I

Name _____

Roll No. _____ Year 20____ 20____

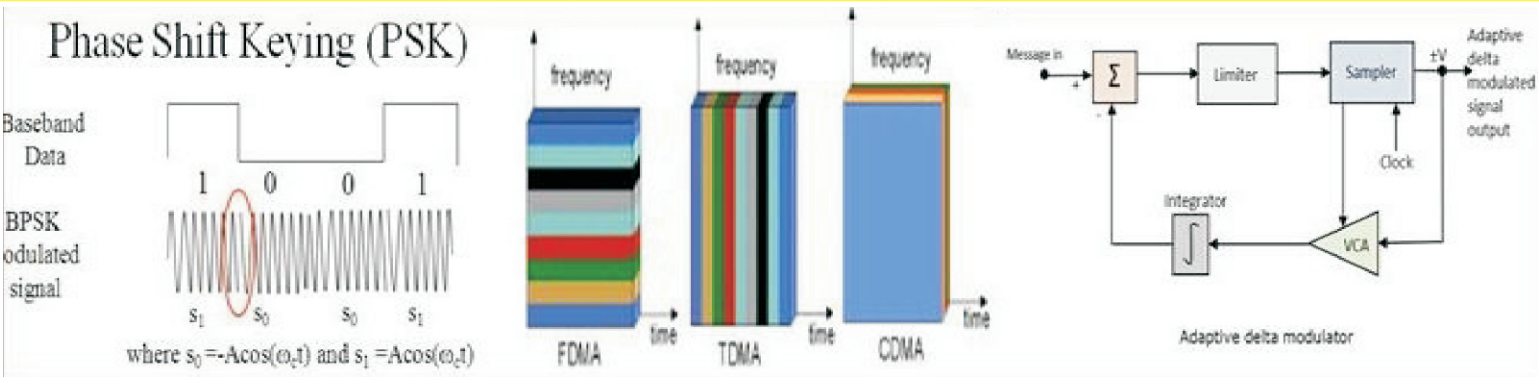
Exam Seat No. _____

ELECTRONICS GROUP | SEMESTER - IV | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

DIGITAL COMMUNICATION SYSTEMS (22428)



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual for

Digital Communication System

(22428)

Semester IV

(EJ, ET, EN, EX, EQ)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO 9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on November 2018)

Maharashtra State
Board of Technical Education
Certificate

This is to certify that Mr. / Ms. ……

Roll No…….of Fourth Semester of Diploma in

…….of Institute

……..

(Code……..) has attained predefined practical outcomes(PROs) satisfactorily in course **Digital Communication System (22428)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ……. Enrollment No……

Date:…..... Exam Seat No. ……..

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a 'vehicle' to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practical to focus on the outcomes, rather than the traditional age old practice of conducting practical to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Communication technologies have undergone radical changes, especially due to convergence of computers and communication. No industry is untouched by the digital communication. This course will enable the diploma engineers to apply facts, concepts and working principles of Digital commendation for the troubleshooting and maintenance of digital communication systems. This course is intended to develop the skills to diagnose and rectify the errors occurred in Digital communication systems. The concepts and principles of digital communication will also lay the foundation to understand the various modern communication systems.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course

Following programme outcomes are expected to be achieved through the practical of the course:

PO 1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.

PO 2. Discipline knowledge: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems

PO 3. Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems

PO 4. Engineering tools: Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

PO 5. The engineer and society: Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Electronics and Telecommunication engineering.

PO 6. Environment and sustainability: Apply Electronics and Telecommunication engineering solutions also for sustainable development practices in societal and environmental contexts

PO 7. Ethics: Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Electronics and Telecommunication engineering

PO 8. Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams

PO 9. Communication: Communicate effectively in oral and written form.

PO 10. Life-long learning: Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry

Program Specific Outcomes (PSO) :-

PSO 1. Electronics and Telecommunication Systems: Maintain various types of Electronics and Telecommunication systems.

PSO 2. EDA Tools Usage: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits.

Practical- Course Outcome matrix

Course Outcomes (COs)

a. Analyze various error detection and correction codes in digital communication systems.
b. Use various pulse code modulation techniques
c. Maintain systems based on digital modulation techniques.
d. Multiplex and demultiplex digital signals.
e. Maintain spread spectrum based systems.

Pro. No.	Practical Outcomes	CO a.	CO b.	CO c.	CO d.	CO e.
1.	To construct the circuit for Generation of hamming code for 4 bits data.	√	-	-	-	-
2.	To construct the circuit for one bit error correction using hamming code.	√	-	-	-	-
3.	Generate: (a) Unipolar –NRZ, RZ (b) Bipolar- NRZ (AMI), Manchester codes for given data.	√	-	-	-	-
4.	Observe the effect of average DC value and bit duration for unipolar non return zero (UPNRZ) and polar return zero (PRZ).	√	-	-	-	-
5.	Detect error by VRC techniques using relevant simulation tool.	√	-	-	-	-
6.	Detect error by LRC techniques using relevant simulation tool.	√	-	-	-	-
7.	Test the performance of natural and flat top sampling circuit.	-	√	-	-	-
8.	Test the performance of sampling circuit for variation in sampling frequency.	-	√	-	-	-
9.	Test the performance of the Pulse Code modulator/ demodulator circuit.	-	√	-	-	-
10.	Test the performance of the delta modulator/ demodulator circuit. .	-	√	-	-	-
11.	Test the performance of the adaptive delta modulator/ demodulator circuit.	-	√	-	-	-
12.	Test the performance of the differential pulse code modulator (DPCM) modulator/ demodulator circuit.	-	√	-	-	-
13.	Write a program using a relevant simulation tool to observe sampling process for sampling rate less than, equal to and greater than the Nyquist rate.	-	√	-	-	-

Pro. No.	Practical Outcomes	CO a.	CO b.	CO c.	CO d.	CO e.
14.	Test the performance of the Amplitude Shift Keying (ASK) modulator / demodulator circuits.	-	-	√	-	-
15.	Test the performance of the Amplitude Shift Keying (ASK) using relevant simulation software.	-	-	√	-	-
16.	Test the performance of the Binary Phase Shift Keying (BPSK) Modulator and Demodulator circuits.	-	-	√	-	-
17.	Test the performance of Frequency Shift Keying (FSK) Modulator and Demodulator circuits.	-	-	√	-	-
18.	Test the performance of the Differential Phase shift keying (DPSK) modulator / demodulator circuits.	-	-	√	-	-
19.	Test the performance of Quadrature Phase shift keying (QPSK) modulator and demodulator circuits.	-	-	√	-	-
20.	Test the performance of Quadrature Amplitude Modulation (QAM) modulator and demodulator circuits.	-	-	√	-	-
21.	Test the performance for 4-input time division multiplexing circuit.	-	-	-	√	-
22.	Test the performance for 2- input frequency division multiplexing (FDM) circuit.	-	-	-	√	-
23.	Generate a TDM signal using relevant simulation software.	-	-	-	√	-
24.	Generate a FDM signal using relevant simulation software.	-	-	-	√	-
25.	Generate PN sequence for given maximum length.	-	-	-	-	√
26.	Generate PN sequence for given maximum length using relevant simulation software.	-	-	-	-	√
27.	Generate two channel CDMA-DSSS signal and demodulate it.	-	-	-	-	√
28.	Generate two channel CDMA-FHSS signal and demodulate it.	-	-	-	-	√

List of Industry Relevant Skills

The following industry relevant skills of the competency "**Maintain basic digital communication systems.**" are expected to be developed in the student by undertaking the practical of this laboratory manual.

1. Identify the digital communication system.
2. Interpret waveforms of different digital communication system
3. Select the proper digital communication system as per the requirement.
4. Compare the observed output with the expected output.
5. Use relevant EDA tool for simulating digital communication systems

Guidelines to Teachers

1. Teacher is expected to refer complete curriculum document and follow guidelines for implementation before start of curriculum**.**
2. At the beginning teacher should make the students acquainted with any of the given simulation software environment as few practical are based on simulation.
3. Teacher should provide the guideline with demonstration of practical to the students with all features.
4. Teacher shall explain prior concepts to the students before starting of each practical
5. Involve students in performance of each practical.
6. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
7. Teachers should give opportunity to students for hands on experience after the demonstration.
8. Teacher is expected to share the skills and competencies to be developed in the students.
9. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.

Instructions for Students

1. Listen carefully the lecture given by teacher about course, curriculum, learning structure, skills to be developed.
2. Before performing the practical student shall read lab manual of related practical to be conducted.
3. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which she /he has to ***submit for assessment to the teacher***.
4. Organize the work in the group and make record of all observations.
5. Students shall develop maintenance skill as expected by industries.
6. Student shall attempt to develop related hand-on skills and gain confidence.
7. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
8. Student shall refer technical magazines, IS codes and data books.
9. Student should develop habit to submit the practical on date and time.
10. Student should well prepare while submitting write-up of exercise.

Content Page

List of Practicals and Progressive Assessment Sheet

Sr. No	Title of the practical	Page No.	Date of perfor mance	Date of submit--ssion	Assess--ment marks(25)	Dated sign. of teacher	Rema rks (if any)
1*	To construct the circuit for Generation of hamming code for 4 bits data.						
2*	To construct the circuit for one bit error correction using hamming code.						
3	Generate: (c) Unipolar –NRZ, RZ (d) Bipolar- NRZ (AMI), Manchester codes for given data.						
4	Observe the effect of average DC value and bit duration for unipolar non return zero (UPNRZ) and polar return zero (PRZ).						
5*	Detect error by VRC techniques using relevant simulation tool.						
6	Detect error by LRC techniques using relevant simulation tool.						
7*	Test the performance of natural and flat top sampling circuit.						
8	Test the performance of sampling circuit for variation in sampling frequency.						
9*	Test the performance of the Pulse Code modulator/ demodulator circuit.						
10	Test the performance of the delta modulator/ demodulator circuit. .						
11	Test the performance of the adaptive delta modulator/ demodulator circuit.						
12*	Test the performance of the differential pulse code modulator (DPCM) modulator/ demodulator circuit.						
13	Write a program using a relevant simulation tool to observe sampling process for sampling rate less than, equal to and greater than the Nyquist rate.						
14*	Test the performance of the Amplitude Shift Keying (ASK) modulator / demodulator circuits.						
15	Test the performance of the Amplitude Shift Keying (ASK) using relevant simulation software.						
16*	Test the performance of the Binary Phase Shift Keying (BPSK) Modulator and Demodulator circuits.						

Sr. No	Title of the practical	Page No.	Date of perfor mance	Date of submit--ssion	Assess--ment marks(25)	Dated sign. of teacher	Rema rks (if any)
17	Test the performance of Frequency Shift Keying (FSK) Modulator and Demodulator circuits.						
18*	Test the performance of the Differential Phase shift keying (DPSK) modulator / demodulator circuits.						
19	Test the performance of Quadrature Phase shift keying (QPSK) modulator and demodulator circuits.						
20	Test the performance of Quadrature Amplitude Modulation (QAM) modulator and demodulator circuits.						
21*	Test the performance for 4-input time division multiplexing circuit.						
22*	Test the performance for 2- input frequency division multiplexing (FDM) circuit.						
23	Generate a TDM signal using relevant simulation software.						
24	Generate a FDM signal using relevant simulation software.						
25	Generate PN sequence for given maximum length.						
26	Generate PN sequence for given maximum length using relevant simulation software.						
27*	Generate two channel CDMA-DSSS signal and demodulate it.						
28	Generate two channel CDMA-FHSS signal and demodulate it.						
Total marks							

- ***The practical marked as '*' are compulsory,***
- **Column 6th marks to be transferred to Proforma of CIAAN-2017**.

Practical No.1: To construct the circuit for Generation of Hamming code for 4 bits data.

I Practical Significance

A Hamming code is a specific type of error correcting code that allows the detection and correction of single bit transmission errors. Hamming codes are used in applications where single bit errors are common, including DRAM memory chips and satellite communication hardware. Although Hamming codes are the oldest error correcting codes, it is still widely used in the field of mobile communication systems because of the excellent distance property, the good algebraic structure, and the ease of implementation. This practical is designed to explain generation of Hamming code for 4 bit data.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Analyse various error detection and correction codes in digital communication systems.

V Practical Outcome

- To construct the circuit for Generation of hamming code for 4 bits data.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Hamming code is basically a linear block code it is error correcting code. The parity bits are inserted in between the data bits shown in Table1.1,the parity bits are inserted at each 2^n bit where n= 0,1,2,…….,n. thus P_1 is at $2^0 = 1$. P_2 is at $2^1 = 2$. P_4 is at $2^2 = 4$ shown in the Table.1.1

Table 1.1. Hamming code word

d_7	d_6	d_5	P_4	d_3	P_2	P_1

Where d_3, d_5, d_6, d_7 are data bits and P_1, P_2, P_4 are parity bits.
Selection of parity bits for 7 bit hamming code
P_1- P_1 is calculated using even / odd parity considering bits 1:- 1, 3, 5, 7.
P_2- P_2 is calculated using even / odd parity considering bits 2:- 2, 3, 6, 7.
P_4- P_4 is calculated using even / odd parity considering bits 4:- 4, 5, 6, 7.

VIII Practical Circuit Diagram

a) Sample Circuit diagram

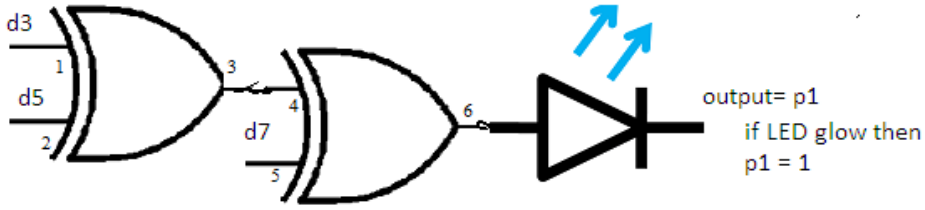


Figure 1.1: Circuit diagram for generation of P_1

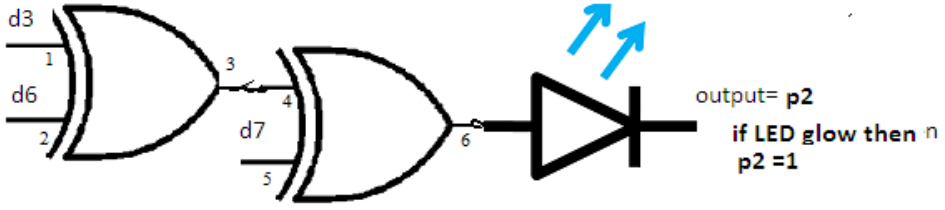


Figure 1.2: Circuit diagram for generation of P_2

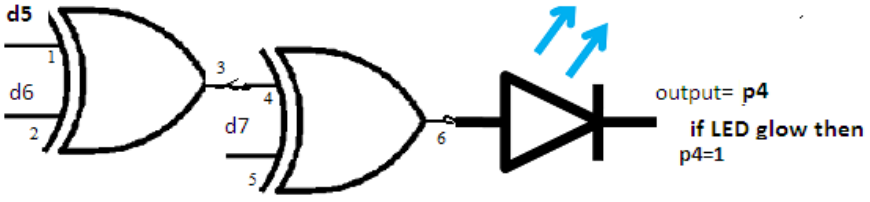


Figure 1.3: Circuit diagram for generation of P_4

b) Actual block diagram / Circuit diagram

c) Sample Practical Setup

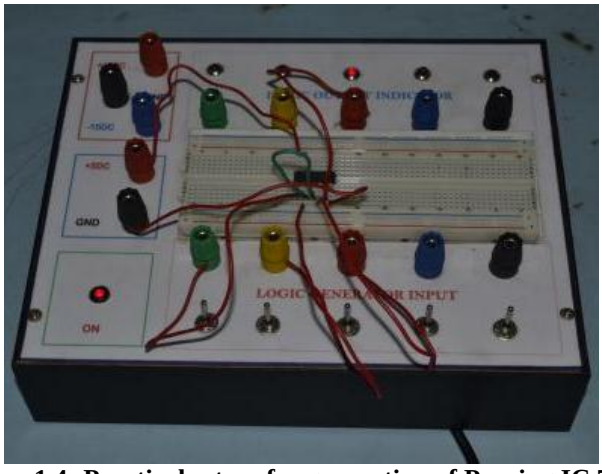


Figure 1.4: Practical set up for generation of P_1 using IC 7486

d) **Actual Practical Setup (**Students should draw Practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	DC Regulated power supply	Variable DC power supply 0-30V, 2A, SC protection, display for voltage and current.	1
2.	Switch(Simplex)	Toggle Switch	1
3.	LED	1.8V to 2.2V	1
4.	IC 7486	TTL EX-OR gate	1
5.	Bread board	5.5cm x 17cm	1
6.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Assume four data bits 1011 [d_3=1, d_5=1,d_6=0,d_7=1] for generation of parity bits(P_1,P_2 and P_4)
2. Generation of P_1:
   i. Mount EX-OR IC on bread board as shown in figure 1.4.
   ii. Make connection as shown in figure1.1
   iii. Switch ON the power supply.
   iv. Check output of figure 1.1 Note the value of P_1 in table1.2.
   v. Generation of P_1 is shown in figure 1.4
3. For generation of P_2:
   i. Mount EX-OR IC on bread board as shown in figure 1.4.
   ii. Make connection as shown in figure1.2
   iii. Switch ON the power supply.
   iv. Check output of figure 1.2 Note the value of P_2 in table 1.2.
4. For generation of P_4:
   i. Mount EX-OR IC on bread board as shown in figure 1.4.
   ii. Make connection as shown in figure1.3
   iii. Switch ON the power supply.
   iv. Check output of figure 1.3 Note the value of P_4 in table1.2.
5. Put all values of data bits (d_3, d_5, d_6 and d_7) and parity bits (P_1, P_2 and P_4) in table1.2 to get hamming code.
6. After completion of practical switch off the supply, remove the connection and submit the instruments and components.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIII Precautions followed

.....
.....
.....
.....

XIV Observations

Table 1.2: Hamming code word

d_7	d_6	d_5	P_4	d_3	P_2	P_1

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Generate Hamming code for even parity if data is 1110.
2. Generate Hamming code for odd parity if data is 1010.

[Space for Answers]

.....
.....
.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading.

1. https://en.wikipedia.org/wiki/Hamming(7,4)
2. https://www.youtube.com/watch?v=7MFAvMFLLfU
3. http://users.cis.fiu.edu/~downeyt/cop3402/hamming.html.

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.2: To construct the circuit for one bit error correction using Hamming code.

I Practical Significance

Hamming code is a set of error-correction code s that can be used to detect and correct bit errors that can occur when computer data is moved or stored Due to the limited redundancy that Hamming codes add to the data, they can only detect and correct errors when the error rate is low. This is the case in computer memory (ECC memory), where bit errors are extremely rare and Hamming codes are widely used. This practical is designed to explain how to correct one bit error using hamming code.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication system'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Analyse various error detection and correction methods in Digital communication systems.

V Practical Outcome

- To construct the circuit for one bit error correction using hamming code.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Hamming code is basically a linear block code it is error correcting code.

Error detection by using Hamming code is as follows.

To each group of m information bits k parity bits are added to form (m+k) bit code as shown in Table2.1

Table2.1: Format of hamming code word

d_7	d_6	d_5	C_3	d_3	C_2	C_1

Location of each of the (m+k) digits is assigned a decimal value. The k parity bits are placed in positions 1, 2… 2k-1 positions.–K parity checks are performed on selected digits of each code word. At the receiving end the parity bits are recalculated. The decimal value of the k parity bits provides the bit-position in error, if any

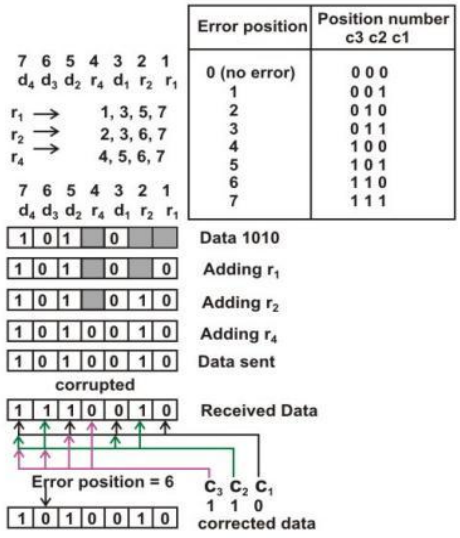


Figure 2.1: Use of Hamming code for error correction for a 4-bits data
[Courtesy: *http://nptel.ac.in/courses/106105080/pdf/M3L2.pdf*]

Figure 2.1 shows how hamming code is used for correction for 4-bit numbers ($d_4d_3d_2d_1$) with the help of three redundant bits ($C_3C_2C_1$). For the example data 1010, first C_1 (0) is calculated considering the parity of the bit positions, 1, 3, 5 and 7. Then the parity bits C_2 is calculated considering bit positions 2, 3, 6 and 7. Finally, the parity bits C_3 is calculated considering bit positions 4, 5, 6 and 7 as shown. If any corruption occurs in any of the transmitted code 1010010, the bit position in error can be found out by calculating $C_3C_2C_1$ at the receiving end. For example, if the received code word is 1110010, the recalculated value of $C_3C_2C_1$ is 110, which indicates that bit position in error is 6, the decimal value of 110.

VIII Practical Circuit Diagram

a) Sample Circuit diagram

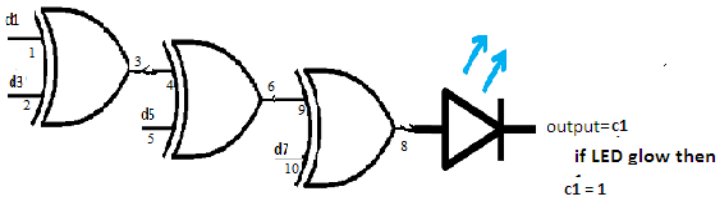


Figure2.2: Circuit diagram for generation of C_1

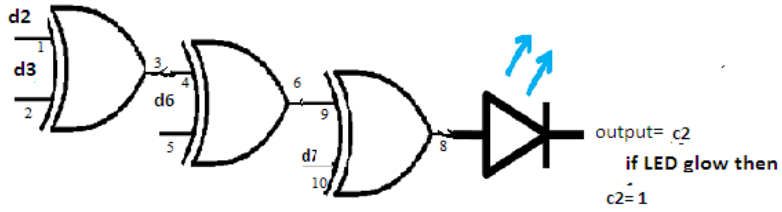


Figure2.3: Circuit diagram for generation of C_2

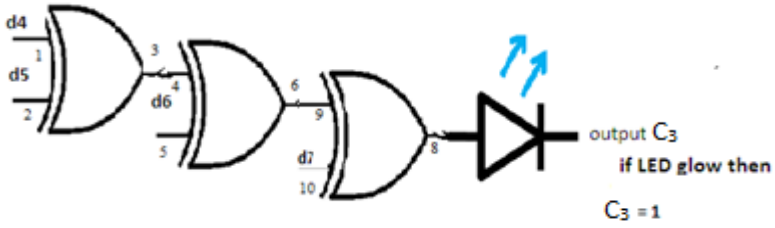


Figure2.4: Circuit diagram for generation of C_3.

b) Actual block diagram / Circuit diagram

c) Sample Practical Setup

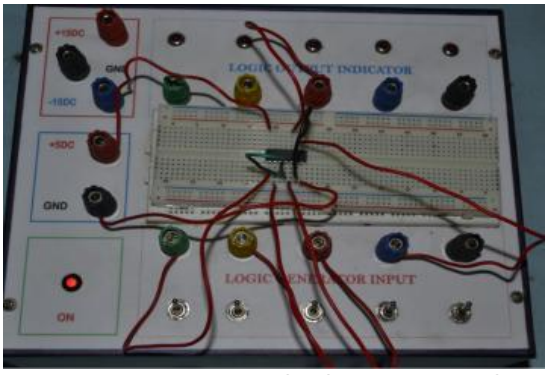


Figure 2.5: Practical set up for finding value of C_1

d) **Actual Practical Setup (**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	DC Regulated power supply	Variable DC power supply 0-30V, 2A, SC protection, display for voltage and current.	1
2	Switch(Simplex)	Toggle Switch	1
3	LED	1.8V to 2.2V	1
4	IC 7486	EX-OR gate	1
5	Bread board	5.5cm x 17cm	1
6	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure:

2. Assume received hamming code word is 1110101 [d_1=1, d_2=0, d_3=1, d_4=0, d_5=1, d_6=1, d_7=1) to find C_1, C_2 and C_3.

3. **For C_1:**
   i. Mount EX-OR IC on bread board as shown in figure 2.5.
   ii. Make connection as shown in figure2.2
   iii. Switch ON the power supply.
   iv. Check output of figure 2.2 Note the value of c1 in table 2.2
   v. Generation of C_1 is shown in figure 2.5

3. **For C_2:**
   i. Mount EX-OR IC on bread board as shown in figure 2.5.
   ii. Make connection as shown in figure2.3
   iii. Switch ON the power supply.
   iv. Check output of figure 2.3 Note the value of C_2 in table 2.2

4. **For C_3:**
   i. Mount EX-OR IC on bread board as shown in figure 2.5.
   ii. Make connection as shown in figure 2.4
   iii. Switch ON the power supply.
   iv. Check output of figure 2.4 Note the value of C_3 in table 2.2
   v. Table 2.2indicates position of incorrect bit $\mathbf{(C_3C_2C_1)_{10}}$ where error is present.
   vi. Invert (0 to 1 or 1 to 0) the value of incorrect bit to obtain correct code word.
   vii. Write the correct code word in table2.3.

5. After completion of practical switch off the supply, remove the connection and submit the instruments and components.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....
.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....
.....
.....
.....
.....

XV Observations:

Table2.2: position of incorrect bit

C_3	C_2	C_1

Table2.3: corrected code word

d_7	d_6	d_5	d_4	d_3	d_2	d_1

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. If the 7- bit Hamming code word received by a receiver is 1011011. Assuming the even parity state whether the received code word is correct or wrong? If wrong locate the bit in error.
2. If the 7- bit Hamming code word received by a receiver is 1010111. Assuming the even parity state whether the received code word is correct or wrong? If wrong locate the bit in error.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://en.wikipedia.org/wiki/Hamming(7,4).
2. https://www.youtube.com/watch?v=7MFAvMFLLfU
3. http://users.cis.fiu.edu/~downeyt/cop3402/hamming.html.

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 3: Generate: a) Unipolar –NRZ, RZ b) Bipolar- NRZ (AMI), Manchester codes for given data.

I Practical Significance

Electrical representation of binary codes is called "line code". A line code is a code chosen for use within a communications system for transmitting a digital signal down a transmission line. Line-coded signal is used to create an "RF signal" that can be sent through free space. The line-coded signal can be converted to bits on an optical disc. In this practical students will convert the given digital data into various line codes.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and bocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Analyse various error detection and correction methods in Digital communication systems.

V Practical Outcome

- Generate: a) Unipolar –NRZ, RZ b) Bipolar- NRZ (AMI), Manchester for given data.

VI Relevant Affective domain related Outcomes

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

A line code is the code used for data transmission of a digital signal over a transmission line.

Types of Line Coding:

Unipolar Non-Return to Zero (NRZ)

In this type of unipolar signaling, a High in data is represented by appositive pulse called as Mark, which has a duration T_0 equal to the symbol bit duration. A Low in data input has no pulse. Figure 3.1 clearly depicts this.

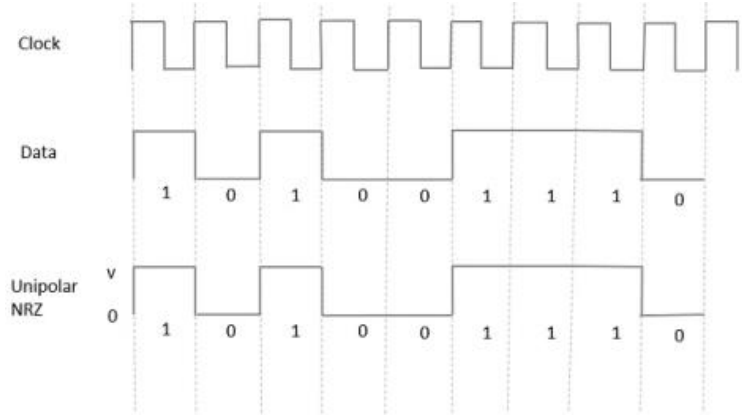


Figure 3.1: Unipolar NRZ

[Courtsey:*https://www.tutorialspoint.com/digital_communication/digital_communication_line_codes.htm]*

Unipolar Return to Zero (RZ)

In this type of unipolar signaling, a High in data, though represented by a Mark pulse, its duration T0 is less than the symbol bit duration. Half of the bit duration remains high but it immediately returns to zero and shows the absence of pulse during the remaining half of the bit duration. It is clearly understood with the help of the figure. 3.2

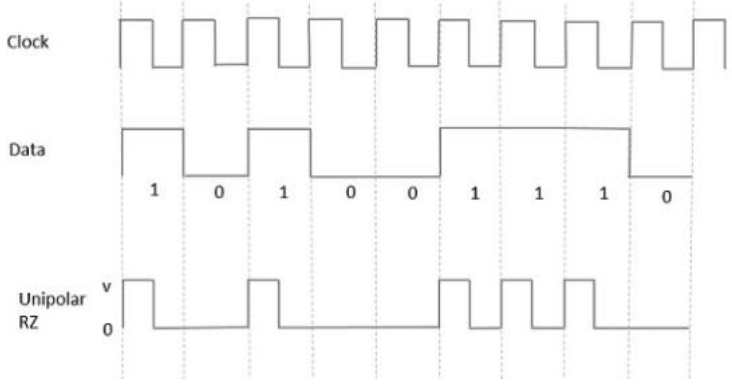


Figure 3.2: Unipolar RZ

[Courtsey:*https://www.tutorialspoint.com/digital_communication/digital_communication_line_codes.htm]*

Bipolar Signaling

This is an encoding technique which has three voltage levels namely +, - and 0. Such a signal is called as duo-binary signal. An example of this type is Alternate Mark Inversion (AMI). For a 1, the voltage level gets a transition from + to – or from – to +, having alternate 1s to be of equal polarity. A 0 will have a zero voltage level. We have two types 1. Bipolar NRZ 2. Bipolar RZ or Manchester shown in figure 3.3

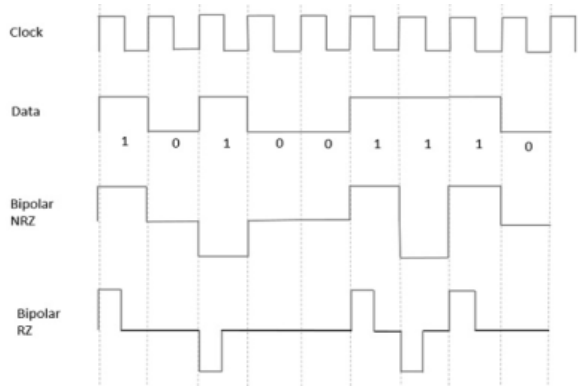


Figure3.3: Bipolar NRZ and Bipolar RZ

[Courtsey:*https://www.tutorialspoint.com/digital_communication/digital_communication_line_codes.htm]*

VIII Practical Circuit Diagram

a) Practical set up

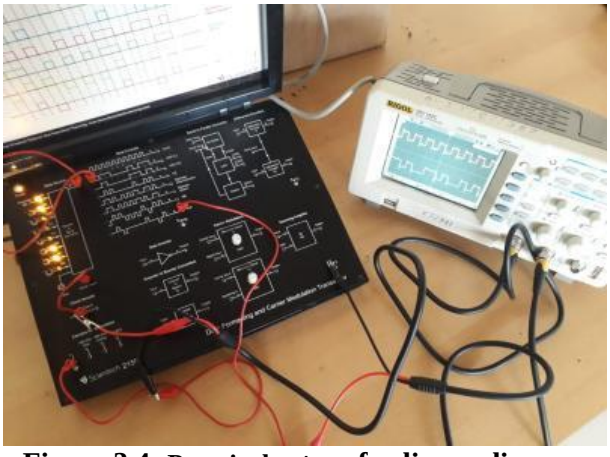


Figure 3.4: Practical set up for line coding

b) **Actual Practical set up used in laboratory (**Student should draw Practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Line Coding Kit	8 bit variable NRZ-L pattern Data Simulator using 8 way DIP Switch,15 clock states constant data pattern,125 KHz serial data pattern or equivalent trainer kit	1
2.	CRO/ DSO	25MHz,dual scope	1
3.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connections as shown in figure 3.4
2. Select the input bit stream from kit to set digital word 01100011.
3. Observe the waveforms of unipolar RZ, NRZ and Bipolar NRZ, Manchester line coding formats using CRO/DSO and draw the waveform on graph paper.
4. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Equipments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

……
……..
.....
.....

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

……..
……..
…..

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Draw the unipolar RZ, NRZ waveforms for a binary sequence 11001010.
2. Draw the Bipolar NRZ (AMI), Manchester waveforms for a binary sequence 11001010.
3. Draw the unipolar RZ, NRZ waveforms for a binary sequence 11001100.
4. Draw the Bipolar NRZ (AMI), Manchester waveforms for a binary sequence 11001100.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.sqa.org.uk/elearning/NetTechDC01ECD/page_02.htm
2. https://en.wikipedia.org/wiki/Line_code.

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the trainer kit	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
T**otal (25 Marks)**		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 4: Observe the effect of average DC value and bit duration for unipolar non return zero (UPNRZ) and polar return z (PRZ).

I Practical Significance

Electrical representations of binary code are called "line code". a line code is code chosen for use within a communications system for transmitting a digital signal down a transmission line. Line-coded signal is used to create an "RF signal" that can be sent through free space. The line-coded signal can be converted to bits on an optical disc.In this practical students will observe the effect of average DC value and bit duration for unipolar non return zero(UPNRZ) and polar return zero(PRZ).

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Analyse various error detection and correction methods in Digital communication systems.

V Practical Outcome

- Observe the effect of average DC value and bit duration for unipolar non return zero (UPNRZ) and polar return zero (PRZ).

VI Relevant Affective domain related Outcomes

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

A line code is the code used for data transmission of a digital signal over a transmission line. Types of Line Coding:

Unipolar Non-Return to Zero (NRZ)

In this type of unipolar signaling, a High in data is represented by appositive pulse called as **Mark**, which has a duration $\mathbf{T_0}$ equal to the symbol bit duration. A Low in data input has no pulse. Figure 3.1 clearly depicts this.

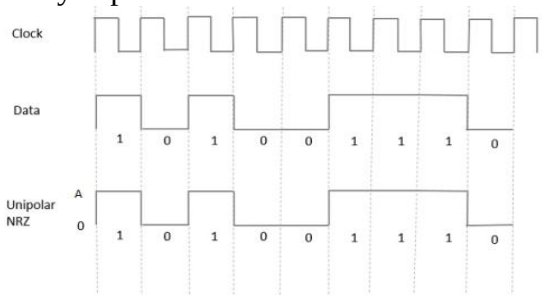


Figure 4.1: Unipolar NRZ

[Courtsey:https://www.tutorialspoint.com/digital_communication/digital_communication_line_codes.htm]

Polar RZ

In this type of Polar signaling, a High in data, though represented by a **Mark pulse**, its duration $\mathbf{T_0}$ is less than the symbol bit duration. Half of the bit duration remains high but it immediately returns to zero and shows the absence of pulse during the remaining half of the bit duration.

However, for a Low input, a negative pulse represents the data, and the zero level remains same for the other half of the bit duration. Figure4.2 depicts this clearly.

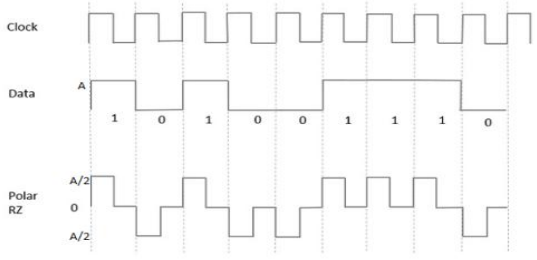


Figure4.2: Polar RZ line code

[Courtsey:https://www.tutorialspoint.com/digital_communication/digital_communication_line_codes.htm]

VIII Practical Circuit Diagram

a) Sample Practical Setup

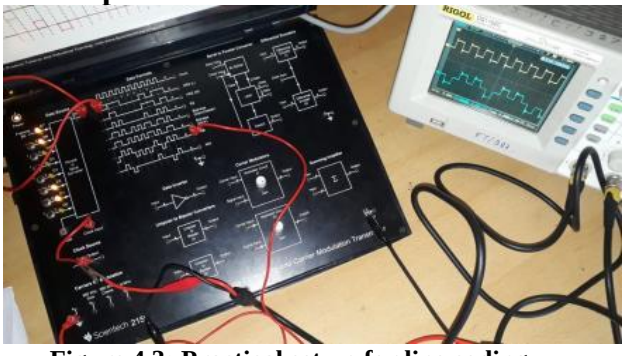


Figure 4.3: Practical set up for line coding

b) Actual Practical Setup (Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Line Coding trainer kit	8 bit variable NRZ-L pattern Data Simulator using 8 way DIP Switch,15 clock states constant data pattern,125 KHz serial data pattern or equivalent trainer kit	1
2.	CRO / DSO	25MHz,dual scope	1
3.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connections as shown in figure 4.3
2. Select the input bit stream from kit to set digital word 10101101.
3. Observe the waveforms of Polar: RZ, NRZ line coding formats using CRO/DSO and draw the waveform on graph paper.
4. Measure the average DC voltage and bit duration of both line code and write the values in table4.1.
5. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Equipments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations

Table 4.1: Average DC voltage value and Bit duration

Sr. No.	Type of line code	DC voltage	Bit duration
1	**Polar RZ**		
2	**Unipolar NRZ**		

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Observe the Polar RZ, Bipolar NRZ waveforms for the given binary sequence 10101010 and draw its output.
2. Observe the Polar RZ, Bipolar NRZ waveforms for the given binary sequence 11001100 and draw its output.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.sqa.org.uk/elearning/NetTechDC01ECD/page_02.htm
2. https://en.wikipedia.org/wiki/Line_code

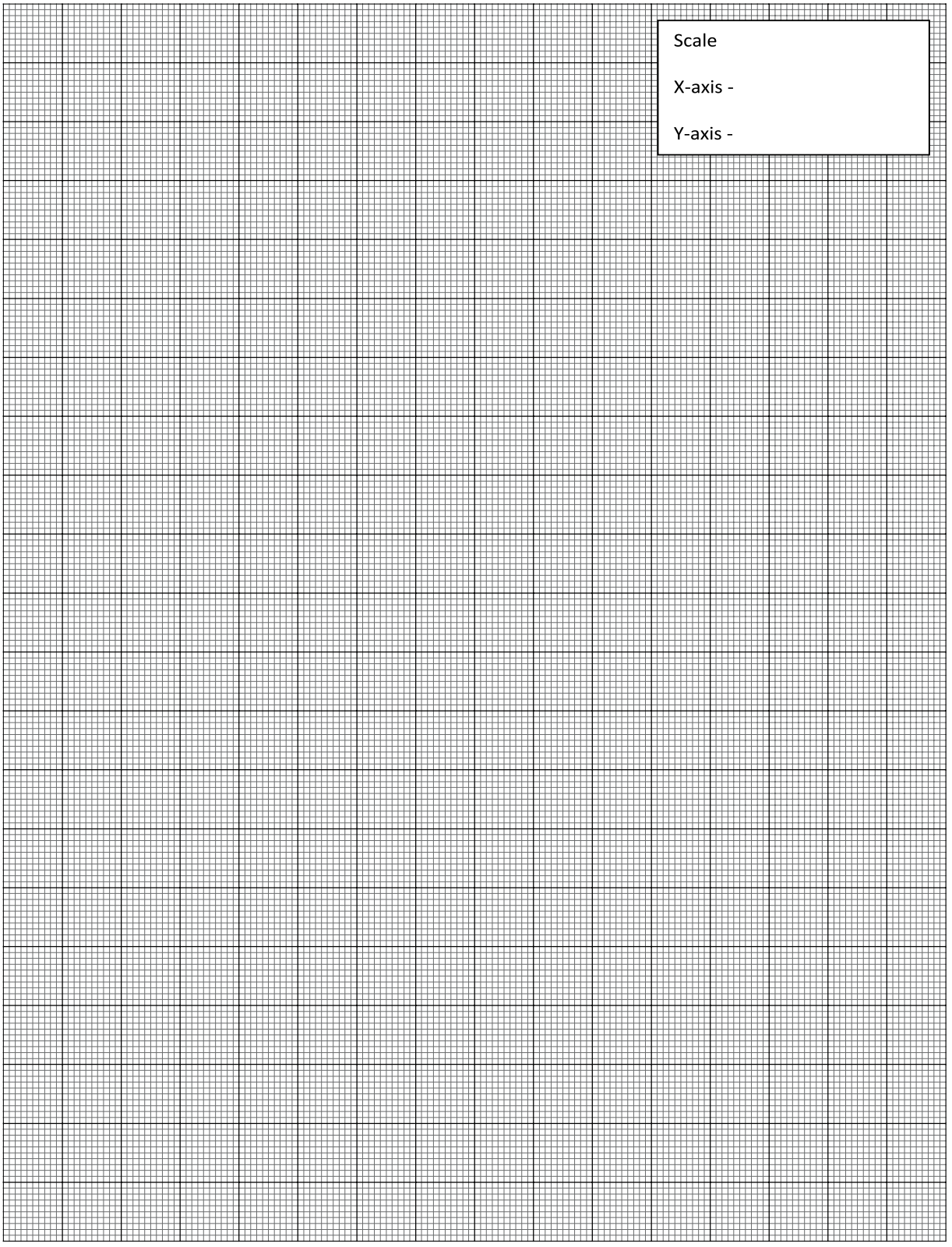
XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of the trainer kit	10 %
2	Identification of component	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
T**otal (25 Marks)**		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.5: Detect error by VRC techniques using relevant simulation Tool.

I Practical Significance

An error-correcting code (ECC) or forward error correction (FEC) code is a process of adding redundant data, or parity data, to a message, such that it can be recovered by a receiver even when a number of errors (up to the capability of the code being used) were introduced, during the process of transmission. Vertical redundancy check (VRC) is an error-checking method used on an eight-bit ASCII character. This practical is designed to explain how VRC error detecting method is used for serial communication.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.

IV Relevant Course Outcomes

- Analyze various error detection and correction codes in digital communication systems.

V Practical Outcome

- Detect error by VRC techniques using relevant simulation tool.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

To detect or correct errors the redundant bits are append with the data. Vertical redundancy check (VRC) is one of the error-checking methods used on an eight-bit ASCII character. In VRC, a parity bit is attached to each byte of data, which is then tested to determine whether the transmission is correct. VRC is considered an unreliable error-detection method because it only works if an even number of bits is distorted.

A vertical redundancy check is also called a transverse redundancy check when used in combination with other error-controlling codes such as a longitudinal redundancy check.

VRC can detect all single bit errors. It can also detect burst errors if the total number of errors in each data unit is odd. VRC can detect errors where total number of bits changed is even

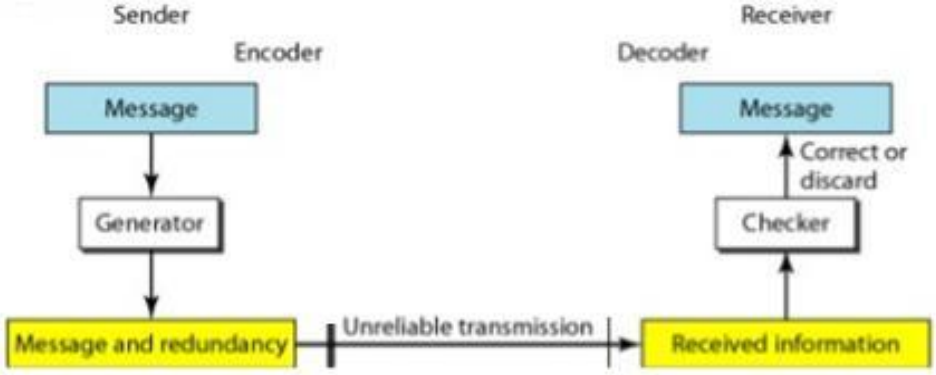


Figure 5.1: Structure of Encoder and Decoder

For Example:
1110110 1101111 1110010
After adding the parity bit
1110110<u>1</u> 1101111<u>0</u> 1110010<u>0</u>

VIII Sample Simulation Code

a) "C" programming codes for VRC Technique

```
void main()
{
int data[3][5],i,j,a[4],count=0;
clrscr();
printf("Enter 3 numbers in 4 bit binary format e.g:-1 1 0 0\n");

for(i=0;i<3;i++)
{
printf("%d binary number (4bit with space)\n",i+1);
for(j=0;j<4;j++)
{
scanf("%d",&data[i][j]);
}
}
for(i=0;i<3;i++)
{
for(j=0;j<4;j++)
{
if(data[i][j]==1)
count++;
}
a[i]=count;
count=0;
}
for(i=0;i<4;i++)
{
if(a[i]%2!=0)
{
data[i][4]=0;
```

```
}
else
{
data[i][4]=1;
}
}
printf("\nGiven Data\n");
for(i=0;i<3;i++)
{
for(j=0;j<4;j++)
{
printf("%d ",data[i][j]);
}
printf("\n");
}

printf("\nData    VRC\n");
for(i=0;i<3;i++)
{
for(j=0;j<5;j++)
{
printf("%d ",data[i][j]);
}
printf("\n");
}
getch();
}
```

Simulation Output:

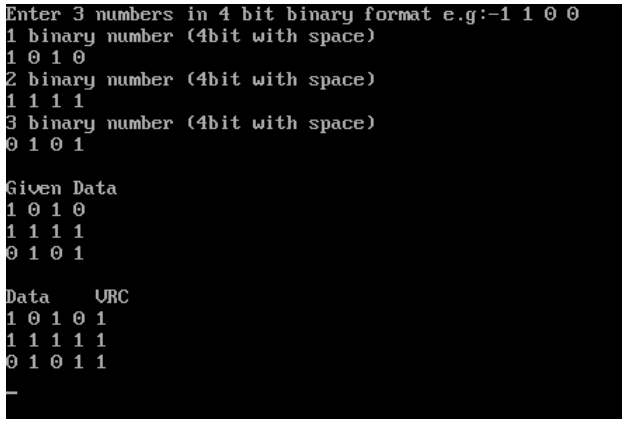


Figure 5.2: VRC Output

b) Actual simulation code (Paste the coding sheet**)**

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Suitable specifications as per requirement of simulation software with Latest Processor	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software/ C programming	1

X Precautions

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

1. Open the “C” software.
2. Create New file in “C”
3. Type the program code in command window.
4. Save the file with .C extension.
5. Compile the program code using Alt+C or Alt+F9 command and remove the errors if any.
6. Run the program codes using Alt+R or Ctrl+F9.
7. Enter the valid input.
8. Observe the output
9. After completion of practical shut down the PC and switch off the supply.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations:

a) Actual simulation output observed (Student should paste the simulation output**)**

XVI Results

.....

.....

.....

.....

XVII Interpretation of results

.....

.....

.....

.....

XVIII Conclusions and Recommendation

.....

.....

.....

.....

.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Determine the VRC for the following ASCII encoded message: “DATA” Use odd parity for VRC.
2. Determine the VRC for the following ASCII encoded message: “WIFE” Use odd parity for VRC.

[Space for Answers]

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.techopedia.com/definition/1804/vertical-redundancy-check-vrc
2. https://www.slideshare.net/kewalramani_renu/error-detection-and-correction-12980998

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

ASCII Coding Sheet

Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII
0	0	0	0	NUL	43	101011	53	2B	+
1	1	1	1	SOH	44	101100	54	2C	,
2	10	2	2	STX	45	101101	55	2D	-
3	11	3	3	ETX	46	101110	56	2E	.
4	100	4	4	EOT	47	101111	57	2F	/
5	101	5	5	ENQ	48	110000	60	30	0
6	110	6	6	ACK	49	110001	61	31	1
7	111	7	7	BEL	50	110010	62	32	2
8	1000	10	8	BS	51	110011	63	33	3
9	1001	11	9	HT	52	110100	64	34	4
10	1010	12	0A	LF	53	110101	65	35	5
11	1011	13	0B	VT	54	110110	66	36	6
12	1100	14	0C	FF	55	110111	67	37	7
13	1101	15	0D	CR	56	111000	70	38	8
14	1110	16	0E	SO	57	111001	71	39	9
15	1111	17	0F	SI	58	111010	72	3A	:
16	10000	20	10	DLE	59	111011	73	3B	;
17	10001	21	11	DC1	60	111100	74	3C	<
18	10010	22	12	DC2	61	111101	75	3D	=
19	10011	23	13	DC3	62	111110	76	3E	>
20	10100	24	14	DC4	63	111111	77	3F	?
21	10101	25	15	NAK	64	1000000	100	40	@
22	10110	26	16	SYN	65	1000001	101	41	A
23	10111	27	17	ETB	66	1000010	102	42	B
24	11000	30	18	CAN	67	1000011	103	43	C
25	11001	31	19	EM	68	1000100	104	44	D
26	11010	32	1A	SUB	69	1000101	105	45	E
27	11011	33	1B	ESC	70	1000110	106	46	F
28	11100	34	1C	FS	71	1000111	107	47	G
29	11101	35	1D	GS	72	1001000	110	48	H
30	11110	36	1E	RS	73	1001001	111	49	I
31	11111	37	1F	US	74	1001010	112	4A	J
32	100000	40	20	SP	75	1001011	113	4B	K
33	100001	41	21	!	76	1001100	114	4C	L
34	100010	42	22	“	77	1001101	115	4D	M
35	100011	43	23	#	78	1001110	116	4E	N
36	100100	44	24	$	79	1001111	117	4F	O
37	100101	45	25	%	80	1010000	120	50	P
38	100110	46	26	&	81	1010001	121	51	Q
Decimal	**Binary**	**Octal**	**Hex**	**ASCII**	**Decimal**	**Binary**	**Octal**	**Hex**	**ASCII**
39	100111	47	27	‘	82	1010010	122	52	R
40	101000	50	28	(	83	1010011	123	53	S

41	101001	51	29	)	84	1010100	124	54	T
42	101010	52	2A	*	85	1010101	125	55	U
86	1010110	126	56	V	107	1101011	153	6B	k
87	1010111	127	57	W	108	1101100	154	6C	l
88	1011000	130	58	X	109	1101101	155	6D	m
89	1011001	131	59	Y	110	1101110	156	6E	n
90	1011010	132	5A	Z	111	1101111	157	6F	o
91	1011011	133	5B	[	112	1110000	160	70	p
92	1011100	134	5C	\	113	1110001	161	71	q
93	1011101	135	5D	]	114	1110010	162	72	r
94	1011110	136	5E	^	115	1110011	163	73	s
95	1011111	137	5F	_	116	1110100	164	74	t
96	1100000	140	60	`	117	1110101	165	75	u
97	1100001	141	61	a	118	1110110	166	76	v
98	1100010	142	62	b	119	1110111	167	77	w
99	1100011	143	63	c	120	1111000	170	78	x
100	1100100	144	64	d	121	1111001	171	79	y
101	1100101	145	65	e	122	1111010	172	7A	z
102	1100110	146	66	f	123	1111011	173	7B	{
103	1100111	147	67	g	124	1111100	174	7C	|
104	1101000	150	68	h	125	1111101	175	7D	}
105	1101001	151	69	i	126	1111110	176	7E	~
106	1101010	152	6A	j	127	1111111	177	7F	DEL

Practical No. 6: Detect error by LRC techniques using relevant Simulation tool

I Practical Significance

Longitudinal redundancy check (LRC) is an error-checking method used on an eight-bit ASCII character. This practical is designed to explain how LRC error detecting method is used for serial communication.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '**Maintain basic digital communication systems'.**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.

IV Relevant Course Outcomes

- Analyze various error detection and correction codes in digital communication systems.

V Practical Outcome

- Detect error by LRC techniques using relevant simulation tool.

VI Relevant Affective domain related Outcome(s)

- Select proper programming environment.
- Follow ethical practices

VII Minimum Theoretical Background

In this method, a block of bits is organized in table (rows and columns). Calculate the parity bit for each column and the set of this parity bit is also sending with original data. Let the block of data send is as follows:

11100111 11011101 00111001 10101001

However it is hit by burst of length eight and some bits are corrupted. When the receiver checks the LRC, some of the bits are not follow even parity rule and whole block is discarded. The process of LRC is shown in figure 6.1

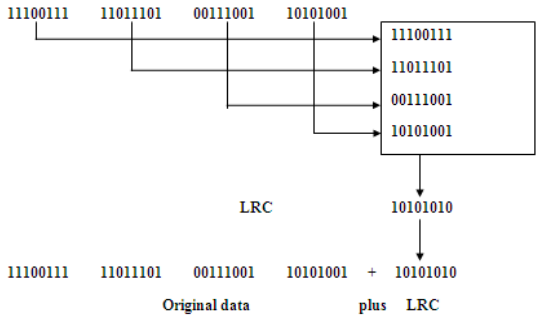


Figure 6.1: LRC Example

VIII Sample Simulation Code

a) Sample " C" code for detection of error using LRC technique

```
void main()
{
int data[3][4],i,j,a[4],count=0;
clrscr();
printf("Enter 3 numbers in 4 bit binary format e.g:-1 1 0 0\n");

for(i=0;i<3;i++)
{
printf("%d binary number (4bit with space)\n",i+1);
for(j=0;j<4;j++)
{
scanf("%d",&data[i][j]);
}
}
for(i=0;i<4;i++)
{
for(j=0;j<3;j++)
{
if(data[j][i]==1)
count++;
}
a[i]=count;
count=0;
}
for(i=0;i<4;i++)
{
if(a[i]%2==0)
{
a[i]=0;
}
else
{
a[i]=1;
}
}
printf("\nGiven Data\n");
for(i=0;i<3;i++)
```

```
{
for(j=0;j<4;j++)
{
printf("%d ",data[i][j]);
}
printf("\n");
}

printf("\nData\n");
for(i=0;i<3;i++)
{
for(j=0;j<4;j++)
{
printf("%d ",data[i][j]);
}
printf("\n");
}
for(i=0;i<4;i++)
{
printf("%d ",a[i]);
}
printf(" LRC");
getch();
}
```

Simulation Output:

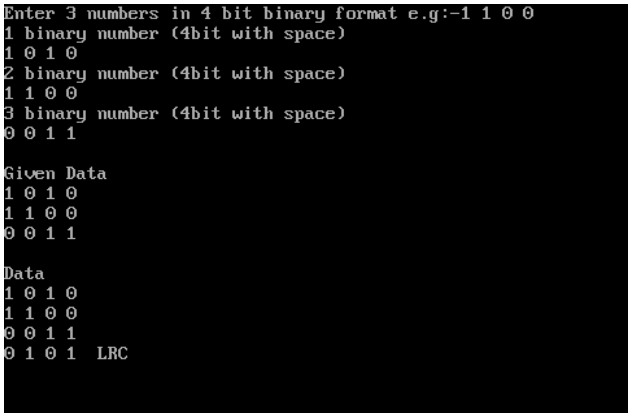


Figure 6.2: LRC Output

b) Actual Simulation Code (Paste the coding sheet**)**

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Suitable specifications as per requirement of simulation software with Latest Processor	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software / "C" programming	1

X Precautions

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

1. Open the "C" software.
2. Create New file in "C"
3. Type the program code in command window.
4. Save the file with .C extension.
5. Compile the program code using Alt+C or Alt+F9 command and remove the errors if any.
6. Run the program codes using Alt+R or Ctrl+F9.
7. Enter the valid input.
8. Observe the output
9. After completion of practical shut down the PC and switch off the supply

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....

.....

.....

.....

XIV Precautions followed

.....

.....

.....

.....

XV Observations and Calculations

a) Actual simulation output observed (Student should paste the simulation output**)**

XVI Interpretation of results

.....
.....
.....
.....

XVII Conclusions & Recommendation

.....
.....
.....
.....

XVIII Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Determine the LRC for the following ASCII encoded message: “THE CAT” Use even parity for LRC refer the ASCII sheet in Experiment No.5.
2. Determine the LRC for the following ASCII encoded message: “HELLO” Use even parity for LRC.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://asecuritysite.com/calculators/lrc
2. https://www.slideshare.net/TechiNerd/error-detection-and-correction-36618963
3. https://www.slideshare.net/kewalramani_renu/error-detection-and-correction-12980998

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 7: Test the performance of Natural and Flat top sampling circuit

I Practical Significance

In modern communication, sampling has the wide application of various forms: such as A/D conversion, digital communications, audio and video signal processing and radar signal processing. In this practical, students will understand nature of natural and flat top samples.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Test the performance of natural and flat top sampling circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Handle instruments carefully.

VII Minimum Theoretical Background

Sampling is the reduction of a continuous-time signal to a discrete-time signal.

Types of sampling are:

1) **Natural Sampling:** It is a practical method of sampling in which pulse have finite width equal to τ. Sampling is done in accordance with the carrier signal which is digital in nature.it is shown in figure 7.1

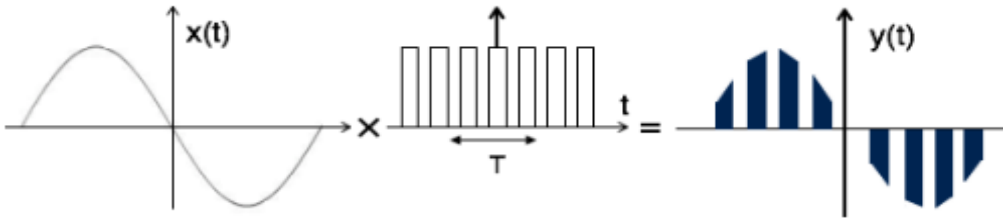


Figure 7.1: Natural sampling process

[Courtesy:https://www.tutorialspoint.com/signals_and_systems/signals_sampling_techniques.htm]

2) **Flat top sampling:** it is like natural sampling i.e.; practical in nature. In comparison to natural sampling flat top sampling can be easily obtained. In this sampling techniques, the top of the samples remains constant and is equal to the instantaneous value of the message signal x (t) at the start of sampling process. Sample and hold circuit are used in this type of sampling. During transmission, noise is introduced at top of the transmission pulse which can be easily removed if the pulse is in the form of flat top.it is shown in figure

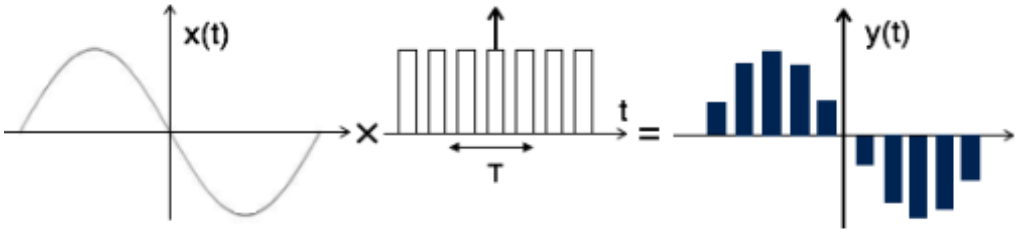


Figure 7.2: Flat top sampling process

[Courtesy:https://www.tutorialspoint.com/signals_and_systems/signals_sampling_techniques.htm]

VIII Practical Circuit Diagram

a) Sample Circuit Diagram

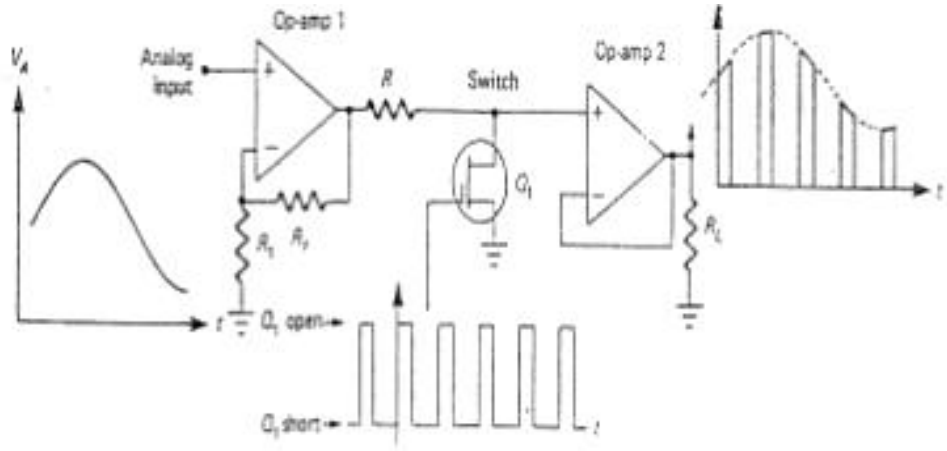


Figure 7.3: Natural sampling

[Courtesy:https://www.google.co.in/search?q=natural+and+flat+top+sampling+in+communication&source=lnms&tbm=isch&sa=X&ved=0ahUKEwielcXQva_cAhXGL48KHfgfCF0Q_AUICigB&biw=1024&bih=662#imgrc=wt4ODsGgLj0iTM:]

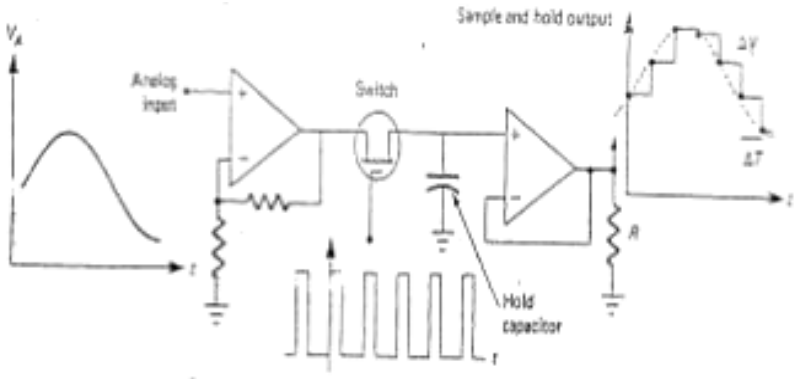


Figure 7.4: Flat-top sampling

[Courtesy:https://www.google.co.in/search?q=natural+and+flat+top+sampling+in+communication&source=lnms&tbm=isch&sa=X&ved=0ahUKEwielcXQva_cAhXGL48KHfgfCF0Q_AUICigB&biw=1024&bih=662#imgrc=wt4ODsGgLj0iTM:]

b) Sample Practical set up

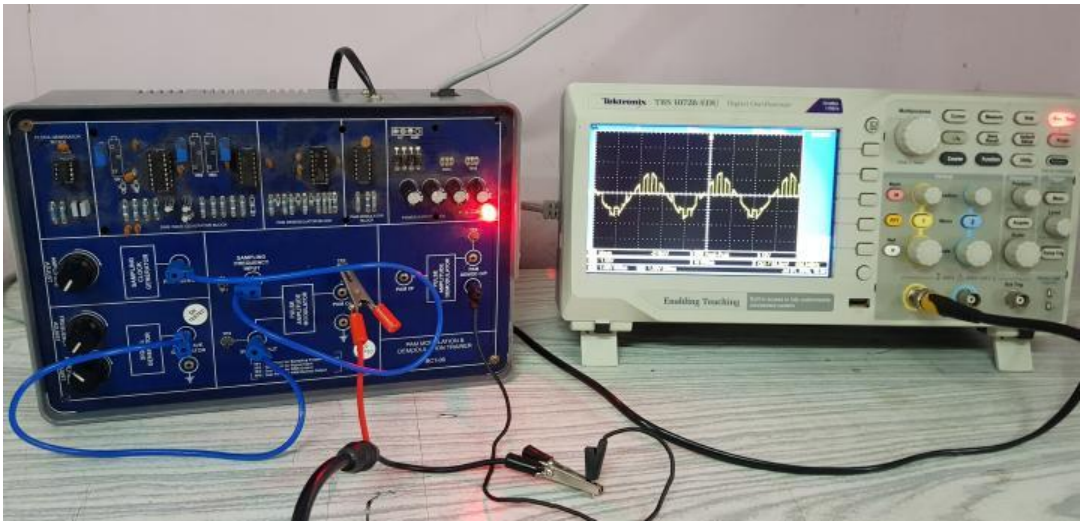


Figure 7.5: Practical set up for Natural sampling

Figure 7.6: Practical set up for flat top sampling

b) **Actual Practical set up used in laboratory (**Student should draw Practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	DC Regulated power supply	Variable DC power supply 0-30V, 2A, SC protection, display for voltage and current.	1
2.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope / / 25 MHz Dual Trace Digital Storage Oscilloscope	1
3.	PAM and PCM modulator kit	Sampling Frequency 110KHz for PAM, Sampling Frequency 8 to 12KHz for PCM or equivalent trainer kit	1

X Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment adjust proper volt/div and times/div selection on CRO/DSO.

XI Procedure

1. For Natural sampling

i. Use PAM modulator kit for natural sampling.

ii. Make the connection as per the Figure7.5.

iii. Switch ON the power supply.

iv. Adjust the sampling frequency of 8 kHz pulse and input signal of $1V_{PP}$, 1 kHz.

v. Observe the waveforms of input signal, sampling signal and output of PAM modulator (natural samples) on CRO/DSO

vi. Draw the waveforms of input signal, sampling signal and output of PAM modulator (natural samples) on graph paper.

2. For Flat-top sampling

i. Use PCM modulator kit for flat–top sampling.
ii. Make the connection as per the Figure7.6.
iii. Switch ON the power supply.
iv. Adjust the sampling frequency of 8 kHz and input signal of $1V_{PP}$, 1 kHz.
v. Observe the waveforms of input signal, sampling signal and output of sampled and hold circuit (flat-top samples) on CRO/DSO
vi. Draw the waveforms of input signal, sampling signal and output of sampled and hold circuit (flat-top samples) on graph paper.
vii. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity
		Make	Details	
1.				
2.				
3.				

XIII Actual Procedure followed

.....
.....
.....
.....
.....

XIV Precautions Followed

.....
.....
.....
.....

XV Observations

.....
.....
.....
.....

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions

.....
.....
.....
.....

XIX Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design ***more such questions so as to ensure the achievement of identified CO.***

1. Select input frequency 500Hz and sampling frequency 16 KHz apply to PCM kit and observe output of sample and hold circuit. Draw the same.
2. Compare natural sampling and flat top sampling

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

XX References / Suggestions for further Reading

1. https://www.tutorialspoint.com/signals_and_systems/signals_sampling_techniques.htm.
2. https://www.youtube.com/watch?v=WUCMavXbJo4.

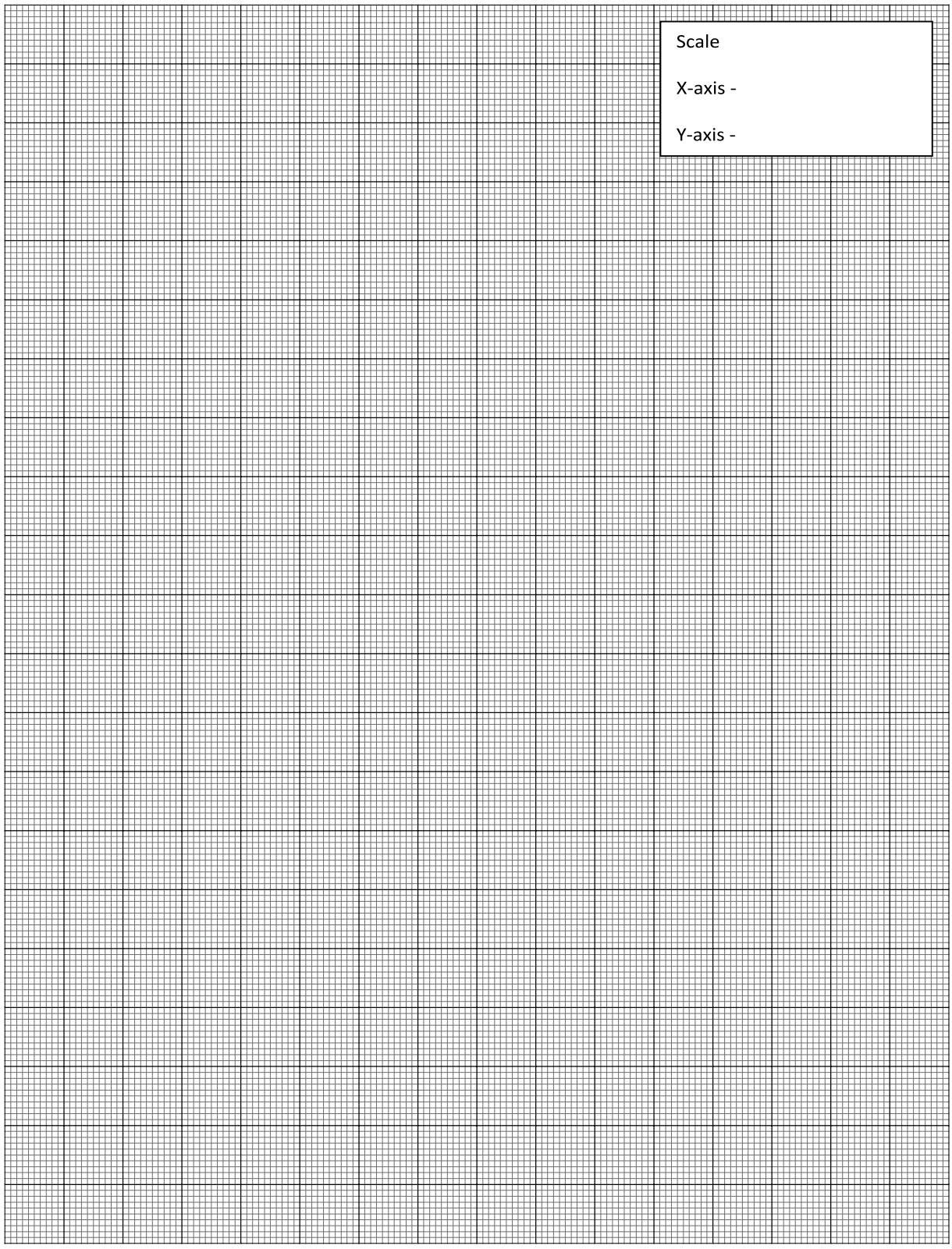
XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
T**otal (25Marks)**		100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.8: Test the performance of sampling circuit for variation in Sampling frequency.

I Practical Significance

To process signals in most of the electronic gadgets like computers, we need to convert the signals to "digital" form. While an analog signal is continuous in both time and amplitude, a digital signal is discrete in both time and amplitude. To convert a signal from continuous time to discrete time, a process called sampling is used. In this practical, students will vary the sampling frequencies and observe its effect on output samples.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop to following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Test the performance of sampling circuit for variation in sampling frequency.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Handle instruments carefully.

VII Minimum Theoretical Background

Sampling is the reduction of a continuous-time signal to a discrete-time signal.

Sampling theorem states that A continuous time signal can be represented in its samples and can be recovered back when sampling frequency f_s is greater than or equal to the twice the highest frequency component of message signal. i.e. $fs \geq 2fm$.To reconstruct x(t), you must recover input signal spectrum X(ω) from sampled signal spectrum Y(ω), which is possible when there is no overlapping between the cycles of Y(ω).Possibility of sampled frequency spectrum with different conditions is given by the following diagrams:

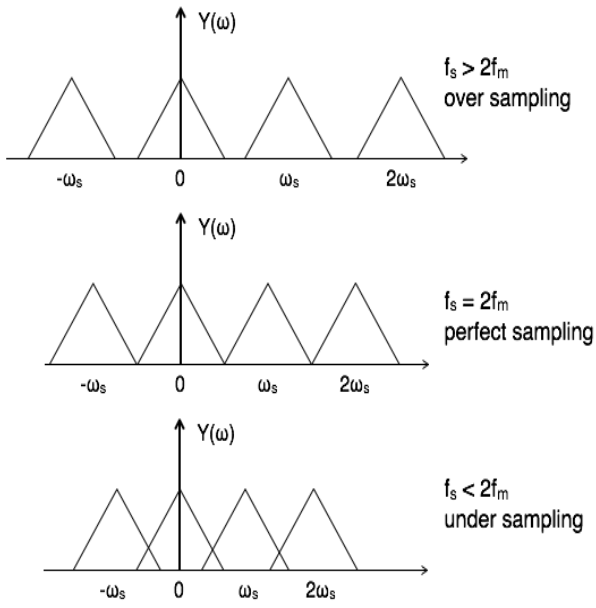


Figure8.1: Effect of different sampling frequencies

[Courtesy: https://www.tutorialspoint.com/signals_and_systems/signals_sampling_theorem.htm.]

The overlapped region in case of under sampling represents aliasing effect, which can be removed by

- considering $f_s > 2f_m$
- By using anti-aliasing filters.

VIII Practical Circuit Diagram

a) Sample Circuit Diagram

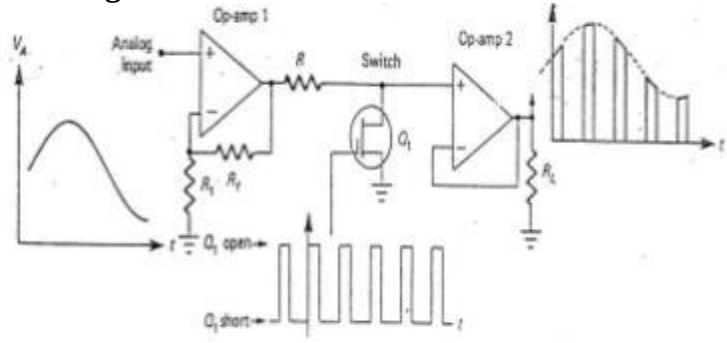


Figure 8.2: Circuit for Natural Sampling

[Courtesy:https://www.google.co.in/search?q=natural+and+flat+top+sampling+in+communication&source=lnms&tbm=isch&sa=X&ved=0ahUKEwielcXQva_cAhXGL48KHfgfCF0Q_AUICigB&biw=1024&bih=662#imgrc=wt4ODsGgLj0iTM:]

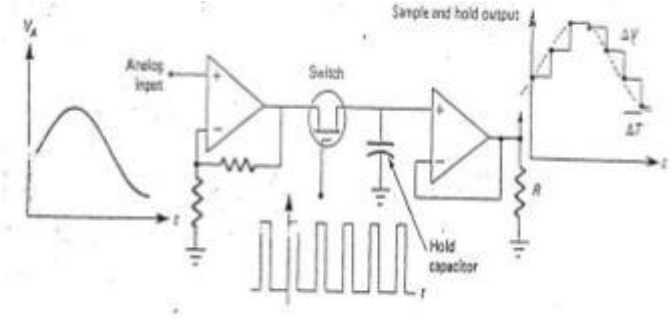


Figure 8.3: Circuit for flat-top sampling

[Courtesey:https://www.google.co.in/search?q=natural+and+flat+top+sampling+in+communication&source=lnms&tbm=isch&sa=X&ved=0ahUKEwielcXQva_cAhXGL48KHfgfCF0Q_AUICigB&biw=1024&bih=662#imgrc=ko1z2XHxInaz0M:]

b) Sample Practical set up

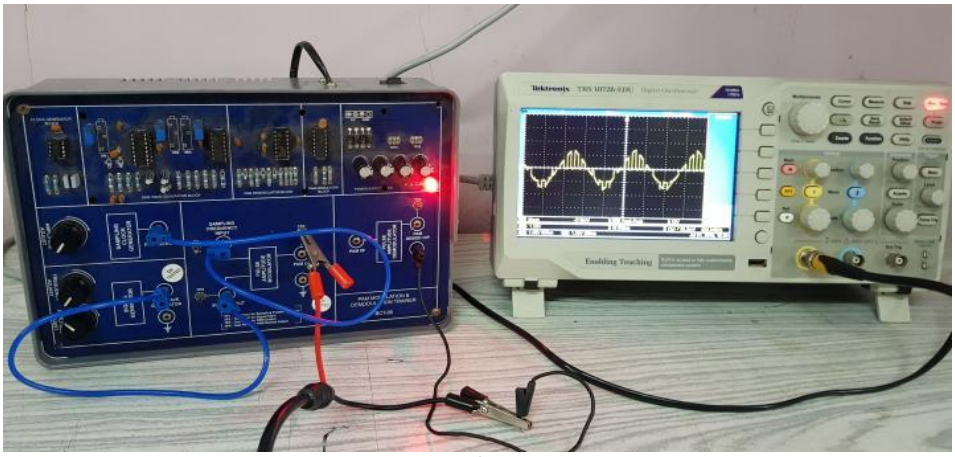


Figure 8.4: Practical set up for Natural sampling

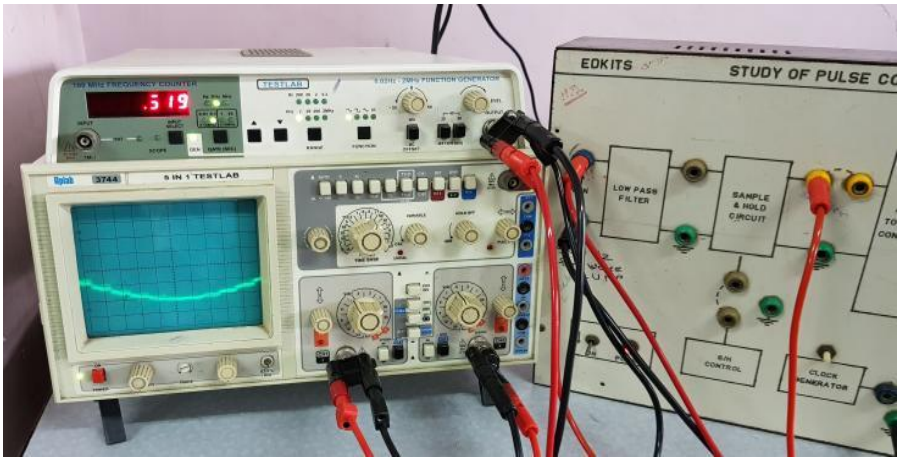


Figure 8.5: Practical set up for Flat top sampling

c) Actual Practical set up used in laboratory **(**Student should draw Practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	DC Regulated power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1
2.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope / /25 MHz Dual Trace Digital Storage Oscilloscope	1
3.	PAM and PCM modulator kit	Sampling Frequency 110KHz for PAM, Sampling Frequency 8 to 12KHz for PCM or equivalent trainer kit	1

X Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment adjust proper volt/div and times/div selection on CRO/DSO.

XI Procedure

1. Use PAM modulator kit / PCM modulator kit
2. Make the connection as per the Figure 8.4/8.5.
3. Switch ON the power supply.
4. Adjust the sampling frequency of 8 kHz pulse and input signal of $1V_{PP}$, 1 kHz.
5. Observe the waveforms of output of PAM modulator (natural samples) / output of sampled and hold circuit (flat-top samples) on CRO/DSO.
6. Draw the waveforms of output of PAM modulator (natural samples)/ output of sampled and hold circuit (flat-top samples) on graph paper.
7. Repeat step 4,5, and 6 for sampling frequency:16KHz,32KHz and 64KHz
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity
		Make	Details	
1.				
2.				
3.				

XIII Actual Procedure followed

.....

.....

.....

.....

.....

XIV Precautions Followed

.....
.....
.....
.....
.....

XV Observations

.....
.....
.....
.....

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions

.....
.....
.....
.....

XIX Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Find which circuit is used for sample and hold for the above practical.
2. Use internet to check is there any ready IC available for sampling if yes, state its name and IC number.
3. Select input frequency 500Hz and sampling frequency 16 KHz observe the output of PAM modulator and on PCM modulator kit output of sampled and hold circuit and draw them.
4. Select input frequency 200Hz and sampling frequency 8KHz observe the output of PAM modulator and on PCM modulator kit output of sampled and hold circuit and draw them Compare natural sampling and flat top sampling

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.tutorialspoint.com/signals_and_systems/signals_samplingtechniques.htm
2. https://www.youtube.com/watch?v=WUCMavXbJo4.

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
T**otal (25 Marks)**		100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -


Scale
X-axis -
Y-axis -

Practical No.9: Test the performance of the pulse code modulator / Demodulator circuit.

I Practical Significance

Pulse-code modulation (PCM) is a method used to digitally represent sampled analog signals. It is the standard form for digital audio in computers and various Blu-ray, Compact Disc and DVD formats. This practical is designed to explain how different types of information signals which are analog in nature can be converted to digital form.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations.

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Test the performance of the pulse code modulator / demodulator circuit.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

A PCM stream is a digital representation of an analog signal, in which the magnitude of the analog signal is sampled regularly at uniform intervals, with each sample being quantized to the nearest value within a range of digital steps. The next step is to assign a binary sequence to each of those voltage samples, this step is called quantization. The purpose of a PCM system is to transmit to the distant end the value of a voltage sample at a certain moment in time.

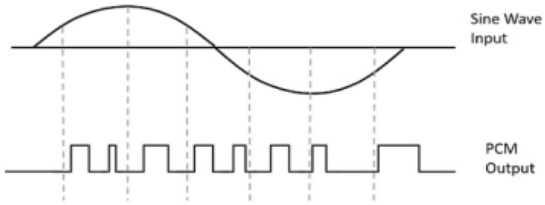


Figure 9.1: PCM input-output waveforms

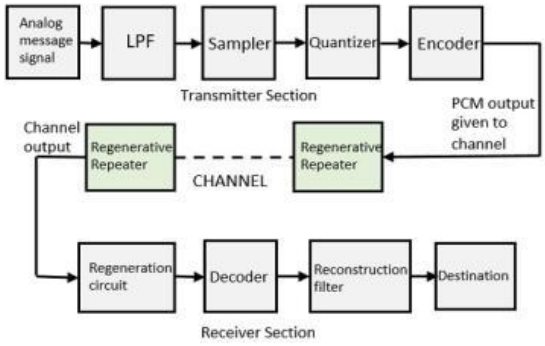


Figure 9.2: Basic Elements of PCM system

[Courtsey:*https://www.google.co.in/search?biw=1024&bih=662&tbm=isch&sa=1&ei=2zNEW8DyFZqYvQTMkIrADQ&q=pcm+demodulator+block+diagram&oq]*

VII Practical Circuit Diagram

a) Sample block diagram

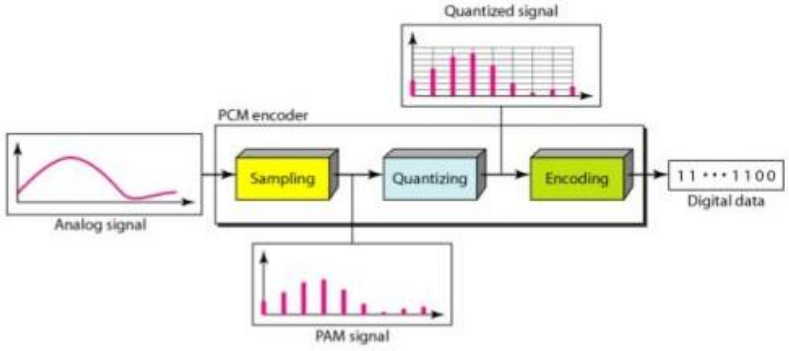


Figure 9.3: PCM transmitter

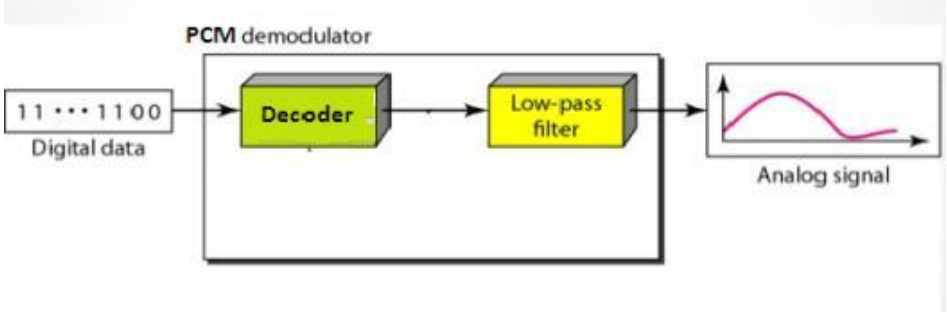


Figure 9.4: PCM Receiver

[Courtesy:*https://www.google.co.in/search?biw=1366&bih=662&tbm=isch&sa=1&ei=ePZBW9yTFYTevASX44jwCQ&q=pcm+modulation+circuit+diagram&oq=+PCM+circuit]*

b) Actual block diagram / Circuit diagram

c) **Actual Practical Setup (**Students should draw practical set up used in their laboratory)

VIII Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20 MHz dual trace oscilloscope / 25 MHz Dual Trace Digital Storage Oscilloscope	1
2	Power supply	(0-30V,0-2A)	1
3	PCM Trainer kit	On board modulating sine wave generator 300 Hz – 3.4 KHz, on board sampling pulse generator fast mode – 1.2 – 1.4 MHz, slow mode 0.8 Hz – 1.2 Hz or equivalent trainer kit	1
4	Connecting wires	CRO probes, attenuation probes, patch chords	2

IX Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

X Procedure

1. Make the connection as per the available trainer kit.
2. Switch ON the power supply.
3. Set the input analog signal at (1-2 V_{PP}, 500Hz) from function generator.
4. Connect the above signal to the input of trainer kit.
5. Observe the waveform at the output of each block of PCM transmitter.
6. Measure the frequency and voltage of input modulating signal, sampling signal.
7. Connect the PCM modulated waveform to the input of PCM demodulator.
8. Observe the demodulated waveforms with and without filter.
9. Measure the frequency and voltage of LPF output of demodulator.
10. Draw observed waveforms on the graph paper.
11. Verify from the above observations that the given sampling frequency is greater than the $2f_{max}$ (where f_{max} is the modulating frequency).
12. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XI Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

XII Actual Procedure followed

.....

.....

.....

.....

XIII Actual Precautions followed

.....

.....

.....

.....

XIV Observations and Calculations

Table 9.1: Waveforms at Various stages of PCM

Sr. No.	Output at	Amplitude	Time period	Frequency	Waveform
1	Input signal				
2	Sampling signal				
3	Sampler signal (sample and hold)	-			
4	A to D converter	-			
5	Demodulated output without filter				
6	Demodulated output with filter				

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Refer the Experiment Manual provided by trainer supply and find which circuit or IC is used for
   i. Sampling,

ii. Quantizing
iii. Encoding

2. Check if any single IC can do all the three process given in question one.
3. Change the sampling frequency and draw the corresponding PCM output.
4. Change the input frequency and keep the sampling frequency as per above and draw the corresponding PCM output.
5. Name the ADC IC used in your experimental kit.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.tutorialspoint.com/digital_communication/digital_communication_pulse_code_modulation.html
2. https://en.wikipedia.org/wiki/Differential_pulse-code_modulation

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.10: Test the performance of the delta modulator/ demodulator Circuit.

I Practical Significance

In PCM the signaling rate and transmission channel bandwidth are quite large since it transmits all the bits which are used to code a sample. To overcome this problem, Delta modulation is used. A delta modulation is an analog-to-digital and digital-to-analog signal conversion technique used for transmission of voice information. DM is the simplest form of differential pulse-code modulation (DPCM) where the difference between successive samples is encoded into n-bit data streams. In delta modulation, the transmitted data are reduced to a 1-bit data stream. This practical is designed to explain how different types of information signals which are analog in nature can be converted to digital form.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations.

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Test the performance of the delta modulator/ demodulator circuit.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Delta modulation is a Differential Pulse Code modulation (DPCM) technique in which the difference signal is encoded into a single bit .Delta modulation provides a staircase approximation of the input sampled signal where only one bit per sample is transmitted.

This one bit is sent by comparing the present sample value with the previous sample value and the result whether the amplitude is to be increased or decreased is transmitted. If the step is reduced, 0 is transmitted and if the step is increased then 1 is transmitted. The Fig1 illustrates the block diagram of Delta modulation transmitter.

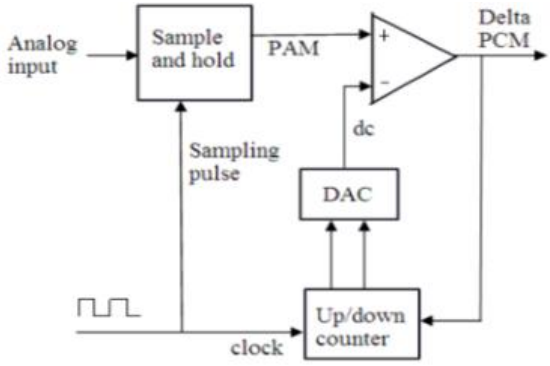


Figure 10.1: Delta modulation Transmitter

Sample and hold circuit will sample the analog input signal into Pulse amplitude modulated (PAM) signal. The Up-down counter stores the magnitude of the previous sample in the binary value. This binary number is converted into equivalent voltage in the Digital-to-analog converter (DAC).The PAM signal and the DAC output are compared in the comparator. The Up-down counter is incremented or decremented depending on whether the previous sample is larger or smaller than the current sample. The output of the comparator generates the Delta pulse code modulated signal.

The Figure 10.2 illustrates the block diagram of Delta modulation receiver.

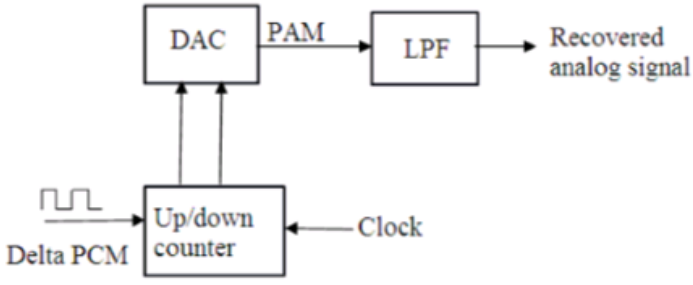


Figure 10.2: Delta modulation Receiver

The receiver of the delta modulator consists of DAC, up/down counter and LPF. The Delta PCM signal is fed to the up/down counter. Based on the input received from the up/down counter, DAC will generate the output PAM signal. The output of DAC is given LPF which will filter out high frequency component Thus the output signal of DAC in the transmitter and receiver is identical to the original information signal.

There are two distortions; slope overhead error and granular noise are present in DM.

VIII Practical Circuit Diagram

a) Sample Block diagram

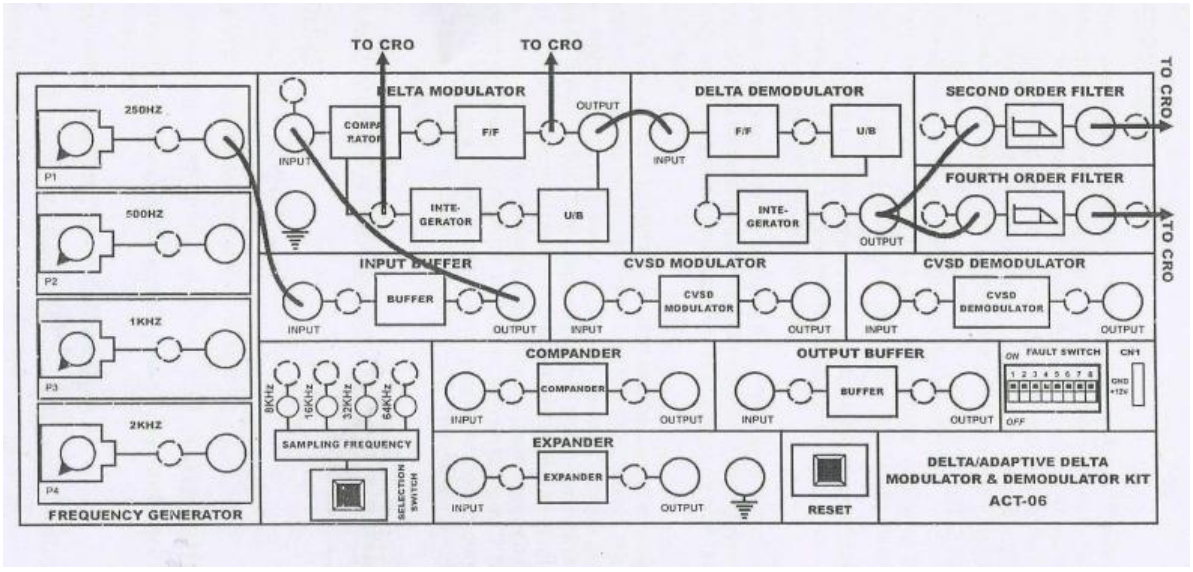


Figure 10.3: Practical set up

b) Actual block diagram / Circuit diagram

c) **Actual Practical Setup (**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	30MHz dual trace oscilloscope / 25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	(0-30V,0-2A)	1
3.	DM Trainer kit	Input frequency (250Hz,500Hz,1 KHz, 2 KHz), Sampling frequency (8,16,32,64) KHz or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per figure 10.3.
2. Switch ON the power supply.
3. Set the input information signal at $1V_{pp}$, 500 Hz.
4. Connect the above set input to DM modulator input i.e. to comparator input.
5. Select the sampling frequency of 8 KHz.
6. Observe the integrator output by varying amplitude from 0.5 V to 1V
7. Observe the output waveform at various block output of DM modulator.
8. Connect the output of DM modulator to demodulator the input.
9. Observe the output of DM demodulator
10. Observe the waveform at the output of filter by connecting the output of demodulator to the input of low pass filter.
11. Repeat the above procedure from step 6 to 10 for sampling frequency of 32 KHz.
12. Draw observed waveforms on the graph paper.
13. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

XIII Actual Procedure followed

.....

.....

.....

.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table 10.1: Waveforms at Various stages of DM

Sr. No.	Output at	Amplitude	Time period	Frequency
1	Input signal			
2	Sampling signal			
3	Integrator signal			
4	DM modulator output			
5	Compressor output			
6	Expander output			
7	DM demodulator output without filter			
8	DM demodulator output with filter			

Note: Draw waveforms on graph paper

XVI Results

.....
.....
.....
.....
.

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....

.....

.....

.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1 Observe the effect of increasing or decreasing amplitude of input signal on DM output.
2 Observe the effect of increase or decrease in amplitude of input signal on integrator output.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. http://www.eng.auburn.edu/~troppel/courses/TIMS-manuals-r5/TIMS%20Experiment%20Manuals/Student_Text/Vol-D1/D1-13.pdf
2. https://www.slideshare.net/stk_gpg/pulse-modulation-9526921?next_slideshow=1
3. https://www.slideshare.net/azizulhoque539/311-pulse-modulation

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.11: Test the performance of the adaptive delta modulator (ADM) modulator/ demodulator circuit.

I Practical Significance

Adaptive delta modulation (ADM) is used in digital conferencing of voice signals in systems .The performance of a delta modulator can be improved significantly by making the step size of the modulator assume a time-varying form. During a steep segment of the input signal the step size is increased. Conversely, when the input signal is varying slowly, the step size is reduced. In this way, the size is adapted to the level of the input signal. The resulting method is called adaptive delta modulation (ADM).This practical is designed to explain how different types of information signals which are analog in nature can be converted to digital form.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations.

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Test the performance of the Adaptive delta modulator (ADM) modulator/ demodulator circuit.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Short-range wireless digital voice transmission is used extensively in contemporary consumer electronics. Products such as cordless telephones, wireless headsets (for mobile and landline telephones) and baby monitors are just a few of the items that use digital techniques to wirelessly communicate voice information.

ADM is a voice coding technique that quantizes the difference between the current sample and the predicted value of the next sample. It uses a variable 'step height' to adjust the predicted value of the next sample so that both slowly and rapidly changing input signals can be faithfully reproduced. One bit is used to represent each sample in ADM

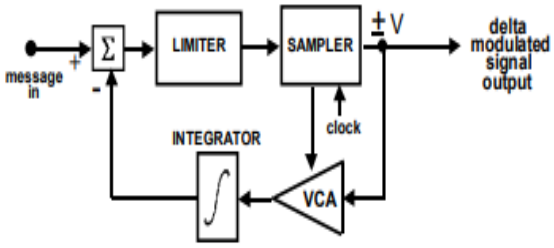
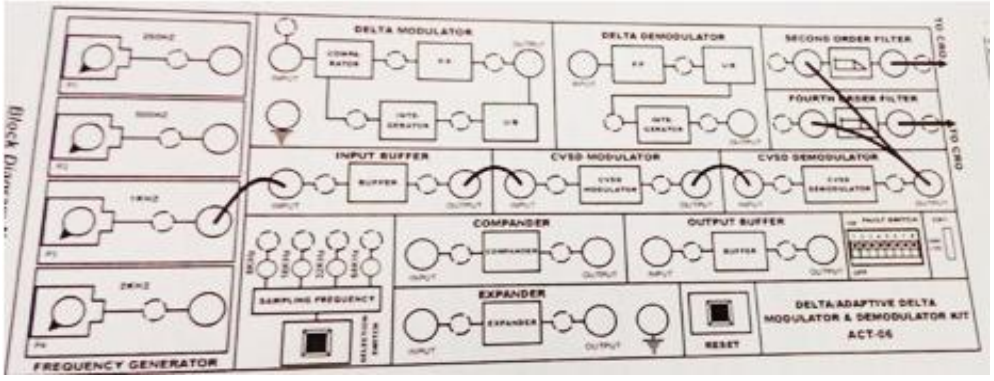


Figure 11.1: Basic elements of ADM system

VIII Practical Circuit Diagram

a) Sample block diagram



b) Actual block diagram / Circuit diagram

c) **Actual Practical Setup (**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable DC 0-30V,0-2A with SC protection Digital meter	1
3.	ADM Trainer kit	Sampling frequency (8,16,32,64)KHz or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	AS per requirement

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per figure 11.2.
2. Switch ON the power supply.
3. Set the input signal at 1 KHz, $2V_{pp}$ sine wave to the input of the buffer section.
4. Connect the buffer output to the CVSD (continuously variable slope delta modulator) signal to input of DPCM transmitter.
5. Adjust the clock frequency to 32 KHz.
6. Connect the output of CSVD modulated output to input buffer of ADM demodulator.
7. Observe the input sine wave, ADM output and demodulated output waveforms with and without filter.
8. Repeat the above procedure from step 3 to 8 for different input signal frequency and different clock rates.
9. Observe the response of CVSD modulator and demodulator.
10. Draw observed waveforms on the graph paper.
11. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table 11.1: Waveforms at Various stages of ADM

Sr. No.	Output at	Amplitude	Time period	Frequency
1	Input signal			
2	Sampling signal			
3	CVSD modulator output			
4	CVSD demodulator output without filter			
5	CVSD demodulator output with filter			

Note: Draw the waveforms on graph.

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Explore internet and check for ADM IC available in market name it and state its number.
2. Observe the effect on the retrieved information signal by varying sampling frequency.
3. Observe the effect of retrieved information signal by varying amplitude of information signal.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. http://www.allsyllabus.com/aj/note/ECE/Digital%20Communication/unit3/index.php#.W0MQ69UzbIU
2. https://www.tutorialspoint.com/digital_communication/digital_communication_differential_adm.htm
3. http://www.eeeguide.com/delta-modulation/

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.12: Test the performance of the differential pulse code Modulator (DPCM) modulator / demodulator circuit

I Practical Significance

The DPCM technique mainly uses Speech, image and audio signal compression. The DPCM conducted on signals with the correlation between successive samples leads to good compression ratios. The samples which are highly correlated are encoded by PCM technique, leave redundant information behind. To process this redundant information and to have a better output, it is a wise decision to take a predicted sampled value, assumed from its previous output and summarize them with the quantized values. Such a process is called as Differential PCM (DPCM) technique. This practical designed to explain how different types of information signals which are analog in nature can be converted to digital form.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Test the performance of the differential pulse code modulator (DPCM) modulator/ demodulator circuit.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Differential pulse-code modulation (DPCM) is a signal encoder that uses the baseline of pulse-code modulation (PCM) but adds some functionality based on the prediction of the samples of the signal. The input can be an analog signal or a digital signal.

If the input is a continuous-time analog signal, it needs to be sampled first so that a discrete-time signal is the input to the DPCM encoder. By taking the values of two consecutive samples; if they are analog samples, quantize them; calculate the difference between the first one and the next; the output is the difference, and it can be further entropy coded or instead of taking a difference relative to a previous input sample, take the difference relative to the output of a local model of the decoder process; in this option, the difference can be quantized, which allows a good way to incorporate a controlled loss in the encoding.

The block diagram of DPCM Transmitter consists of Quantizer and Predictor with two summer circuits. DPCM Receiver consists of a decoder, a predictor and a summer circuit.

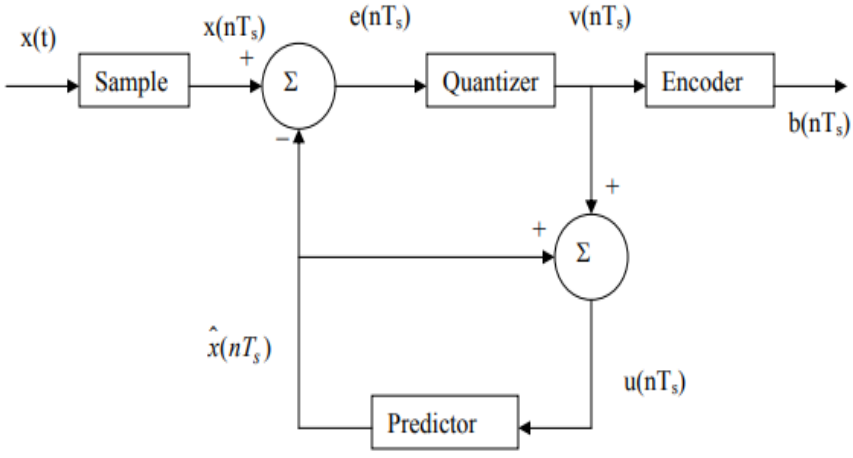


Figure12.1: DPCM transmitter / Modulator

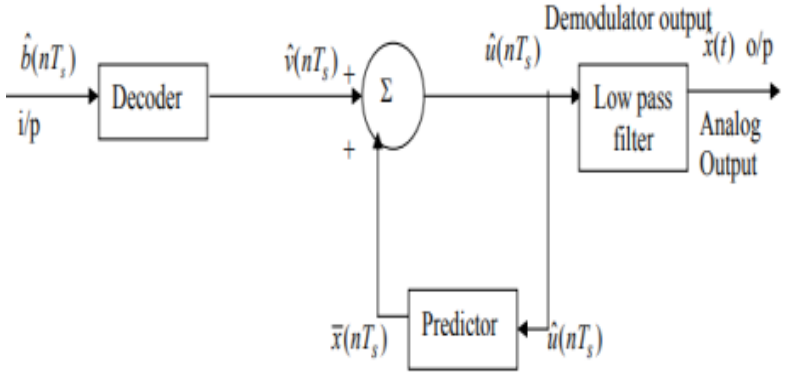


Figure12.2: DPCM receiver / Demodulator

VIII Practical Circuit Diagram

a) Sample Block Diagram

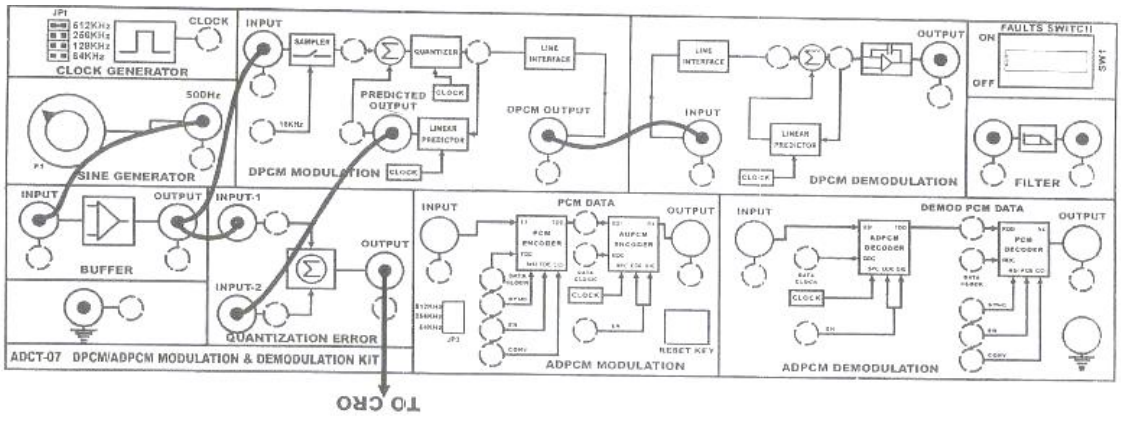


Figure12.3: DPCM Modulator and Demodulator

b) Actual Block Diagram / Circuit Diagram

c) **Actual Practical Setup (**Students should draw Practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C power supply 0-30V,0-2A with SC protection , Digital meters	1
3.	DPCM Trainer kit	Sine wave generator using 74164, jumper selectable clock frequency 64 KHz, 128 KHz, 256 KHz, 512 KHz or equivalent trainer kit	1
4.	Connecting wires	CRO probes, attenuation probes, patch chords	02

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per figure 12.3.
2. Switch ON the power supply.
3. Set the input analog signal at (1-2 $V_{PP,}$ 500Hz) from function generator.
4. Connect the above signal to the input of trainer kit.
5. Observe the waveform at the output of each block of DPCM transmitter.
6. Measure the frequency and voltage of input modulating signal, sampling signal.
7. Connect the DPCM modulated waveform to the input of DPCM demodulator.
8. Observe the demodulated waveforms with and without filter.
9. Measure the frequency and voltage of LPF output of demodulator.
10. Draw observed waveforms on the graph paper.
11. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

XIII Actual Procedure followed

.....
.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....
.....

XV Observations and Calculations:

Table 12.1: Waveforms at Various stages of DPCM

Sr. No.	Output at	Amplitude	Time period	Frequency
1	Input signal			
2	Sampling signal			
3	Sample and hold signal	-		
4	Predictor output			
5	Encoder output	-	-	-
6	Demodulated output with filter			

Note: Draw the waveforms on graph.

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Explain the role of predictor in DPCM.
2. List the IC's used in the practical kit available in the lab.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.google.co.in/search?q=dpcm&sa
2. https://www.tutorialspoint.com/digital_communication/digital_communication_differential_pcm.html

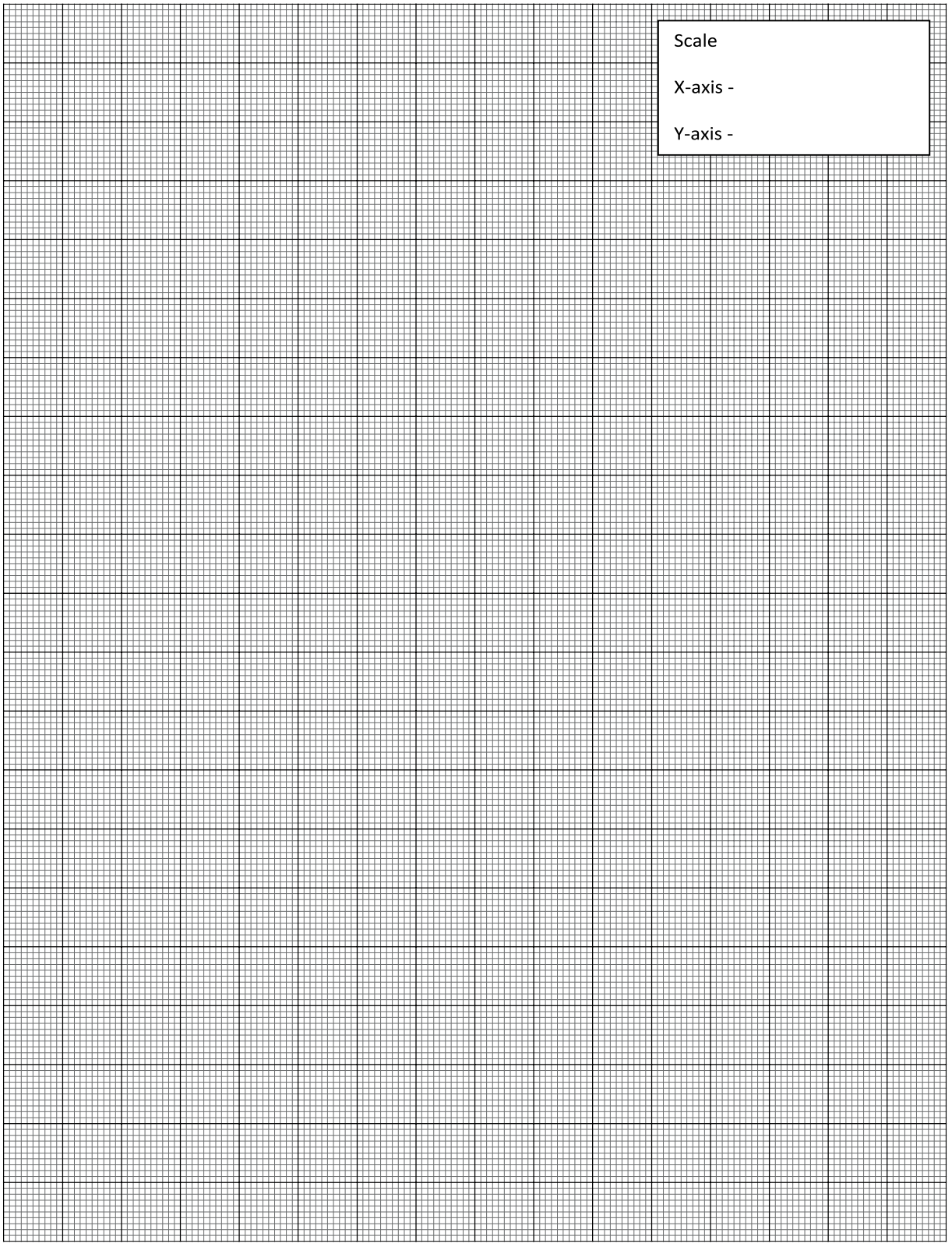
XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 13: Write a program using relevant simulation tool to observe Sampling process for sampling rate less than, equal to and greater than the Nyquist rate.

I Practical Significance

Sampling theorem is one of the very basic theorems in the field of digital processing and communication which has gained increasing importance because of its many advantages over its analog counterpart. Sampling refers to picking out values of the signal for certain values of the independent variables. A band limited signal can be reconstructed exactly if it is sampled at a rate at least twice the maximum frequency component in it. This practical is designed to view the effect of different conditions of sampling rate on the output.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '**Maintain basic digital communication systems'.**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.
- Calculate various parameters

IV Relevant Course Outcomes

- Use various pulse code modulation techniques.

V Practical Outcome

- Write a program using relevant simulation tool to observe sampling process for sampling rate less than, equal to and greater than the Nyquist rate

VI Relevant Affective domain related Outcome(s)

- Select proper programming environment.
- Follow ethical practices

VII Minimum Theoretical Background

A continuous time signal can be represented in its samples and can be recovered back when sampling frequency f_s is greater than or equal to the twice the highest frequency component of message signal. i.e.

$$f_s \geq 2f_m$$

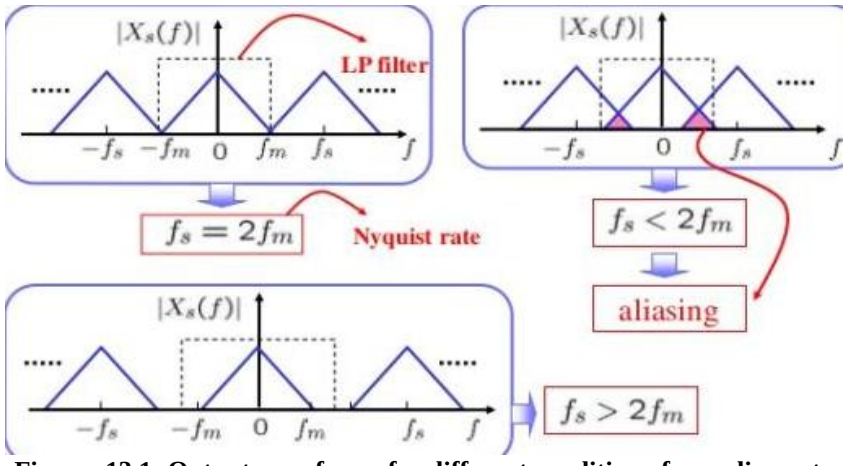


Figure: 13.1: Output waveforms for different condition of sampling rate

VIII Sample Simulation Code

a) Sample Code for Sampling theorem

```
clc;
clear all;
close all;
t=-10:0.01:10;
T=8;
Fm= 1/T;
X= cos(2*pi*Fm*t);
Fs1=1.2*Fm;
Fs2=2*Fm;
Fs3=8*Fm;
n1=-5:1:5;
xn1=cos(2*pi*n1*Fm/Fs1);
subplot(2,2,1);
plot (t,X);
xlabel('Time in seconds');
ylabel('X(t)');
title ('contineous time signal');
subplot(2,2,2);
stem (n1,xn1);
hold on;
plot (n1,xn1);
xlabel('N');
ylabel('X(n)');
title ('Discrete time signal with Fs<2Fm');
n2=-5:1:5;
xn2=cos(3*pi*n2*Fm/Fs2);
subplot(2,2,3);
stem (n2,xn2);
hold on;
plot (n2,xn2);
xlabel('N');
ylabel('X(n)');
title ('Discrete time signal with Fs<2Fm');
```

Simulation output:

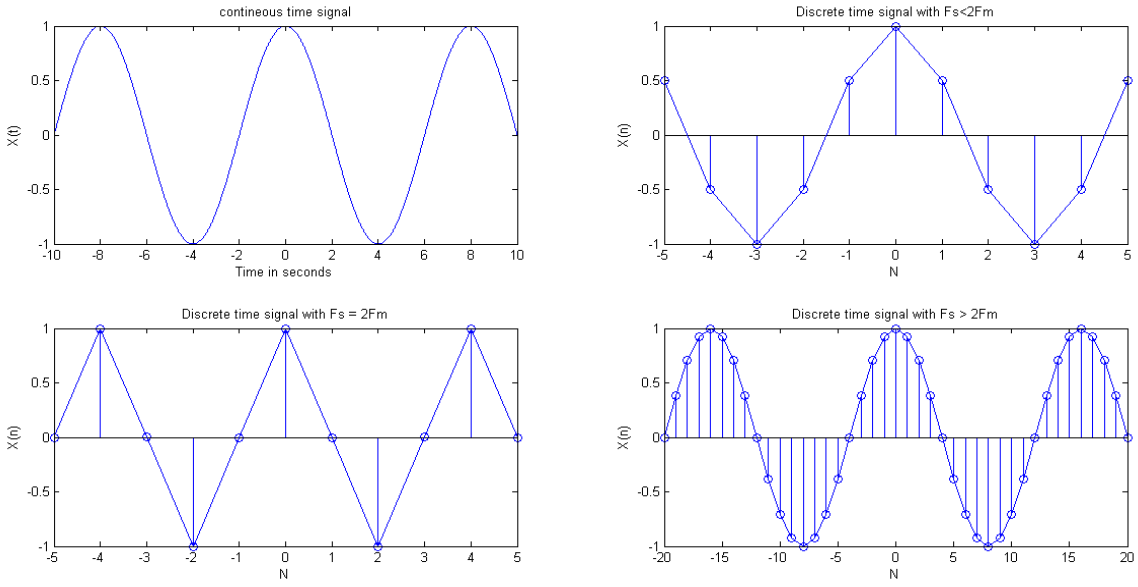


Figure: 13.2: Output for different Sampling condition

b) Actual Simulation Code (Paste the coding sheet)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Suitable specifications as per requirement of simulation software with Latest Processor	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

X Precautions

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

1. Open the MATLAB.
2. Go to file and create a new file with extension (.m file)
3. Write the MATLAB code in program window.
4. Save the file.
5. Define path directory.
6. Run the program using function key (F5) or use "RUN" command.
7. Observe the output.
8. After completion of practical shut down the PC and switch off the supply.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			

XIII Actual Procedure follow

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

a) **Actual Simulation Output Observed (**Student should paste the Simulation Output)

XVI Interpretation of results

.....
.....
.....
.....

XVII Conclusions and Recommendation

.....
.....
.....
.....

XVIII Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Use some different simulation tool and test the output for the given sampling condition.
2. State the effect of aliasing in communication system.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

XIX References / Suggestions for further Reading

1. https://www.tutorialspoint.com/signals_and_systems/signals_sampling_theorem.htm
2. https://www.google.co.in/search?q=sampling+theorem&sa
3. http://engineering-matlab.blogspot.com/2011/03/matlab-program-to-implement-sampling.html

XX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.14: Test the performance of the Amplitude shift keying (ASK) Modulator and demodulator circuits.

I Practical Significance

Amplitude-shift keying (ASK) is type of digital modulation that represents digital data as variations in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal) where frequency and phase are keeping constant .This practical is designed to explain how change of amplitude in to level corresponds to logic 1 and logic 0.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and different blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations.

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of the amplitude shift keying (ASK) Modulator/demodulator circuit.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Any digital modulation scheme uses a finite number of distinct signals to represent digital data. ASK uses a finite number of amplitudes, each assigned a unique pattern of binary digits. Each amplitude encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular amplitude. The demodulator is designed specifically for the symbol-set used by the modulator, determines the amplitude of the received signal and maps it back to the symbol it represents, thus recovering the original data. Frequency and phase of the carrier are kept constant in ASK.

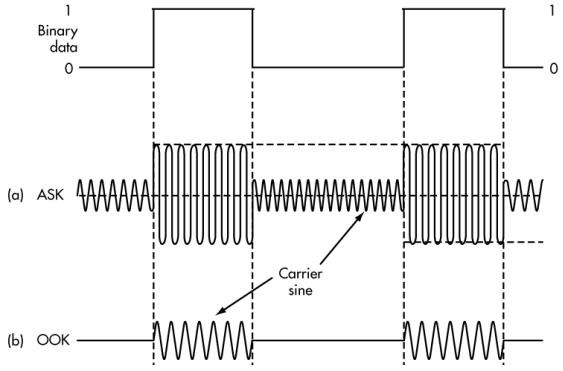


Figure 14.1: ASK Input output

VIII Practical Circuit Diagram

a) Sample Block Diagram

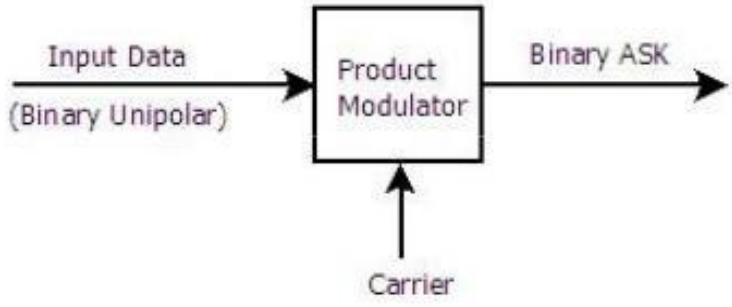


Figure 14.2 ASK modulator

[Courtesy:*https://www.slideshare.net/aknigin/digital-communicationunit-3]*

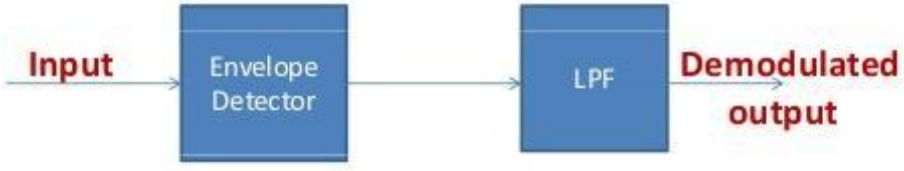


Figure 14.3 ASK demodulator

[Courtesy:*http://www.evalidate.in/lab2/pages/Demod-ASK/DMASK/DMASK_I.html]*

b) Actual block diagram / Circuit diagram

c) **Actual Practical Setup (**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable DC power supply 0-30V,0-2A , SC protection , Digital meters	1
3.	ASK Trainer kit	Data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	02

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per circuit diagram.
2. Switch ON the power supply.
3. Connect digital input signal 1010110 on to the trainer kit of ASK modulator.
4. Observe the output of ASK modulator on CRO.
5. Connect output of ASK modulator to input of ASK demodulator.
6. Observe the output of ASK demodulator.
7. Draw the waveform on graph showing digital input signal, carrier signal, modulated signal and demodulated signal.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table 14.1: Waveforms at Various stages of ASK

Sr. No.	Output at	Amplitude	Time period	Frequency	Waveform
1	Input signal bit stream				
2	Carrier signal				
3	ASK modulator output				
4	ASK demodulator output				

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Note down the amplitude of ASK modulated waveform for Logic "1" and Logic "0"
2. Perform same practical for ON-OFF shift key(OOK) and note down amplitude of ASK modulated waveform for logic"1" and logic "0"

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

XX References / Suggestions for further Reading

1. http://www.allsyllabus.com/aj/note/ECE/Digital%20Communication/unit3/index.php#.W0MQ69UzbIU
2. http://www.evalidate.in/lab2/pages/ASK-M/ASK/ASK_T.html

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.15: Test the performance of Amplitude Shift Keying (ASK) using relevant simulation software

I Practical Significance

Amplitude Shift Keying (ASK) is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal. Any modulated signal has a high frequency carrier. The binary signal when ASK modulated, gives a zero value for Low input while it gives the carrier output for High input. This practical is designed to explain how change of amplitude in to level corresponds to logic 1 and logic 0.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of Amplitude Shift Keying (ASK) using relevant simulation software.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Amplitude Shift Keying (ASK) is the digital modulation technique. In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements. Both frequency and phase remain constant while the amplitude changes.

In ASK, the amplitude of the carrier assumes one of the two amplitudes dependent on the logic states of the input bit stream. This modulated signal can be expressed as: Amplitude shift keying (ASK) in the context of digital signal communications 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. Thus the modulated waveform consists of bursts of a sinusoid.

Figure 15.1 illustrates a binary ASK signal (lower), together with the binary sequence which initiated it (upper). Neither signal has been band limited.

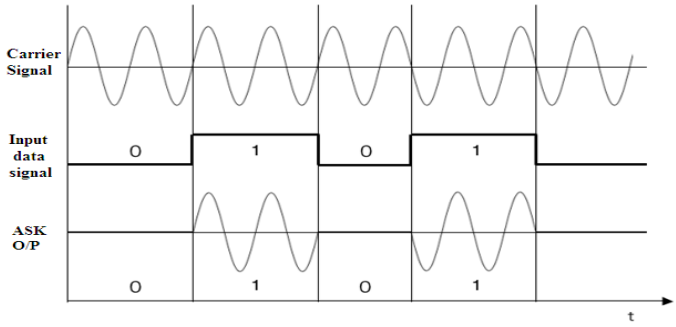


Figure 15.1: ASK I/P- O/P waveforms

VIII Sample Simulation Code

a) Generation of ASK waveform using MATLAB code

```
clc

t=0:0.001:30;

f1=input('carrier frequency:');

f2=input('pulse frequency:');

a=3;

x=a.*sin(2*pi*f1*t);

u=(a/2).*square(t)+(a/2);

v=x.*u;

subplot(3,1,1);

plot(t,x);

subplot(3,1,2);

plot(t,u);

subplot(3,1,3);

plot(t,v);
```

Simulation Output:

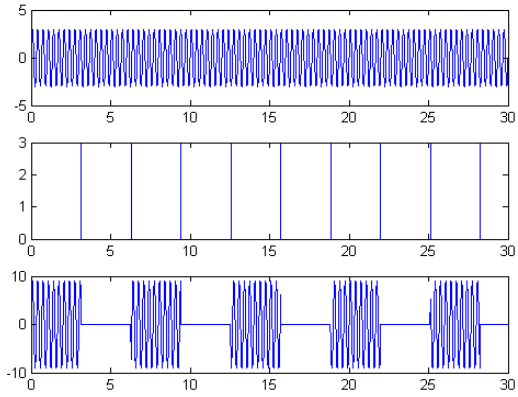


Figure 15.2: ASK Output

b) Actual simulation code
(Paste / Write the coding sheet)

VII Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software/	1

VIII Precautions

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

IX Procedure

1. Open the MATLAB.
2. Go to file and create a new file with extension (.m file)
3. Write the MATLAB code in program window.
4. Save the file.
5. Define path directory.
6. Run the program using function key (F5) or use "RUN" command.
7. Observe the output of ASK in command window.
8. After completion of practical shut down the PC and switch off the supply

X Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

XI Actual procedure followed

.....
.....
.....
.....

XII Precautions followed

.....
.....
.....
.....

XIII Observations and Calculations:

a) Actual simulation output observed (Student should paste the simulation output**)**

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Observe the ASK output for bit stream 1100101 using the above MATLAB code.
2. Observe the ASK output for bit stream 1110100 using the above MATLAB code for carrier frequency of 1 KHz.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

XX References / Suggestions for further Reading

1. http://www.srmuniv.ac.in/sites/default/files/files/TN0501%20lab%20mannual.pdf
2. https://www.google.co.in/search?q=ask+waveform&source

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
	T**otal**	100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 16: Test the performance of the Binary Phase Shift Keying (BPSK) Modulator and Demodulator circuits.

I Practical Significance

PSK technique is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications. BPSK has a bandwidth which is lower than that of BFSK signal. It has a very good noise immunity .This practical enable the students to generate and decode BPSK signal.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'.**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of the Binary Phase Shift Keying (BPSK) Modulator and Demodulator circuits.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Phase Shift Keying (PSK) is the digital modulation technique in which the phase of the carrier signal is changed by varying the sine and cosine inputs at a particular time with respect to the given digital input Figure 16.1 shows BPSK modulator.

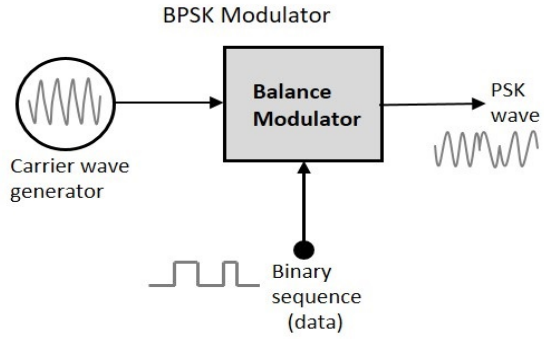


Figure 16.1: Generation of PSK/ BPSK Modulator

[Courstey:https://www.tutorialspoint.com/digital_communication/digital_communication_phase_shift_keying.htm]

In BPSK modulation, phase of the carrier signal is changed according to the data bit to be transmitted. Keeping its frequency and amplitude constant as shown in Figure 16.2

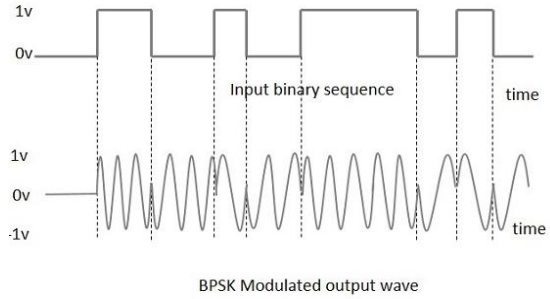


Figure 16.2: Waveform of BPSK modulation

[Courstey:https://www.tutorialspoint.com/digital_communication/digital_communication_phase_shift_keying.htm]

BPSK demodulator

Figure 16.3 shows BPSK demodulator. The BPSK modulating signal is demodulated with a synchronous detection system. The synchronous detection system uses a modulator to multiply the received signal and regenerated carrier wave. The frequency and phase of the regenerated carrier wave must match (synchronize with) the carrier wave used on the transmitting end.

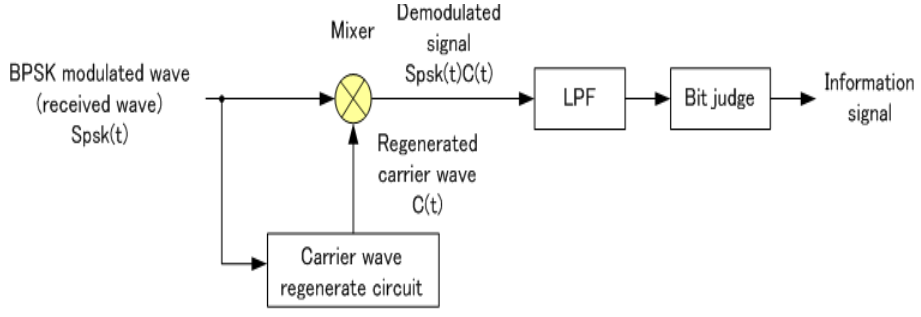


Figure 16.3: BPSK demodulator

[Courstey:https://www.tutorialspoint.com/digital_communication/digital_communication_phase_shift_keying.htm]

VIII Practical Circuit Diagram

a) Sample Practical Setup

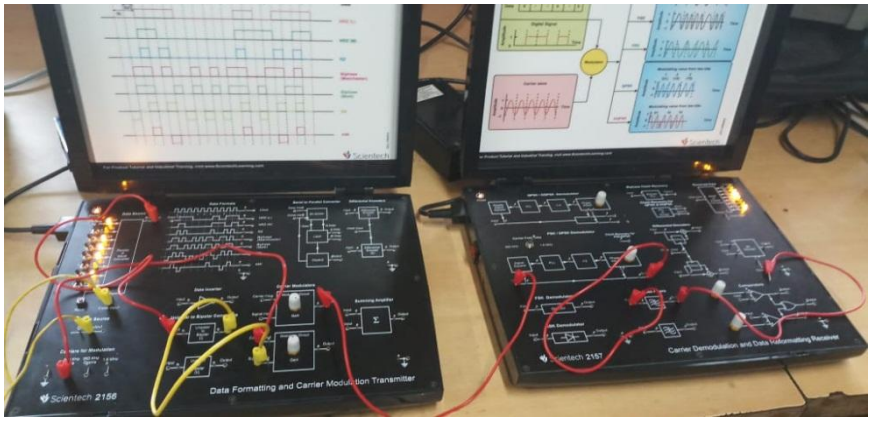


Figure16.4: Practical set up for BPSK modulation and demodulation

b) Actual Practical Setup **(**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1	BPSK modulator and demodulator trainer kit	Four type selectable data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, And four selectable types bit data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
2	CRO / DSO	25 MHz, dual Trace / Bandwidth 30MHz – 200MHz	1
3	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment adjust proper volt/div and times/div selection on CRO/DSO.

XI Procedure

1. Make connections as shown in figure 16.4
2. Select input data 11001011 from data generator using switches and connect it to bipolar convertor.
3. Connect bipolar data to signal input of balanced modulator (BPSK modulator).
4. Select carrier signal from carrier generator and connect it to carrier input of balanced modulator (BPSK modulator).
5. Switch on the power supply.
6. Connect DSO/CRO probe at output of balanced modulator (BPSK modulator).
7. Observe output waveforms of balanced modulator (BPSK modulator) on CRO.
8. Write output signal phase shift with respect to carrier for input signal (logic 1 and logic 0) in observation table16.1.
9. For BPSK demodulation connect output of balanced modulator (BPSK modulator) to input of BPSK demodulator kit as shown in figure 16.4
10. Observe output of low pass filter on DSO/CRO.
11. Draw the waveform of input data, carrier signal, BPSK signal and output of low pass filter on graph paper for observed value.
12. After completion of practical switch off the supply, remove the connection and submit the wires and equipments**.**

XII Actual Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1			
2			
3			
4			

XIII Actual procedure followed

.....
.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....
.....

XV Observations

Table 16.1: Measurement of phase shift of given carrier

Sr. No.	Input Signal	Modulated output signal phase shift w.r.t. carrier
1	Logic 0	
2	Logic 1	

XVI Result

As input signal is at logic 1 output signal phase shift with respect to carrier is …… (180^0 / No Change)**.**

XVII Interpretation of result

.....
.....
.....
.....

XVIII Conclusions

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Draw BPSK modulated waveforms for input data 11110000.
2. Draw BPSK modulated waveforms for input data 10101010
3. Draw BPSK modulated waveforms for input data 11111111
4. Draw BPSK modulated waveforms for input data 11001100

[Space for Answers]

.....
.....
.....
.....
.....
.....

.....

.....

.....

XX References / Suggestions for further Reading

1. http://www.ques10.com/p/3631/explain-the-operating-principle-working-of-trans-1/.
2. https://www.gaussianwaves.com/2010/04/bpsk-modulation-and-demodulation-2/.

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
	T**otal**	100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.17: Test the performance of the Frequency shift keying (FSK) Modulator and demodulator circuits.

I Practical Significance

FSK technology is used for communication systems such as amateur radio, caller ID and emergency broadcasts. This practical is designed to explain how modem converts the binary data from a computer to FSK for transmission over telephone lines, cables, optical fiber, or wireless media. The modem also converts incoming FSK signals to digital low and high states, which the computer can understand. In this practical student are able to view shifts in frequency as per the input digital data.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems.**"

- Identify different components, IC's and different blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations.

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of the Frequency shift keying (FSK) modulator and demodulator circuits.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Frequency-shift keying (FSK) is a method of transmitting digital signals. The two binary states, logic 0 (low) and 1 (high), are each represented by an analog waveform. Logic 0 is represented by a wave at a specific frequency, and logic 1 is represented by a wave at a different frequency. The simplest FSK is binary FSK (BFSK). BFSK uses a pair of discrete frequencies to transmit binary (0s and 1s)

information. With this scheme, the "1" is called the mark frequency and the "0" is called the space frequency.

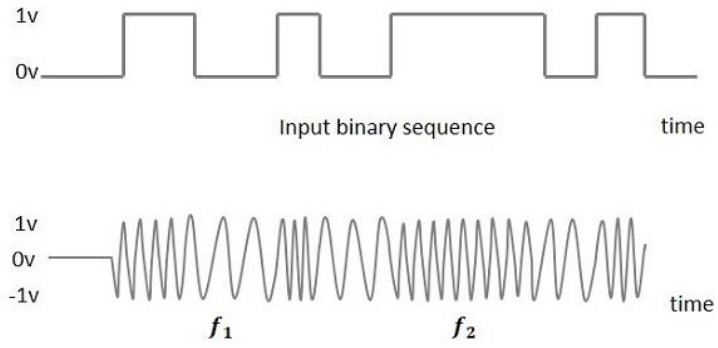


Figure 17.1: FSK Input –Output waveform

VIII Practical Circuit Diagram

a) Sample Block Diagram

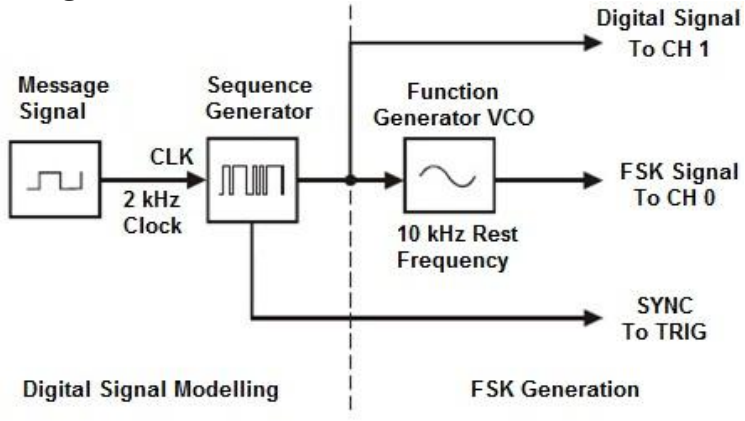


Figure 17.2: FSK Modulator

***[Courtesy:**http://www.evalidate.in/lab2/pages/FSKS/FSK/FSK_T.html]*

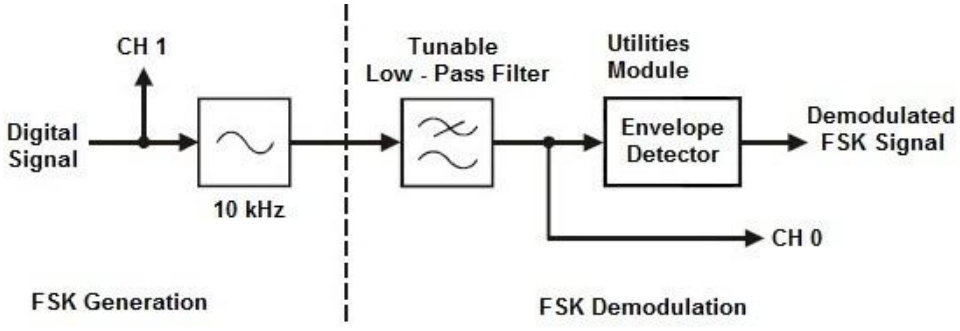


Figure 17.3: FSK demodulator

***[Courtesy:**http://www.evalidate.in/lab2/pages/Demod-FSK/DFSK/DFSK_T.html]*

b) Actual Block Diagram / Circuit diagram

c) Actual Practical Setup (Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C power supply 0 -30 V ,2A with SC protection , Digital meters	1
3.	FSK Trainer kit	Four type selectable data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, and four selectable types bit data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per circuit diagram.
2. Switch ON the power supply.
3. Select the input bit stream of 1010110 and connect it to input terminals of FSK modulator.
4. Observe the output of FSK modulator on CRO.
5. Connect output of FSK modulator to input of FSK demodulator.
6. Observe the output of FSK demodulator.
7. Draw the waveform on graph showing digital input signal, carrier signal, modulated signal and demodulated signal.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table 17.1: Waveforms at Various stages of FSK

Sr. No.	Input signal	Modulated output signal Frequency	Waveform
1	Logic "1"		
2	Logic "0"		

XVI Results

Modulated signal frequency for Logic"1" =
Modulated signal frequency for Logic"0" =

XVII Interpretation of results

.....
.....
.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Name the IC used in FSK modulator and demodulator experimental set up.
2. State the value of supply voltage applied to the trainer kit.
3. Apply input waveform 11110000 to FSK trainer kit and draw the corresponding FSK output waveform.

[Space for Answers]

.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. http://www.allsyllabus.com/aj/note/ECE/Digital%20Communication/unit3/index.php#.W0MQ69UzbIU
2. http://www.evalidate.in/lab2/pages/Demod-FSK/DFSK/DFSK_T.html
3. http://www.rfwireless-world.com/Terminology/ASK-vs-FSK-vs-PSK.html

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.18: Test the performance of the Differential Phase shift keying (DPSK) modulator / demodulator circuits.

I Practical Significance

DPSK (Differential Phase Shift Keying) is a common form of phase modulation used in analog modems. DPSK does not require complex demodulation circuitry and is less susceptible to random phase changes in the transmitted waveform. This practical is designed to explain how with differential Phase Shift Keying technique. We can read the data stream .DPSK is widely used for wireless LANs, bio-metric, contactless operations, along with RFID and Bluetooth communications.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations.

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of the Differential Phase shift keying (DPSK) modulator / demodulator circuits.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

DPSK is the combination of differential encoding and BPSK. Binary bit b (t) and its previous bit b ($t-T_b$) are used to generate differential encoding with the help of EX-OR gate. The differential encoding signal is converted to bipolar non return zero signal. The signal is multiplied with carrier to produce required DPSK. The DPSK input and one bit delayed output are added and given to where be integrator.

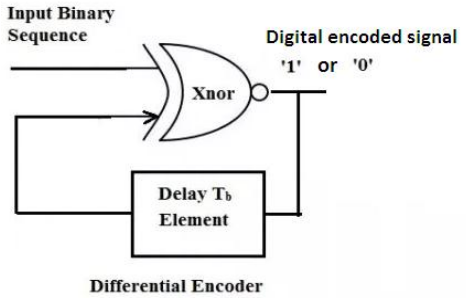


Figure 18.1: Differential encoding process

The output of integrator is given to decision device will generate logic "1" if integrator output is greater than 0 and generate logic "0" if integrator output is less than 0, in the demodulation.

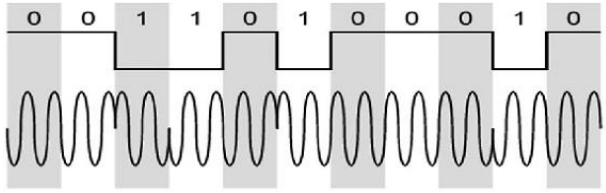


Figure 18.2: DPSK output waveforms

VIII Practical Circuit Diagram

a) Sample block diagram

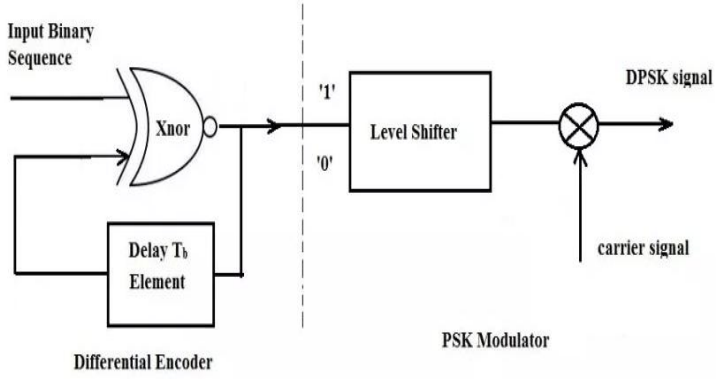


Figure 18.3: DPSK transmitter

***[Courtesy:**https://ece4uplp.com/2018/06/09/differential-phase-shift-keying-dpsk/]*

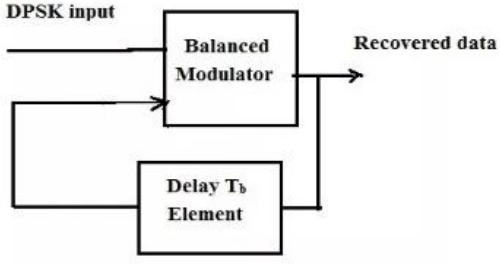


Figure 18.4: DPSK receiver

***[Courtesy:** https://ece4uplp.com/2018/06/09/differential-phase-shift-keying-dpsk/]*

b) Actual Block Diagram / Circuit diagram

c) Sample Practical Setup

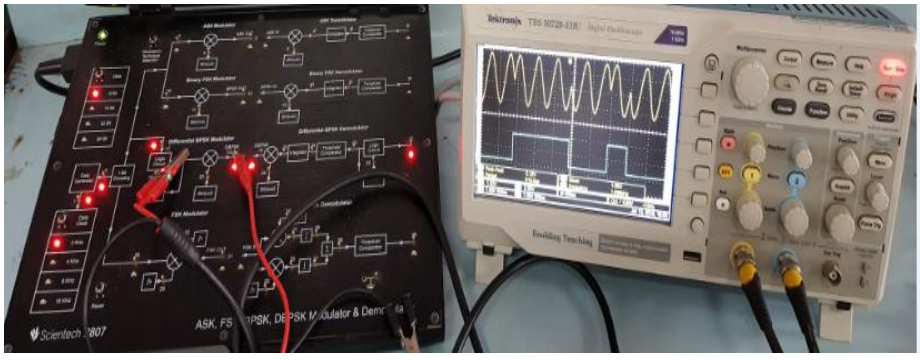


Figure 18.5 Practical set up

OR

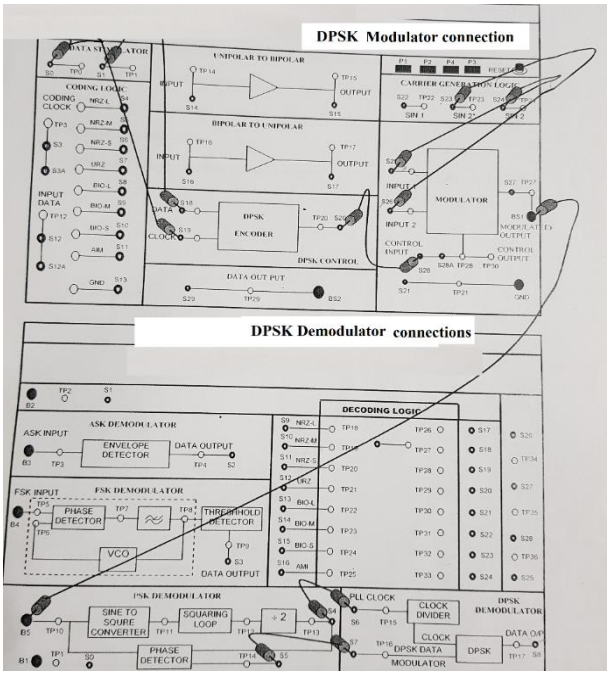


Figure 18.6 Practical set up

d) Actual Practical Setup (Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20 MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C Power supply 0-30V,0-2A , SC protection Digital meters	1
3.	DPSK Trainer kit	Four type selectable data clock frequency 2 KHz, 4 KHz, 8 KHz, 16 KHz, And four selectable types bit data 8 bit, 16 bit, 32 bit, 64 bit or equivalent trainer kit	1
4.	Connecting wires	CRO probes, attenuation probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per circuit diagram.
2. Switch ON the power supply.
3. Set the input bit stream as 10110010
4. Observe the output waveform at the output of DPSK modulator.
5. Connect the output of DPSK modulator to DPSK demodulator input.
6. Observe the waveforms at various test points using CRO.
7. Sketch the waveforms of DPSK modulator output and demodulator output on graph paper.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

XIII Actual procedure followed

.....
.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table 18.1: Waveforms at Various stages of DPSK

Sr. No.	Output at	Waveform
1	**Input signal bit stream**	
2	**Clock**	
3	**Differential encoded output**	
4	**DPSK modulator output**	
5	**DPSK demodulator output**	

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Draw DPSK waveform for digital word 11101001.
2. For digital word 11101001 draw differential encoded signal output at DPSK encoder.
3. State the IC no used for DPSK modulator and demodulator.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. http://www.rfwireless-world.com/Terminology/DPSK.html
2. https://www.tutorialspoint.com/digital_communication/digital_communication_differential_phase_shift_keying.html

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.19: Test the performance of Quadrature Phase shift keying (QPSK) modulator and demodulator circuits.

I Practical Significance

Quadrature phase shift keying (QPSK) modulation technique is the most widely used modulation scheme in modern digital communication system; it provides high performance on bandwidth efficiency and bit error rate. This practical is designed to explain how QPSK modulation is used in the design of wireless modem.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems.**"

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of Quadrature Phase shift keying (QPSK) modulator and demodulator circuits.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

The Quadrature Phase Shift Keying (QPSK) is a variation of BPSK, and it is also a Double Side Band Suppressed Carrier (DSBSC) modulation scheme, which sends two bits of digital information at a time, called as dibits. Instead of the conversion of digital bits into a series of digital stream, it converts them into bit pairs. This decreases the data bit rate to half, which allows space for the other users. Hence with less bandwidth many user can send or receive the information.

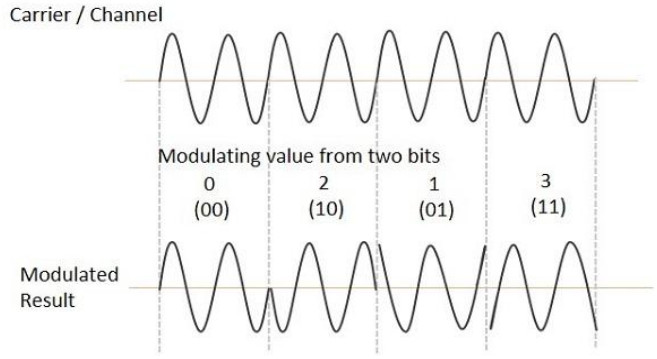


Figure 19.1: QPSK output waveform

VIII Practical Circuit Diagram

a) Sample block diagram

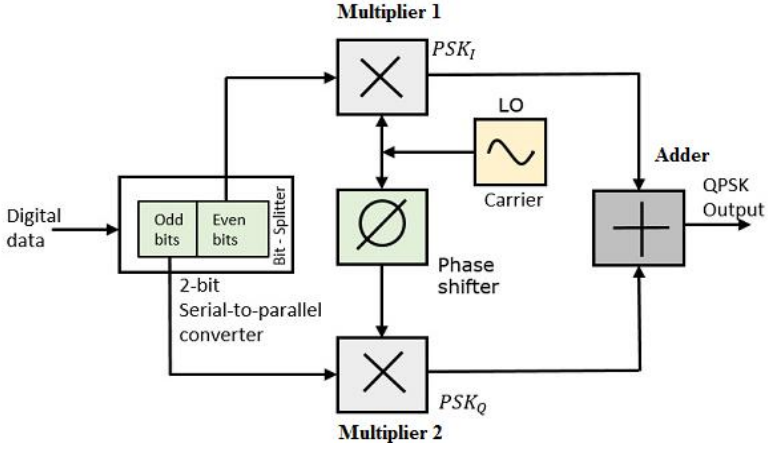


Figure 19.2: QPSK modulator

***[Courtesy:-**https://www.tutorialspoint.com/digital_communication/digital_communication_quadrature_phase_shift_keying.htm]*

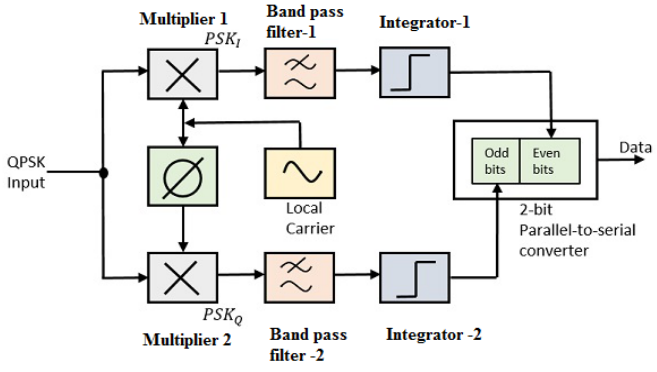


Figure 19.3: QPSK demodulator

***[Courtesy:-**https://www.tutorialspoint.com/digital_communication/digital_communication_quadrature_phase_shift_keying.htm]*

b) Actual Block Diagram / Circuit diagram

c) Sample Practical Setup

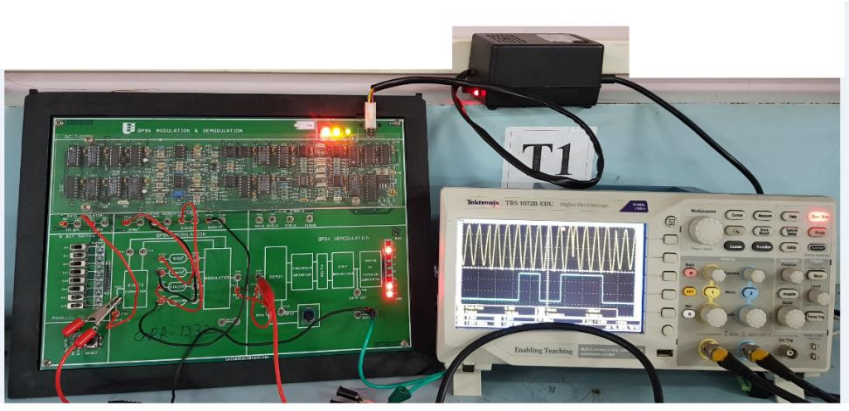


Figure 19.4: QPSK modulator and demodulator practical set up

d) Actual Practical Setup **(**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C power supply 0-30V,0-2A with SC protection , Digital Meters	1
3.	QPSK Trainer kit	On board 8 bit data pattern generation, sinusoidal signals 8 KHz, 4 KHz bit rate, 500 Hz byte rate or equivalent trainer kit	1
4.	Connecting wires	CRO probes, attenuation probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per Figure19.4.
2. Switch ON the power supply.
3. Connect data to the DATA IN of trainer kit.
4. Connect carrier generator block to respective sine degrees on the kit.
5. Observe the QPSK modulated output by varying data switches for different patterns of data.
6. Connect modulated output of QPSK to the input of receiver block of QPSK demodulator.
7. Compare the LED output of QPSK demodulator kit with input data pattern applied to the QPSK modulator.
8. Draw the observed output waveforms of QPSK modulator and demodulator on the graph paper.
9. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

XIII Actual procedure followed

.....

.....

.....

.....

.....

XIV Precautions followed

.....
.....
.....
.....
.....
.....

XV Observations and Calculations

Table19.1: Waveforms at Various stages of QPSK

Sr. No.	Output at	Waveform
1	Input data bit stream	
2	QPSK modulator output	
3	QPSK demodulator output	

Table19.2: Measurement of phase shift for Input signal dibits

Sr. No.	Input signal dibits	Phase shift in the carrier
1	00	
2	01	
3	10	
4	11	

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....

.....
.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the rate of QPSK modem gives the input IC number of QPSK modulator and demodulator.
2. Change the data pattern at the input and observe its corresponding waveform.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.google.co.in/search?q=dpcm&sa
2. https://www.tutorialspoint.com/digital_communication/digital_communication_differential_pcm.htm
3. http://www.rfwireless-world.com/Terminology/QPSK-vs-OQPSK-vs-pi-4QPSK.html

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.20: Test the performance of Quadrature amplitude Modulation (QAM) modulator and demodulator circuits.

I Practical Significance

QAM is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth. QAM is used in wireless applications like the PAL and NTSC television systems, where the different channels, which are provided by QAM, enable the transmission of the components of Chroma or colour information to TV sets. It is often used for radio communication systems from regular cellular to LTE including Wi-Max and Wi-Fi. In this practical students are able to view hoe two signals (I, Q) gets modulated on career and 90^0shifted careers.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and different blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations

IV Relevant Course Outcomes

- Maintain systems based on digital modulation techniques.

V Practical Outcome

- Test the performance of Quadrature amplitude modulation (QAM) modulator and demodulator circuits.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Quadrature amplitude modulation (QAM) is a technique used to transmit two digital bit streams or two analog signals by modulating or changing the amplitudes of two carrier waves so that they differ in phase by 90 degrees, a quarter of a cycle, hence the name quadrature. One signal is called the "I" signal and the other is the "Q" signal, which can be mathematically represented by a cosine and a sine wave, respectively. QAM combines the two carriers and sends the combined signals in a single transmission

to be separated and extracted at the destination. The signals are demodulated, and the data are then extracted from each and recombined to form the original modulating information.

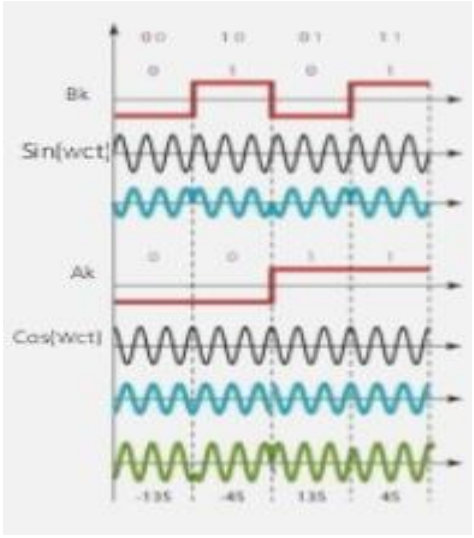


Figure 20.1: QAM Input- Output waveform

VIII Practical Circuit Diagram

a) Sample Block Diagram

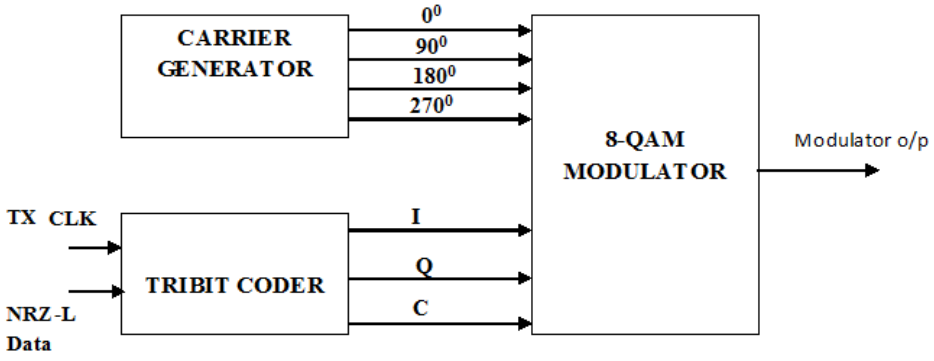


Figure 20.2: QAM modulator

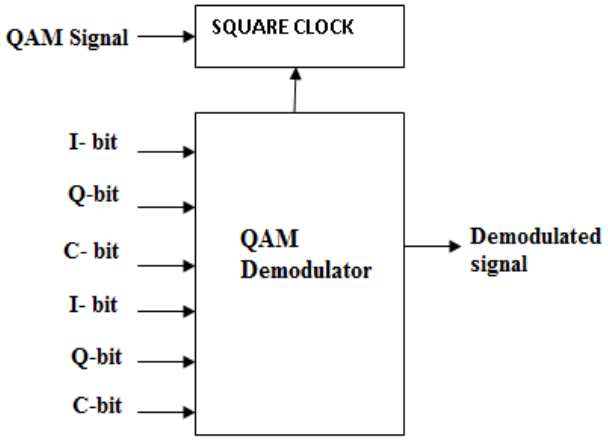


Figure 20.3: QAM demodulator

b) Actual Block Diagram / Circuit Diagram

c) Actual Practical Setup **(**Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	30MHz dual trace oscilloscope / 25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C power supply 0-30V,0-2A , SC protection Digital meters	1
3.	QAM Trainer kit	NRZ-L , tribit decoded data(I, Q, C), differential decoded I and Q bits, receiver clock generated PLL method or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per circuit diagram.
2. Switch ON the power supply.
3. Connect data pattern to NRZ-L coder.
4. Connect NRZ-L coder to data of TRIBIT coder.
5. Connect clock to CLK of TRIBIT coder.
6. Connect the tribit data I-bit, Q-bit and C-bit to control input of carrier modulator respectively.
7. Connect sine carrier to the input of carrier generator.
8. Observe the output waveform of QAM modulator.
9. Connect QAM modulated signal to input of QAM demodulator.
10. Connect I-bit, Q-bit and C-bit output of QAM demodulator to I-bit, Q-bit and C-bit of data decoder.
11. Observe the decoded data and compare with input data pattern.
12. Draw the observed output waveforms of QAM modulator and demodulator on the graph paper.
13. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			

XIII Actual procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table20.1: Waveforms at Various stages of QAM

Sr. No.	Input signal tribits	Phase	Amplitude
1	000		
2	001		
3	010		
4	011		
5	100		
6	101		
7	110		
8	111		

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Observe the shift in phase and amplitude of carrier when input bit pattern changed from 011 to 101.
2. Observe the shift in phase and amplitude of carrier when input bit pattern changed from 101 to 011.
3. "QAM is best choice for efficient use of bandwidth" Justify it.

[Space for Answers]

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.google.co.in/
2. https://www.slideshare.net/ahsanhalini/quadrature-amplitude-modulation-
3. https://www.radio-electronics.com/info/rf-technology-design/quadrature-amplitude-modulation-qam/what-is-qam-tutorial.php

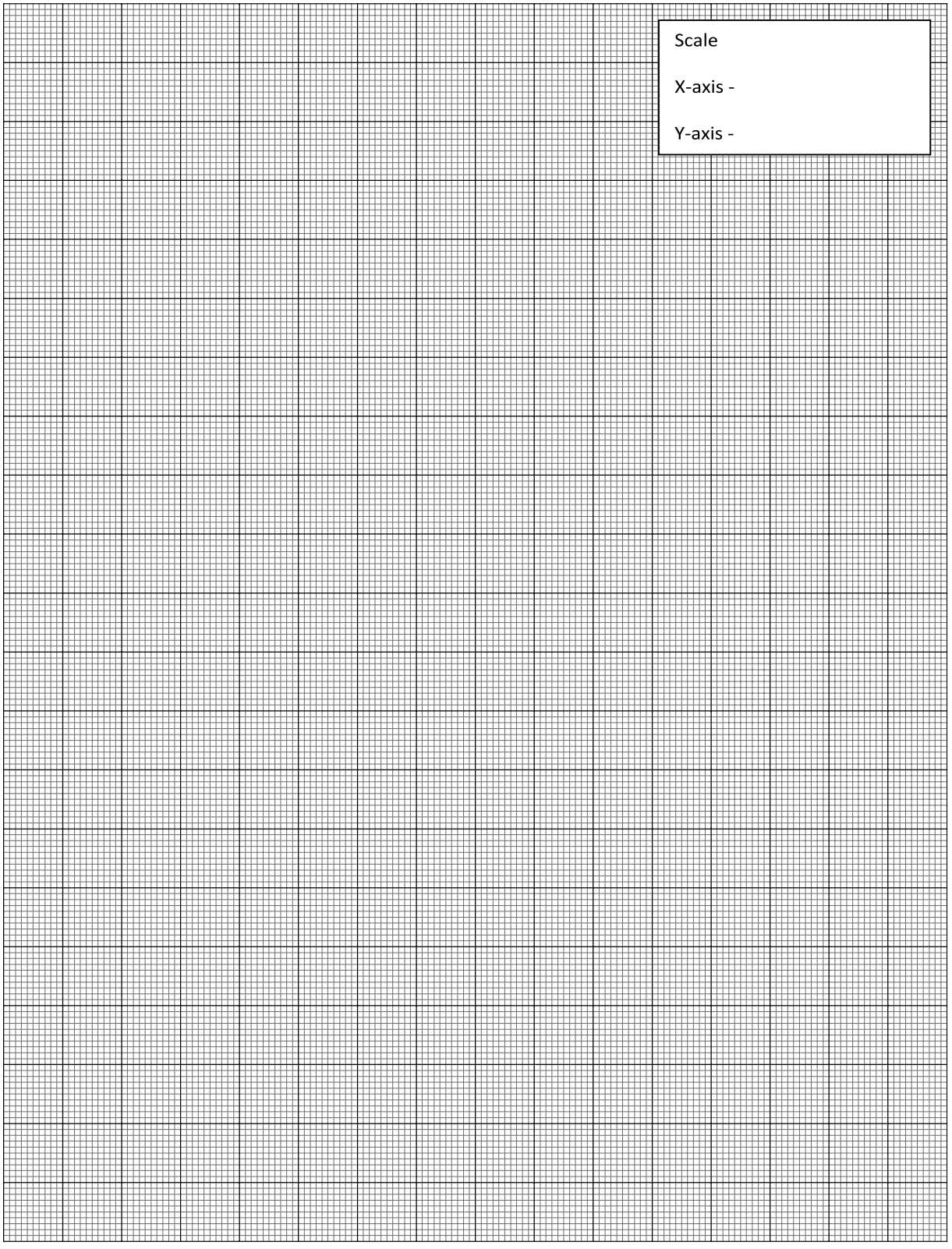
XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 21: Test the performance for 4-input time division multiplexing circuit.

I Practical Significance

Time-division multiplexing (TDM) is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. Time division multiplexing (TDM) has many applications, including wire line telephone systems and some cellular telephone systems. In this practical, students will multiplex individual signal on one common line at transmitter and demultiplex it at other end.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Multiplex and demultiplex digital signals.

V Practical Outcome

- Test the performance for 4-input time division multiplexing circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Handle instruments carefully.

VII Minimum Theoretical Background

Multiplexing is used to increase the channel capacity. Time division multiplexing (TDM) is a method in which different information signals transmitted over a common carrier one after other. Each information signal transmitted over short interval of time. TDM is suitable for transmission of digital signal. figure 21.1 shows working of TDM transmitter and receiver.

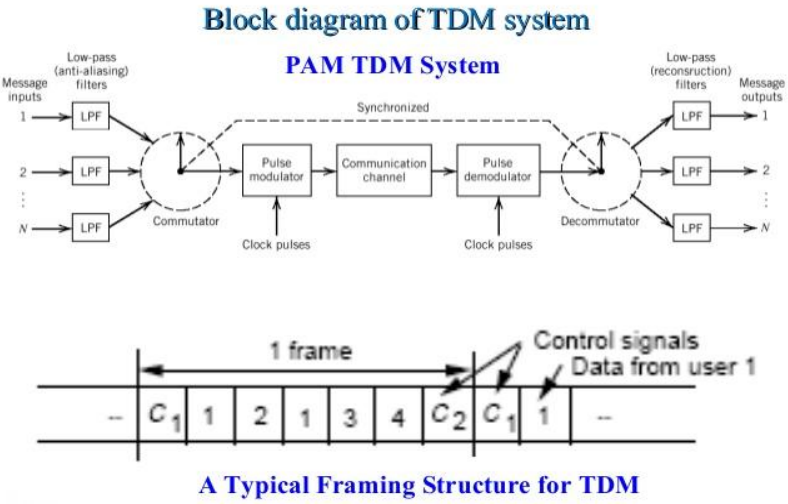


Figure 21.1: TDM transmitter and receiver

[Courtesy:https://www.google.co.in/search?q=TDM+transmitter+and+receiver+block+diagram&tbm=isch&source=iu&ictx=1&fir=Lh2PEUjQ1_A_LM%253A%252CWqOhhlCqRZjvvM%252C_&usq=__fAo6avhHHzF5JHfYfWpUI7JbTNA%3D&sa=X&ved=0ahUKEwjF0KDep6_cAhXKMY8KHWraDnYQ9QEINDAG&biw=1366&bih=613#imgrc=Lh2PEUjQ1_A_LM:]

VIII Practical Circuit Diagram

a) Sample Practical Setup

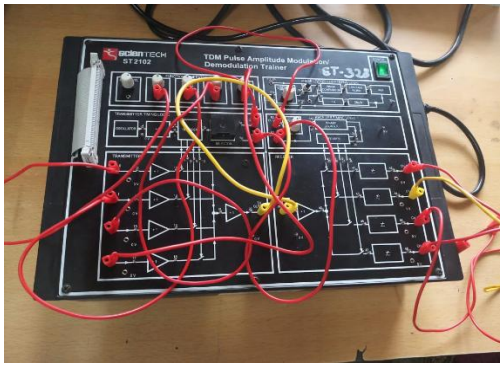


Figure21.2: TDM transmitter and receiver

b) Actual Practical Setup (Students should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	TDM Modem trainer kit	Four input sine wave generator 25 Hz, 500 Hz, 1 KHz, 2 KHz; on board sampling pulse generator frequency range 2 KHz – 64 KHz or equivalent trainer kit	1
2.	CRO/ DSO	25MHz, dual scope Bandwidth 30MHz – 200MHz Analog Channels 2-4	1
3.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment adjust proper volt/div and times/div selection on CRO/DSO.

XI Procedure

1. Make connections as shown in figure 21.2.
2. Select any four input signals and connect it to four channels of TDM transmitter.
3. Connect output of TDM transmitter to CRO/DSO and observe output.
4. Connect output of TDM transmitter to input of TDM receiver as shown in figure 21.2.
5. Connect the output of channel 1, channel 2, channel 3, channel 4 of TDM receiver to CRO/DSO and observe output.
6. Note values of amplitude and frequency of input signal and output signal present at channel 1, 2, 3 and 4 of TDM transmitter and TDM receiver respectively in observation table21.1.
7. Plot wave forms for observed signals.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

.....
.....
.....
.....

XIV Precautions Followed

.....
.....
.....
.....

XV Observations

Table 21.1: Measurement of amplitude and frequency of input signal and output signal

Sr. No.	Information	Values at TDM transmitter	Received signal	Values at TDM receiver
1.	Input signal at channel 1	Amplitude = Frequency =	output signal at channel 1	Amplitude = Frequency =
2.	Input signal at channel 2	Amplitude = Frequency =	output signal at channel 2	Amplitude = Frequency =
3.	Input signal at channel 3	Amplitude = Frequency =	output signal at channel 3	Amplitude = Frequency =
4.	Input signal at channel 4	Amplitude = Frequency =	output signal at channel 4	Amplitude = Frequency =

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions

.....
.....
.....
.....

XIX Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more ***such questions so as to ensure the achievement of identified CO.***

1. Change the input signal frequency and draw the output waveforms of TDM transmitter.
2. Explain how TDM is used in communication application now days in day to day life.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=pL3jnnue9Hc.
2. http://ecomputernotes.com/computernetworkingnotes/network-technologies/time-division-multiplexing.

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		100 %

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.22: Test the performance for 2- input frequency division Multiplexing (FDM) circuit.

I Practical Significance

In Frequency-division multiplexing (FDM) numerous signals are combined for transmission on a single communication line or channel. Each signal is assigned a different frequency (sub channel) within the main channel. It is used in public telephones and in cable TV systems and in AM and FM broadcasting as it does not need synchronization between its transmitter and receiver. It is simpler and easy for demodulation. In this practical, students will mix two or more analog signals using FDM multiplexer and retrieve the original signal using FDM de-multiplxer.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Multiplex and demultiplex digital signal.

V Practical Outcome

- Test the performance for 2- input frequency division multiplexing (FDM) circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

The operation of frequency division multiplexing (FDM) is based on sharing the available bandwidth of a communication channel among the signals to be transmitted. Each signal to be transmitted modulates a different carrier. The modulation can be AM, SSB, FM or PM. The modulated signals are then added together to form a composite signal which is transmitted over a single channel. Generally, the FDM systems are used

for multiplexing the analog signal.Figure22.1 and figure22.2 shows FDM transmitter and FDM receiver respectively.

FDM Transmitter

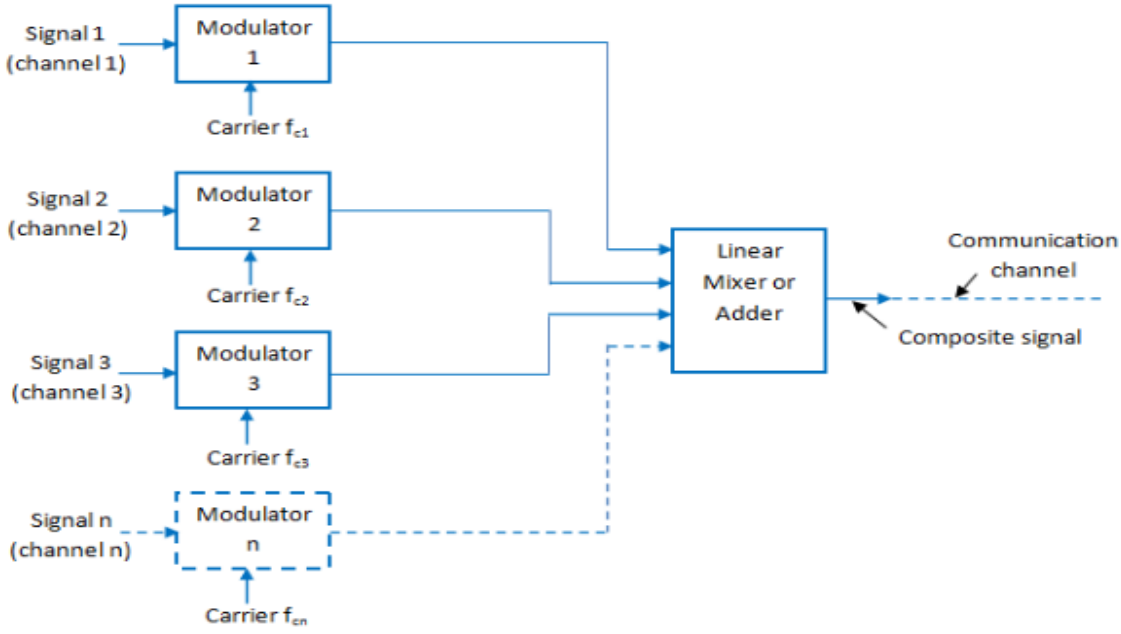


Figure 22.1: Block diagram of FDM transmitter.

[Courtesy:http://www.nawandihalabja.com/block-diagram-of-am-transmitter-and-receiver/block-diagram-of-am-transmitter-and-receiver-unique-frequency-division-multiplexing-fdm-system-electronics-post/]

FDM Receiver

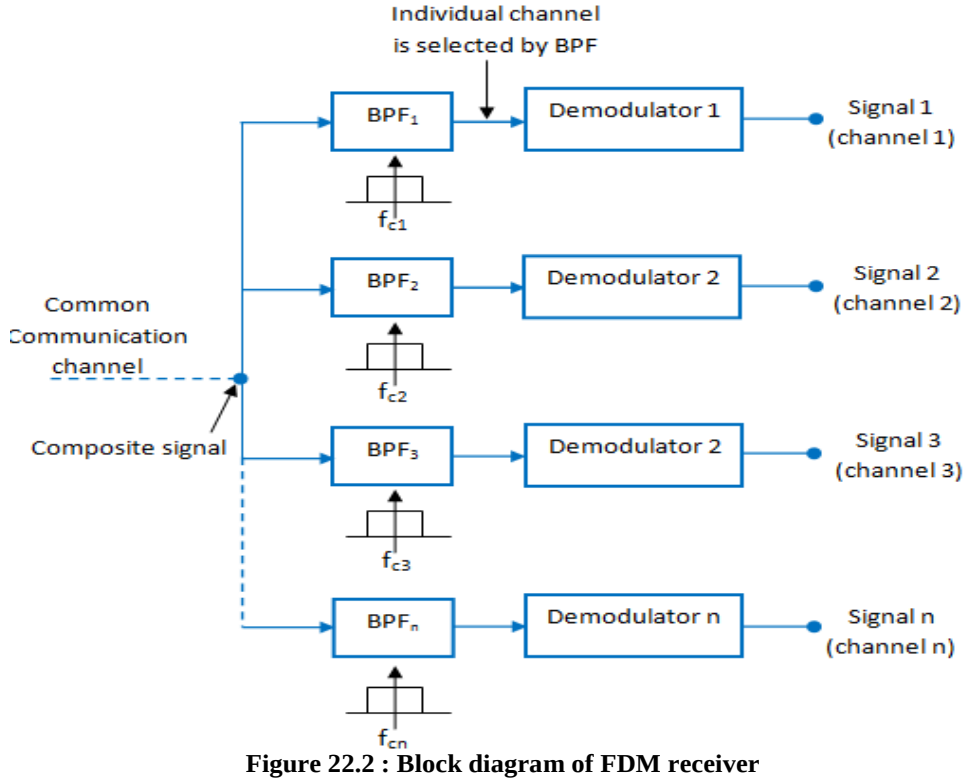


Figure 22.2 : Block diagram of FDM receiver

[Courtesy:http://www.nawandihalabja.com/block-diagram-of-am-transmitter-and-receiver/block-diagram-of-am-transmitter-and-receiver-unique-frequency-division-multiplexing-fdm-system-electronics-post/]

VIII Practical Circuit Diagram

a) Sample Practical Set up

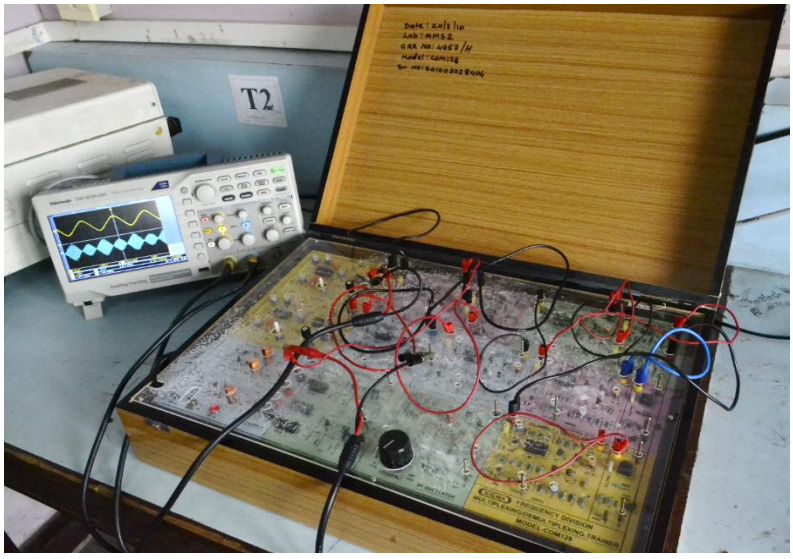


Figure 22.3: Practical set up for FDM system

b) **Actual Practical Set up (**Student should draw practical set up used in their laboratory)

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	FDM generation and detection trainer kit	Two input variable sine wave generator frequency range 1KHz – 4 KHz, on board sampling pulse generator frequency range 2 KHz – 64 KHz or equivalent trainer kit	1
2.	Function generator if required	0.01Hz to 1MHz, 10V p-p output.	1
3.	CRO / DSO	25MHz, dual trace / Bandwidth 30MHz – 200MHz	1
4.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions to be followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
2. While doing the experiment adjust proper volt/div and times/div selection on CRO/DSO .

XI Procedure

1. Make connections as shown in figure 22.3.
2. Select any two input signals and connect it to two channels of FDM transmitter.
3. Connect output of FDM transmitter to CRO/DSO and observe output.
4. Connect output of FDM transmitter to input of FDM receiver as shown in figure 22.3
5. Connect the output of channel 1 and channel 2 of FDM receiver to CRO/DSO and observe output.
6. Write values of amplitude and frequency of input signal and output signal present at channel 1 and 2 of FDM transmitter and FDM receiver respectively in observation table 22.1.
7. Plot wave forms for observed signals.
8. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					
4.					
5.					

XIII Actual Procedure Followed

……..…

……...

……

……..…

……...

XIV Precautions Followed

.....

.....

.....

.....

XV Observations:

Table 22.1: Measurement of amplitude and frequency of input signal and output signal

Sr. No	Information	Values at FDM transmitter	Received signal	Values at FDM receiver
1	Input signal at channel 1	Amplitude = Frequency =	Output signal at channel 1	Amplitude = Frequency =
2	Input signal at channel 2	Amplitude = Frequency =	Output signal at channel 2	Amplitude = Frequency =

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions

.....
.....
.....
.....

XIX Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write the number of IC used as FDM mux/demux in your experimental set up.
2. List application of FDM used in day to day electronic communication.

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://en.wikipedia.org/wiki/Frequency-division_multiplexing.
2. https://www.britannica.com/technology/frequency-division-multiplexing.

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
T**otal (25 Marks)**		**100 %**

Name of Team Members

1. ……...
2. ……...
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 23: Generate a TDM signal using relevant simulation software.

I Practical Significance

Time division multiplexing (TDM) is a communications process that transmits two or more streaming digital signals over a common channel. In TDM, incoming signals are divided into equal fixed-length time slots. After multiplexing, these signals are transmitted over a shared medium and reassembled into their original format after de-multiplexing. Time slot selection is directly proportional to overall system efficiency.
Time division multiplexing (TDM) is also known as a digital circuit switched.

Time division multiplexing (TDM) has many applications in ISDN telephone lines, PSTN. In this practical, students will generate TDM signal and reconstruct it using simulation software.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '**Maintain basic digital communication systems'.**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.
- Calculate various parameters

IV Relevant Course Outcomes

- Multiplex and demultiplex digital signals.

V Practical Outcome

- Generate a TDM signal using relevant simulation software.

VI Relevant Affective domain related Outcome(s)

- Select proper programming environment.
- Follow ethical practices

VII Minimum Theoretical Background

Multiplexing is used to increase the channel capacity. Time division multiplexing (TDM) is a method in which different information signals transmitted over a common carrier one after other. Each information signal transmitted over short interval of time. TDM is suitable for transmission of digital signal. Figure 23.1 shows working of TDM transmitter and receiver.

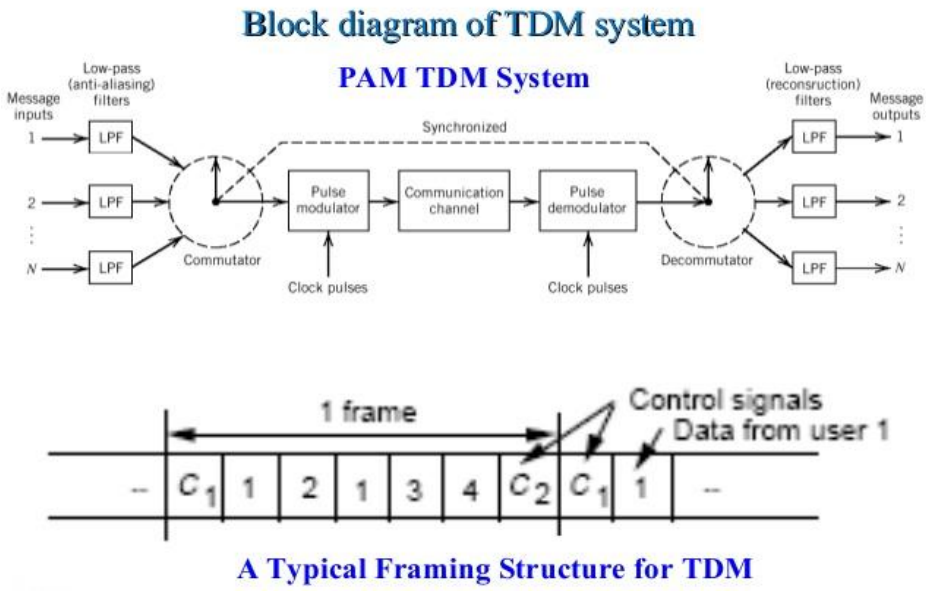


Figure 23.1: TDM transmitter and receiver

[Courtesy:https://www.google.co.in/search?q=TDM+transmitter+and+receiver+block+diagram&tbm=isch&source=iu&ictx=1&fir=Lh2PEUjQ1_A_LM%253A%252CWgOhhlCgRZjvvM%252C_&usg=__fAo6avhHHzF5JHfYfWpUI7JbTNA%3D&sa=X&ved=0ahUKEwjF0KDep6_cAhXKMY8KHWraDnYQ9QEINDAG&biw=1366&bih=613#imgrc=Lh2PEUjQ1_A_LM:]

VIII Sample Simulation Code

a) Sample code for TDM signal Generation using MATLAB -code

```
clc;
close all;
clear all;
% Signal generation
x=0:.5:4*pi;                                % signal taken upto 4pi
sig1=8*sin(x);                              % generate 1st
sinusoidal signal
l=length(sig1);
sig2=8*triang(l);                           % Generate 2nd
triangular Signal

% Display of Both Signal
subplot(2,2,1);
plot(sig1);
title('Sinusoidal Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
subplot(2,2,2);
plot(sig2);
title('Triangular Signal');
ylabel('Amplitude--->');
xlabel('Time--->');

% Display of Both Sampled Signal
subplot(2,2,3);
stem(sig1);
title('Sampled Sinusoidal Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
subplot(2,2,4);
stem(sig2);
title('Sampled Triangular Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
```

```
l1=length(sig1);
l2=length(sig2);
for i=1:l1
sig(1,i)=sig1(i);                          % Making Both row vector
to a matrix
sig(2,i)=sig2(i);
end

% TDM of both quantize signal
tdmsig=reshape(sig,1,2*l1);
% Display of TDM Signal
figure
stem(tdmsig);
title('TDM Signal');
ylabel('Amplitude--->');
xlabel('Time--->');

% Demultiplexing of TDM Signal
demux=reshape(tdmsig,2,l1);
for i=1:l1
sig3(i)=demux(1,i);                      % Converting The matrix
into row vectors
sig4(i)=demux(2,i);
end

 % display of demultiplexed signal
figure
subplot(2,1,1)
plot(sig3);
title('Recovered Sinusoidal Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
subplot(2,1,2)
plot(sig4);
title('Recovered Triangular Signal');
ylabel('Amplitude--->');
xlabel('Time--->');
```

Simulation Output:

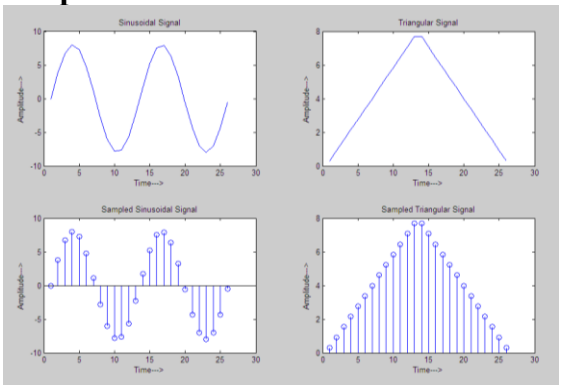


Figure 23.2: Input for TDM system

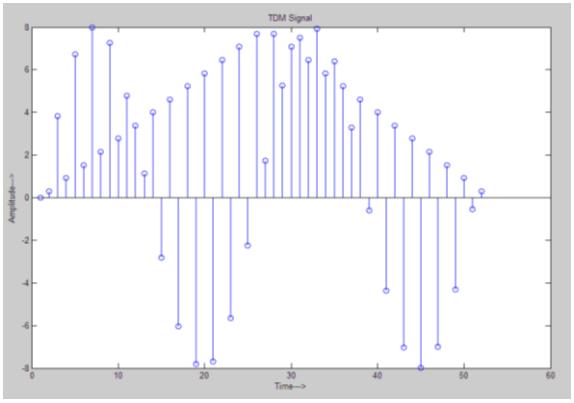


Figure 23.3: Output of TDM transmitter

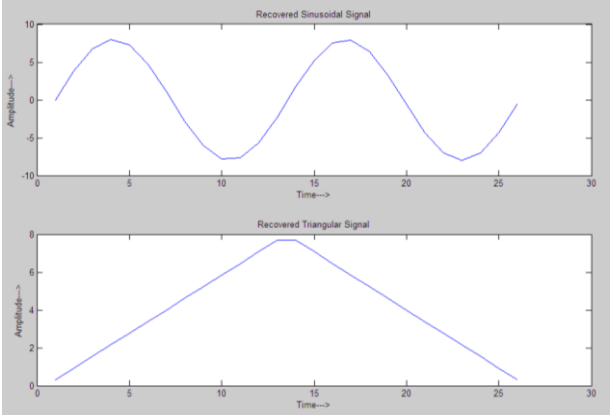


Figure 23.4: Output of TDM receiver

b) Actual Simulation Code

IX Resources required

Sr. No.	Instruments/ Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

X Precautions

1. Ensure proper earthling to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

1. Open MATLAB
2. Go to file and create a new (.m) file.
3. Type the above code in the code window.
4. Save the file.
5. Define the path directory.
6. Run the program using F5 key or run command.
7. Observe the output TDM signal in command window.
8. Paste the print out under observations heading.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

XIII Actual procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations

Actual TDM signal observed (Student should paste TDM signal waveform)

XVI Interpretation of results

.....
.....
.....
.....

XVII Conclusions and Recommendation

.....
.....
.....
.....

XVIII Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List application of TDM used in day to day life.
2. State the function of commutator and decommutator switches
3. Why TDM more suitable for digital signal transmission

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.cfd-online.com/Forums/main/97367-tdma-code-matlab.html.
2. https://www.mathworks.com/matlabcentral/fileexchange/28422-time-division-multiplexing-tdm.

XIX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 24: Generate a FDM signal using relevant simulation software

I Practical Significance

In telecommunications, frequency-division multiplexing (FDM) is a technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands, each of which is used to carry a separate signal. This allows a single transmission medium such as the radio spectrum, a cable or optical fiber to be shared by multiple independent signals. In this practical, students will generate a FDM signal using simulation software and reconstruct the same.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '**Maintain basic digital communication systems'.**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.
- Calculate various parameters.

IV Relevant Course Outcomes

- Multiplex and demultiplex digital signals.

V Practical Outcome

- Generate a FDM signal using relevant simulation software.

VI Relevant Affective domain related Outcome(s)

- Select proper programming environment.
- Follow ethical practices

VII Minimum Theoretical Background

The operation of frequency division multiplexing (FDM) is based on sharing the available bandwidth of a communication channel among the signals to be transmitted. Each signal to be transmitted modulates a different carrier. The modulation can be AM, SSB, FM or PM. The modulated signals are then added together to form a composite signal which is transmitted over a single channel. Generally, the FDM systems are used for multiplexing the analog signal.

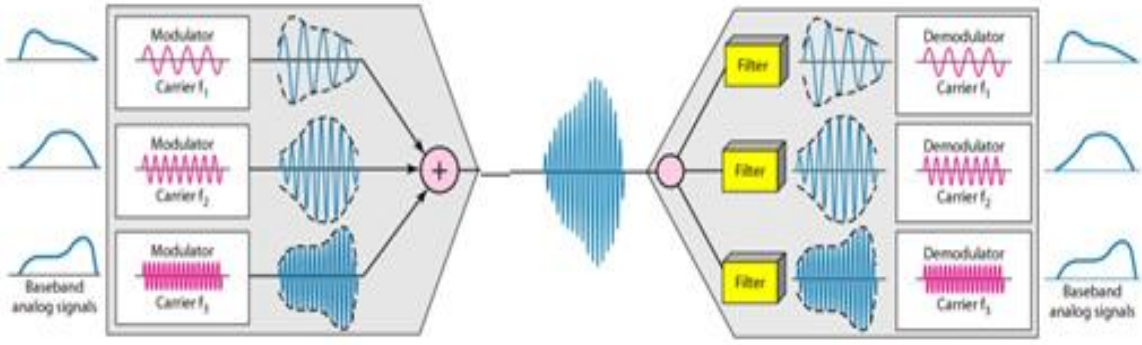


Figure 24.1 FDM transmitter and FDM receiver.

VIII Sample simulation code

a) Sample code for FDM signal Generation using MATLAB -code

```
clc;
clear all
close all
samples=1000;
% number of users
nos=8;
% modulating signal frequency in Hz
mfreq=[30 40 50 60 70 80 90 100];
% carrier frequency allocated to the different users in Hz
cfreq=[300 600 900 12000 1500 1800 2100 2400];
% choose frequency deviation
freqdev=10;
% generate modulating signal
t=linspace(0,1000,samples);
parfor i=1:nos
   m(i,:)=sin(2*pi*mfreq(1,i)*t)+2*sin(pi*8*t);
end
% Generate the modulated signal
parfor i=1:nos
   y(i,:)=fmmod(m(i,:),cfreq(1,i),10*cfreq(1,i),freqdev);
end
% pass the modulated signal through the channel
ch_op=awgn(sum(y),0,'measured');
% demodulate the received signal at the base station
parfor i=1:nos
   z(i,:)=fmdemod(y(i,:),cfreq(1,i),10*cfreq(1,i),freqdev);
end
% display the transmitted signal  and received signal at the base station
% figure
C = {'k','b','r','g','y',[.5 .6 .7],[.8 .2 .6],[.3 .2 .2]}; % Cell array of colros.
for i=1:nos
figure (1)
hold on
plot(y(i,:),'color',C{i});
xlabel('time index'); ylabel('amplitude'); title('Signal from different users combined
in the channel');
```

```
figure
subplot(3,1,1)
plot(m(i,:))            % modulating signal
xlabel('time index'); ylabel('amplitude'); title('modulating Signal from user');
subplot(3,1,2)
plot(y(i,:),'color',C{i}); % modulated signal
xlabel('time index'); ylabel('amplitude'); title('modulated Signal from user');
subplot(3,1,3)
plot(z(i,:),'color',C{i}); % demodulated signal
xlabel('time index'); ylabel('amplitude'); title('demodulated Signal from user at the
base station');
end
figure
plot(ch_op) % combination of all modulated signals passed through the channel
xlabel('time index'); ylabel('amplitude'); title('Signal after passing through the
channel')
```

Simulation Output:

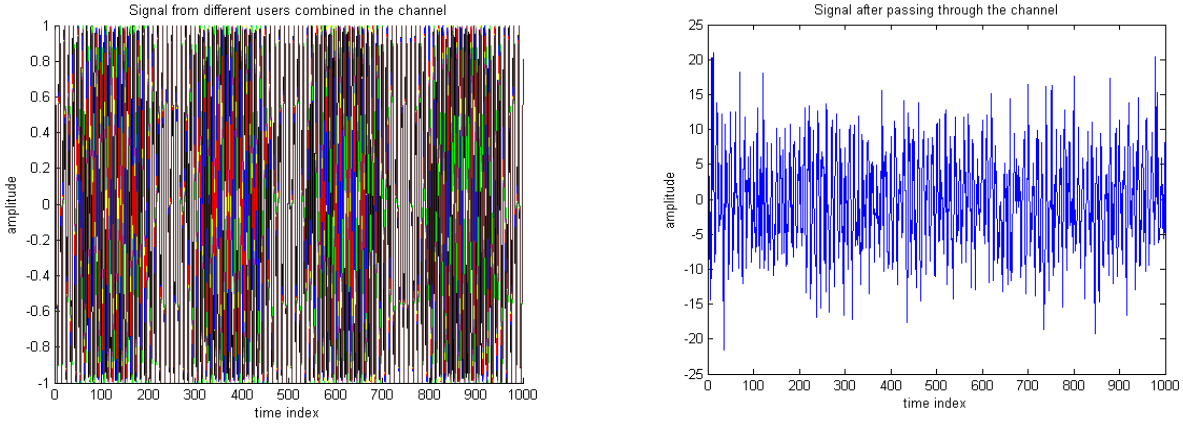


Figure 24.2 Output of FDM transmitter and FDM receiver.

b) Actual Simulation Code

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

X Precautions

1. Ensure proper earthing to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

1. Open MATLAB
2. Go to file and create a new (.m) file.
3. Write the above code.
4. Save the file.
5. Define the path directory.
6. Run the program using F5 key or run command.
7. Observe the output FDM signal in command window.
8. Paste the print out under observations heading.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			

XIII Actual procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations

Actual FDM signal observed (Student should paste the FDM waveform)

XVI Interpretation of results

.....
.....
.....
.....

XVII Conclusions & Recommendation

.....
.....
.....
.....

XVIII Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Change the input signal frequency and observe the output
2. Write the number and function of IC used as FDM mux/demux.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://kr.mathworks.com/matlabcentral/fileexchange/48796-simulation-of-frequency-division-multiple-access-in-matlab?focused=e147d1c0-830f-259c-e8c8-1fa9400c7026&tab=function
2. https://en.wikipedia.org/wiki/Frequency-division_multiplexing.

XIX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 25: Generate PN sequence for given maximum length.

I Practical Significance

Pseudo-Noise coding sequence is used in spread spectrum techniques. It is used in cryptographic devices, electronic musical instruments. Spread spectrum technology has blossomed from military technology in to one of the fundamental building blocks in current and next generation wireless system .From cellular to cordless to wireless LAN (WLAN) system. In this practical, students design PN-Sequence for given data length and calculate its maximum length.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: **'Maintain basic digital communication systems'**

- Identify different Components, IC's and blocks on trainer kit.
- Make the connection as per the given experimental set up.
- Test the output signals at the different testing points.
- Interpret the result as per the observation.

IV Relevant Course Outcomes

- Maintain spread spectrum based systems. .

V Practical Outcome

- Generate PN sequence for given maximum length.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Follow ethical practices.
- Handle instruments carefully.

VII Minimum Theoretical Background

A coded sequence of 1's and 0's with certain auto-correlation properties called as Pseudo-Noise coding sequence is used in spread spectrum techniques.it is generated by a shift register and EX-OR gate. Maximum length of PN sequence has a period of 2^m-1 clock cycles where m is number of flip-flops in shift register. All flip-flops operate on same clock.at each clock pulse .the state of each flip-flop is shifted to next one. Figure 25.1 shows 4bit PN –Sequence Generator of maximum length of 15 bits. after every 15 clock pluses PN-Sequence will repeat.

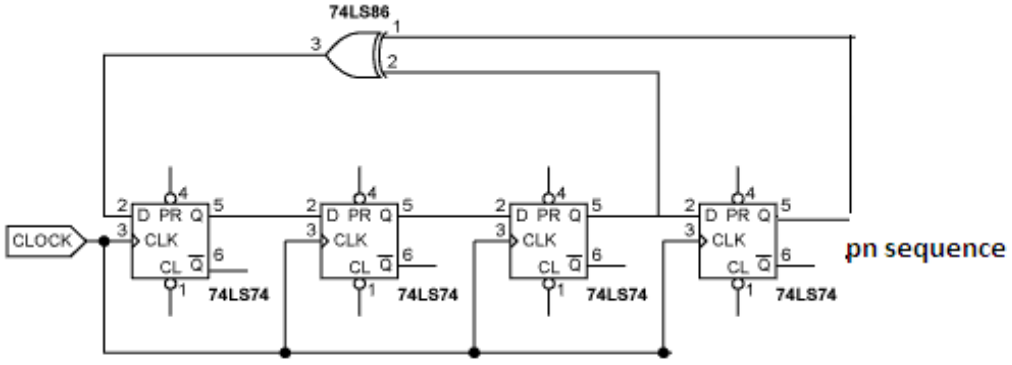


Figure 25.1: 4bit PN-Sequence Generator

[Courtesy:https://electronics.stackexchange.com/questions/30521/random-bit-sequence-using-verilog]

VIII Practical Circuit Diagram

a) Sample Circuit Diagram

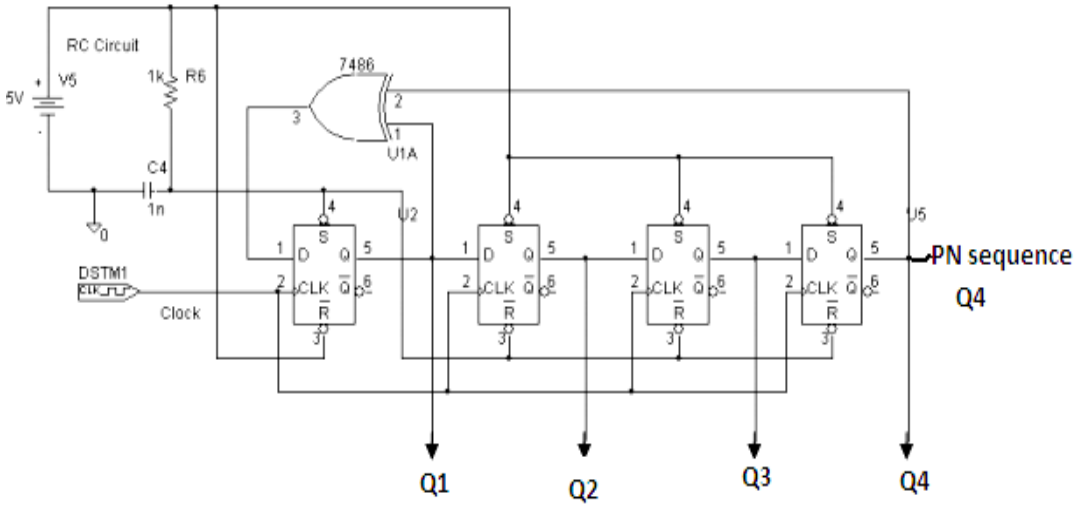


Figure 25.2: 4 bit PN-Sequence Generator

[Courtesy:http://shodhganga.inflibnet.ac.in/bitstream/10603/39978/14/14_chapter%204.pdf]

b) Sample Practical Setup

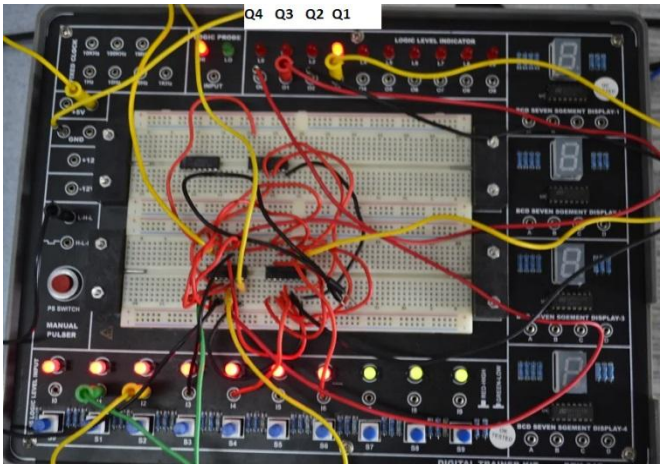


Figure 25.3: Practical setup for 4-Bit PN-Sequence generator

c) Actual Practical set up used in laboratory

(Student should draw practical set up used in their laboratory**)**

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	DC Regulated power supply	Variable DC power supply 0-30V, 2A, SC protection, display for voltage and current.	1
2.	LED	1.8V to 2.2V	4
3.	IC 7486 (EX-OR gate),	TTL Family	1
4.	IC7474(D-flip-flop)	TTL Family	2
5.	Digital trainer kit (if required)	Data Switches: 8 No's, DC Power supply: +5V, +12V, (0-12V), Pulse Generator: square Frequency range: 1Hz to700KHZ, Seven Segment Display: 1 Nos, 1 Buzzer or equivalent trainer kit.	1
6.	Bread board	5.5cm x 17cm	1
7.	Connecting wires	Single strand Teflon coating (0.6mm diameter)	As per requirement

X Precautions to be Followed

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make connections as shown in figure 25.2.
2. Connect LEDs at output of each flip-flop to check status of Q_1,Q_2,Q_3 and Q_4
3. Switch ON the power supply.
4. Clear all flip-flops.
5. Initialize the initial state to 0001($Q_4Q_3Q_2Q_1$) using preset terminal
6. Apply 1st clock signal and observe outputs ,
7. Write the state of Q_1,Q_2,Q_3,Q_4 in observation table 25.1
8. Repeat step 6 and 7up to 14th clock pulse.
9. At 15th clock pulse state of Q_1, Q_2, Q_3, Q_4 is same as initial state.
10. Draw the Sequence on graph paper.
11. After completion of practical switch off the supply, remove the connection and submit the wires and equipments.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

XIV Precautions Followed

.....
.....
.....
.....

XV Observations :

Table 25.1: Generation of PN sequence

Sr. No.	Clock	State of Shift Register				Mod.2 adder Output	PN Sequence (Q_4)
		Q_1	Q_2	Q_3	Q_4	$Q_3 \oplus Q_4$	
1	Initial state	1	0	0	0	0	0
2	1						
3	2						
4	3						
5	4						
6	5						
7	6						
8	7						
9	8						
10	9						
11	10						
12	11						
13	12						
14	13						
15	14						
16	15						

XVI Results

.....

.....

.....

.....

XVII Interpretation of results

.....

.....

.....

.....

XVIII Conclusions

.....

.....

.....

.....

XIX Practical related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Generate PN sequence for initial state 1010
2. At initial state 0000 what should be PN sequence

[Space for Answers]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://en.wikipedia.org/wiki/Pseudorandom_noise.
2. https://www.youtube.com/watch?v=GrA46JJ0xbU.

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various out put on trainer kit	20 %
4	Handling of the kit, Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No. 26: Generate PN sequence for given maximum length using Relevant simulation software.

I Practical Significance

The PN Sequence Generator block generates a sequence of pseudorandom binary numbers using a linear-feedback shift register (LFSR). A pseudo noise sequence can be used in a pseudorandom scrambler and descrambler. It can also be used in a direct-sequence spread-spectrum system. In this practical, students will simulate PN-Sequence for given data length using simulation software.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '**Maintain basic digital communication systems'.**

- Use basic programming skills to simulate communication system.
- Debug and execute the program
- Interpret the output.
- Calculate various parameters

IV Relevant Course Outcomes

- Maintain spread spectrum based systems.

V Practical Outcome

- Generate PN sequence for given maximum length using relevant simulation software.

VI Relevant Affective domain related Outcome(s)

- Select proper programming environment.
- Follow ethical practices

VII Minimum Theoretical Background

Pseudo-Noise (PN) sequences are commonly used to generate noise that is approximately "white". It has applications in scrambling, cryptography, and spread-spectrum communications. It is also commonly referred to as the Pseudo-Random Binary Sequence (PRBS). These are very widely used in communication standards these days. The qualifier "pseudo" implies that the sequence is not truly random. Actually, it is periodic with a (possibly large) period, and exhibits some characteristics of a random white sequence within that period. PN sequences are generated by Linear Feedback Shift Registers (LFSR)

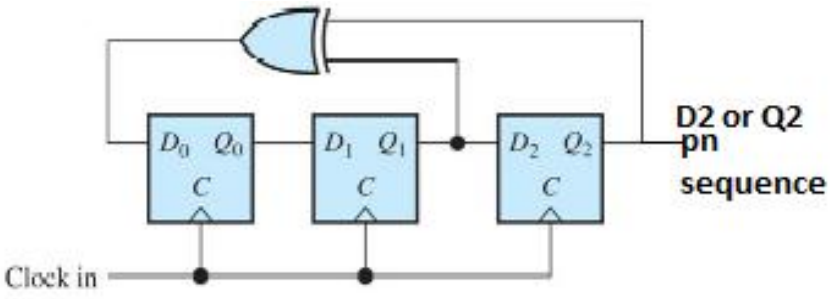


Figure 26.1: PN-Sequence Generator

VIII Sample simulation code:

a) PN-sequence Generation using MATLAB

```
clear
clc
G=63;  % Code length
%Generation of first m-sequence using generator polynomial [45]
sd1 =[0 0 0 0 1];           % Initial state of Shift register
PN1=[];                     % First m-sequence
for j=1:G
   PN1=[PN1 sd1(5)];
if sd1(1)==sd1(4)
      temp1=0;
else temp1=1;
end
sd1(1)=sd1(2);
sd1(2)=sd1(3);
sd1(3)=sd1(4);
sd1(4)=sd1(5);
sd1(5)=temp1;
end
subplot(3,1,1)
stem(PN1)
title('M-sequence generated by generator polynomial [45]')
```

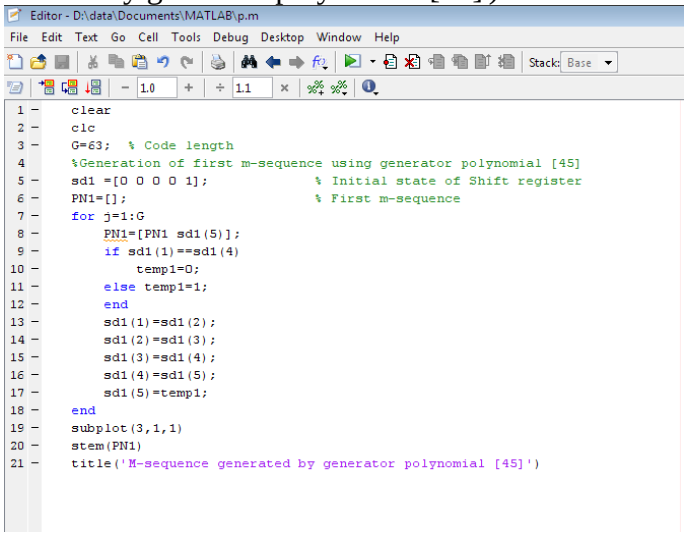


Figure 26.2: Code of PN-Sequence Generator

Output of above code:

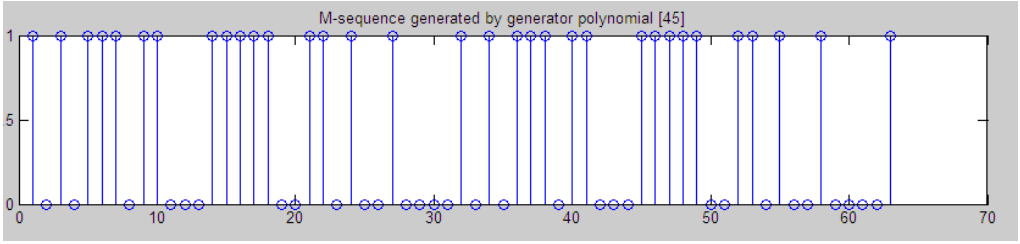


Figure 26.3: Output of PN-Sequence Generator

b) Actual Simulation Code

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Computer	Latest Specifications with high end Processor suitable for simulation software	1
2.	Simulation Software	Lab view/ MATLAB /SCILAB/P Spice /HS Spice / Multisim/ Proteus or any other relevant open source software	1

X Precautions

1. Ensure proper earthling to the computer system.
2. Ensure compatibility of computer system with software.
3. Ensure proper installation of simulation software.

XI Procedure

1. Open MATLAB
2. Go to file and create a new (.m) file.
3. Type the above code in the code window.
4. Save the file.

5. Define the path directory.
6. Run the program using F5 key or run command.
7. Observe the generated PN Sequence in command window.
8. Paste the print out under observations heading.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			

XIII Actual procedure followed

.....
.....
.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations Actual PN sequence observed

(Student should paste the PN sequence waveform**)**

XVI Interpretation of results

.....
.....
.....
.....

XVII Conclusions & Recommendation

.....
.....
.....
.....
.....

XVIII Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Generate PN-sequence of length 15.
2. List IC numbers used as PN code generator.

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.mathworks.com/help/comm/ref/pnsequencegenerator.html.
2. https://www.youtube.com/watch?v=GrA46JJ0xbU.

XIX Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of simulation software	10 %
2	Building of diagram	20 %
3	Measuring values from PC Screen	20 %
4	Working in team	10 %
Product related (10 Marks)		**40%**
5	Correctness of output	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related(15)	**Product Related(10)**	**Total (25)**	

Practical No.27: Generate two channel CDMA-DSSS signal and demodulate it.

I Practical Significance

CDMA technology is known as a spread-spectrum technique which allows many users to occupy the same time and frequency allocations in a given band and space. Individual conversations are encoded with the help of pseudo-random digital sequence. This practical is designed to explain how two different signals can be send using CDMA-DSSS and reconstructed successfully at other end.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and different blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations

IV Relevant Course Outcomes

- Maintain spread spectrum based systems.

V Practical Outcome

- Generate two channel CDMA-DSSS signal and demodulate it

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

CDMA technology is known as a spread-spectrum technique which allows many users to occupy the same time and frequency allocations in a given band and space.

Types of Spread Spectrum Communications: There are two types of spread spectrum communications:

1. Frequency Hopping
2. Direct Sequence

CDMA employs analog-to-digital conversion (ADC) in combination with spread spectrum technology. Audio input is first digitized into binary elements. The frequency of the transmitted signal is then made to vary according to a defined pattern (code), so it can be intercepted only by a receiver whose frequency response is programmed with the same code, so it follows exactly along with the transmitter frequency.

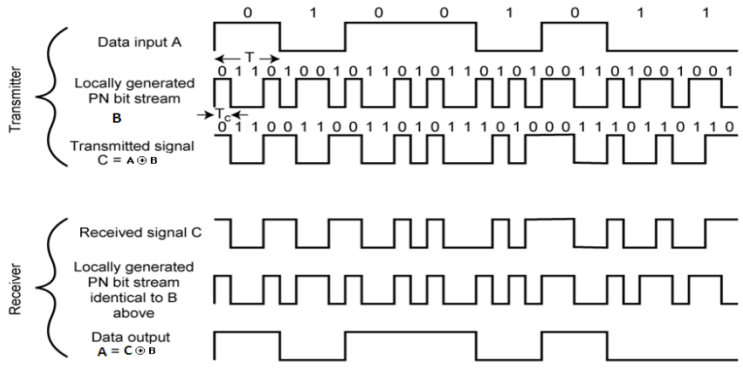


Figure 27.1: CDMA-DSSS waveforms
*[**Courtesy:**https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt]*

VIII Practical Circuit Diagram

a) Sample Block Diagram

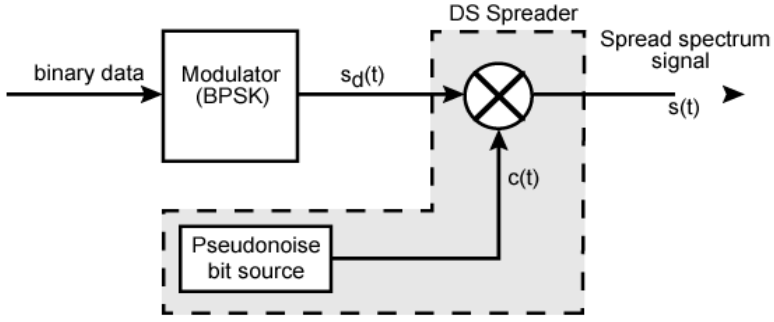


Figure 27.2: CDMA-DSSS Transmitter
*[**Courtesy:**https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt]*

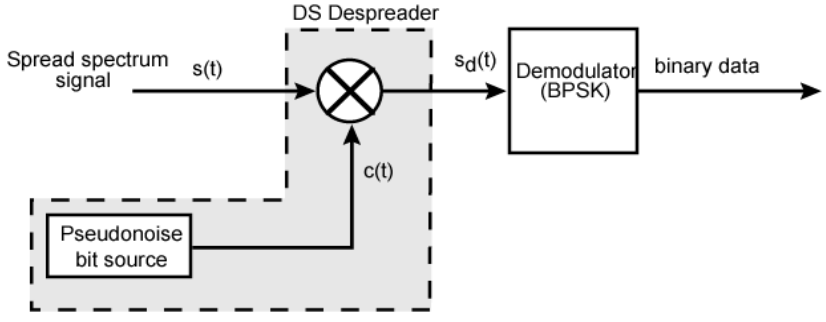


Figure 27.3: CDMA-DSSS Receiver
*[**Courtesy:**https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt]*

b) Actual Block Diagram / Circuit Diagram

c) Sample Practical Setup

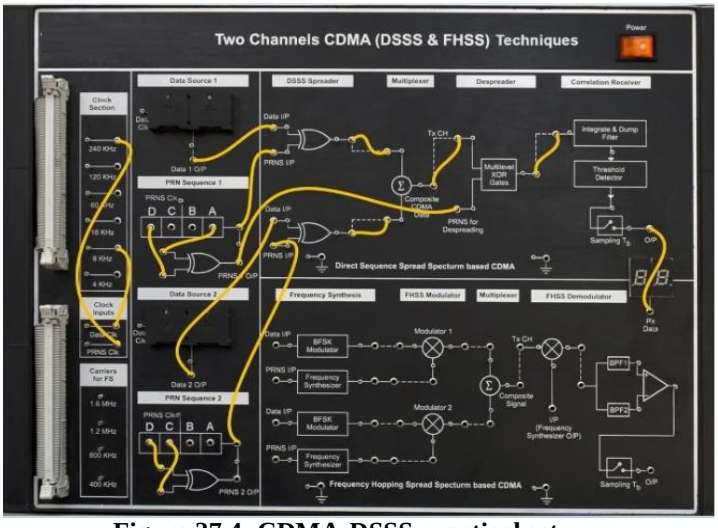


Figure 27.4: CDMA-DSSS practical set up

d) Actual Practical Setup

(Students should draw practical set up used in their laboratory**)**

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C power supply 0-30V,0-2A , SC protection Digital meters	1
3.	CDMA-DSSS Trainer kit	Two channel, Four bit PN sequence or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per Figure27.4.
2. Switch ON the power supply.

For CDMA DSSS transmitter:-

i. Connect 8 KHz clock signal from the clock section to “data clk” of the clock input section.
ii. Connect 240 KHz clock signal from the clock section to “PRNS clk” of the clock input section.
iii. Connect input of the feedback EX-OR gate of PRNS sequence-1 and PRNS sequence-2.
iv. Connect Data-1 output of “data generator-1” to “data I/P” of one of the two EX-OR gate under DSSS modulator section.
v. Connect “PRNS I/P” of same EX-OR gate to the “PRNS -1 O/P of the PRNS seuquence-1 generator.
vi. Connect Data-2 output of “data generator-2” to “data I/P” of other EX-OR gate under DSSS modulator section.
vii. Connect “PRNS I/P” of same EX-OR gate to the “PRNS -2 O/P of the PRNS seuquence-2 generator.
viii. Connect the output of these EX-OR gates to the respective inputs of the MUX.
ix. Observe the data O/P’s of data generators and PRNS sequence O/P of PRNS sequence generator.
x. Observe the DSSS spread signal at the output of DSSS modulator.
xi. Observe the final Multiplexed CDMA signal at the output of the MUX.

For CDMA DSSS Receiver:-

i. Connect the output of MUX to the demodulator I/P.
ii. Connect the PRNS sequence -1 at the PRNS for dispreading socket of demodulator.
iii. Connect the O/P of demodulator to the I/P of Correlation Receiver.

iv. Draw observed waveforms in the table27.1.
v. Note: The above procedure as given for experimental setup as given in figure 27.4
a. Procedure will change for different setups so do refer the particular manual.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table27.1: CDMA-DSSS waveforms

Sr. No.	Output at	Waveform
1	**Carrier clock signal**	
2	**Bit clock signal**	
3	**Data – 1 (Modulator section)**	

Sr. No.	Output at	Waveform
4	**PRNS-1**	
5	**MUX O/P / DSSS signal**	
6	**PRNS dispreading O/P**	

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Use PN-sequence for the Direct Sequence Spread Spectrum (DSSS) signal to trace the DSSS signal corresponding to 2 different bit patterns and the same PN -Sequence used as the modulator
2. Observe the DSSS signal corresponding to 2 different bit patterns for clock frequency 120KHz

[Space for Answers]

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.elprocus.com/cdma-technology-working-applications/
2. https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt
3. www.ccs.neu.edu/home/rraj/Courses/G250/S05/Lectures/SpreadSpectrum.ppt

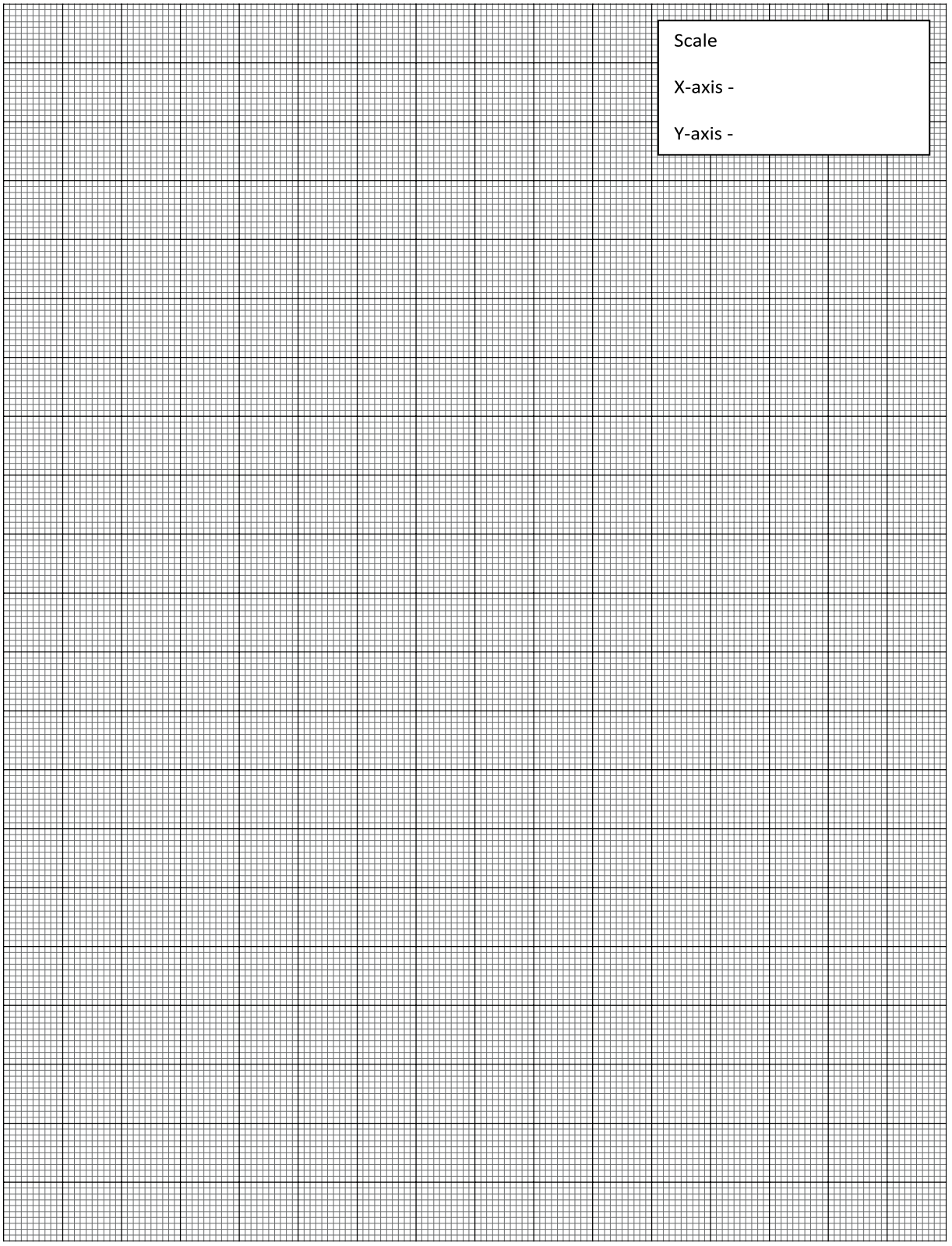
XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No.28: Generate two channel CDMA-FHSS signal and demodulate it.

I Practical Significance

Frequency-hopping spread spectrum (FHSS) is a method of transmitting radio signals by rapidly switching a carrier among many channels, using pseudorandom sequence known to both transmitter and receiver. It also used in Bluetooth wireless data transfer. This practical is designed to explain how generated FHSS signal is used in many space systems and avionics systems for multiple access communications, protection against jamming and interference and various Communication, Command and Control applications.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified Competency: "**Maintain basic digital communication systems."**

- Identify different components, IC's and blocks on the trainer kit
- Make the connection as per the given experimental set up
- Test the output signals at the different testing points.
- Interpret the result as per the observations

IV Relevant Course Outcomes

- Maintain spread spectrum based systems.

V Practical Outcome

- Generate two channel CDMA-FHSS signal and demodulate it.

VI Relevant Affective domain unrelated Outcome(s)

- Follow safe practices.
- Handle instruments carefully.
- Follow ethical practices.

VII Minimum Theoretical Background

Frequency-hopping spread spectrum (FHSS) is a method of transmitting radio signals by rapidly switching a carrier among many channels using pseudorandom sequence known to both transmitter and receiver. It is used as a multiple access method in the code division multiple access (CDMA) scheme frequency-hopping code division multiple access (FH-CDMA). Each available frequency band is divided into sub-frequencies. Signals rapidly change ("hop") among these in a predetermined order.

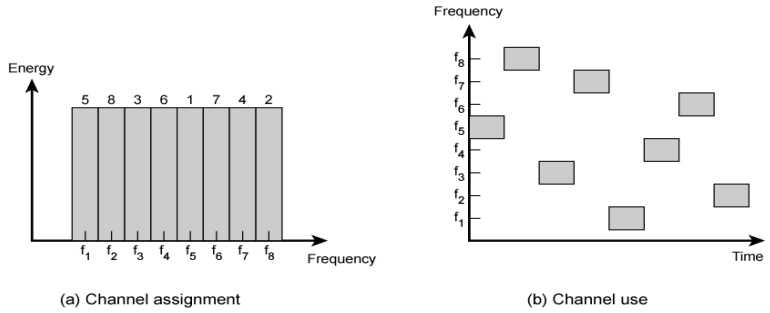


Figure 28.1: CDMA-FHSS concept

[Courtesy:https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt]

VIII Practical Circuit Diagram

a) Sample Block diagram

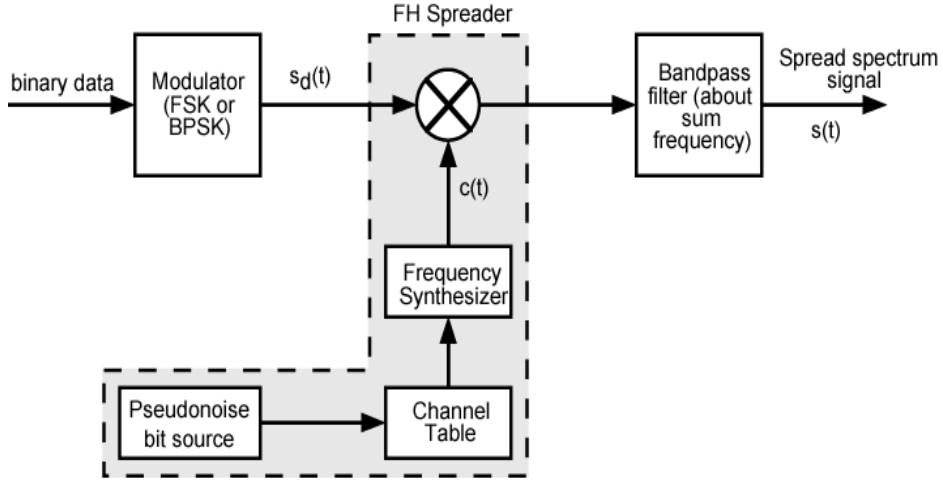


Figure 28.2: CDMA-FHSS Transmitter

[Courtesy:https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt]

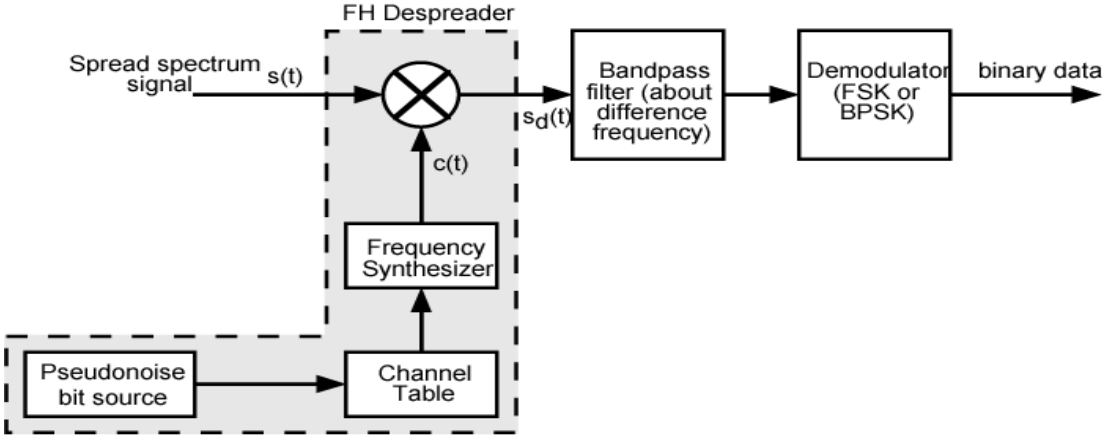


Figure 28.3: CDMA-FHSS Receiver

[*Courtesy:https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt]*

b) Actual Block Diagram / Circuit Diagram

c) Sample Practical Setup

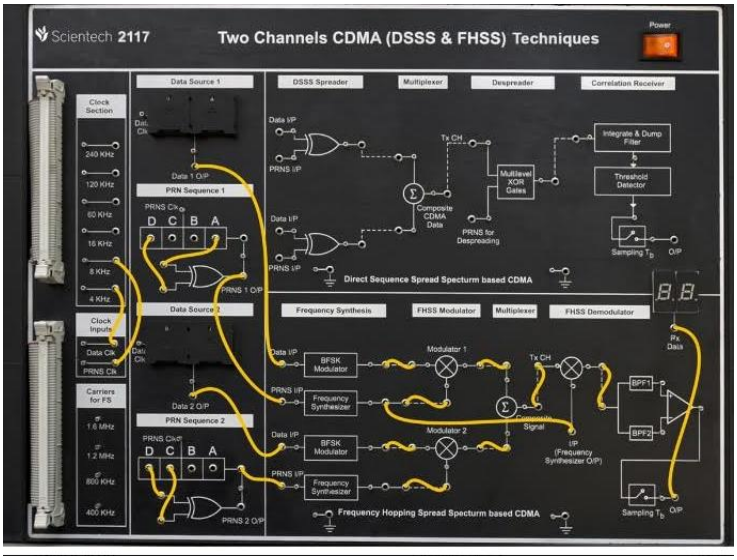


Figure 28.4: CDMA-FHSS practical set up

d) Actual practical set up used in laboratory

(Student should draw practical set up used in their laboratory**)**

IX Resources required

Sr. No.	Instruments /Components	Specifications	Quantity
1.	Dual trace cathode ray oscilloscope / Digital storage oscilloscope	20MHz dual trace oscilloscope /25 MHz Dual Trace Digital Storage Oscilloscope	1
2.	Power supply	Variable D C power supply 0-30V,0-2A , SC protection , Digital meter	1
3.	CDMA-FHSS Trainer kit	Two channel, four bit PN Sequence or equivalent trainer kit	1
4.	Connecting wires	CRO probes, patch chords	2

X Precautions

1. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Make the connection as per Figure 28.4.
2. Switch ON the power supply.

For CDMA FHSS transmitter (Modulator):-

i. Connect 4 KHz clock signal from the clock section to "data clk" of the clock input section.
ii. Connect 8 KHz clock signal from the clock section to "PRNS clk" of the clock input section.
iii. Connect input of the feedback EX-OR gate of PRNS sequence-1 and PRNS sequence-2 to the corresponding frequency synthesizer
iv. Connect Data-1 output of "data generator-1" to "data I/P" of one of the two BFSK modulator under frequency synthesis is section.
v. Connect "PRNS-1 O/P" of "PRNS sequence-1 generator to the I/P of the frequency synthesizer.
vi. Connect Data-2 output of "data generator-2" to "data I/P" of second BFSK modulator under frequency synthesis section.
vii. Connect "PRNS-2 O/P" of "PRNS sequence-2 generator to the I/P of second frequency synthesizer.
viii. Connect the O/P of BFSK modulators and frequency synthesizers to their respective modulators.
ix. Connect the O/P's of modulators to the respective I/P's of the Multiplexers.
x. Observe the data O/P's of data generators and PRNS sequence O/P of PRNS sequence generator.
xi. Observe the outputs of BFSK modulators and Frequency synthesizers
xii. Observe the final FHSS signal at the output of the MUX.

a. For CDMA FHSS Receiver (Demodulator):-

xiii. Connect the output of MUX to the demodulator I/P.
xiv. Connect the output of frequency synthesizer of modulator section to the I/P of frequency synthesizer of demodulator section.
xv. Connect the O/P of FHSS demodulator to the I/P of Band pass filter.
xvi. Draw observed waveforms in the table28.1.

XII Resources used (with major specifications)

Sr. No.	Instruments /Components	Specifications	Quantity
1.			
2.			
3.			
4.			
5.			

XIII Actual Procedure followed

.....
.....
.....
.....
.....
.....

XIV Precautions followed

.....
.....
.....
.....

XV Observations and Calculations

Table28.1: FHSS modulator and demodulator waveforms

Sr. No.	Output at	Waveform
1	**Carrier clock signal**	
2	**Bit clock signal**	
3	**Data – 1 / Data -2 (Modulator section)**	

Sr. No.	Output at	Waveform
4	**PRNS-1/ PRNS-2**	
5	**BFSK -1 / BFSK -2 modulator**	
6	**Frequency synthesizer-1 / Frequency synthesizer-2**	
7	**FHSS Modulated signal**	
8	**FHSS demodulated signal**	
9	**Filter O/P**	

XVI Results

.....
.....
.....
.....

XVII Interpretation of results

.....
.....
.....
.....

XVIII Conclusions and Recommendation

.....
.....
.....
.....

XIX Practical related Questions

Note: Below few sample questions are given for the reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Use PN-Sequence to measure the frequency of the FHSS Modulator for the Frequency Hopped Spread Spectrum (FHSS) signal and the same PN -Sequence used as the modulator
2. Observe the FHSS signal corresponding to 2 different bit patterns for clock frequency 60KHz

[Space for Answers]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

.....

.....

.....

.....

.....

.....

.....

XX References / Suggestions for further Reading

1. https://www.elprocus.com/cdma-technology-working-applications/
2. https://www2.rivier.edu/faculty/vriabov/CS553_ST7_Ch09-SpreadSpectrum.ppt
3. www.ccs.neu.edu/home/rraj/Courses/G250/S05/Lectures/SpreadSpectrum.ppt

XXI Assessment Scheme

Performance Indicators		Weightage
Process related (15 Marks)		**60%**
1	Identification of different blocks on trainer kit	10 %
2	Preparation of Experimental set up	20 %
3	Observation and measurement of various output on trainer kit	20 %
4	Handling of the kit ,Working in team	10 %
Product related (10 Marks)		**40%**
5	Interpretation of result	15 %
6	Conclusions	05 %
7	Practical related questions	15 %
8	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Name of Team Members

1. ……
2. ……
3. ……
4. ……

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101W
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics Engineering	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	C Language programming	22218
15	Basic Electronics	22225
16	Programming in C	22226
17	Fundamental of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemical	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurement	22420
12	Digital Electronic And Microcontroller Application	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048
20	Micro Project & Industrial Training Assessment Manual	22049

Fifth Semester:

1	Network Management & Administration	17061
2	Solid Modeling	17063
3	CNC Machines	17064
4	Behavioral Science(Hand Book)	17075
5	Behavioral Science (Assignment Book)	17075
6	Windows Programming using VC++	17076
7	Estimation and Costing	17501
8	Public Health Engineering	17503
9	Concrete Technology	17504
10	Design of Steel Structures	17505
11	Switchgear and Protection	17508
12	Microprocessor & Application	17509
13	A.C. Machines	17511
14	Operating System	17512
15	Java Programming	17515
16	System Programming	17517
17	Communication Technology	17519
18	Hydraulic & Pneumatics	17522
19	Advanced Automobile Engines	17523
20	Basic Electrical & Electronics	17524
21	Measurement and Control	17528
22	Power Engineering	17529
23	Metrology & Quality Control	17530
24	Computer Hardware & Networking	17533
25	Microcontroller	17534
26	Digital Communication	17535
27	Control System & PLC	17536
28	Audio Video Engineering	17537
29	Control System	17538
30	Industrial Electronics and applications	17541
31	Heat Transfer Operations	17560
32	Chemical Process Instrumentation & control	17561

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
10	Advanced Java Programming	17625
11	Mobile Computing	17632
12	System Programing	17634
13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
17	Environmental Technology	17646
18	Mass Transfer Operation	17648
19	Advanced Communication System	17656
20	Mobile Communication	17657
21	Embedded System	17658
22	Process Control System	17663
23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

HEAD OFFICE

Secretary,
Maharashtra State Board of Technical Education
49, Kherwadi, Bandra (East), Mumbai - 400 051
Maharashtra (INDIA)
Tel: (022)26471255 (5 -lines)
Fax: 022 - 26473980
Email: -secretary@msbte.com
Web -www.msbte.org.in

REGIONAL OFFICES:

MUMBAI

Deputy Secretary (T),
Mumbai Sub-region,
2nd Floor, Govt. Polytechnic Building,
49, Kherwadi, Bandra (East)
Mumbai - 400 051
Phone: 022-26473253 / 54
Fax: 022-26478795
Email: rbtemumbai@msbte.com

PUNE

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
412-E, Bahirat Patil Chowk,
Shivaji Nagar, Pune
Phone: 020-25656994 / 25660319
Fax: 020-25656994
Email: rbtepn@msbte.com

NAGPUR

Deputy Secretary (T),
M.S. Board of Technical Education
Regional Office,
Mangalwari Bazar, Sadar, Nagpur - 440 001
Phone: 0712-2564836 / 2562223
Fax: 0712-2560350
Email: rbteng@msbte.com

AURANGABAD

Deputy Secretary (T),
M.S. Board of Technical Education,
Regional Office,
Osmanpura, Aurangabad -431 001.
Phone: 0240-2334025 / 2331273
Fax: 0240-2349669
Email: rbteau@msbte.com