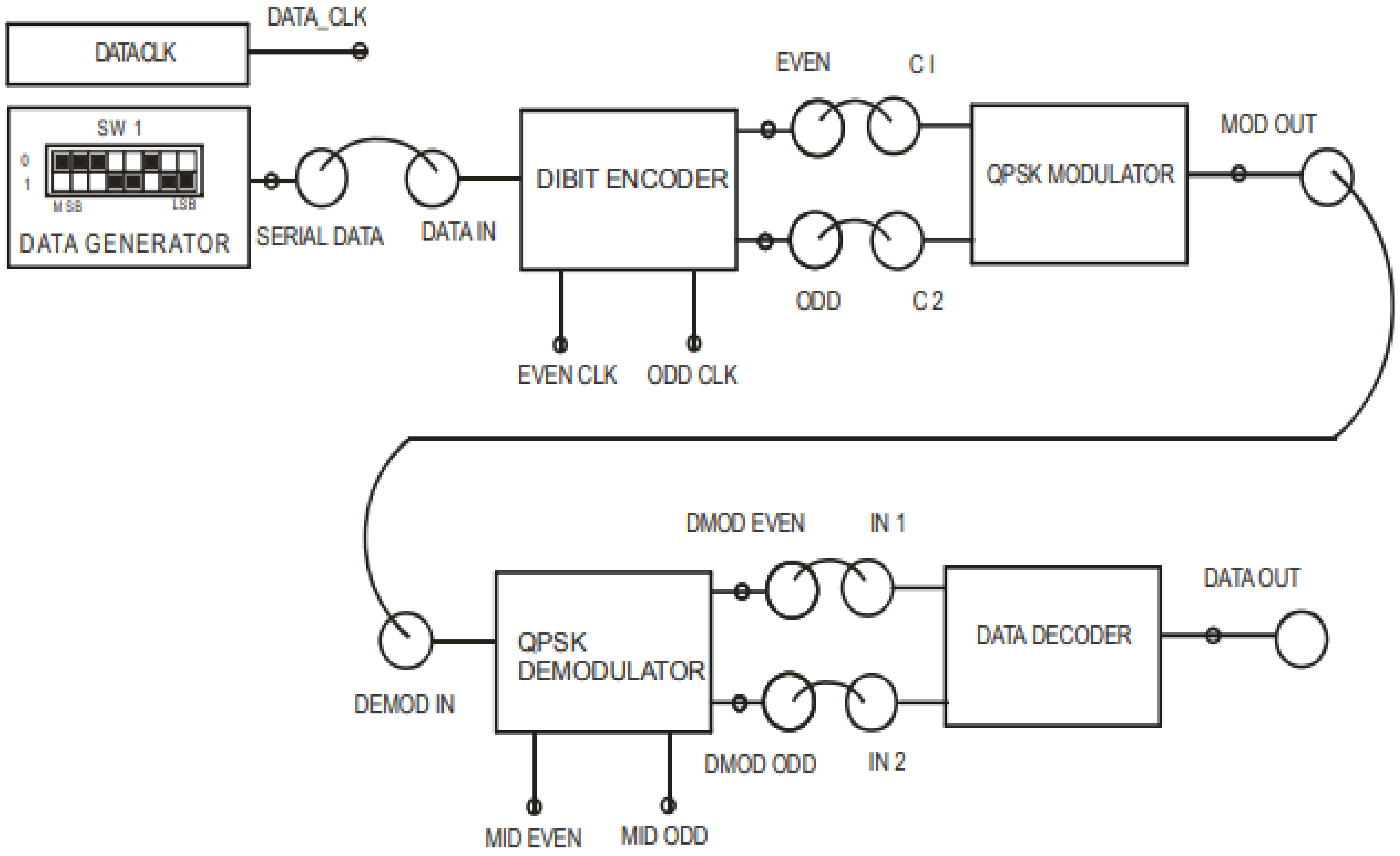
2. **What is the difference between coherent and non coherent BFSK?**

3. **Write the expression for bit probability and bandwidth of BFSK signal?**

4. **What are the advantages and disadvantages of BFSK when compared with other digital carrier modulation techniques?**

5. **Write the expression for threshold level of BFSK signal?**

BLOCK DIAGRAM FOR QUADRATURE PHASE SHIFT KEYING MODULATION



Exp .No: 7 **Date:**

QPSK MODULATION AND DEMODULATION

Aim: To design and verify the working principle of QPSK modulation and demodulation with suitable setup.

Equipments:

S.No	Apparatus	Ranges	Quantity
1	Experimental Kits DCL-QPSK	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Refer to the block diagram (Fig.7.1) and carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kits DCL-QPSK and switch it on.
3. Select Data pattern of simulated data using switch SW1.
4. Connect SERIAL DATA generated to DATA IN of the DIBIT ENCODER.
5. Connect the dibit data EVEN&ODD bit to control input C1 and C2 of QPSK MODULATOR respectively
6. Connect QPSK modulated signal MOD OUT to the DEMOD IN of the QPSK DEMODULATOR.
7. Connect DEMOD EVEN&DEMOD ODD outputs of QPSK DEMODULATOR to IN 1, & IN 2posts of Data Decoder respectively.
8. Observe various waveforms as mentioned below.

OBSERVATIONS:

Observe the following waveforms on oscilloscope and plot it on the paper.

ON KIT DCL-QPSK/DQPSK

1. Input NRZ-L Data at SERIAL DATA. (Fig.7.2(a))
2. DATA CLOCK (Fig.7.2(a))
3. Carrier frequency SIN 0, SIN 90, SIN 180 and SIN 270. (Fig.7.2.1(b),Fig.7.2.2(b))
4. EVEN CLK with respect to ODD CLOCK. (Fig.7.2(c))

5. Coded data EVEN with respect to EVEN CLK (Fig.7.2(d))
6. Coded data ODD with respect to ODD CLK (Fig.7.2(e))
7. QPSK modulated signal at MOD OUT. (Fig.7.2(f))
8. EVEN multiplier at MID EVEN with respect to DEMOD EVEN(Fig.7.2(g))
9. ODD multiplier at MIDODD with respect to DEMOD ODD. (Fig.7.2(h))
10. Recovered DEMOD EVEN with respect to Coded data EVEN. (Fig.7.2(i))
11. Recovered DEMOD ODD with respect to Coded data ODD. (Fig.7.2(j))
12. DATA OUT with respect to SERIAL DATA. (Fig.7.2(k))

Model graphs:

CH 1: DATA CLK (256 KHz) &
CH 2 : SERIAL DATA (00011011)

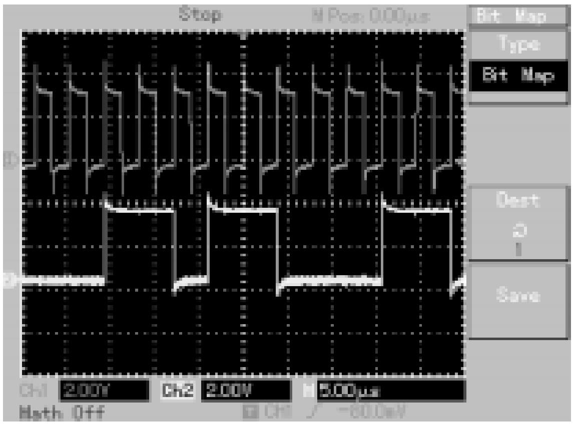


Fig.7.2(a)

CH 1: SIN 0 (1 MHz) &
CH 2: SIN 90 (1 MHz)

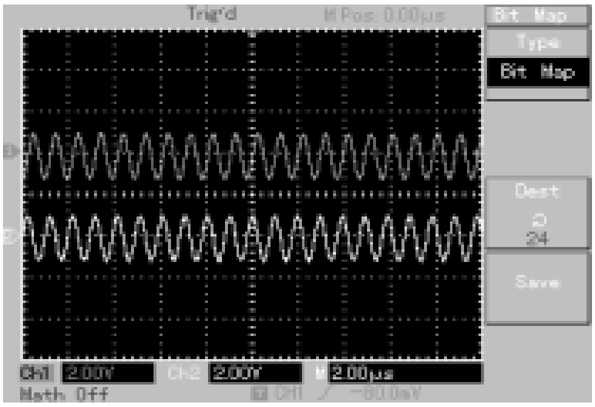


Fig.7.2.1(b)

CH 1: SIN 180 (1 MHz) &
CH 2: SIN 270 (1 MHz)

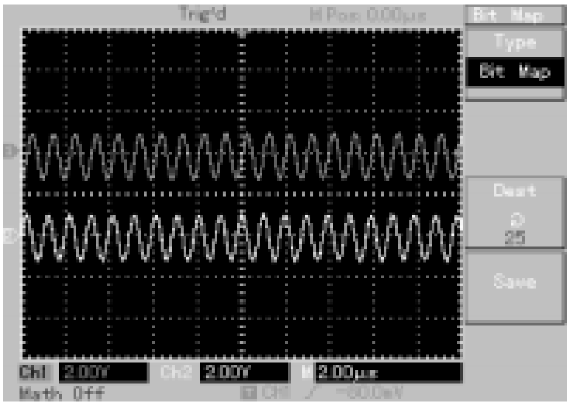


Fig.7.2.2(b)

CH 1: EVEN CLK (128 KHz) &
CH 2 : ODD CLK (128 KHz)

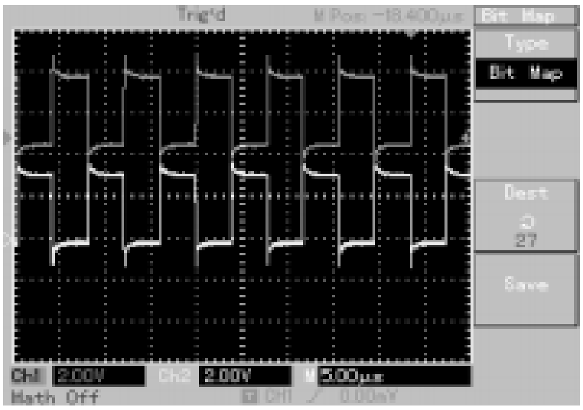


Fig.7.2(c)

CH 1: EVEN CLK (128 KHz) &
CH 2 : EVEN DATA

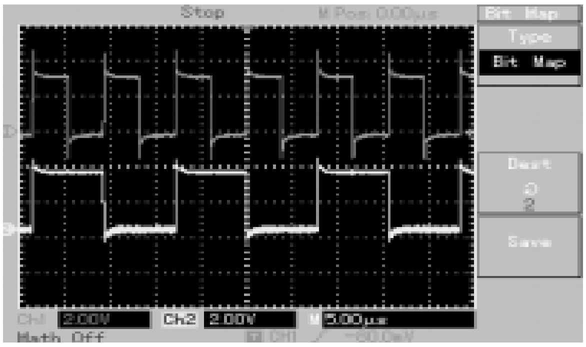


Fig.7.2(d)

CH 1 : ODD CLK (128 KHz) &
CH 2 : ODD DATA

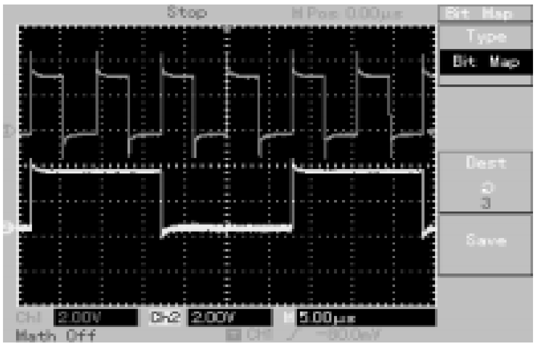


Fig.7.2(e)

NOTE:

For MOD OUT, select a symbol using EVEN and ODD and then observe the MOD OUT for waveform below a symbol is selected using EVEN and ODD and then MOD OUT is observed with respect to EVEN.

CH 1: EVEN &
CH 2 : MOD OUT

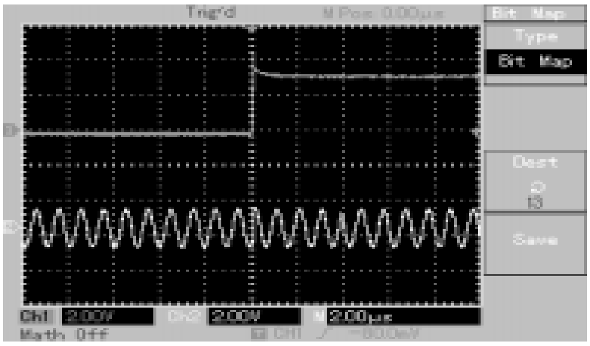


Fig.7.2(f)

CH 1: MID EVEN &
CH 2: DEMOD EVEN

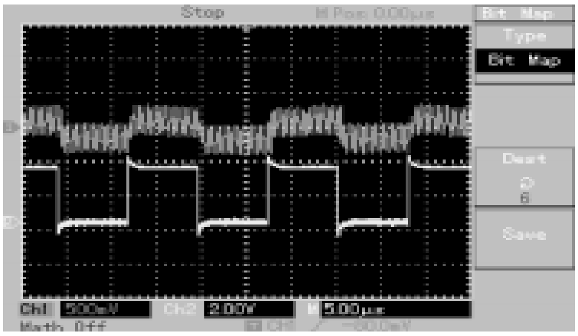


Fig.7.2(g)

CH 1: MID ODD &
CH 2: DEMOD ODD

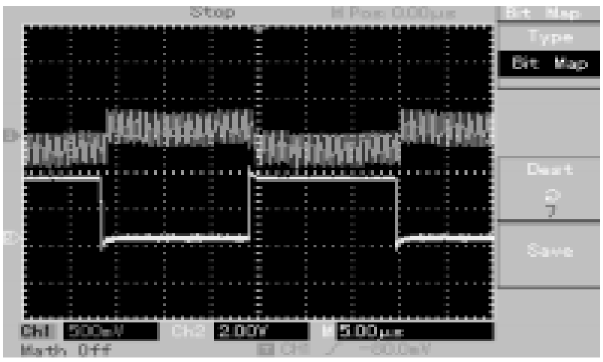


Fig.7.2(h)

CH 1: EVEN &
CH 2: DEMOD EVEN

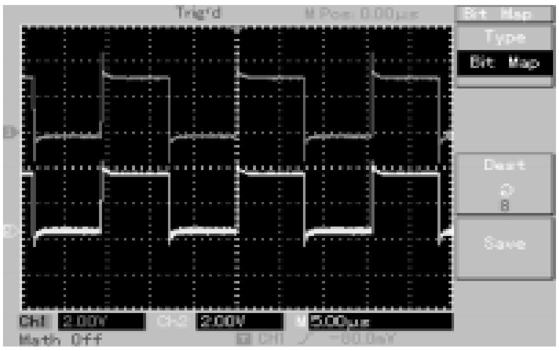


Fig.7.2(i)

CH 1: ODD &
CH 2: DEMOD ODD

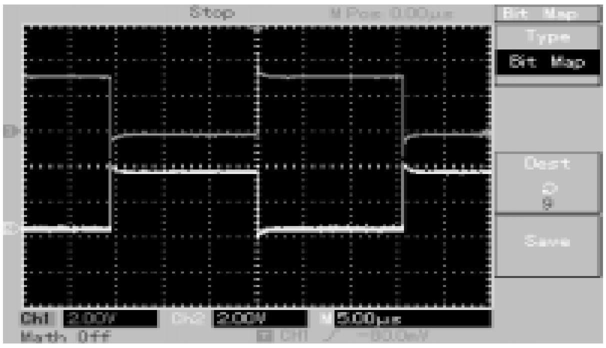


Fig.7.2(j)

CH 1: SERIAL DATA &
CH 2 : DATA OUT

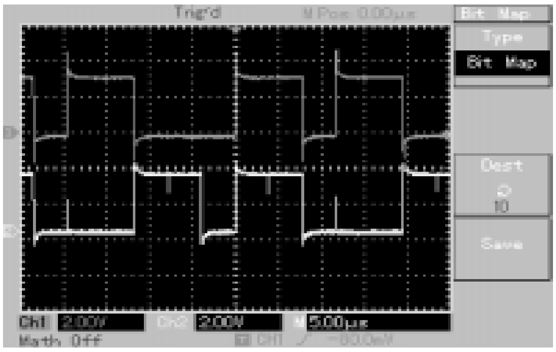


Fig.7.2(k)

Result:

Conclusion:

Viva-voce:

1. **What is meant by QPSK?**

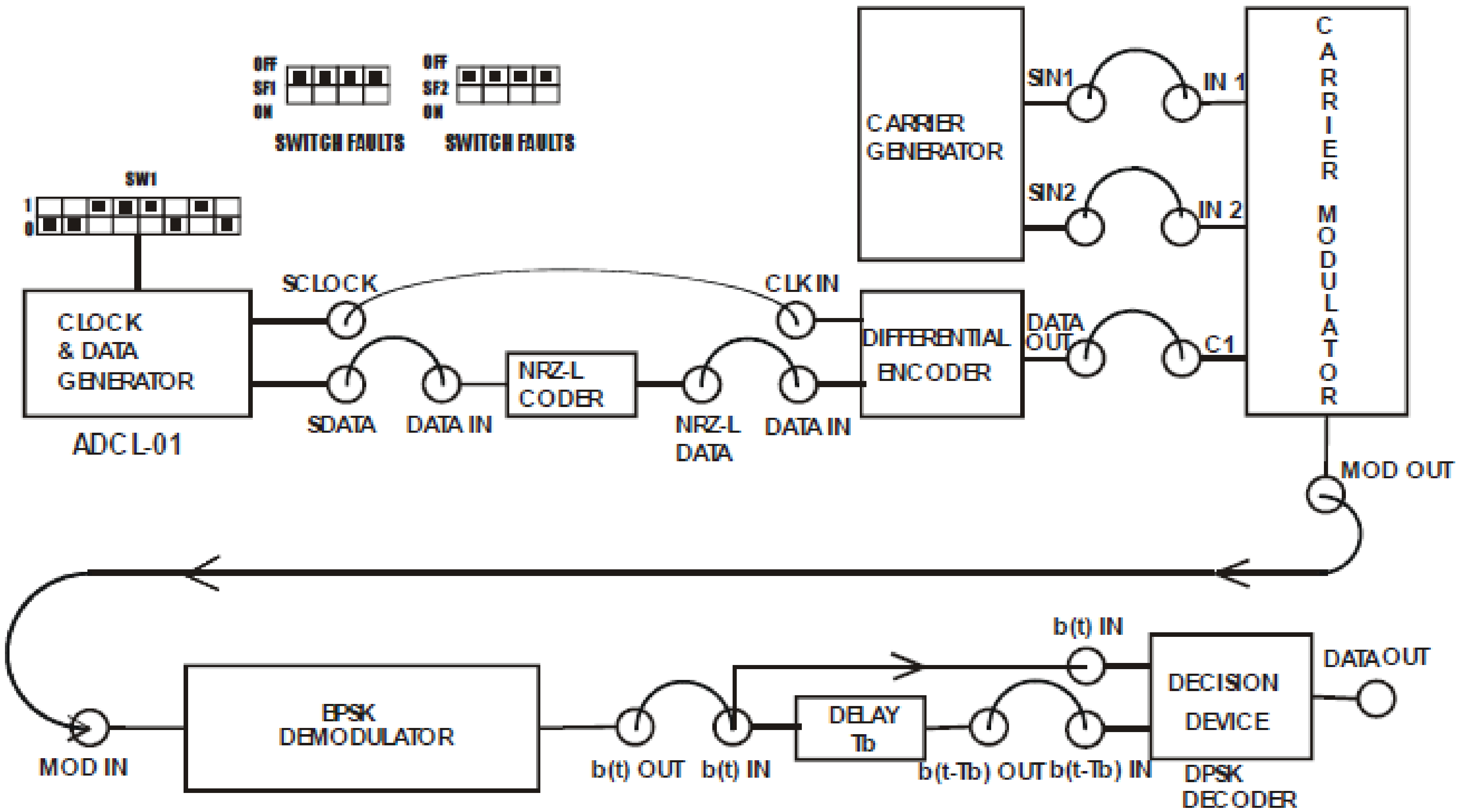
2. **What is probability of error in QPSK?**

3. **Compare BPSK & QPSK?**

4. **Draw the vector diagram of QPSK?**

5. **Write the expression for QPSK?**

BLOCK DIAGRAM FOR DIFFERENTIAL PHASE SHIFT KEYING MODULATION



Exp .No: 8 **Date:**

DIFFERENTIAL PHASE SHIFT KEYING

Aim: To construct a modulated and demodulated circuit for Differential phase shift keying.

Equipments Required:

S.No	Apparatus	Ranges	Quantity
1	Experimental kit ADCL-01.	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Refer to the block diagram and carry out the following connections and switch techniques.
2. Connect power supply in proper polarity to the kit ADCL-01 and switch it on.
3. Select data pattern of simulated data using switch SW1.
4. Connect SDATA generated to DATA IN of NRZ-L CODER.
5. Connect the NRZ-L DATA output to the DATA IN of the DIFFERENTIAL ENCODER.
6. Connect the clock generated SCLOCK to CLK IN of the DIFFERENTIAL ENCODER.
7. Connect differentially encoded data to control input C1 of CARRIER MODULATOR.
8. Connect carrier component SIN1 to IN 1 and SIN 2 to IN 2 of the carrier modulator logic.
9. Connect DPSK modulated signal MOD OUT to MOD IN of the BPSK DEMODULATOR.
10. Connect output of BPSK demodulator b(t) OUT to input of DELAY SECTION b(t) IN and one input b(t) IN of decision device.
11. Connect the output of delay section b(t-Tb) OUT to the input b(t-Tb) IN of decision device.
12. Compare the DPSK decoded data at DATA OUT with respect to input SDATA.
13. Observe various waveforms as mentioned below, if recovered data mismatches with respect to the transmitter data, then use RESET switch for clear observation of data output.

Model Graph:

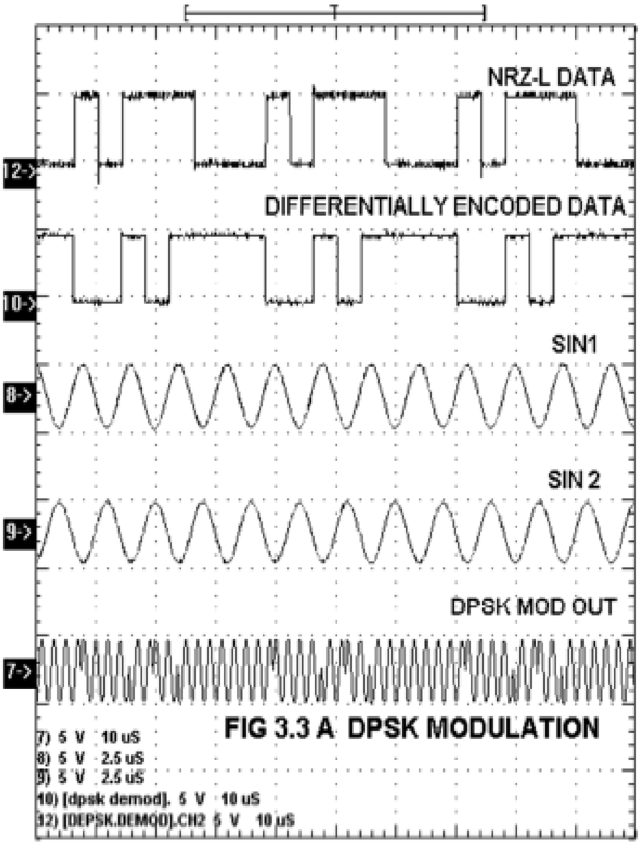


FIG 3.3 A DPSK MODULATION

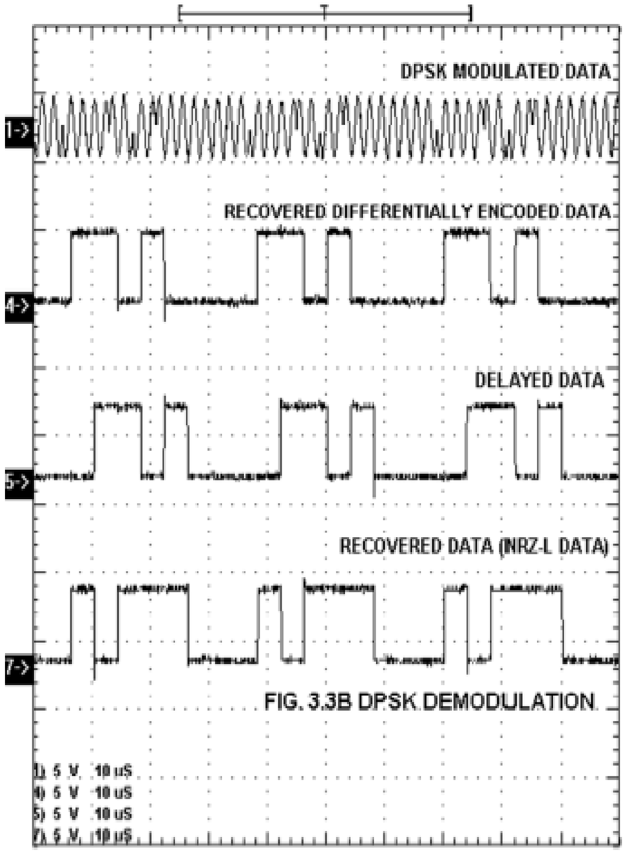


FIG. 3.3B DPSK DEMODULATION

Observations:

Signal	Amplitude	Time period
SDATA		
SCLOCK		
NRZ-L DATA		
Differentially encoded data		
SIN 1		
SIN 2		
DPSK MOD OUT		
Recovered differentially encoded data		
Delayed data		
Recovered data (NRZ-L DATA)		
DPSK Demodulation		

Result:

Conclusion:

Viva-voce:

1. **What is meant by DPSK?**

2. **Why DPSK is preferred than PSK?**

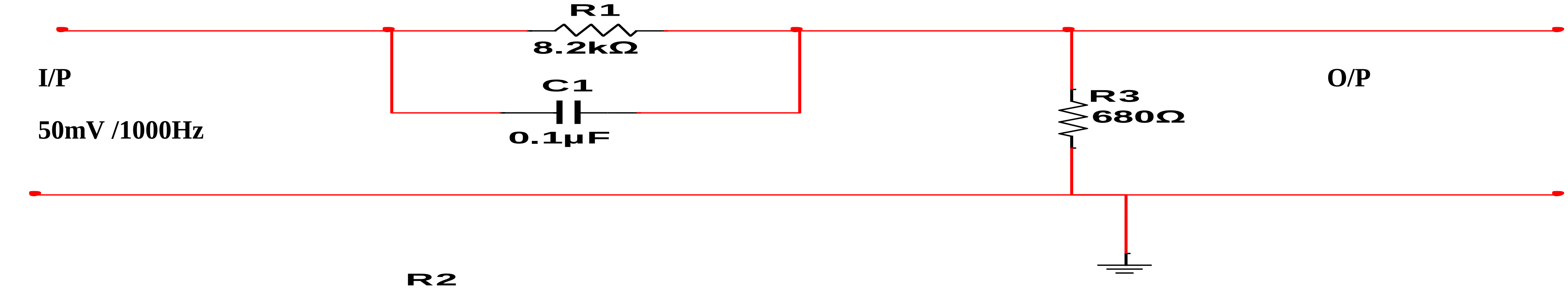
3. **What are the advantages and disadvantages of DPSK?**

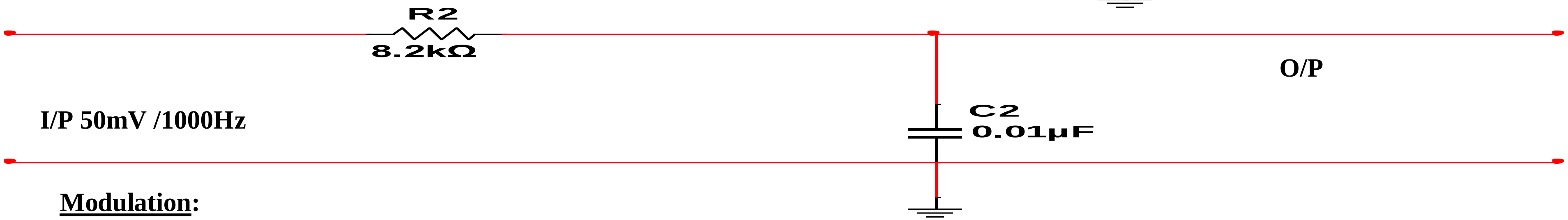
4. **What is coherent and non coherent modulation?**

5. **What is the probability of error in DPSK?**

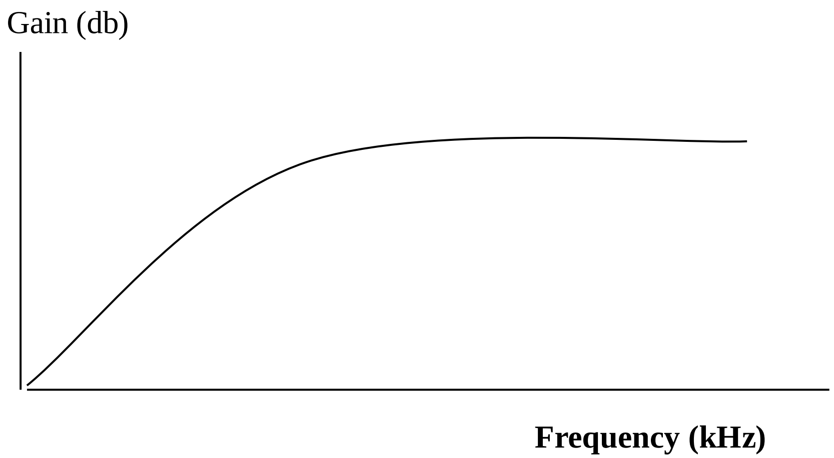
Additional experiments

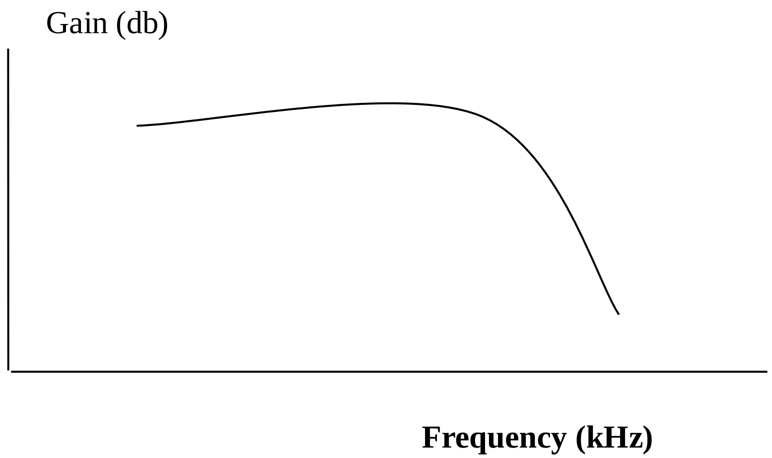
PRE-EMPHASIS AND DE-EMPHASIS CIRCUIT DIAGRAM





Modulation:





Exp .No: 1 **Date:**

PRE-EMPHASIS & DE-EMPHASIS CIRCUIT

Aim: To study the functioning of pre-emphasis and de-emphasis circuits.

Equipments Required:

S.No	Apparatus	Ranges	Quantity
1.	Resistor	8.2kΩ and 680Ω	(each)-1
2.	Capacitor	0.1µF,0.01µF	(each)-1
3.	Digital oscilloscope	(100MHz)	1
4.	Connecting wires	-	As per Required
5.	BNC Probes	50Ω	2

Procedure:

Pre-emphasis:

1. Connect the circuit as per circuit diagram
2. Apply the sine wave to input circuit diagram
3. Varying the input frequency with fixed amplitude, note down the output amplitude (Vo) with respect to input frequency.
4. Calculate the gain using the formula

   Gain= 20log(Vo/Vi) dB ; where Vo= Output voltage in volts

   Vi = Input voltage in volts
5. Plot the frequency response.

De-emphasis:

1. Connect the circuit as per circuit diagram
2. Apply the sine wave to input circuit diagram
3. Varying the input frequency with fixed amplitude, note down the output amplitude (Vo) with respect to input frequency.
4. Calculate the gain using the formula

   Gain= 20log(Vo/Vi) dB ; where Vo= Output voltage in volts

   Vi = Input voltage in volts
5. Plot the frequency response.

TABULAR COLUMN:

Pre-emphasis: Input voltage Vi=

Input frequency (20Hz-20KHz)	Output voltage (Vo)	Gain=Vo/Vi	Gain in dB= 20log(Vo/Vi)

De-emphasis: Input voltage Vi=

Input frequency (20Hz-20KHz)	Output voltage (Vo)	Gain=Vo/Vi	Gain in dB= 20log(Vo/Vi)

Result:

Time Constant of Pre-Emphasis & De-Emphasis τ = ___________Sec

Cut off frequency of Pre-Emphasis & De-Emphasis fc = _________KHz

Conclusion:

Viva questions:

1. **What is need of pre emphasis and de emphasis in FM system?**

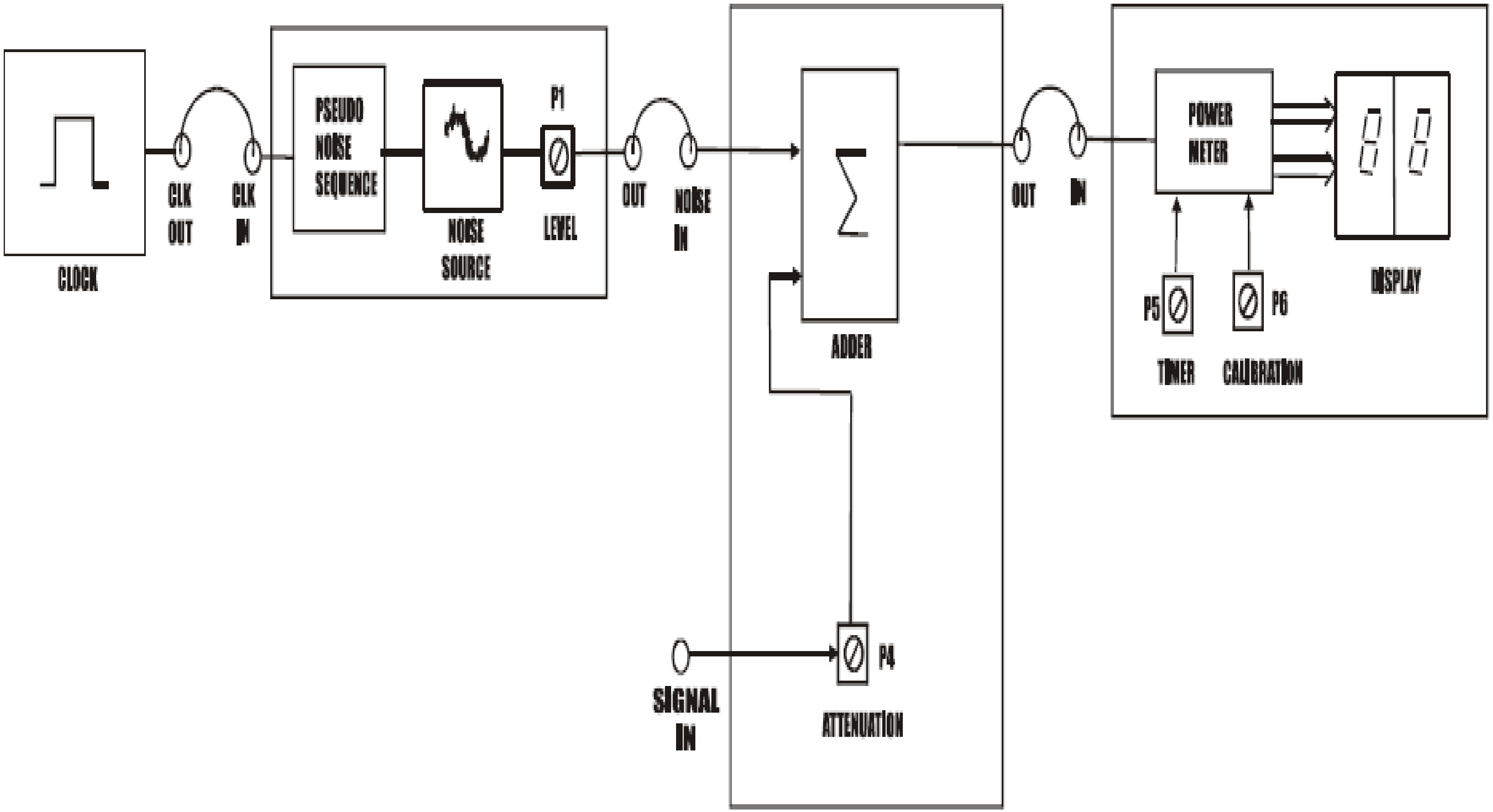
2. **What is time constant of pre emphasis and de emphasis in audio applications?**

3. **Pre emphasis and De emphasis in are not used in AM system.Why?**

4. **What are the cutoff frequencies of pre emphasis and de emphasis?**

5. **Write the transfer function pre emphasis and de emphasis?**

BLOCK DIAGRAM FOR MEASUREMENT OF NOISE POWER SPECTRAL DENSITY



Exp .No: 2 **Date:**

NOISE POWER SPECTRAL DENSITY

Aim: To Study Measurement of Noise Power and Noise Power Spectral Density

Equipments Required:

S.No	Apparatus	Ranges	Quantity
1	ACL-NP	kit	1
2	Digital oscilloscope	(100MHz)	1
3	Patch chords	-	As per Required
4	BNC Probes	50Ω	2

Procedure:

1. Connect the power supply with proper polarity to the kit **ACL-NP** and switch it **ON**.
2. Ref to the fig. & carry out the following connections and settings.
3. Connect the **CLK OUT** post to **CLK IN** post of noise generator.
4. Connect **OUT** post of noise generator to **NOISE IN** post of adder
5. Keep the **LEVEL** pot **P1** of noise generator to maximum position.
6. Keep the attenuation pot **P4** to minimum position.
7. Connect **OUT** post of adder to **IN** post of power meter.
8. Keep Timer pot **P5** to maximum position.
9. Measure noise power **Pni** on power meter.

Single sided PSD = (noise power) / bandwidth.

No = single sided PSD / 2.

Result:

Let Noise Voltage be 1Vpp
We will get Noise power on display as ________ Watt
Single sided PSD = Noise power / bandwidth
=
= Watts/Hz
Noise Power Spectral Density = Single sided PSD / 2
=
= Watts/Hz

Conclusion:

Viva-voce:

1. **What is power spectral density?**

2. **What is matched filter?**

3. **What is ISI?**

4. **What is Signal to Noise ratio?**

5. **What is probability of error?**