MICROWAVE ENGINNERING
AND
DIGITAL COMMUNICATIONS
LABORATORY MANUAL
B.TECH
(IV YEAR – I SEM)
(2019-20)

Prepared by:

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MALLA REDDY COLLEGE
OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

Recognized under 2(f) and 12 (B) of UGC ACT 1956

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Maisammaguda, Dhulapally (Post Via. Kompally), Secunderabad – 500100, Telangana State, India

VISION

To evolve into a center of excellence in Engineering Technology through creative and innovative practices in teaching-learning, promoting academic achievement & research excellence to produce internationally accepted competitive and world class professionals.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry institute interaction aimed at employability, entrepreneurship, leadership and research aptitude among students.

QUALITY POLICY

- Impart up-to-date knowledge to the students in Electronics & Communication area to make them quality engineers.
- Make the students experience the applications on quality equipment and tools.
- Provide systems, resources and training opportunities to achieve continuous improvement.
- Maintain global standards in education, training and services.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: PROFESSIONALISM & CITIZENSHIP To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
PEO2: TECHNICAL ACCOMPLISHMENTS To provide knowledge based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
PEO3: INVENTION, INNOVATION AND CREATIVITY To make the students to design, experiment, analyze, interpret in the core field with the help of other multi disciplinary concepts wherever applicable.
PEO4: PROFESSIONAL DEVELOPMENT To educate the students to disseminate research findings with good soft skills and become a successful entrepreneur.
PEO5: HUMAN RESOURCE DEVELOPMENT To graduate the students in building national capabilities in technology, education and research.

CODE OF CONDUCT FOR THE LABORATORIES

1. All students must observe the Dress Code while in the laboratory.
2. Sandals or open-toed shoes are NOT allowed.
3. Foods, drinks and smoking are NOT allowed.
4. All bags must be left at the indicated place.
5. The lab timetable must be strictly followed.
6. Be PUNCTUAL for your laboratory session.
7. Program must be executed within the given time.
8. Noise must be kept to a minimum.
9. Workspace must be kept clean and tidy at all time.
10. Handle the systems and interfacing kits with care.
11. All students are liable for any damage to the accessories due to their own negligence.
12. All interfacing kits connecting cables must be RETURNED if you taken from the lab supervisor.
13. Students are strictly PROHIBITED from taking out any items from the laboratory.
14. Students are NOT allowed to work alone in the laboratory without the Lab Supervisor
15. USB Ports have been disabled if you want to use USB drive consult lab supervisor.
16. Report immediately to the Lab Supervisor if any malfunction of the accessories, is there.

Before leaving the lab

- Place the chairs properly.
- Turn off the system properly
- Turn off the monitor.
- Please check the laboratory notice board regularly for updates.

MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY
ECE DEPARTMENT
MICROWAVE AND DIGITAL COMMUNICATION LABORATORY

LIST OF EXPERIMENTS

EXPERIMENT NO-1

GUNN DIODE CHARACTERISTICS

Aim: To study the characteristics of a Gunn diode oscillator.

Apparatus:

Gunn power supply, Gunn oscillator with micrometer, Isolator, Tunable frequency meter, Detector Mount, Ammeter (0-10mA), Cable, Cooling fan.

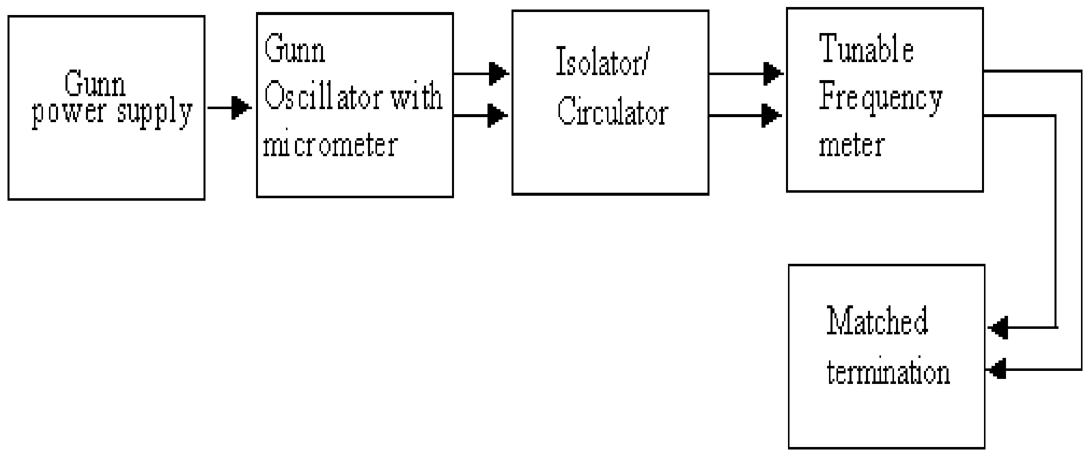
Theory:

The Gunn Diode makes use of velocity modulation to transform a continuous electron beam into microwave power. Electrons emitted from the cathode are accelerated and passed through the positive resonator towards negative reflector, which reflects the electrons and the electrons turn back through the resonator. Suppose the RF- field exists between the resonators, the electron accelerated or retarded, as the voltage at an increased velocity and the retarded electrons leave at the reduced velocity. As a result, returning electrons group together in bunches. As the electron bunches pass through the resonator, they interact with the voltage at resonator grids.

If the bunches pass the grid at such a time that the electrons are slowed down by the voltage then energy will be delivered to the resonator, and the klystron will oscillate. The frequency is primarily determined by the dimensions of resonant cavity. Hence by changing the volume of the resonator, mechanical tuning of the klystron is possible. A small frequency change can be obtained by adjusting reflector voltage. This is called electronic tuning.

Block Diagram:

Setup for V-I Characteristics of Gunn Oscillator



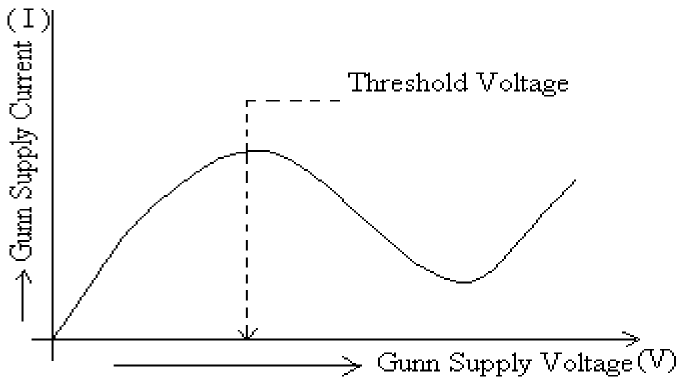
Procedure:

1. First connect the Gunn test bench as shown in block diagram (a). Switch on the Gunn power supply.
2. The Gunn bias is adjusted to 9V (below 10V).
3. The micrometer of the Gunn oscillator is varied.
4. The tunable frequency meter is tuned until there is a dip in the ammeter.
5. The operating frequency can be taken in terms of GHz.
6. The Gunn oscillator micrometer reading and the corresponding frequency are shown in the frequency conversion charts.
7. Similar frequency conversion charts are provided for the frequency meter reading.
8. Note the frequency corresponding to Gunn oscillator micrometer reading and the frequency corresponding to frequency meter reading.
9. Both the frequency readings should be the same.
10. The above procedure is repeated for different values of the Gunn oscillator micrometer values.
11. For V-I characteristics of Gunn connect the test bench as block diagram.
12. Vary Gunn supply voltage from minimum (i.e. 0V to 6V), note down the Corresponding Gunn current when it is in current (I) mode.
13. Plot graph between Gunn supply voltage Vs Gunn supply current.

Tablular Column:

S.No.	Gunn Supply Voltage(V)	Gunn Supply Current(mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

Expected Graphs:



Result:

Questions:

1. What is GUNN diode ?
2. Draw the equivalent Circuit for GUNN?
3. What are the different modes in GUNN diode oscillator?
4. How many junctions are there in GUNN?
5. Explain the transferred electron effect in GUNN?
6. What are applications of GUNN?

EXPERIMENT NO-2

CHARACTERISTICS OF THE REFLEX KLYSTRON TUBE

Aim: To study the characteristics of the reflex klystron tube and to determine its electronic tuning range.

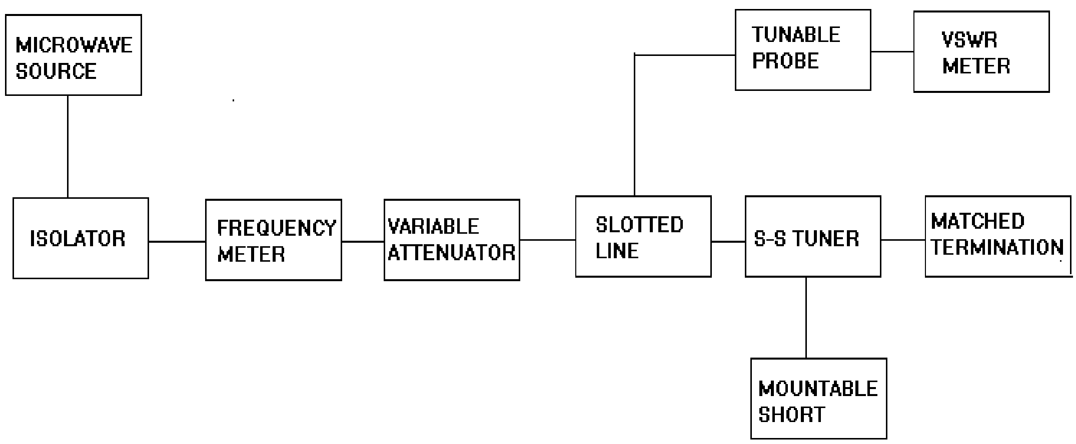
Apparatus:

Klystron power supply, klystron mount, isolator, frequency mount, variable attenuator, detector mount, wave guide stands, oscilloscope, BNC cable, cooling fan.

Theory:

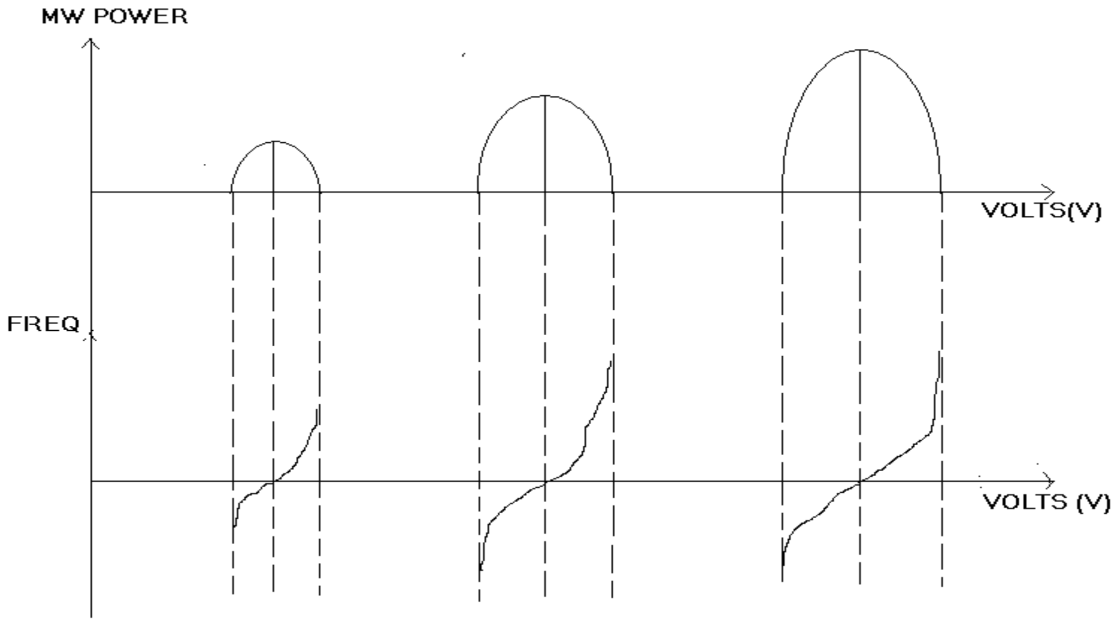
The reflex klystron makes use of velocity modulation to transform a continuous electron beam into microwave power. Electrons emitted from the cathode are accelerated and passed through the positive resonator towards negative reflector, which reflects the electrons and the electrons turn back through the resonator. Suppose the RF- field exists between the resonators, the electron accelerated or retarded, as the voltage at an increased velocity and the retarded electrons leave at the reduced velocity. As a result, returning electrons group together in bunches. As the electron bunches pass through the resonator, they interact with the voltage at resonator grids.If the bunches pass the grid at such a time that the electrons are slowed down by the voltage then energy will be delivered to the resonator, and the klystron will oscillate. The frequency is primarily determined by the dimensions of resonant cavity. Hence by changing the volume of the resonator, mechanical tuning of the klystron is possible. A small frequency change can be obtained by adjusting repeller voltage. This is called electronic tuning.

Block Diagram:



MICROWAVE BENCH

Model Graph:



Procedure:

1. Connect the components and equipments as shown in the block diagram.
2. Set the variable attenuator at the minimum attenuation position.
3. Set the mod. Switch of klystron power supply at CW position, beam voltage control knob to fully antic lock wise and repeller voltage control knob to fully clock wise.
4. Rotate the knob of the frequency meter at one side fully.
5. Connect dc mille ampere meter with detector.
6. Switch on the klystron power supply and cooling fan.
7. Put on the beam voltage switch (ht) and rotate the beam voltage knob slowly up to 300v and observe the beam current which do not increase more than 30ma. Do not change the beam voltage while taking the readings.
8. Change the repeller voltage slowly and watch the current meter set the maximum deflection in the ammeter.
9. Tune the plunger of klystron mount for maximum output.
10. Rotate the frequency meter slowly and stop at that position, where there is lowest output on mille ampere meter. Read frequency meter between two horizontal red lines and vertical marker.
11. Change the reflector voltage and read the current and frequency for each repeller voltage to get different modes of the klystron.
12. Note the readings in tabular column for every repeller voltage and draw the graph for klystron modes.

Observation:

Beam voltage (Vo) = , Beam current (I) =

Repeller Voltage (V)	Current (mA)	Power (mW)	Dip Frequency (GHz)

Result:

Questions:

1) What is klystron tube?
2) What is velocity modulation?
3) What is bunching?
4) Importance of multicavity klystron?
5) What is electronic tuning?

EXPERIMENT NO-3

ATTENUATION MEASUREMENT

Aim: To study insertion loss and attenuation of an attenuator

Apparatus:

1. Microwave source Klystron tube (2k25)
2. Isolator (xI-621)
3. Frequency meter (xF-710)
4. Variable attenuator (XA-520)
5. Slotted line (XS-651)
6. Tunable probe (XP-655)
7. Detector mount (XD-451)
8. Matched termination (XL-400)
9. Test attenuator
   a) Fixed
   b) Variable
10. Klystron power supply & Klystron mount
11. Cooling fan
12. BNC-BNC cable
13. VSWR or CRO

BLOCK DIAGRAM

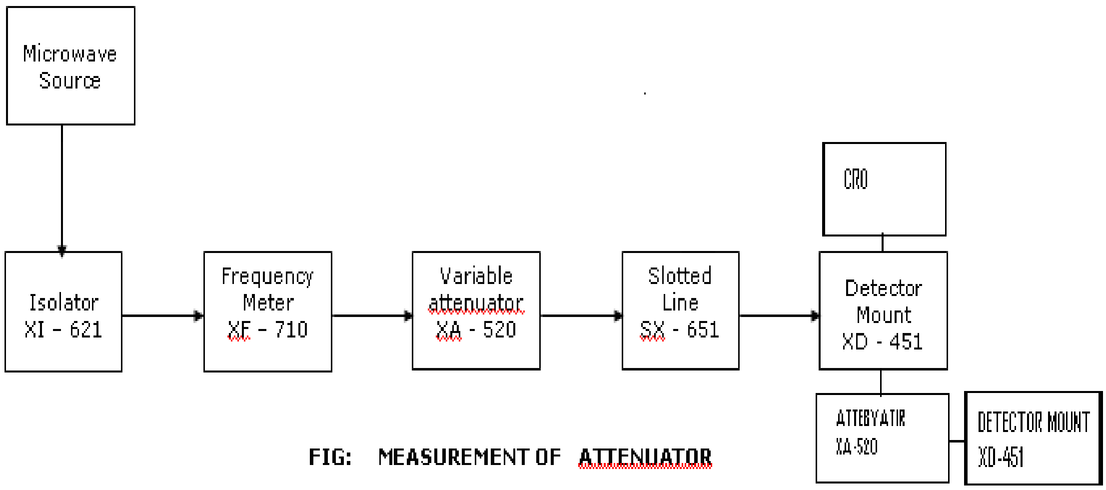


FIG: MEASUREMENT OF ATTENUATOR

Theory:

The attenuator is a two port bidirectional device which attenuates some power when inserted into a transmission line.

Attenuation A (dB) = 10 log (P1/P2)

Where P1 = Power detected by the load without the attenuator in the line

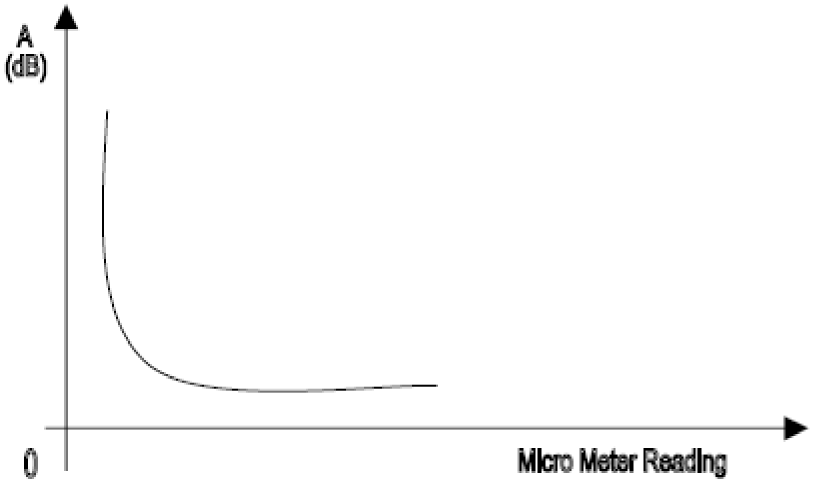
P2 = Power detected by the load with the attenuator in the line.

Procedure:

1. Connect the equipments as shown in the above figure.
2. Energize the microwave source for maximum power at any frequency of operation.
3. Connect the detector mount to the slotted line and tune the detector mount also for max deflection on VSWR or on CRO.
4. Set any reference level on the VSWR meter or on CRO with the help of variable attenuator. Let it be P1.
5. Carefully disconnect the detector mount from the slotted line without disturbing any position on the setup place the test variable attenuator to the slotted line and detector mount to O/P port of test variable attenuator.
6. Keep the micrometer reading of text variable attenuator to zero and record the readings of VSWR meter or on CRO. Let it to be P2. Then the insertion loss of test attenuator will be P1-P2 db.
7. For measurement of attenuation of fixed and variable attenuator. Place the test attenuator to the slotted line and detector mount at the other port of test attenuator. Record the reading of VSWR meter or on CRO. Let it be P3 then the attenuation value of variable attenuator for particular position of micrometer reading of will be P1-P3 db.
8. In case the variable attenuator change the micro meter reading and record the VSWR meter or CRO reading. Find out attenuation value for different position of micrometer reading and plot a graph.
9. Now change the operating frequency and all steps should be repeated for finding frequency sensitivity of fixed and variable attenuator.

Note:1. For measuring frequency sensitivity of variable attenuator the position of micrometer reading of the variable attenuator should be same for all frequencies of operation.

Expected Graph:



OBSERVATION TABLE:

Micrometer reading	P1 (dB)	P2 (dB)	Attenuation = P1-P2 (dB)

Result:

Questions:

1. What is attenuation?
2. How many types of attenuators are there?
3. What is insertion loss?
4. What is the min value of insertion loss?
5. What are the methods used for measuring attenuation?
6. What are the methods used for measuring insertion loss?

EXPERIMENT NO-4

IMPEDANCE MEASUREMENT

Aim: To calculate the impedance of the given load of the Klystron.

Apparatus:

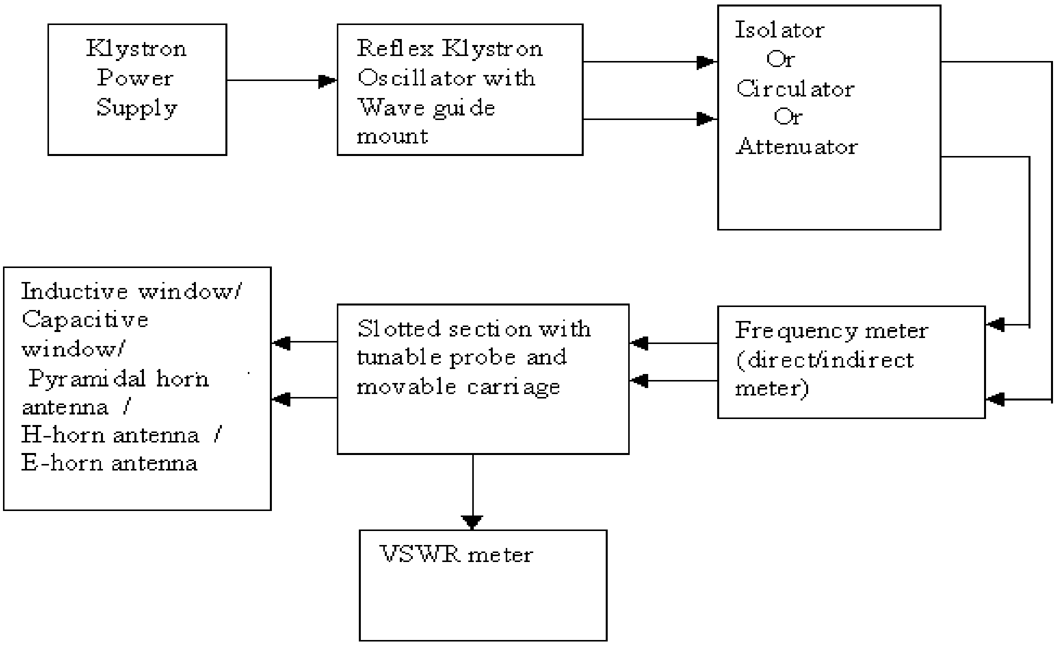
1. Reflex Klystron power supply.
2. Reflex Klystron tube with mount
3. Isolator or Circulator or Attenuator
4. VSWR meter
5. Tunable frequency meter
6. Slotted section with tunable probe and movable probe carriage
7. Shorting plate
8. Loads (Inductive window, Capacitive window, Slide screw tuner, Pyramidal Horn antenna, H-horn antenna, E-horn Antenna)

Theory:

The reflex klystron makes use of velocity modulation to transform a continuous electron beam into microwave power. Electrons emitted from the cathode are accelerated and passed through the positive resonator towards negative reflector, which reflects the electrons and the electrons turn back through the resonator. Suppose the RF- field exists between the resonators, the electron accelerated or retarded, as the voltage at an increased velocity and the retarded electrons leave at the reduced velocity. As a result, returning electrons group together in bunches. As the electron bunches pass through the resonator, they interact with the voltage at resonator grids.

If the bunches pass the grid at such a time that the electrons are slowed down by the voltage then energy will be delivered to the resonator, and the klystron will oscillate. The frequency is primarily determined by the dimensions of resonant cavity. Hence by changing the volume of the resonator, mechanical tuning of the klystron is possible. A small frequency change can be obtained by adjusting reflector voltage. This is called electronic tuning.

Block Diagram:



Procedure:

1. Connect the Reflex Klystron microwave test bench as per the block diagram.
2. Keep the Modulation switch in CW mode.
3. Adjust the repeller voltage (V_r) in maximum position.
4. Switch on the power supply and HT is ON condition.
5. Adjust beam current slowly, by increasing the beam voltage (V_o) slowly till the beam current reaches 21mA to 23mA. Do not change the beam voltage, repeller Voltage and beam current throughout the experiment.
6. Note the output current. Tune the frequency meter and observe the dip in the ammeter and note the corresponding frequency (i.e. operational frequency).
7. Detune the frequency meter.
8. Keep the modulation switch in AM mode.
9. Connect the tunable probe of the slotted section and VSWR meter using BNC cable.
10. Connect the required load to the slotted section .
11. Keep Range switch of VSWR meter in 30dB or 40 dB position.
12. Keep meter selector in normal position and input selection in Xtal position.
13. Keep the tunable probe at extreme right by using probe carriage of slotted section.
14. Tune the probe so that the indicator in VSWR meter will move towards ‘1’.
15. Adjust the amplitude and frequency of modulation so that the indicator in VSWR meter move towards ‘1’ in upper scale.

16. Now adjust the fine and coarse so that indicator is positioned on '1'
17. Now the probe is on V_{max} position, move the probe carriage such that indicator Is deflected away from '1' and a dip is observed on meter. Now the probe is positioned in V_{min} position. The meter reading directly gives the VSWR.
18. If the range switch is placed on 30db the reading must be taken from 1 to 3 scale. If the range switch is 40 db position, 3 to 10 scale is considered. If the variation of probe carriage in the above two scales exceeded then change the range switch to 50db and consider the scale 1 to 3 multiplied by 10.If the reading is beyond the scale then change the range switch to 60 db and consider 3 to 10 scale multiplied by 10.
19. Plot the smith chart for the observed values of VSWR for corresponding Loads and then calculate the normalized load impedance from the smith chart.
20. Find the required load impedance for the corresponding load according to the Given formula.

Formulas:

$\lambda_c=2a$, $\eta_o=120\Pi$, a=2.25cm

$Z_o = \eta_o/\sqrt{1-(\lambda_o/\lambda_c)^2}$, $\eta_o = 120\pi$, $\lambda_o = c/f$ and $\lambda_c = 2a$ where a = 2.25 cm.

Z_l/Z_o = normalized load impedance (from the smith chart)

$\therefore$ Load impedance (Z_l) = Zo * normalized load impedance

Result:

Questions:

1. Indicate the frequency Vs wave length for X-band?
2. Explain the principle of isolator & circulator?
3. Explain the principle of frequency meter?
4. What type of frequency meter used in microwave test bench?
5. What is the microwave frequency range?

EXPERIMENT NO-5

FREQUENCY MEASUREMENT

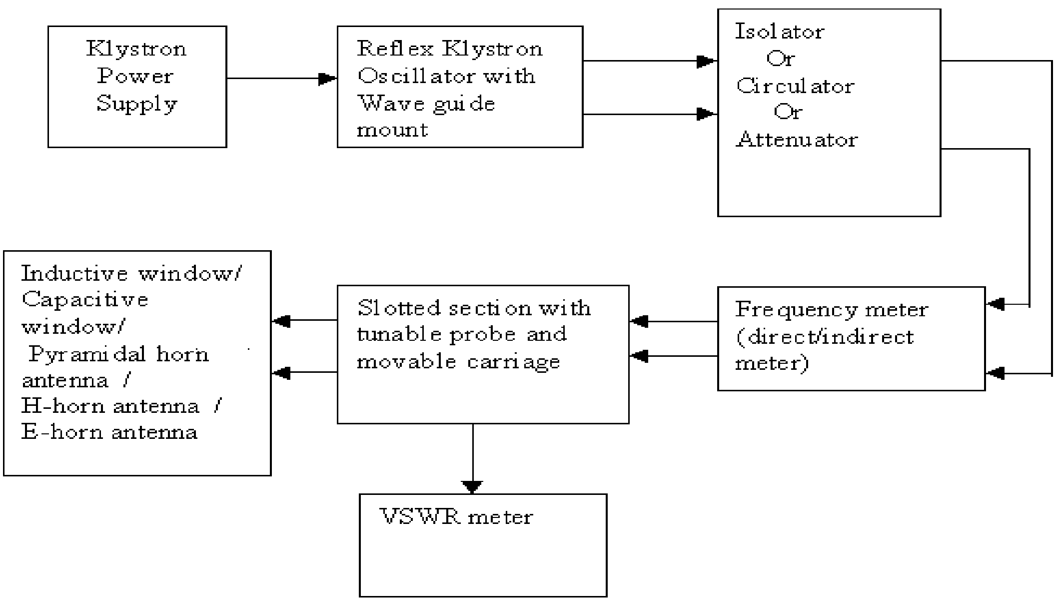
Aim:

To determine the frequency and wavelength in a rectangular wave guide working in TE10 mode.

Equipment Required:

1. Klystron tube
2. Klystron power supply 5kps – 610
3. Klystron mount XM-251
4. Isolator XI-621
5. Frequency meter XF-710
6. Variable attenuator XA-520
7. Slotted section XS-651
8. Tunable probe XP-655
9. VSWR meter SW-115
10. Wave guide stand XU-535
11. Movable Short XT-481
12. Matched termination XL-400

Block Diagram:



Theory:

The cut-off frequency relationship shows that the physical size of the wave guide will Determine the propagation of the particular modes of specific orders determined by values of m and n. The minimum cut-off frequency is obtained for a rectangular wave guide having dimension a>b, for values of m=1, n=0, i.e. TE10 mode is the dominant mode since for TMmn modes, n#0 or n#0 the lowest-order mode possible is TE10, called the dominant mode in a rectangular wave guide for a>b.

For dominant TE10 mode rectangular wave guide λo, λg and λc are related as below.

$$1/\lambda o^2 = 1/\lambda g^2 + 1/\lambda c^2$$

Where λo is free space wave length
λg is guide wave length
λc is cut off wave length
For TE10 mode λc – 2a where 'a' is broad dimension of wave guide.

Procedure:

1. Set up the components and equipments as shown in figure.
2. Set up variable attenuator at minimum attenuation position.
3. Keep the control knobs of klystron power supply as below:
   - Beam voltage – OFF
   - Mod-switch – AM
   - Beam voltage knob – Fully anti clock wise
   - Reflector voltage – Fully clock wise
   - AM – Amplitude knob – Around fully clock wise
   - AM – Frequency knob – Around mid position
4. Switch 'ON' the klystron power supply CRO and cooling fan switch.
5. Switch 'ON' the beam voltage switch and set beam voltage at 300V with help of beam voltage knob.
6. Adjust the reflector voltage to get the maximum amplitude in CRO
7. Maximize the amplitude with AM amplitude and frequency control knob of power supply.
8. Tune the plunger of klystron mount for maximum Amplitude.
9. Tune the reflector voltage knob for maximum Amplitude.
10. Tune the frequency meter knob to get a 'dip' on the CRO and note down the frequency from frequency meter.
11. Replace the termination with movable short, and detune the frequency meter.
12. Move the probe along with slotted line. The amplitude in CRO will vary .Note and record the probe position , Let it be d1
13. Move the probe to next minimum position and record the probe position again Let it be d2
14. Calculate the guide wave length as twice the distance between two successive minimum position obtained as above.

15. Measure the wave guide inner board dimension ‘a’ which will be around 22.86mm for x-band.

16. Calculate the frequency by following equation.

$$f = \frac{c}{\lambda} = \sqrt{\left(\frac{1}{\lambda^2_g} + \frac{1}{\lambda_c^{\ 2}}\right)}$$

Where C = $3x10^8$ meter/sec. i.e. velocity of light.

17. Verify with frequency obtained by frequency modes

18. Above experiment can be verified at different frequencies.

$f_o = C/\lambda o$ => C => $3x10^{10}$ m/s (i.e., velocity of light)

$1/\lambda o^2 = 1/\lambda g^2 + 1/\lambda c^2$

$$\lambda_0 = \frac{\lambda_g \lambda_c}{\sqrt{\lambda_g^{\ 2} + \lambda_c^{\ 2}}}$$

$\lambda g = 2x\Delta_d$

For TE_{10} mode => $\lambda c = 2a$

a → wave guide inner broad dimension

a = 2.286cm” (given in manual)

λc = 4.6cm”

Result:

EXPERIMENT NO-6

CHARACTERISTICS OF MULTI HOLE DIRECTIONAL COUPLER

Aim:

To study the function of multihole directional coupler by measuring the following parameters.

1. Mainline and auxiliary line VSWR.
2. The coupling factor and directivity of the coupler.

Apparatus:

Klystron power supply, klystron mount, isolator, frequency mount, variable Attenuator, detector mount, wave guide stands, oscilloscope, BNC cable, cooling fan, Slotted line tunable probe, VSWR meter.

Theory:

A directional coupler is a device with which it is possible to measure the incident and reflected wave separately. It consists of two transmission lines the main arm and auxiliary arm, electro magnetically coupled to each other. The power entering , in the main- arm gets divided between port 2 and port 3, and almost no power comes out in port 4 power entering at port 2 is divided between port 1 and port 4.The coupling factor is defined as

Coupling (C) = 20log p1/p3 (db) where port 2 is matched.

Isolation (I) = 20log p2/p3 (db) where port 1 is matched.

With built in termination and power entering at port 1, the directivity of the coupler is a measure of separation between incident wave and the reflected wave .directivity is measured indirectly as follows:

Hence Directivity D= I-C= 20log p2/p1 (db).

Main line VSWR is measured, looking into the main line input terminal when the matched loads are placed on other terminals.

Main line insertion loss is the attenuation introduced in the transmission line by insertion of coupler. It is defined as:

Insertion loss = 20log p1/p2(db).

Block Diagram:

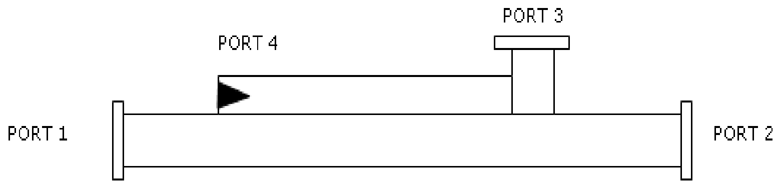
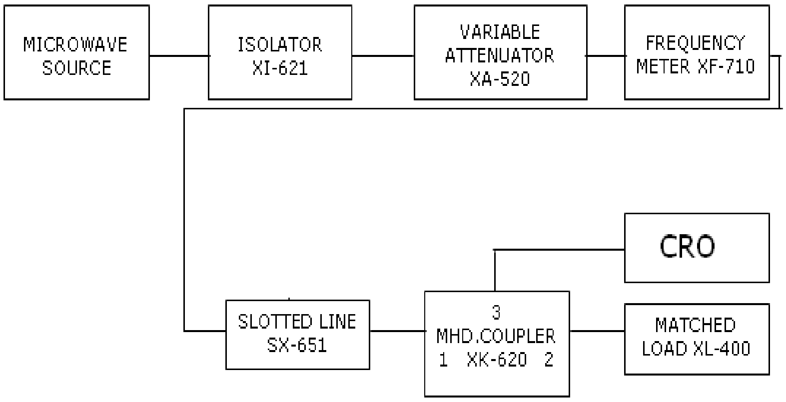


FIG. DIRECTIONAL COUPLER



Procedure:

Measurement of coupling factor, insertion loss, isolation and directivity:

1. Set up the components and equipments as shown in block diagram.
2. Energize the microwave source for particular frequency of operation.
3. Set modulation selector switch to am position.
4. Remove the multi hole directional coupler and connect the detector mount, tune the detector for maximum output.
5. Set any reference level of power on VSWR meter with the help of variable attenuator, gain control knob of VSWR meter, and note down the reading (reference level let X).
6. Insert the directional coupler as shown in second fig with detector to the auxiliary port 3 and matched termination to port 2, without changing the position of variable attenuator and gain control knob of VSWR meter.
7. Note down the reading on VSWR meter on the scale with the help of range db switch if required. Let it be Y.
8. Calculate coupling factor which will be X-Y =C (db).
9. Now carefully disconnect the detector from the auxiliary port 3 and match termination from port 2 without disturbing the set-up.
10. Connect the matched termination to the auxiliary port 3 and detector to port 2 measures the reading on VSWR meter. Suppose it is Z.
11. Connect insertion loss X-Z in db.
12. Repeat the steps from 1 to 5.

13. Connect the directional coupler in the reverse direction, i.e. port 2 to frequency meter side, matched termination to port 1 and detector mount to port 3. Without disturbing the position of the variable attenuator and gain control knob of VSWR meter.
14. Measure and note the reading on VSWR meter let it be $Y_{d.}$ $X-Y_d$ gives isolation I (db).
15. Compute the directivity as $Y-Y_d$= I-C.
16. Repeat the same for other frequencies.

Calculations:

Coupling (C) = 20log p1/p3 (db)

Isolation (I) = 20log p2/p3 (db)

Directivity D= I-C= 20log p2/p1

Insertion loss = 20log p1/p2(db).

Result:

Questions:

1) What is directional coupler?
2) How many ports does it have?
3) What is the difference between dc to magic tee?
4) What is Directivity?
5) What is Insertion Loss?
6) What is Coupling Factor?
7) What is the relation between coupling factor and insertion loss?

EXPERIMENT NO-7

DETERMINATION OF STANDING WAVE RATIO AND REFLECTION COEFFICIENT

Aim:

To determine the standing wave ratio and reflection coefficient of X-band waveguide.

Apparatus:

Klystron power supply, klystron mount, isolator, frequency mount, variable Attenuator, detector mount, wave guide stands, oscilloscope, BNC cable, cooling fan Slotted line tunable probe, S-S tuner.

Theory:

The electromagnetic field at any point of transmission line may be considered as the sum of two travelling waves, the incident wave, which propagates from the source to the load and the reflected wave which propagates towards the generator. The reflected wave is set up by reflection of incident wave from a discontinuity in the line or from the load impedance. The superposition of the two travelling waves, gives rise to a standing wave along the line. The maximum field strength is found where the waves are in phase and minimum where the two waves add in opposite phase. The distance between two successive minimum (maximum) is half the guide wavelength on the line. The ratio of electrical field strength and incident wave is called reflection coefficient.

The voltage standing wave ratio VSWR is defined as ratio between maximum and minimum field strength along the line.

Hence VSWR denoted by s is as follows

$S = E_{max}/E_{min} = [iE_{i1} + iE_{r1}]/[iE_{i1} - iE_{r1}]$.

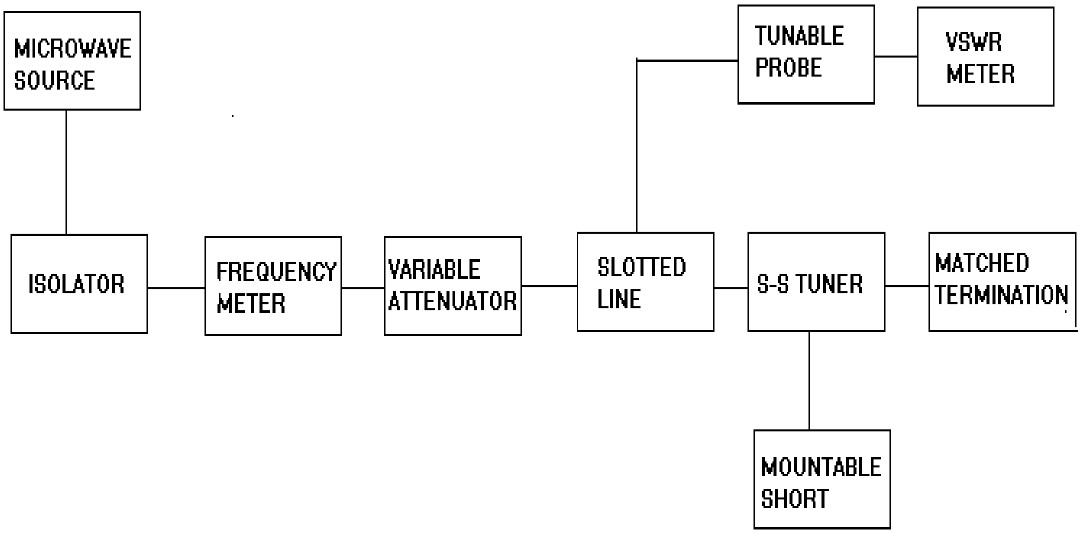
Reflection co efficient (ρ) is

$\rho = E_r/E_i = [Z_l - Z_o]/[Z_l + Zo]$

Where Z_l is the load impedance, Z_o is characteristics impedance. The above equation gives following equation

$\rho = S-1/S+1$.

Block Diagram:



MICROWAVE BENCH

Procedure:

1. Set up the equipment as shown in the block diagram.
2. Keep variable variable attenuator in the minimum attenuated position.
3. Keep the control knobs of VSWR meter as below:
   Range db --- 30 db/ 40 db.
   Input selector switch----- crystal 200k ohm.
   Meter switch ----- normal.
   Gain (coarse fine) ----- mid position approx.
4. Keep the control knobs of klystron power as below:
   Beam voltage (HT) ---- off.
   Mod. Switch ---- AM.
   Beam voltage knob ---- fully antic lock wise.
   Reflector voltage knob----- fully clockwise.
   Am- amplitude knob----- around fully clockwise.
   Am- frequency ----- mid position.
5. Switch on the klystron power supply. VSWR meter and cooling fan.
6. Switch on the beam voltage (ht) switch and set beam voltage at 300v.
7. Rotate the repeller voltage knob to get deflection in VSWR meter.
8. Tune the output by tuning the reflector voltage, amplitude and frequency of AM modulation.
9. Tune plunger of klystron mount and probe for maximum deflection in VSWR meter=1.
10. If required, change the range db- switch, and gain control knob to get deflection in the scale of VSWR meter.

11. As you move probe along the slotted line, the deflection will change.

A. Measurement of low VSWR:

1. Move the probe along the slotted line to get maximum deflection in VSWR meter.
2. Adjust the VSWR meter gain control knob until the meter indicates 1.0 on normal VSWR scale.
3. Keep the entire control knob as it is, move the probe to next minimum position. Read the VSWR on scale.

B. Measurement of high VSWR:

1. Set the depth of S S-S tuner slightly more for maximum VSWR.
2. Move the probe along with slotted line until a minimum is indicated.
3. Adjust the VSWR meter gain control knob to obtain a reading of 3 db in the normal db scale (0- 10 db) of VSWR.
4. Move the probe to the left on slotted line until the deflection is 6 db or 0 db obtain on 0 ---10 db scale. Note the record the probe position on slotted line let it is d1.
5. Repeat the step 3 and then move the probe right along the slotted line until deflection is 6 db or 0 db obtain on 0--- 10 db normal db scale. Let it be d2.
6. Replace the S-S tuner and termination by short.
7. Measure the distance (d) between two successive minima position of probe. Twice this distance is guide wavelength : λ_g
8. Compute SWR from the following equation :

VSWR (s) = $\lambda_g/ (\pi(d1\sim d2))$.

Observations:

Beam voltage: Volts.
Beam current: mA.
Operating frequency of klystron = GHz.
d1 =( )mm, d2 =( )mm, d11 =( )mm,d12=( )mm ,λ_g= 2(d12 ~ d11).
VSWR(S) = λ_g/ 3.14(d1 ~ d2).

Result:

Questions:

1) What is standing wave?
2) What is reflection coefficient?
3) When do standing waves form?
4) How they are useful in microwave engg?
5) What is min. value of VSWR?

EXPERIMENT NO-8

STUDY OF MAGIC TEE

Aim: To study the scattering parameters of magic tee.

Apparatus:

Klystron power supply, klystron mount, isolator , frequency mount, variable attenuator, detector mount, wave guide stands, oscilloscope, BNC cable, cooling fan magic tee, matched termination , accessories

Theory:

Magic tee is also known as hybrid tee or E-H plane tee. It is used to obtain completely matched three part tee junction. Magic tee can be used to measure the impedance as a duplexer and as a mixer. The reflex klystron makes use of velocity modulation to transform a continuous electron beam into microwave power. Electrons emitted from the cathode are accelerated and passed through the positive resonator towards negative reflector, which reflects the electrons and the electrons turn back through the resonator. Suppose the RF- field exists between the resonators, the electron accelerated or retarded, as the voltage at an increased velocity and the retarded electrons leave at the reduced velocity. As a result, returning electrons group together in bunches. As the electron bunches pass through the resonator, they interact with the voltage at resonator grids.

If the bunches pass the grid at such a time that the electrons are slowed down by the voltage then energy will be delivered to the resonator, and the klystron will oscillate. The frequency is primarily determined by the dimensions of resonant cavity. Hence by changing the volume of the resonator, mechanical tuning of the klystron is possible. A small frequency change can be obtained by adjusting reflector voltage. This is called electronic tuning.

Procedure:

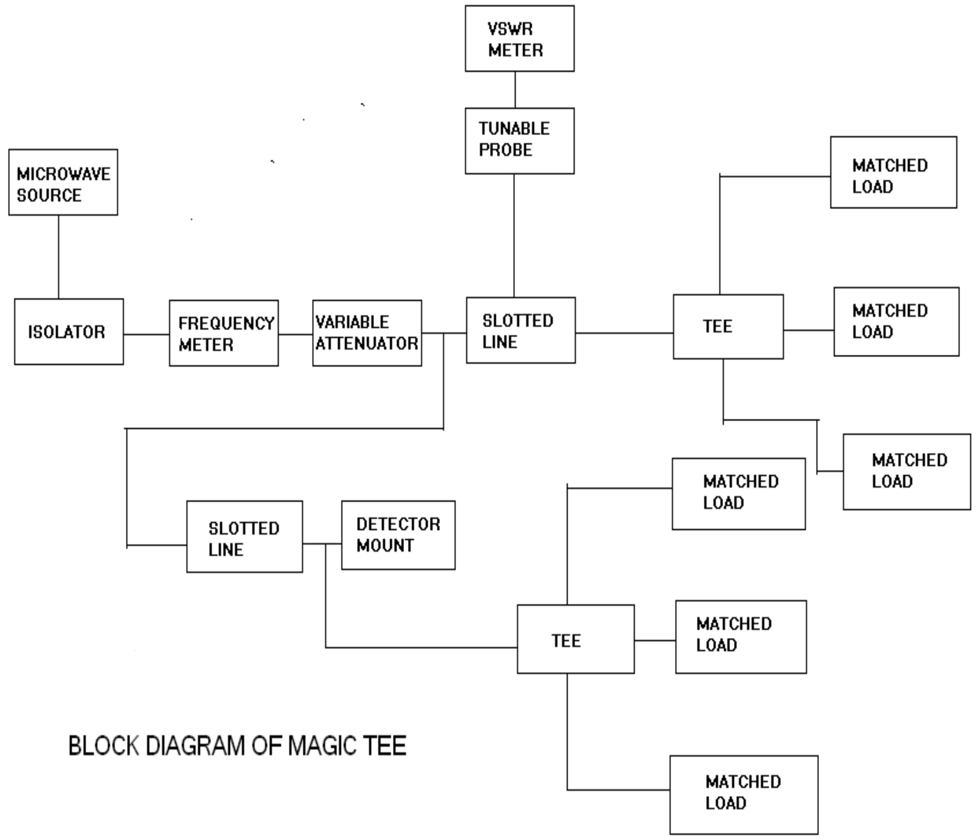
VSWR measurement of the ports:

1. Set up the components and equipment as shown in block diagram keeping E-arm towards slotted line and matched termination to other parts.
2. Energize the microwave source for particular frequency of operation.
3. Measure the VSWR of E- arm as described in measurement of SWR for low and medium value.
4. Connect another arm to slotted line and terminate the other port with matched termination. Measure the VSWR as above. Similarly VSWR of any port can be measured.

Measurement of Isolation and coupling factor:

1. Remove the tunable probe and magic tee from the slotted line and connect the detector mount to slotted line.
2. Energize the microwave source for particular frequency of operation and tune the detector mount for maximum output.
3. With the help of variable attenuator and gain control knob of VSWR meter set any power level in the VSWR meter and note down, readings, let it be port 2.
4. Without disturbing the position of variable attenuator and gain control knob carefully place the magic tee after slotted line keeping arm connected to slotted line, detector to e- arm and matched termination to arm1 and arm 2 . Note down the reading of VSWR meter .let it be port 4.
5. Determine the coupling coefficient from equation given the theory port.
6. Determine the isolation between the port 3 and port 4 on port 3= port 4 in db.
7. Repeat the same experiment for the other ports.
8. Repeat the same experiment for other frequencies

Block Diagram:



BLOCK DIAGRAM OF MAGIC TEE

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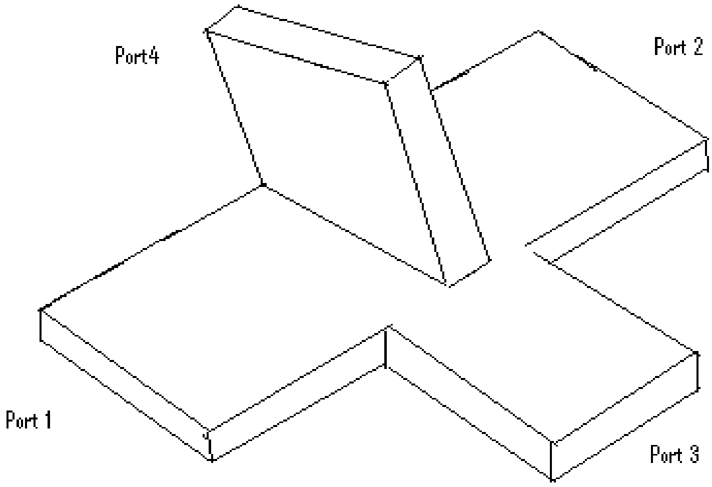


Observations:

P_1 = **$P_3 = P_1 + P_2$.**

P_2 =

P_3 = **$P_4 = P_1 - P_2$**

Result:

Questions:

1) What is magic tee?
2) How many ports does it have?
3) Difference between magic tee to directional coupler?
4) What is magic behind this?

EXPERIMENT NO-9

TIME DIVISION MULTIPLEXING & DEMULTIPLEXING

Aim:

Study of 4 Channel Analog Multiplexing and De multiplexing Techniques.

Apparatus:

1. Time division multiplexing & demultiplexing trainer kit.
2. CRO (30 mhz)
3. Patch chords.

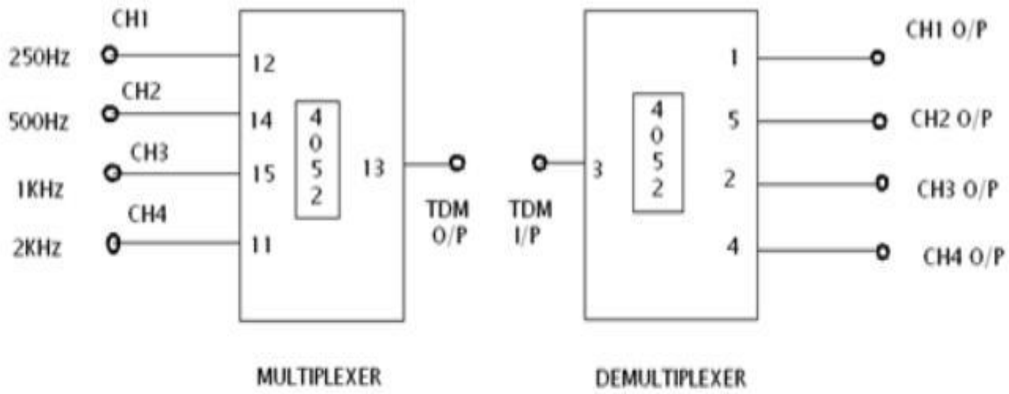
Theory:

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

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

Besides the space diversity & frequency diversity there is a method of sending multiple analog signals on a channel using “TIME DIVISION MULTIPLEXING & DEMULTIPLEXING” Technique.

CIRCUIT DIAGRAM:



Procedure:

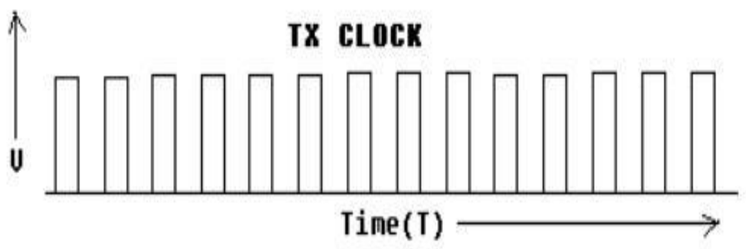
Multiplexing:

1. Connect the circuit as shown in diagram.
2. Switch ON the power supply.
3.Set the amplitude of each modulating signal as 5v peak-peak.
4.Monitor the outputs at test points 5,6,7,8. these are natural sampling PAM outputs.
5.Observe the outputs varying the duty cycle pot(P5). The PAM outputs will varying with 10% to 50% duty cycle.
6.Try varying the amplitude of modulating signal corresponding each channel by using amplitude pots P1,P2,P3,P4. Observe the effect on all outputs.
7.Observe the TDM output at pin no.13 (at TP9) OF 4052. all the multiplexer channel are observed during the full period of the clock(1/32 KHz).

Demultiplexing & Low Pass Filter:

1.Connect the circuit as shown in diagram 2.
2.Observe the demultiplexed outputs at test points 13,14,15,16 respectively.
3.Observe by varying the duty cycle pot P5 and see the effect on the outputs.
4.Observe the low pass filter outputs for each channel at test points 17,18,19,20 and at sockets channels CH1,CH2,CH3,CH4. These signals are true replica of the inputs. These signals have lower amplitude.

Expected Waveforms:



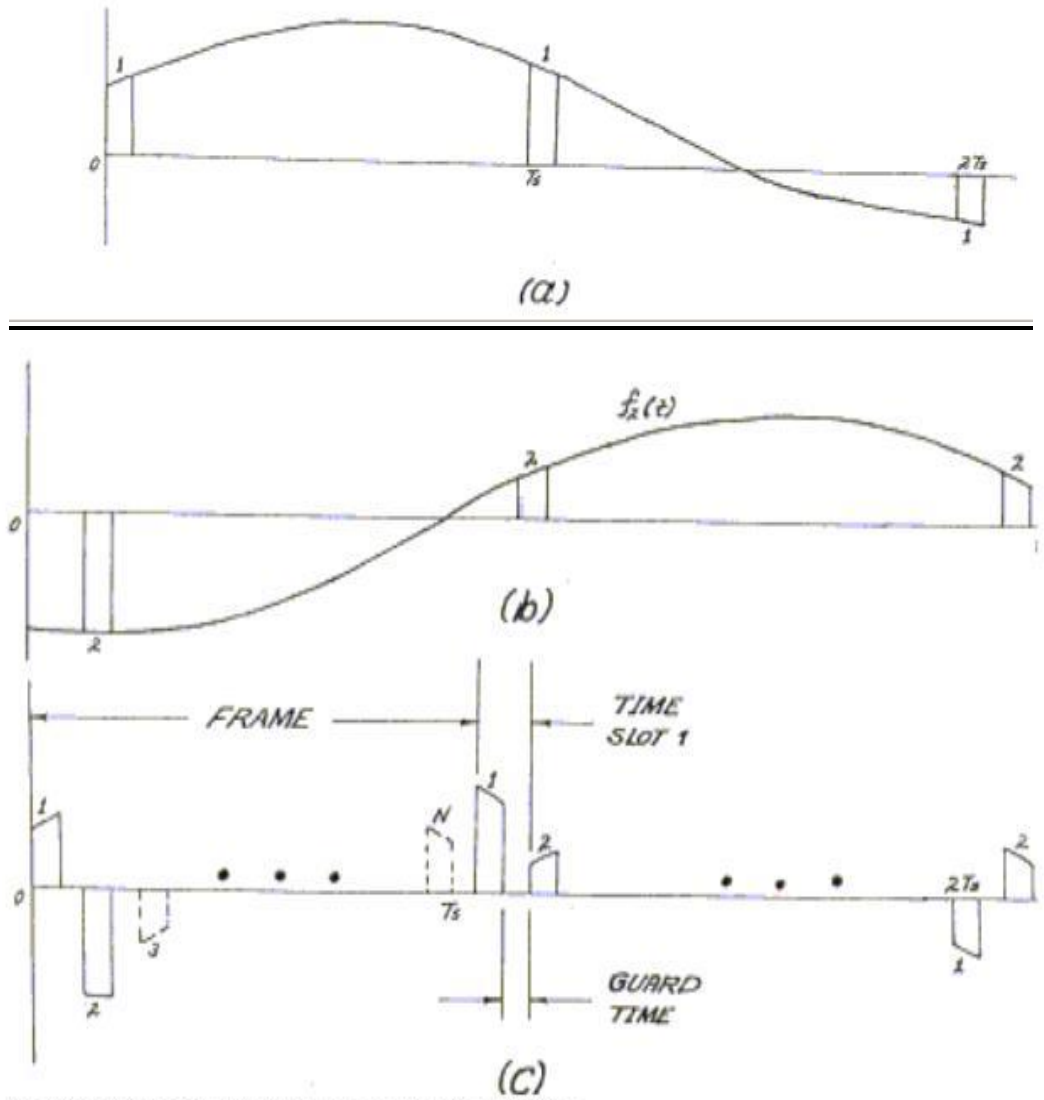


fig (2) TDM output should be natural sampling

Fig (a) message1 (b) message 2 and

Result:

Questions:

1. Draw the TDM signal with 2 signals being multiplexed over the channel?
2. Define guard time & frame time?
3. Explain block schematic of TDM?
4. How TDM differ from FDM?
5. What type of filter is used at receiver end in TDM system?
6. What are the applications of TDM?
7. If 2 signal band limited to 3 kHz, 5KHz & are to be time division multiplexed. What is the maximum permissible interval between 2 successive samples.?
8. Is the bandwidth requirement for TDM & FDM will be same?
9. Is TDM system is relatively immune to interference with in channels (inter channel cross talk) as compared to FDM?
10. Is the FDM susceptible to harmonic distortion compared to TDM?
11. In what aspects, TDM is superior to FDM?

EXPERIMENT NO-10

ASK MODULATION AND DEMODULATION

Aim:

To study the process of ASK modulation& demodulation and study various data formatting modulation and demodulation techniques.

Apparatus:

1. ASK MODULATION & DEMODULATION Trainer kit.
2. CRO 30MHz Dual Channel.
3. Patch Chords.

Theory:

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

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

ASK:-

In this modulation involves the variation of the amplitude of the carrier waves in accordance with the data stream. The simplest method of modulating a carrier with a data stream is to change the amplitude of the carrier wave every time the data changes. This modulation technique is known as amplitude shift keying.

The simplest way of achieving amplitude shift keying is 'ON' the carrier whenever the data bit is 'HIGH' & switching 'OFF' when the data bit is low i.e. the transmitter outputs the carrier for HIGH & totally suppresses the carrier for low. This technique is known as ON-OFF keying Fig. illustrates the amplitude shift keying for the given data stream.

Thus,

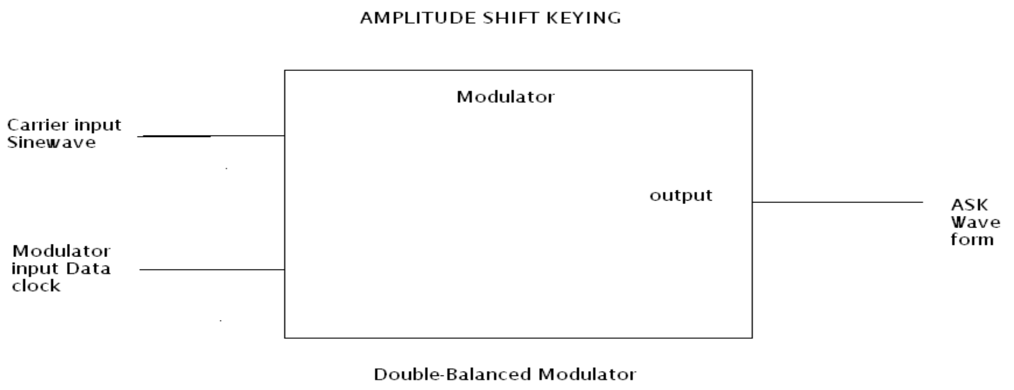
DATA = HIGH CARRIER TRANSMITTED

DATA = LOW CARRIER SUPPRESSED

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

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

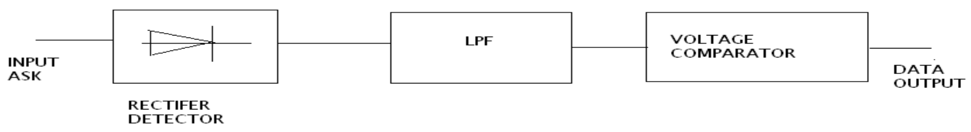
Block Diagram:



The data stream applied is uniploar i.e. 0Volt at logic LOW & +4.5Volts at logic HIGH. The output of balanced modulator is a sinewave, unchanged in phase when a data bit 'HIGH' is applied to it. In this case the carrier is multiplied with a positive constant voltage when the data bit LOW is applied, the carrier is multiplied by 0 Volts, giving rise to 0Volt signal at modulator's o/p.

The ASK modulation results in a great simplicity at the receiver. The method to demodulate the ASK waveform is to rectify it, pass it through the filter &'square up' the resulting waveform. The o/p is the original digital data stream. Fig. shows the functional blocks required in order to demodulate the ASK waveform at receiver.

ASK DEMODULATOR



Circuit Description:-

Carrier Generation:-

The function of the carrier is to generate a stable sine wave signal at the rest frequency, when no modulation is applied. It must be able to linearly change frequency when fully modulated, with no measurable change in amplitude.

Sine wave is generated by using the colpitts Oscillator. 500KHz and 1MHz frequencies are selected.

Modulation Generation:-

The square wave generated by 555 and is given to 74121. the o/p of this multivibrator is used as a clock i/p to a decade counter 7490. Which generators the modulating data outputs D1,D2, D3,D4.

Modulator:-

The ASK215 Modulator is based on U2(LM 1496). It is configured as a linear multiplier. At any movement of time the o/p of this U2(PIN 12) is proportional to the instantaneous product of the CARRIER INPUT and MODULATION INPUT saignals which serves as two inputs to this U2. The CARRIER INPUT can be monitored at TP7 & The MODULATION INPUT can be monitored at TP8.

The o/p voltage from U2 can be adjusted in amplitude by potentiometer P3(5K). it is now fed to the OP-AMP U3, LF 356 at its non-inverting terminal(pin 3). The op-amp configured as a simple non inverting amplifier with the gain of 2.47. the o/p(pin 6 is a/c coupled by capacitor C18 to appear at the o/p of OUTPUT socket.

DC bias can be added to both CARRIER INPUT signal & MODULATION INPUT signals by varying the pots P1&P2 respectively. This action takes place prior to signal multiplication. The DC bias from both the signals can be removed by careful setting of the two potentiometers.

Demodulation:-

The ASK demodulator comprises of

1) op-amp ICU6A configured as a unity gain, non inverting buffer, and
2) A simple half wave rectifier circuit, consisting diode D1 and resistor R72.
   The incoming ASK signal can be monitored at TP12. the signal at TP12 is then buffered by ICU6A & then rectified by half wave rectified CKT comprising of Diode D5 & resistor R72. This removes the negative half cycle of the wave form. The output of rectifier is available at OUTPUT socket of the demodulator & can be monitored at TP13. example waveforms are as shown in the timing diagram in Fig.

Low Pass Filters:-

The low pass filter block consists of two fourth-order butter worth low pass filter circuit. The filter is identical & i.e. is described in the section to follow.

The input signal to this block is first buffered by the op-amp ICU6B. The op-amp is simply configured as a noninvert in, unity-gain buffer. The buffer output(TP15) is then fed into data squaring circuit. The final o/p's of the filter can be monitored at TP15.

Data Squaring Circuits:-

The data squaring circuit 'square up' the input signal. It does this with the help of voltage comparator. The function of comparator circuit is identical & hence only one is described. The input is connected to the non-inverting(+ve) input(pin 5) of the voltage comparator ICU4A whose inverting (-ve) input(pin 4) is connected to a voltage divider network of resistors R61, R60 & variable Resistor P4 through resistor R59. the input impedance of the comparator circuit is set to 100k by resistor R58. A hystersis of 0.3V is set by resistor R59& R57. the slider voltage of can be adjusted from 2.2V to +2.2V.

The output of the comparator is 0V when the input at inverting terminal is more positive then the input at non inverting terminal.

Procedure:

Modulation:

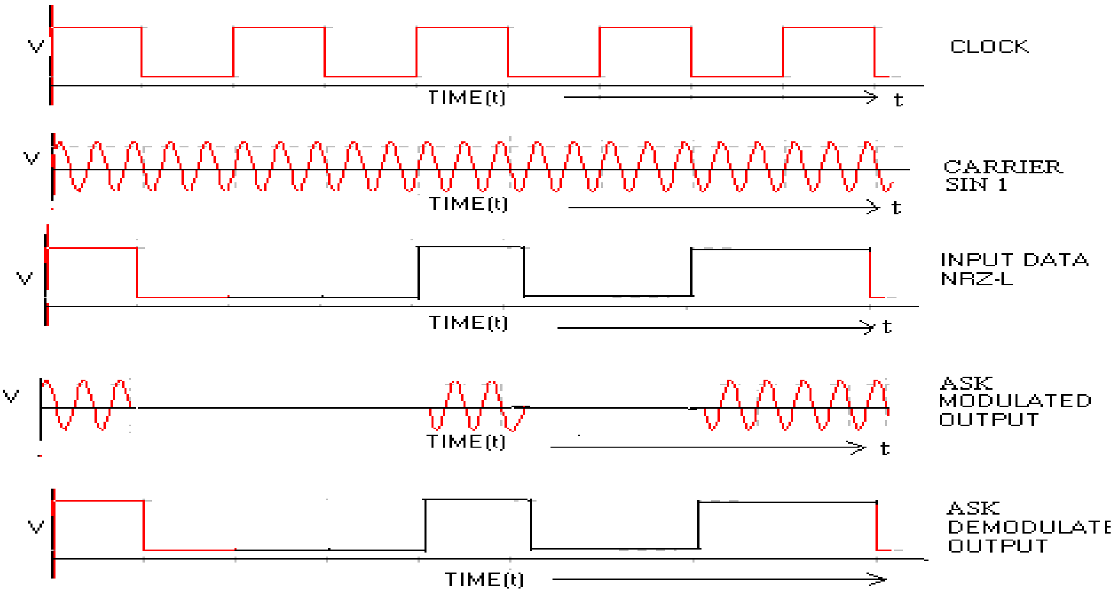
1. Connect the sinewave 500KHz from the carrier generator TP1 to the carrier input of the modulator TP7.

2. And also connect data clock D1 i.e., modulation signal TP3 to the modulation input TP8.
3.Switch ON the power supply.
4. Observe the output at TP9.
5. By varying the gain pot P3 observe the ASK output at TP10.
6. Adjusting the carrier offset and modulation offset we can observe the ASK output.
7. By changing the carrier signal 1MHz and different data clocks D2,D3,D4 observe the output.

Demodulation:

1. Connect ASK output TP10 to the rectifier input TP12 and observe the waveform.
2. Now connect rectifier output TP13 to the low pass filter input TP14 and observe the output at TP15.
3. CONNECT LPF output TP15 to the data squaring circuit input TP16 and observe the demodulation output waveform at TP17.
4.By changing the different data clocks and observe the demodulation output.

Expected Waveforms:



Result:

Questions:

1.If the bit rate of an ASK signal is 1200bps,what is the baud rate?

2.Is ASK highly susceptible?

3.What are the characteristics of transmission medium which effect speed of transmission in ASK?

4.Find the minimum band width for an ASK signal transmitting at 2000bps.The transmission made is half duplex?

5.If B.W is 5000Hz for an ASK signal, what are the baud rate?

6.What is the advantage of ON-OFF keying (   ) in ASK?

7.Given the bandwidth of 10KHz(1Hz to 1KHz), Find the band width for upper side & lower side band of carrier in full duplex ASK?

8.For the above problem, what are the carrier frequencies in upper & lower side bands?

EXPERIMENT NO-11

FREQUENCY SHIFT KEYING

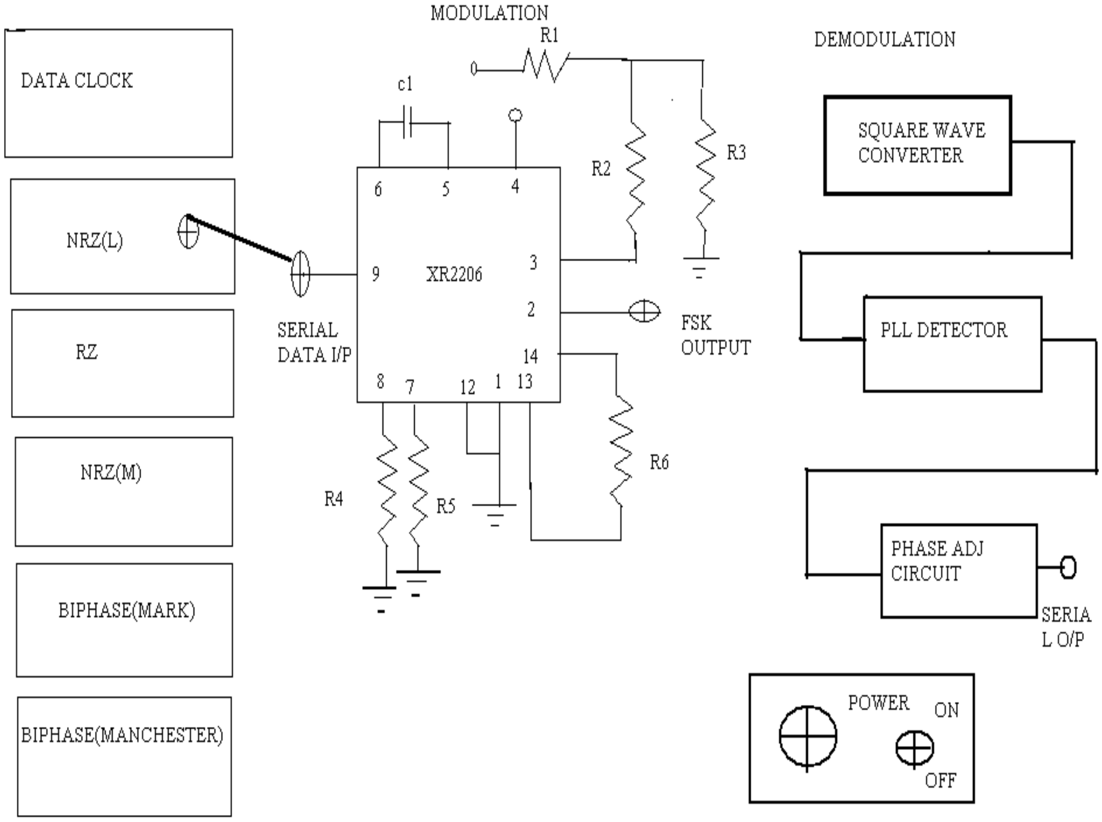
Aim:

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

Apparatus:

1.Frequency Shift Keying kit
2.C.R.O (30MHz)
3.Patch cords

Circuit Diagram:



Theory:

Binary FSK is a form of constant-amplitude angle modulation and the modulating signal is a binary pulse stream that varies between two discreate voltage levels but not continuous changing analog signal. In FSK, the carrier amplitude(Vc) remains constant with modulation and the carrier radian frequency(wc) shifts by an amount equal to +w/2. The frequency shift is proportional to the amplitude and polarity of the input binary signal. For example, a binary 1 could be +1 volt and a binary zero could be -1 volt producing frequency shifts of +delta(w)/2 and –delta(w)/2 respectively. The rate at which the carrier frequency shifts is equal to the rate of change of the binary input signal vm(t). thus the output carrier frequency deviates(shifts) between wc+delta(w)/2 and wc-delta(w)/2 at the rate equal to fm.

Data Formating:-

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

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

Non-return to zero(NRZ):-

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

Return to Zero(RZ):-

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

NRZ(M):-

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

Biphase(Mark):-

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

Biphase(Manchester):-

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

Circuit Description:-

Data clock Generator:-

The bit clock generator is design around the tim IC 555(U1) operated in astable mode. The 100Kohm preset P1 in conjunction with .0047microfarad capacitor in the timing circuit facilitates the frequency to be set and at any chosen value from 300Hz to 1KHz. This output is available at TP1.

Data Selection:-

The 8 bit parallel load serial shift IC 74165(U2) is used to generate the required word pattern. A dip switch is used to set ONE&ZERO pattern. The bit pattern set by the switch is parallely loaded by controlling the logic level at pin 1. The last stage output Q7 is coupled to the first stage input D0 in the shift register. The serial shift clock is given at pin 2. The 8 bit data set by the switch and loaded with the register parallely is now shifted serially right and circulated respectively. Thus the 8 bit word pattern is generated cyclically which is used as modulating signal in the FSK modulator. It is available at TP12.

Fsk Modulation:-

The XR-2206 can be operated with two separate timing resistors, R24 and R25, connected to the timing pin 7 and 8, respectively. Depending on the polarity of the logic signal at pin 9, either one or the other of these timing resistors is activated. If pin 9 is open-circuited or connected to a bias voltage>2V, only R24 is activated. Similarly, if the voltage level at pin 9 is<1v, only R25 is activated. Thus, the output frequency can be keyed between two levels. F1 and F2.

F1=1/R24C9 and f2=1/R25C9. In our circuit R24=3.9Kohm, R25=6.8Kohm, C9= 100nf.For split-supply operation, the keying voltage at pin 9 is referenced to V. the FSK output can be monitored at TP8.

Demodulation:-

Square Wave Converter:-

The incoming FSK modulated signal can be monitored at TP9.This signal is then attenuated by resistor network R43,R44 then AC coupled via capacitor C12 to remove any dc component in the signal. The signal is connected to SIGIN input of the U12. The signal is first squared up by an inbuilt comparator and is connected to one of the input of on chip2 input EX-OR gate. The other 5 input of the gate is connected to the COMPIN input of IC U12. The output is monitored at TP10.

PLL Detector:-

A very useful application of the 565 PLL is as a FSK demodulator. In the 565 PLL the frequency shift is usually accomplished by driving a VCO with the binary data signal so that the two resulting frequencies correspond to the logic 0 and logic 1 states of the binary data signal. The frequencies corresponding to logic 1 and logic 0 states are commonly called the mark and space frequencies. Capacitive coupling is used at the input to remove a dc level. As the signal appears at the input of the 565, the loop to the input frequency and tracks it between the two frequencies with a corresponding dc shift at the output. Preset p2 and capacitor C15 determine the free-running frequency of the VCO. A three-stage RC ladder filter is used to remove the carrier component from the output. The high cutoff frequency of the ladder filter is chosen to be approximately halfway between the max keying rate and twice the input frequency.This output signal can be made logic compatible by connecting voltage comparator(u11) between the output of ladder filter and pin 6 of PLL.

Phase Adjustment Circuit:-

U17,U18 used as phase adjustment circuit. The output of voltage comparator is fed yto pin 2 of U17 which is connected as monostable mode. And the output of U17 is again fed to U18. The output is available at pin 3 of U18 can be monitored at TP11. This is serial date of output.

Procedure:

Modulation:

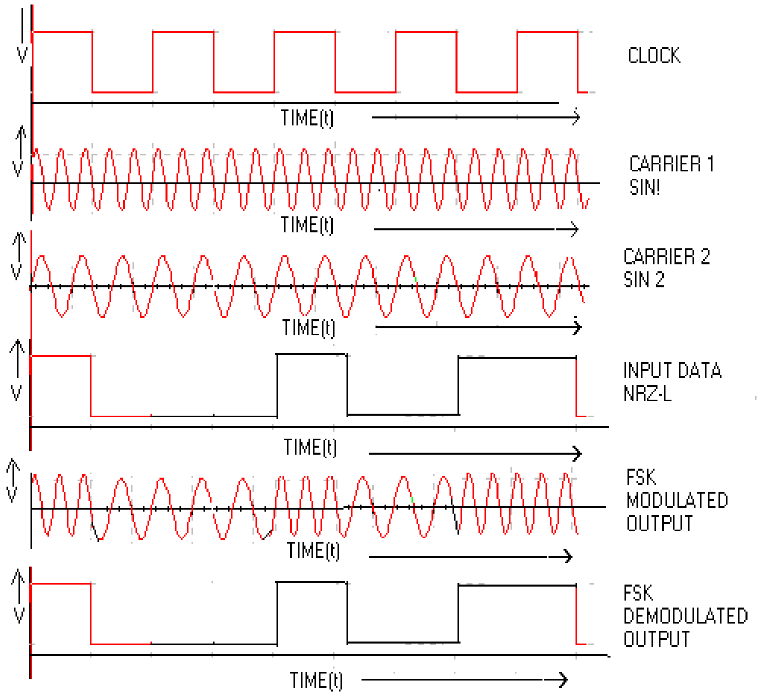
1. Switch ON the power supply.
2. Set the data selection switch ('DATA SELECTION') to the desired code(say 11001100).
3. Set the switch (DATA ON-OFF) ON position. Observe the 8 bit Word pattern at TP12.

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

Demodulation:

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

Expected Waveforms:



Result:

Questions:

1.Explain the concept of FSK?

2.Compare ASK, FSK & PSK?

3.Draw the waveforms of FSK?

4.What is M-ray signaling? What is its advantages over 2-ary signaling?

5.What are the different data coding formats & draw the waveforms what is advantages of Manchaster coding over other formats?

6.Explain the demodulation scheme of FSK?

7.What is the formula for Band Width required in FSK?

8.What is the minimum B.W for an FSK signal transmitting at 2000bps(haif duplex),if carriers are separated by 3KHz?

9.Is the FSK spectrum, a combination of two ASK spectra centered around two frequencies?

10.Is the FSK band width is more than ASK band width for a given band rate?

11.Is it more susceptible to noise than ASK?

12.What are the limiting factors of FSK?

13.Is the band rate & bit rate are same for FSK?

EXPERIMENT NO-12

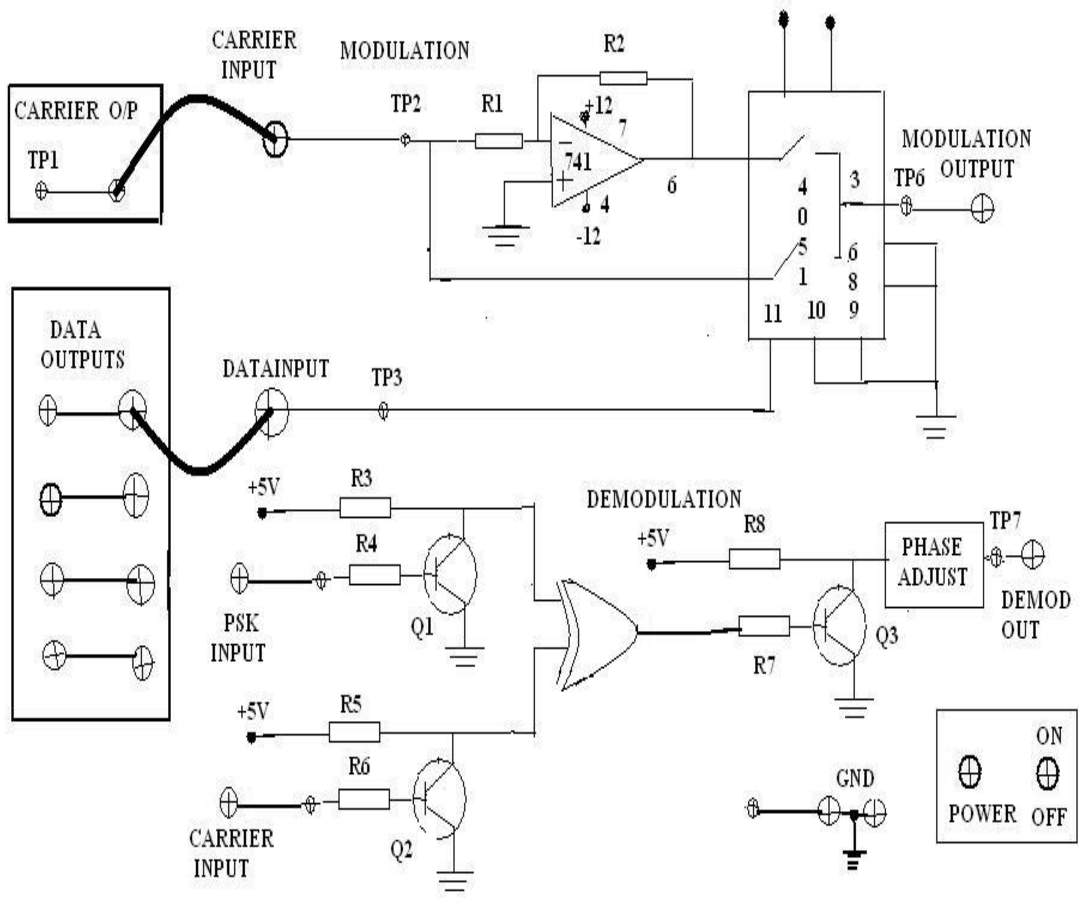
PHASE SHIFT KEYING

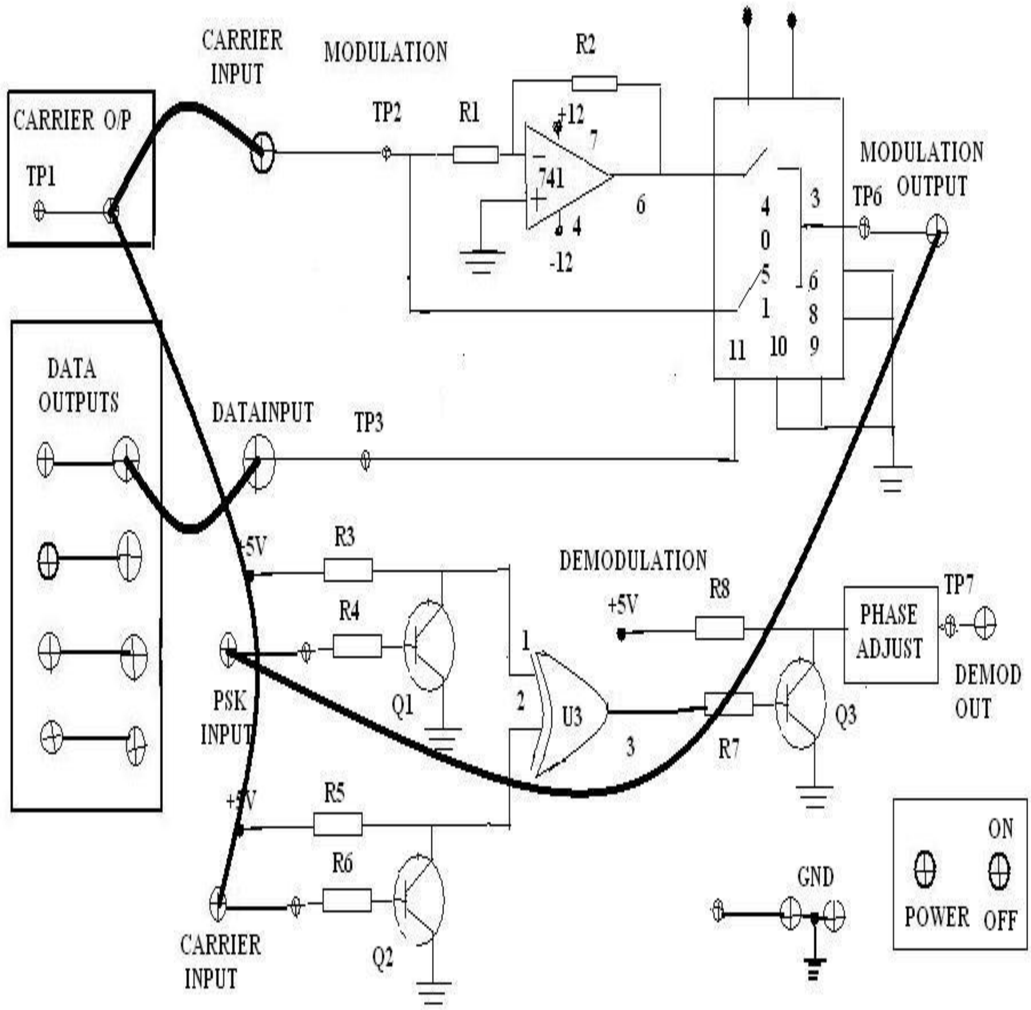
Aim: Study of carrier Modulation techniques by phase shift keying method.

Apparatus:

1. Psk Modulation And Demodulation Trainer.
2. 30MHz Dual Trace Oscilloscope.
3. Patch chords

Circuit Diagram:





Theory:

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

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

To able to transmit the data over antenna, we have to 'module' the signal i.e., phase, frequency or amplitude etc. is varied in accordance with the digital data. At receiver we separate the signal from digital information by the process of demodulation. After this process we are left with high frequency signal which we discard & the digital information, which we utilize.

Modulation also allows different data streams to be transmitted over the same channel.

This process is called as 'multiplexing' & result in a considerable saving in bandwidth no of channels to be used. Also it increases the channel efficiency.

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

Phase Shift Keying(PSK):

The PSK is a form of angle modulated, constant amplitude digital modulation. Digital communications because important with the expansion of the use of computers and data processing, and have continued to develop into a major industry providing the interconnection of computer peripherals and transmission of data between distant sites. Phase shift keying is a relatively new system, in which the carrier may be phase shifted by +90 degree for a mark, and by-90 degrees for a space. PSK has a number of similarities to FSK in may aspects, as in FSK, frequency of the carrier is shifted according to the modulating square wave.

Circuit Description:

In this IC 8038 is a basic wave form generator which generates sine, square, triangle waveforms. The sine wave generated by this 8038 IC is used as carrier signal to the system. This square wave is used as a clock input to a decade counter which generates the modulating data outputs.

The digital signal applied to the modulation input for PSK generation is bipolar i.e. have equal positive and negative voltage levels. When the modulating input is negative the output of modulator is a sine wave in phase with the carrier input. Where as for the positive voltage levels, the output of modulator is a sine wave which is shifted out of phase by 180 degree from the carrier input compared to the differential data stream. This happens because the carrier input is now multiplied by the negative constant level.

Thus the output changes in phase when a change in polarity of the modulating signal results. Fig shows the functional blocks of the PSK modulator & demodulator.

Modulation:-

IC CD 4051 is an analog multiplexer to which carrier is applied with and without 180 degree phase shift to the two multiplex inputs of the IC. Modulating data input is applied to its control input. Depending upon the level of the control signal, carrier signal applied with or without phase shift is steered to the output. the 180 degree phase shift to the carrier signal created by an operational amplifier using 741C.

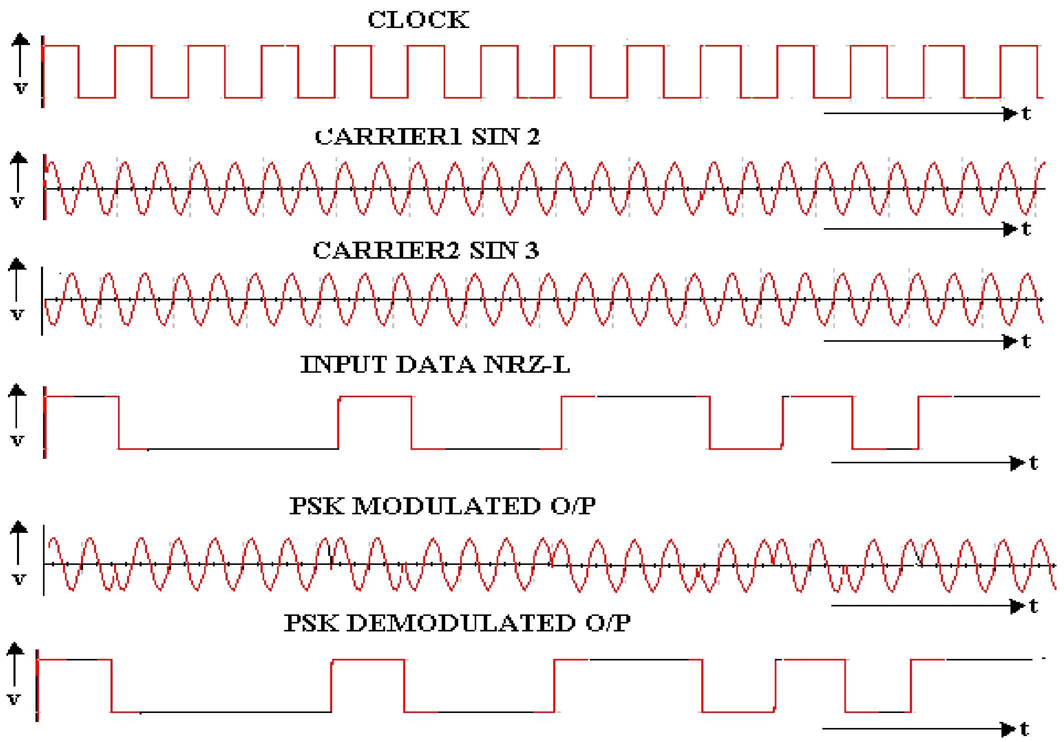
Demodulation:-

During the demodulation the PSK signal is converted into a +5volts square wave signal using a transistor and is applied to one input of an EX-OR gate. To the second input of the gate carrier signal is applied after conversion into a +5volts signal. So the EX-OR gate output is equivalent to the modulating data signal.

Procedure:

1. Now switch ON the trainer and see that the supply LED glows.
2. Observe the carrier output at TP1.
3. Observe the data outputs(D1,D2,D3,D4).
4. Now the connect the carrier output TP1 to the carrier input of PSK modulator TP2 using patch chord(as shown in dig 1).
5. Connect the d1 to data input of PSK modulator TP3(As shown.in dig 1).
6. Observe the phase shifted PSK output waveform on CRO on channel 1 and corresponding data output on channel 2.
7. Repeat the steps 4,5,6 for data outputs D2,D3,D4 and observe the PSK outputs.
8. connect the PSK modulation output TP6 to the PSK input of demodulation TP4(as shown in dig 2).
9. connect the carrier output TP1 to the carrier input of PSK demodulation TP5.(As shown in dig 2).
10. Now, observe the PSK demodulated output at TP7 on CRO at channel 1 and corresponding data output on channel 2.
11. the demodulated output is true replica of data output.
12. Repeat the steps 8 to 10 for other data outputs D2,D3,D4.

Expected Waveforms:



Result:

Questions:

1. Explain the concept of PSK?
2. Compare ASK, FSK, PSK?
3. Draw the waveforms of PSK?
4. What is M-ary signaling? What are its advantages over 2-ary signaling?
5. Explain the demodulation scheme of PSK?.
6. What is the advantage of PSK over ASK, FSK?
7. Will the smaller variations in the signal can be detected reliably by PSK?
8. Can we transmit data twice as for using 4-PSK as we can using 2-PSK?
9. What is the minimum B.W required in PSK?
10. Is the B.W in PSK is same as in ASK?
11. Is the maximum bit rate in PSK is greater than ASK?

EXPERIMENT NO-13

DIFFERENTIAL PHASE SHIFT KEYING

Aim: To study operation Differential Phase shift Keying modulation & demodulation Techniques.

Apparatus:

1. DPSK MODULATION & DEMODULATION Trainer.
2. Oscilloscope 30MHz, Dual Channel
3. Path chords.

Block Diagram:

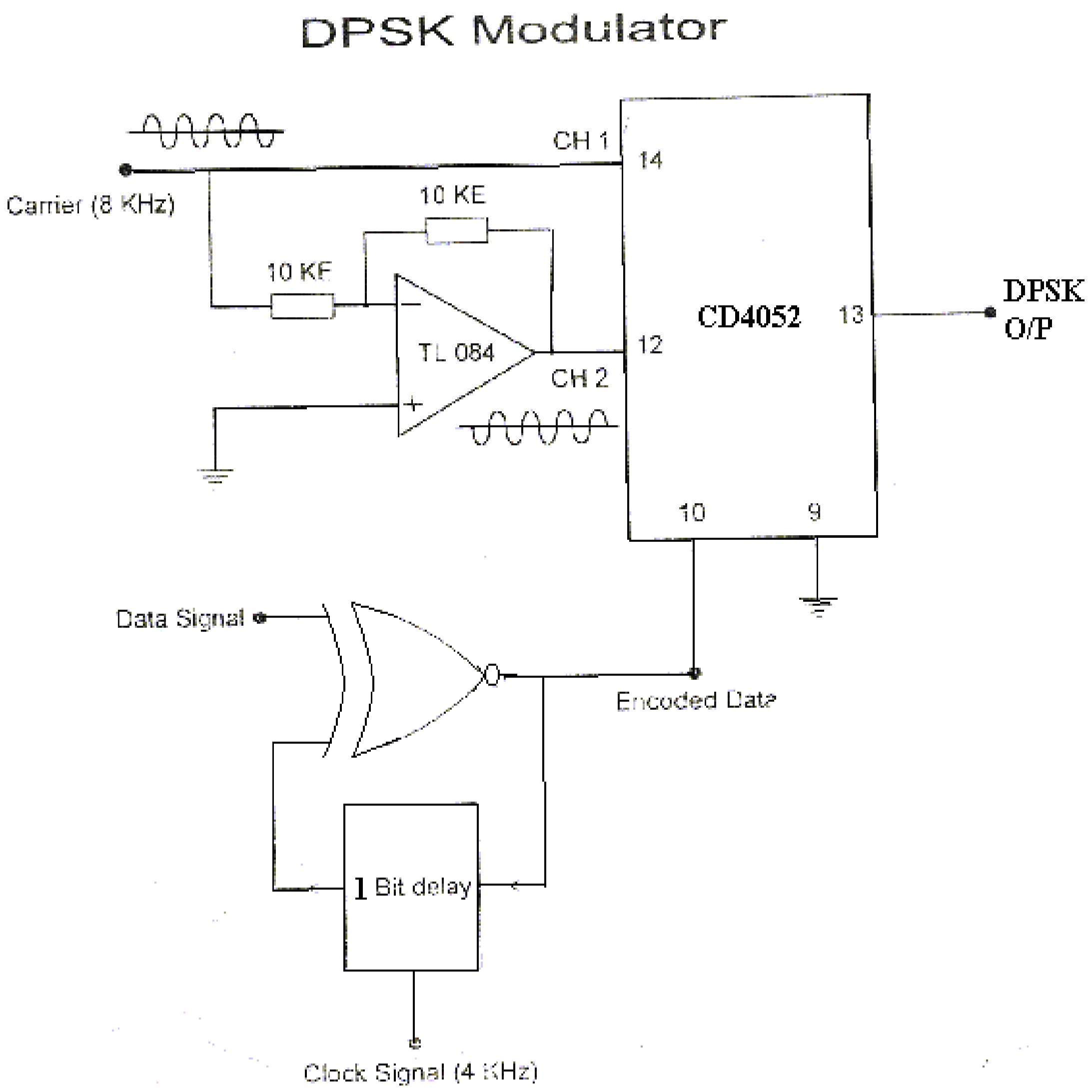
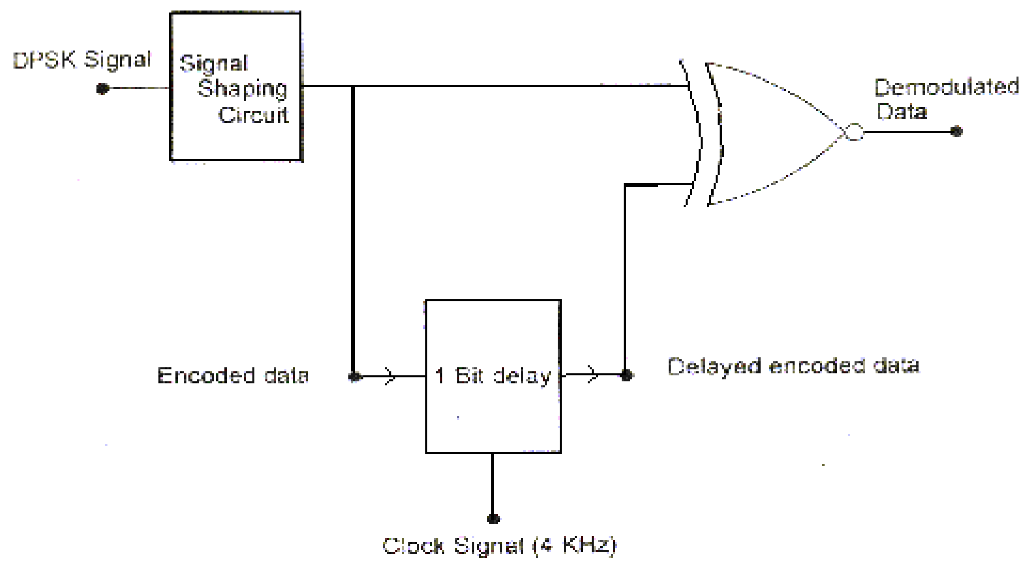


fig (1.1)

DPSK Demodulator



Theory:

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

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

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

Modulation also allows different data streams to be transmitted over the same channel(transmission medium).

This process is called as 'Multeplexing' & result in a considerable saving in bandwidth no of channels to be used. Also it increases the channel efficiency.

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

Differential Phase-Shift Keying(DPSK):-

The DPSK is a non-coherent version of PSK. In coherent detection, the carrier wave's phase reference should be known for obtaining optimum error performance.(However it is impractical to have knowledge of the carrier phase at the receiver).

The DPSK eliminates the need for a coherent reference signal at the receiver by combining two basic operations at the transmitter:

1.Differential Encoding of the input binary wave
2.Phase-shift keying

And hence the name differential phase shift keying. Thus to send symbol 0,we phase advance the current signal waveform by 180 degrees and to send 1, we have the phase of the current signal waveform unchanged. The receiver is equipped with a storage capability so that it can measure the relative phase difference between the wave forms received during two successive bit intervals. Provided that the unknown phase θ contained in the received wave varies slowly (slow enough and considered essentially constant over two bit intervals), the phase difference between waveforms received in two successive bit intervals will be independent of θ.

Circuit Description:-

In this IC 8038 is a basic wave form generator which generates since,square,triangle waveforms. The sine wave generated by this 8038 IC is used as carrier signal to the system. This square wave is used as a clock input to a decade counter which generates the modulating data outputs.

The digital signal applied to the modulation input for DPSK generation is bipolar i.e. have equal positive and negative voltage levels. When the modulating input is negative the output of modulator is a sinewave in phase with the carrier input. Where as for the positive voltage levels,the output of modulator is a sinewave which is shifted out of phase by 180 degrees from the carrier input compared to the differential data stream. This happens because the carrier input is now multiplied by the negative constant level.

Thus the output changes in phase when a change in polarity of the modulating signal results. Fig shows the functional blocks of the DPSK modulator &demodulator.

Modulation:-

The differential signal to the modulating signal is generated using an X-OR gate and 1-bit delay circuit(it is shown in fig).CD 4051 is an analog multiplexer to which carrier is applied with and without 180 degrees phase shift(created by using an operational amplifier connected in inverting amplifier mode) to the two inputs of the ICTL084.Differential signal generated by X-OR gate is given to the multiplexer's control signal input. depending upon the level of the control signal,carrier signal applied with or without phase shift is steered to the output. 1-bit delay generation of differential signal to the input is created by using a D-flip-flop(IC7474).

Demodulation:-

During the demodulation, the DPSK signal is converted into a +5V square wave signal using a transistor and is applied to one input of an X-OR gate. to the second input of the gate, carrier signal is applied after conversion into a +5V signal. So the X-OR gate output is equivalent to the differential signal of the modulating data. This differential data is applied to one input of an X-OR gate and to the second input, after 1-bit delay the same signal is given. So the output of this X-OR gate is modulating signal.

Output Waveforms:-

To see the DPSK demodulation process, examine the input of DPSK demodulator with the demodulation output.

Check the various test points provided at the output of the functional blocks of the DPSK demodulator. This will help you fully grasp the DPSK demodulation technique.

Figure 1.4:

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

Figure 1.5 Example for Complete DPSK operation (with arbitary bit as 0):

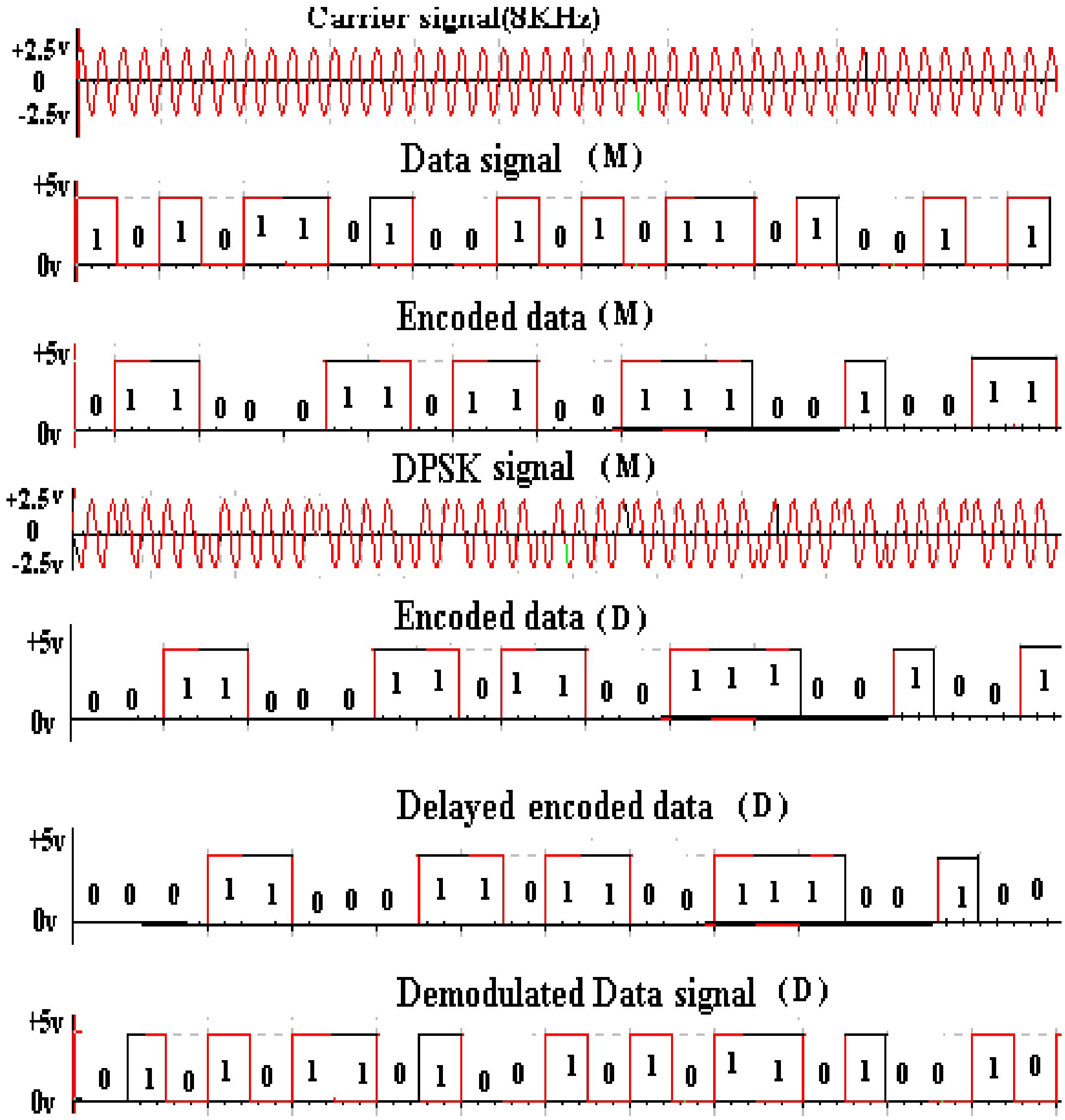
Message signal(to be transmitted)	0	1	1	0	0	
Encoded data(differential data)	0	1	1	1	0	1
Trasnmitted signal phase:	180^0	0^0	0^0	0^0	180^0	0^0
Received signal phase :	180^0	0^0	0^0	0^0	180^0	0^0
Encoded data(differential data)		0	1	1	1	0
Message signal (Demodulation)		0	1	1	0	0

Procedure:

1. Now switch ON the trainer and see that the supply LED glows.
2. Connect data output from 4(D1,D2,D3,D4) data outputs to the data input of the DPSK modulator TP7.
3. Connect clock output TP1 to the clock input of the DPSK modulator TP8.
4. Now connect carrier output TP2 to the carrier input of the DPSK modulator TP10.
5. Observe the differential data output on the CRO at TP9 test point as shown on the front panel.
6. Observe the phase shifted DPSK output waveform on the CRO corresponding to the differential data output.
7. Connect DPSK MODULATOR output TP11 to the DPSK input of the DEMODULATOR TP12.
8. Connect carrier output TP2 to the carrier input of the DPSK Demodulator TP13.
9. Also connect clock output TP1 to the clock input of the DPSK demodulator TP14.
10. Now observe the DPSK demodulated output waveform TP15 on the CRO.

Expected Waveforms:

Fig 1:3 DPSK Wave forms



RESULT:

Questions:

1.How does DPSK differ from PSK?

2.Explain theoretical modulation & demodulation of DPSK using arbitrary bit sequence and assuming initial bit 0 and 1?

3.What is the advantage of DPSK over PSK?

4.Why do we need 1 bit delay in DPSK modulator & demodulator?

5.What does a synchronous detector (multiplier) do in DPSK demodulator?

6.what is the relation between carrier frequency & the bit interval 'T'?

7.What is the disadvantages of DPSK.?

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

9.What is the expression for DPSK error?

10.What are the applications of DPSK?

EXPERIMENT NO-14

PULSE CODE MODULATION & DEMODULATION

Aim: To convert an analog signal into a pulse digital signal using PCM system and to convert the digital signal into analog signal using PCM demodulation system.

Apparatus:

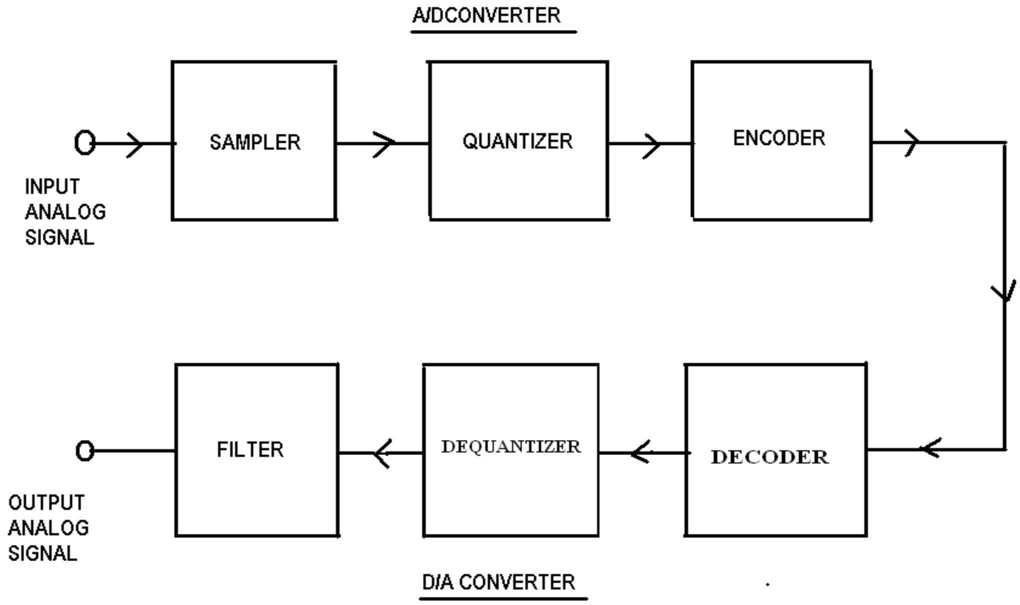
1. PCM transmitter trainer.
2. PCM receiver trainer.
3. CRO and connecting wires.

Theory:

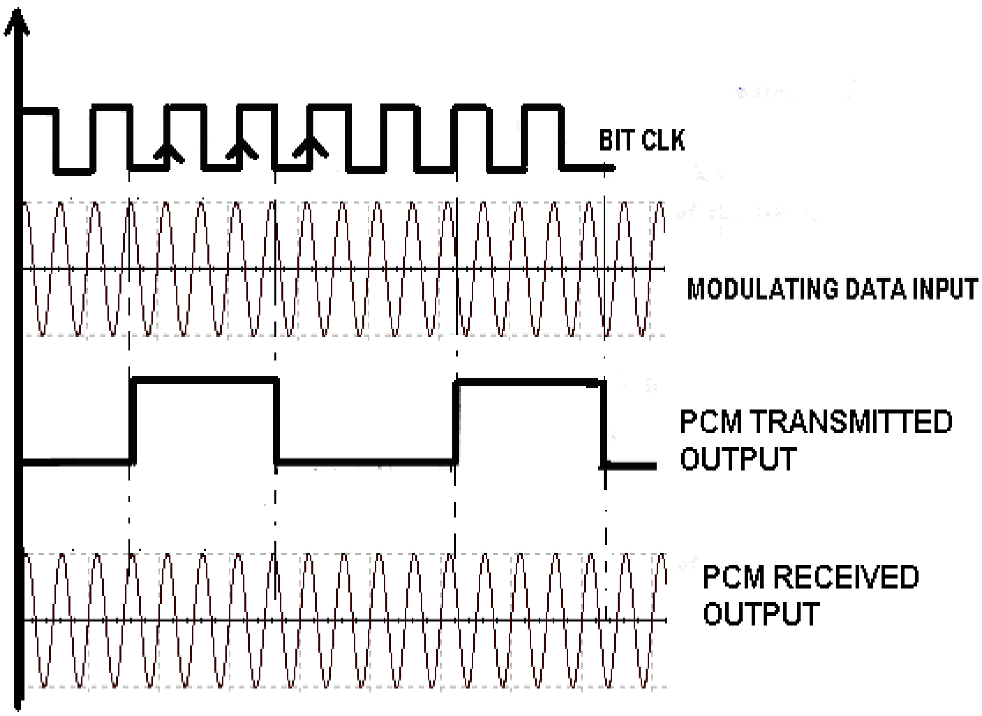
In the PCM communication system, the input analog signal is sampled and these samples are subjected to the operation of quantization. The quantized samples are applied to an encoder. The encoder responds to each such a sample by generation unique and identifiable binary pulse. The combination of quantize and encoder is called analog to digital converter. It accepts analog signal and replaces it with a successive code symbol, each symbol consists of a train of pulses in which the each pulse represents a digit in arithmetic system.

When this digitally encoded signal arrives at the receiver, the first operation to be performed is separation of noise which has been added during transmission along the channel. It is possible because of quantization of the signal for each pulse interval; it has to determine which of many possible values has been received.

Block Diagram:



Output Waveform:



Procedure:

1. The two inputs of function generator are connected to channel -0 and channel-1 simultaneously that is DC_1 output to channel -0 and DC_2 to channel-1.
2. With the help of oscillator DC_1 output is adjusted to 0 volts.
3. Transmitter and receiver are connected by the synchronization of clock pulses and by connecting ground transmitter to ground receiver.
4. The transmitter is connected to the input of receiver to go the original signal at the receiver output.
5. After connection is made the inputs channel 1 and channel 0 are noted. The sampled output of bit channels are taken by connecting DC_1 output to channel 0 and DC_2 output to channel-1.
6. The phase shift of a channel can be obtained by comparing the input and output of channels at the transmitter block.
7. Thus the output of transmitter can be noted down and input of receiver is similar to that.
8. The receiver output signals are noted down at channel 0 and channel 1 of the receiver block.

Result:

Questions:

1. What is the expression for transmission bandwidth in a PCM system?
2. What is the expression for quantization noise /error in PCM system?
3. What are the applications of PCM?
4. What are the advantages of the PCM?
5. What are the disadvantages of PCM?

EXPERIMENT NO-15

DIFFERENTIAL PULSE CODE MODULATION

Aim:

To study the differential pulse code modulation and demodulation by sending variable frequency sine wave and variable DC signal outputs.

Apparatus:

1. DPCM Trainer kit
2. Patch cards
3. CRO- (0-20MHz)
4. AC Adapter (± 8V)
5. CRO Probes.

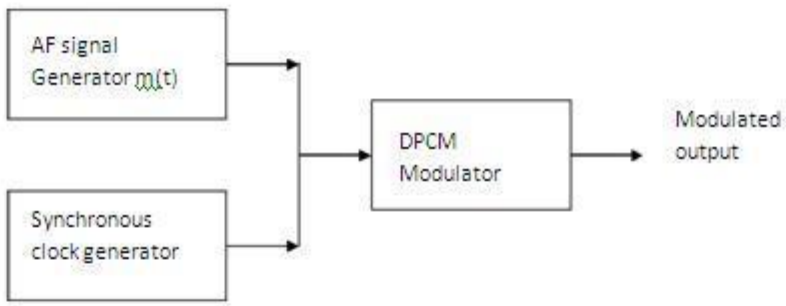
Theory:

In Differential Pulse Code Modulation (DPCM), instead of quantizing each sample, the difference between the two successive samples is quantized, encode, and transmitted as in the PCM. This particularly useful in the Voice communication, because in this case two successive samples do not differ much in amplitude.

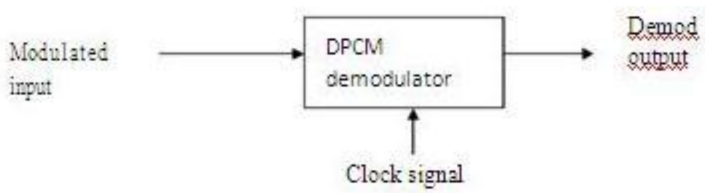
Thus, the difference signal is much less in amplitude than the actual sample and, hence, less number of quantization levels is needed. Therefore, the number of bits per code is reduced, resulting in a reduced bit rate. Thus, the band width required in this case is less than the one required in PCM.

The disadvantage of DPCM is that the modulator and demodulator circuits are more complicated than those in PCM.

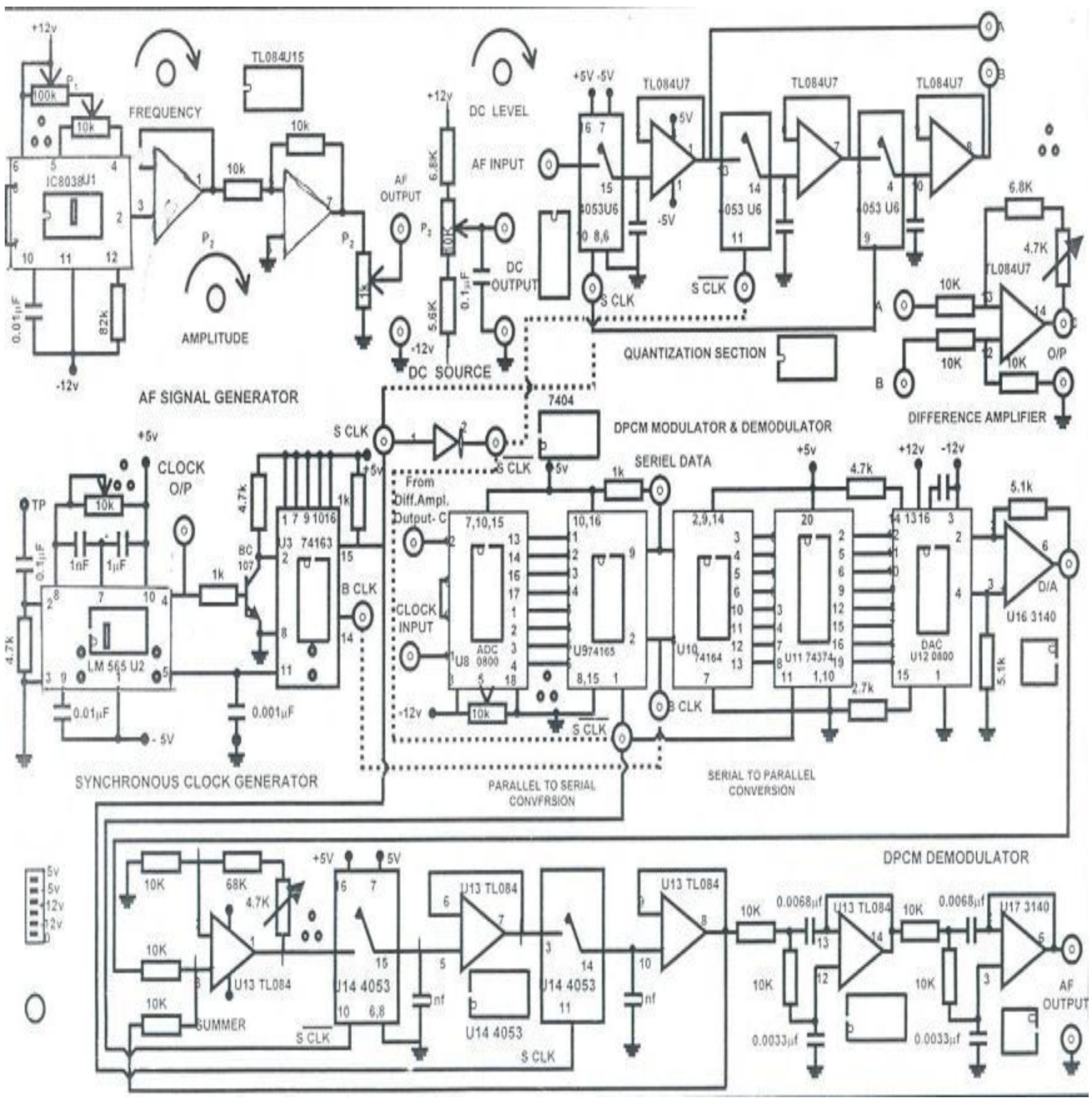
DPCM MODULATOR



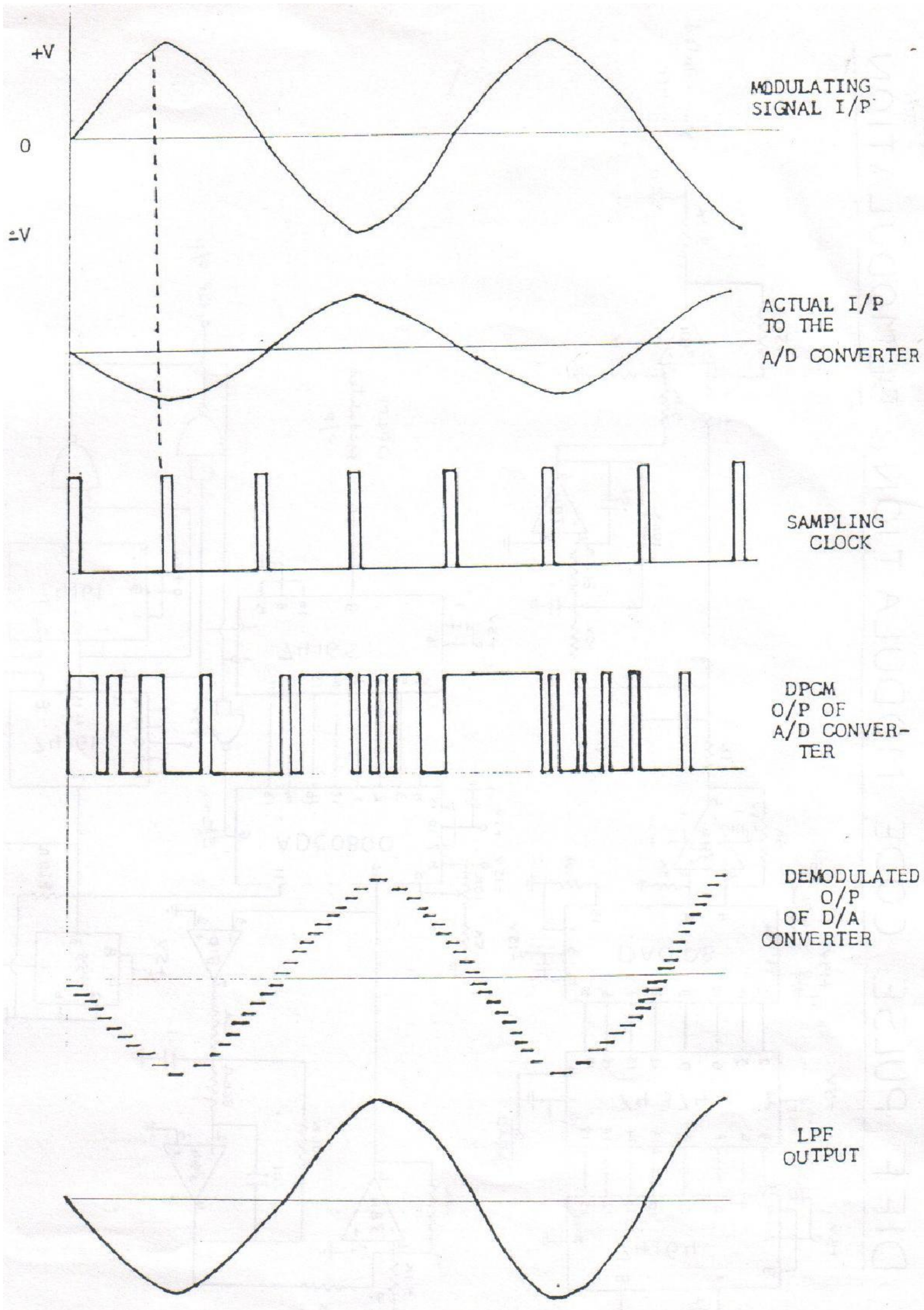
DPCM DEMODULATOR



Circuit Diagram:



Model Waveforms:



Procedure:

1. Switch on the Kit.
2. Apply the variable DC signal to the input terminals of DPCM modulator.
3. Observe the sampling signal output on CRO
4. Observe the output of DPCM on the second channel of CRO
5. By adjusting the DC voltage potentiometer we can get the DPCM output from 0000 0000 to 1111 1111.
6. Now, disconnect the DC voltage and apply AF oscillator output to the input of the DPCM modulator
7. observe the output of conditioning amplifier (differential output) and DPCM outputs in synchronization with the sampling signal.
8. During demodulation, connect DPCM output to the input of demodulation and observe the output of Demodulator

Observations:

1. Amplitude of AF signal = ----------------
2. Frequency of AF signal = ---------------
3. Amplitude of Synchronous clock signal = ---------------
4. Frequency of Synchronous clock signal = ---------------
5. Amplitude of DPCM Modulated signal = ---------------
6. Frequency of DPCM Modulated signal = ---------------
7. Amplitude of demodulated output = ---------------
8. Frequency of demodulated output = ----------------

Result:

EXPERIMENT NO-16

DELTA MODULATION & DEMODULATION

Aim:

To study the Delta modulation process by comparing the present signal with the previous signal of the given modulating signal.

Apparatus:

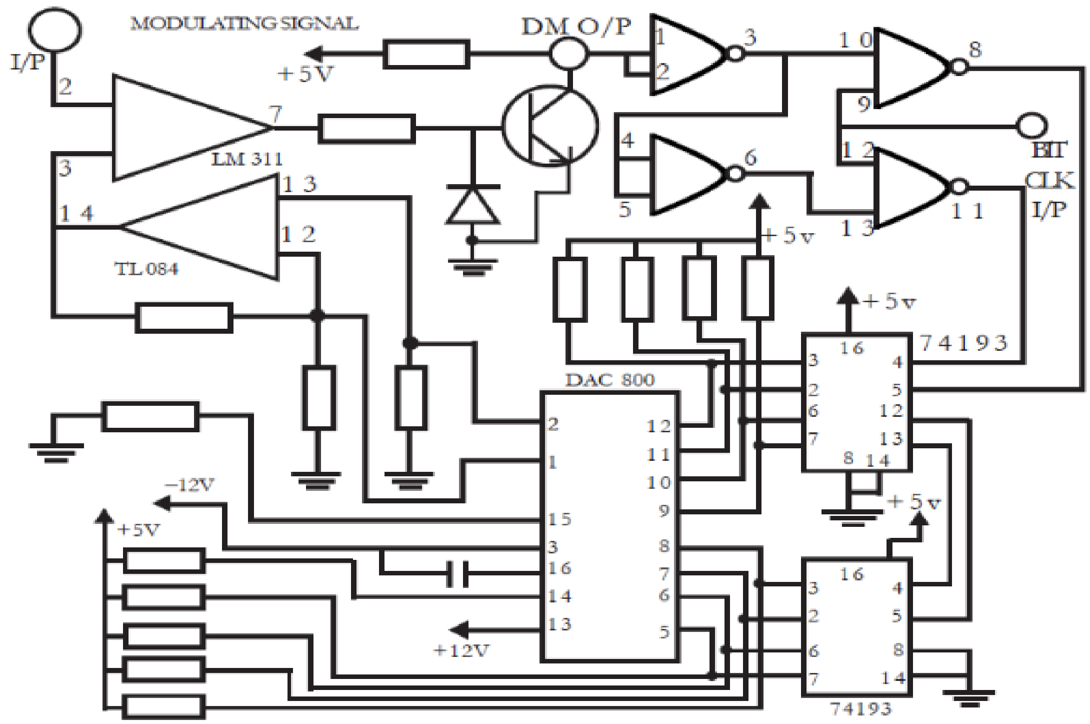
1. Delta Modulation trainer
2. CRO
3. Connecting wires.

Theory:

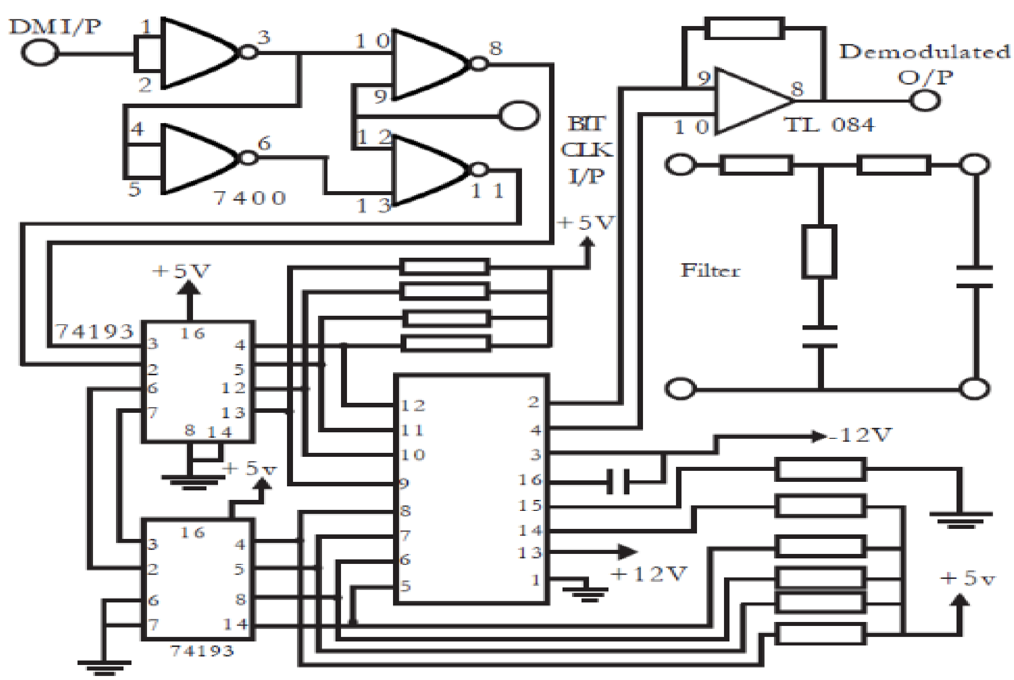
DM uses a single bit PCM code to achieve to achieve digital transmission of analog signal. With conventional PCM each code is binary representation of both sign and magnitude of a particular sample. With DM, rather than transmitting a coded representation of a sample a single bit is transmitted, which indicates whether the sample is smaller or larger than the previous sample.The algorithm for a delta modulation system is a simple one. If the current sample is smaller than the previous sample then logic 0 is transmitted or logic 1 is transmitted if the current sample is larger than the previous sample.The input analog is sampled and converted to a PAM signal followed by comparing it with the output of the DAC.The output of the DAC is equal to the regenerated magnitude of the previous sample which was stored in the up/down counter as a binary number.The up/down counter is incremented or decremented whether the previous sample is larger or smaller than the current sample.The up/down counter is clocked at a rate equal to the sample rate. So, the up/down counter is updated after each comparison.

Circuit Diagram:-

Modulator:-



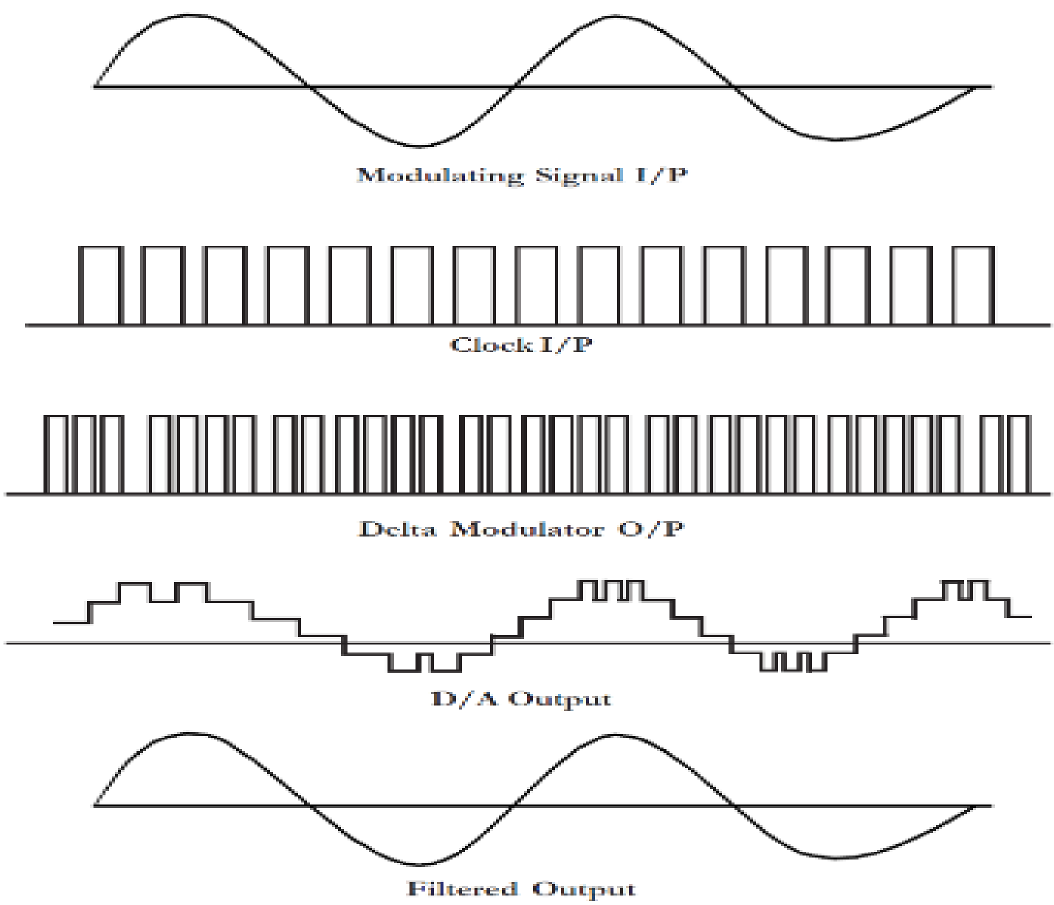
Demodulator:-



Procedure:

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

Expected Waveforms:



Result:

Questions:

1.What is Delta Modulation?

2.Differentiate DM and ADM.

3.What are the drawbacks of DM and what is the remedy?

4.How DM differ from PCM?

5.What is slope overload distortion?