

**DEPARTMENT OF
ELECTRONICS & COMMUNICATION ENGINEERING**

**LABORATORY MANUAL
FOR**

MICROWAVE & DIGITAL COMMUNICATIONS LAB
IV B.Tech. ECE - I - Sem



BALAJI INSTITUTE OF TECHNOLOGY & SCIENCE
Laknepally, Narsampet, Warangal

MICRO WAVE ENGINEERING AND DIGITAL COMMUNICATIONS LAB

Experiments to be conducted

Note: Minimum 12 Experiments to be conducted

PART-A: MICROWAVE ENGINEERING LAB (ANY 6 Experiments)

1. Reflex Klystron Characteristics.
2. Gunn Diode Characteristics.
3. Directional Coupler Characteristics.
4. VSWR Measurement.
5. Measurement of Waveguide Parameter.
6. Measurement of Impedance of a given Load.
7. Measurement of Scattering parameter of a Magic Tee.
8. Measurement of scattering parameters of a Circulators.
9. Attenuation Measurement.
10. Microwave Frequency Measurement.

Part-B: DIGITAL COMMUNICATION LAB (Any 6 Experiments)

1. PCM Generation and Detection.
2. Differential Pulse Code Modulation.
3. Delta Modulation.
4. Time Division Multiplexing of 2 Band limited signals.
5. Frequency shift keying : Generation and Detection.
6. Phase shift Keying: Generation and Detection.
7. Amplitude shift Keying: Generation and Detection.
8. Study of the spectral characteristics of PAM,QAM.
9. DPSK: Generation and Detection.
10. QPSK: Generation and Detection.

PART-A: MICROWAVE ENGINEERING LAB

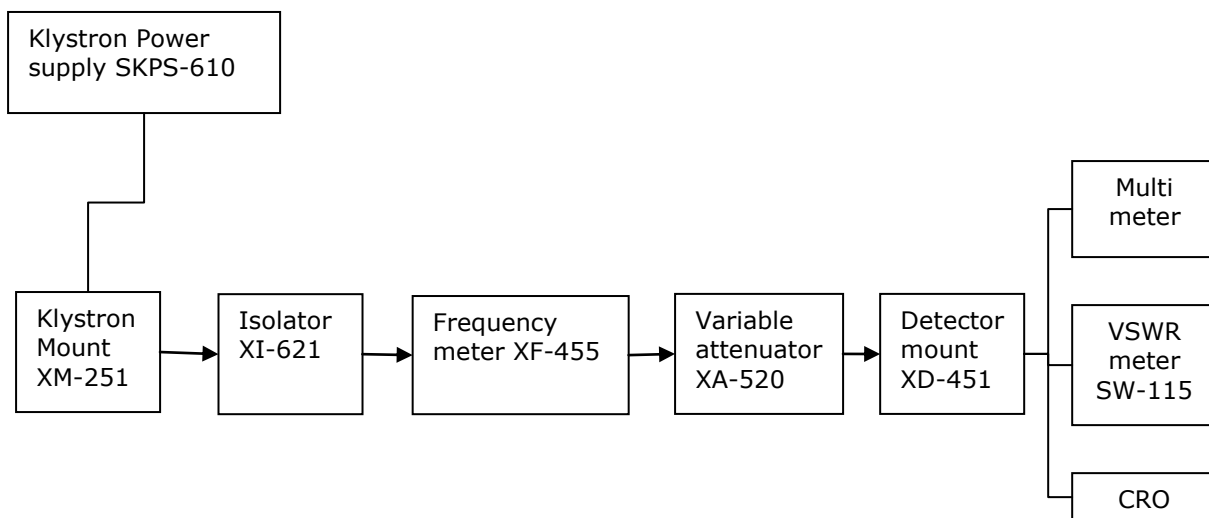
1. REFLEX KLYSTRON CHARACTERISTICS

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

EQUIPMENT REQUIRED:

1. Klystron power supply – {SKPS – 610 }
2. Klystron tube 2k-25 with klystron mount – {XM-251}
3. Isolator {X₁-625}
4. Frequency meter {XF-710}
5. Detector mount {XD-451}
6. Variable Attenuator {XA-520}
7. Wave guide stand {XU-535}
8. VSWR meter {SW-215}
9. Oscilloscope
10. BNC Cable

Block Diagram:



THEORY: The reflex klystron is a single cavity variable frequency microwave generator of low power and low efficiency. This is most widely used in applications where variable frequency is desired as

1. In radar receivers
2. Local oscillator in μ w receivers
3. Signal source in micro wave generator of variable frequency
4. Portable micro wave links.
5. Pump oscillator in parametric amplifier

Voltage Characteristics: Oscillations can be obtained only for specific combinations of anode and repeller voltages that gives favorable transit time.

Power Output Characteristics: The mode curves and frequency characteristics. The frequency of resonance of the cavity decides the frequency of oscillation. A variation in repeller voltages slightly changes the frequency.

EXPERIMENTAL PROCEDURE:

A. CARRIER WAVE OPERATION:

1. Connect the equipments and components as shown in the figure.
2. Set the variable attenuator at maximum Position.
3. Set the MOD switch of Klystron Power Supply at CW position, beam voltage control knob to fully anti clock wise and reflector voltage control knob to fully clock wise and meter switch to 'OFF' position.
4. Rotate the Knob of frequency meter at one side fully.
5. Connect the DC microampere meter with detector.
6. Switch "ON" the Klystron power supply, CRO and cooling fan.
7. Put the meter switch to beam voltage position and rotate the beam voltage knob clockwise slowly up to 300 volts and observe the beam current position. The beam current should not increase more than 30 mA.
8. Change the reflector voltage slowly and watch the current meter, set the maximum voltage on CRO. If no deflection is obtained, change the multimeter knob position to μA .
9. Tune the plunger of klystron mount for the maximum output.
10. Rotate the knob of frequency meter slowly and stop at that position, where there is lowest output current on multimeter. Read directly the frequency meter between two horizontal line and vertical marker. If micrometer type frequency meter is used read the micrometer reading and find the frequency from it's frequency chart.
11. Change the reflector voltage and read the current and frequency for each reflector voltage.

B. SQUARE WAVE OPERATION:

1. Connect the equipments and components as shown in figure
2. Set Micrometer of variable attenuator around some Position.
3. Set the range switch of VSWR meter at 40 db position, input selector switch to crystal impedance position, meter switch to narrow position.
4. Set Mod-selector switch to AM-MOD position .beam voltage control knob to fully anti clockwise position.
5. Switch "ON" the klystron power Supply, VSWR meter, CRO and cooling fan.

6. Switch “ON” the beam voltage. Switch and rotate the beam voltage knob clockwise up to 300V in meter.
7. Keep the AM – MOD amplitude knob and AM – FREQ knob at the mid position.
8. Rotate the reflector voltage knob to get deflection in VSWR meter or square wave on CRO.
9. Rotate the AM – MOD amplitude knob to get the maximum output in VSWR meter or CRO.
10. Maximize the deflection with frequency knob to get the maximum output in VSWR meter or CRO.
11. If necessary, change the range switch of VSWR meter 30dB to 50dB if the deflection in VSWR meter is out of scale or less than normal scale respectively. Further the output can be also reduced by variable attenuator for setting the output for any particular position.

C. MODE STUDY ON OSCILLOSCOPE:

1. Set up the components and equipments as shown in Fig.
2. Keep position of variable attenuator at min attenuation position.
3. Set mode selector switch to FM-MOD position FM amplitude and FM frequency knob at mid position keep beam voltage knob to fully anti clock wise and reflector voltage knob to fully clockwise position and beam switch to ‘OFF’ position.
4. Keep the time/division scale of oscilloscope around 100 HZ frequency measurement and volt/div. to lower scale.
5. Switch ‘ON’ the klystron power supply and oscilloscope.
6. Change the meter switch of klystron power supply to Beam voltage position and set beam voltage to 300V by beam voltage control knob.
7. Keep amplitude knob of FM modulator to max. Position and rotate the reflector voltage anti clock wise to get the modes as shown in figure on the oscilloscope. The horizontal axis represents reflector voltage axis and vertical represents o/p power.
8. By changing the reflector voltage and amplitude of FM modulation in any mode of klystron tube can be seen on oscilloscope.

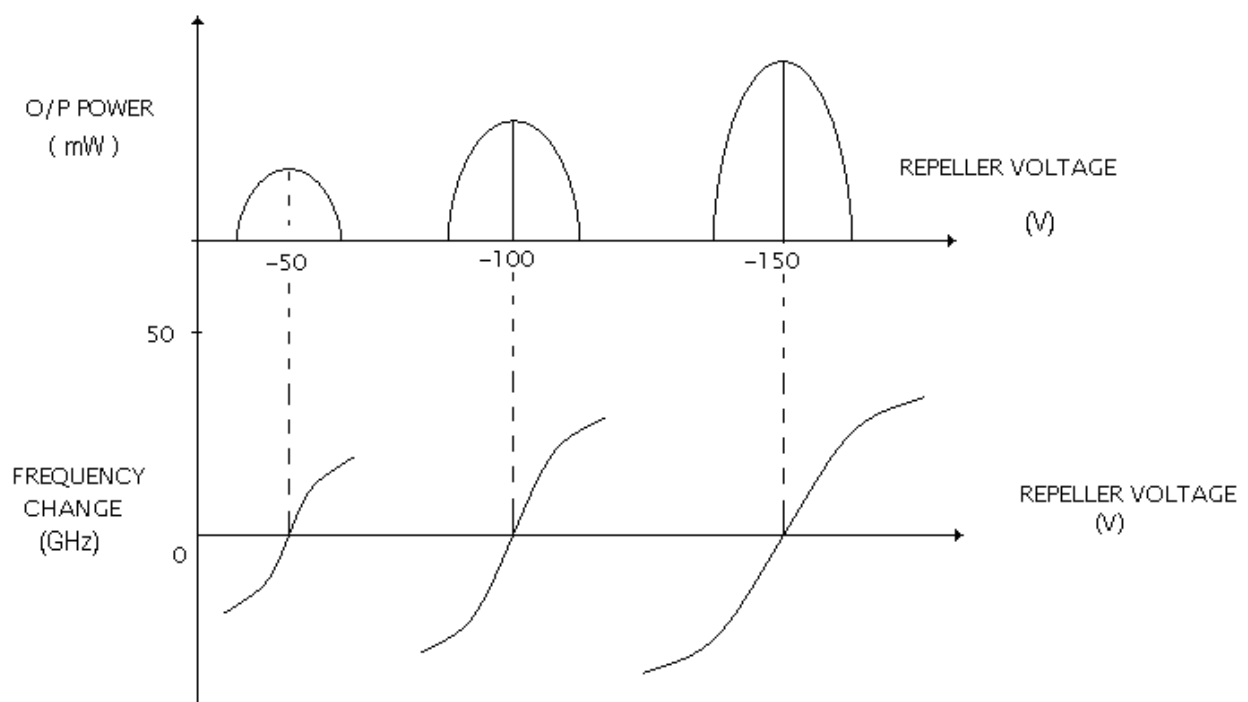
OBSERVATION TABLE:

Beam Voltage :..... V (Constant)

Beam Current :.....mA

Repeller Voltage (V)	Amplitude (mV)	Power (mW)	Dip Frequency (GHz)

EXPECTED GRAPH:



RESULT:



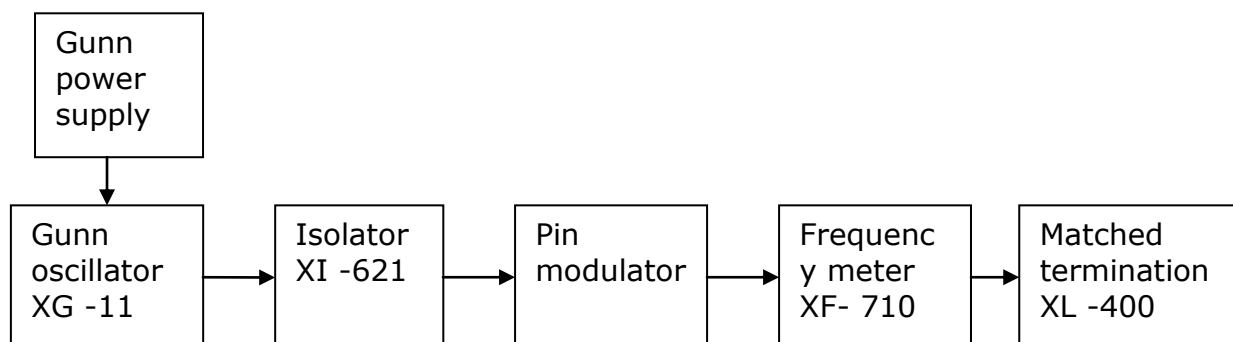
2. GUNN DIODE CHARACTERISTICS

AIM: To study the V-I characteristics of Gunn diode.

EQUIPMENT REQUIRED:

1. Gunn power supply
2. Gunn oscillator
3. PIN Modulator
4. Isolator
5. Frequency Meter
6. Variable attenuator
7. Slotted line
8. Detector mount and CRO.

BLOCK DIAGRAM



THEORY: Gunn diode oscillator normally consist of a resonant cavity, an arrangement for coupling diode to the cavity a circuit for biasing the diode and a mechanism to couple the RF power from cavity to external circuit load. A co-axial cavity or a rectangular wave guide cavity is commonly used.

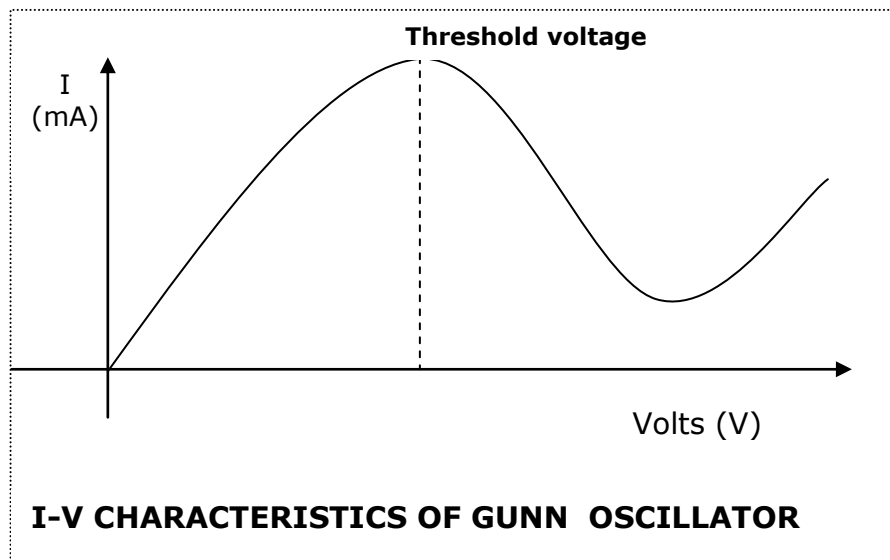
The circuit using co-axial cavity has the Gunn diode at one end at one end of cavity along with the central conductor of the co-axial line. The O/P is taken using a inductively or capacitively coupled probe. The length of the cavity determines the frequency of oscillation. The location of the coupling loop or probe within the resonator determines the load impedance presented to the Gunn diode. Heat sink conducts away the heat due to power dissipation of the device.

PROCEDURE:

1. Set the components and equipments as shown in Figure 1.
2. Initially set the variable attenuator for maximum attenuation.
3. Keep the control knobs of Gunn power supply as below
 - Meter switch – “OFF”
 - Gunn bias knob – Fully anti clock wise
 - PIN bias knob – Fully anti clock wise
 - PIN mode frequency – any position
4. Set the micrometer of Gunn oscillator for required frequency of operation.
5. Switch “ON” the Gunn power supply.
6. Measure the Gunn diode current to corresponding to the various Gunn bias voltage through the digital panel meter and meter switch. Do not exceed the bias voltage above 10 volts.
7. Plot the voltage and current reading on the graph as shown in figure 2.
8. Measure the threshold voltage which corresponding to max current.

Note: Do not keep Gunn bias knob position at threshold position for more than 10-15 sec. readings should be obtained as fast as possible. Otherwise due to excessive heating Gunn diode may burn

EXPECTED GRAPH:



OBSERVATION TABLE:

Gunn bias voltage (v)	Gunn diode current (mA)

RESULT:

3. DIRECTIONAL COUPLER CHARACTERISTICS

AIM: To study the function of multi-hole directional coupler by measuring the following parameters.

1. The coupling factor, Insertion Loss and directivity of the coupler

EQUIPMENT REQUIRED:

1. Microwave Source (Klystron or Gunn-Diode)
2. Isolator, Frequency Meter
3. Variable Attenuator
4. Slotted Line
5. Tunable Probe
6. Detector Mount Matched Termination
7. MHD Coupler
8. Waveguide Stand
9. Cables and Accessories
10. CRO.

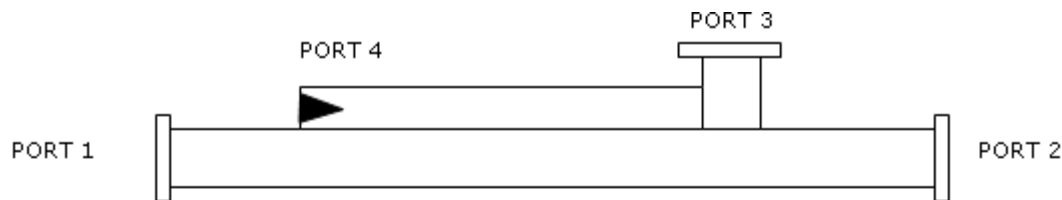


FIG. DIRECTIONAL COUPLER

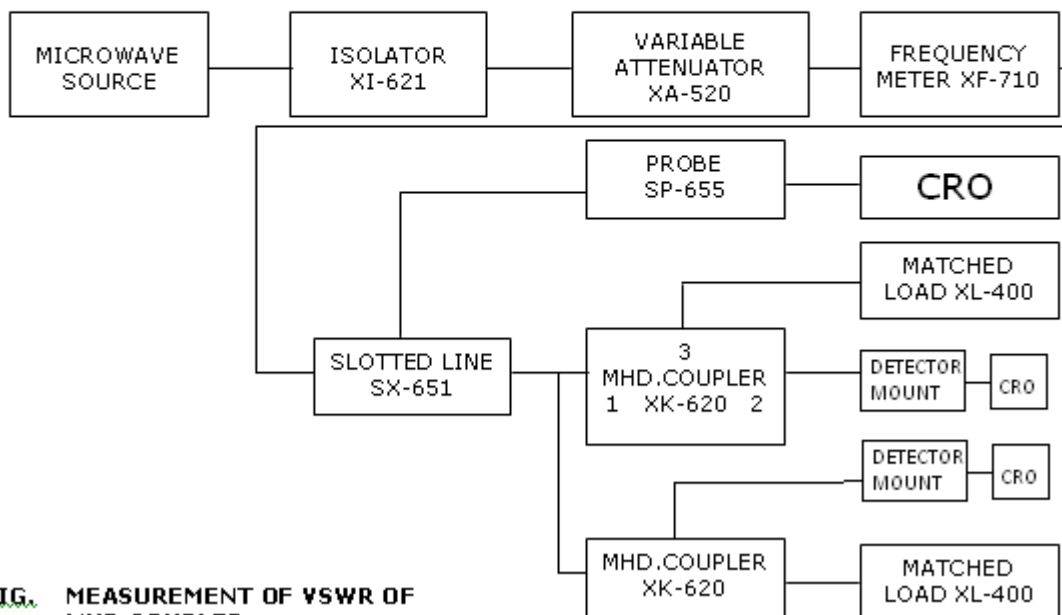


FIG. MEASUREMENT OF VSWR OF MHD.COUPLER

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, electromagnetically coupled to each other. Refer to the Fig.1. The power entering, in the main-arm gets divided between port 2 and 3, and almost no power comes out in port (4). Power entering at port 2 is divided between port 1 and 4.

The coupling factor is defined as

Coupling (db) = $10 \log_{10} [P1/P3]$ where port 2 is terminated, Isolation (dB) = $10 \log_{10} [P2/P3]$ where P1 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 (db) = I-C = $10 \log_{10} [P2/P1]$

Main line VSWR is SWR measured, looking into the main-line input terminal when the matched loads are placed at all other ports.

Auxiliary line VSWR is SWR measured in the auxiliary line looking into the output 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 (dB) = $10 \log_{10} [P1/P2]$

PROCEDURE:

1. Set up the equipments as shown in the Fig.
2. Energize the microwave source for particular operation of frequency .
3. Remove the multi hold directional coupler and connect the detector mount to the slotted section.
4. Set maximum amplitude in CRO with the help of variable attenuator let it be X.
5. Insert the directional coupler between slotted line and detector mount keeping port 1 to slotted line detector mount to the auxiliary port 3 and matched termination to port 2 without changing the position of variable attenuator.
6. Note down the amplitude using CRO let it be Y.
7. Calculate the coupling factor X-Y in dB.
8. Now carefully disconnect the detector mount from the auxiliary port 3 and matched termination from port 2 , without disturbing the setup.
9. Connect the matched termination to the auxiliary port 3 and detector to port 2 and measure the amplitude on CRO .let it be Z
10. Repeat the steps from 1 to 4.

11. Connect the directional coupler in the reverse direction i.e., port 2 to slotted section matched termination to port 1 and detector mount to port 3 without disturbing the position of the variable attenuator.
12. Measure and note down the amplitude using CRO let it be Y_0 .
13. Compute the directivity as $Y - Y_0$ in dB.

RESULT:

4. VSWR MEASUREMENT

AIM: To determine the standing-wave ratio and reflection coefficient.

EQUIPMENT REQUIRED:

1. Klystron tube (2k25)
2. Klystron power supply (skps - 610)
3. VSWR meter (SW 115)
4. Klystron mount (XM – 251)
5. Isolator (XF 621)
6. Frequency meter (XF 710)
7. Variable attenuator (XA – 520)
8. Slotted line (X 565)
9. Wave guide stand (XU 535)
10. Movable short/termination XL 400
11. BNC CableS-S Tuner (XT – 441)

BLOCK DIAGRAM

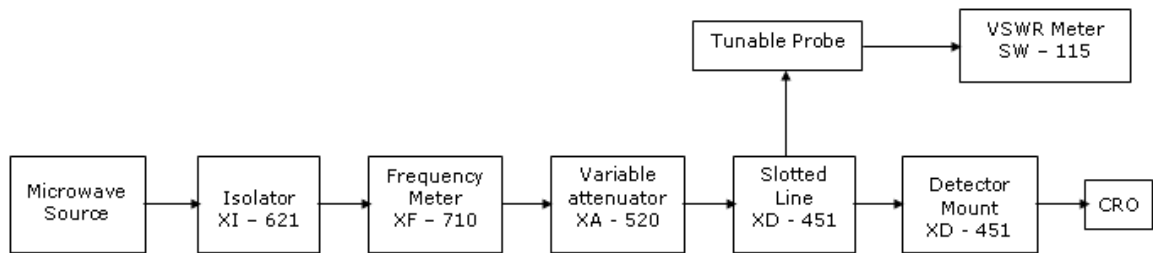


FIG: SET UP FOR LOW VSWR MEASUREMENT

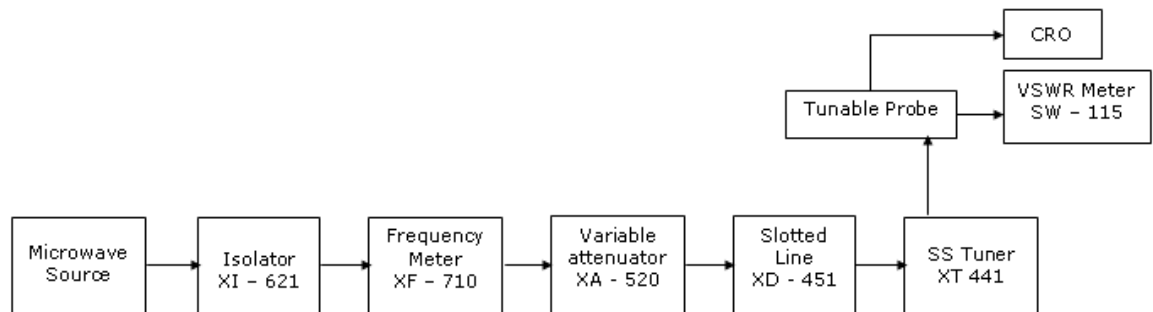


FIG: SET UP FOR HIGH VSWR MEASUREMENT

THEORY: Any mismatched load leads to reflected waves resulting in standing waves along the length of the line. The ratio of maximum to minimum voltage gives the VSWR. Hence minimum value of S is unity. If $S < 10$ then VSWR is called low VSWR. If $S > 10$ then VSWR is called high

VSWR. The VSWR values more than 10 are very easily measured with this setup. It can be read off directly on the VSWR meter calibrated. The measurement involves simply adjusting the attenuator to give an adequate reading on the meter which is a D.C. mill volt meter. The probe on the slotted wave guide is moved to get maximum reading on the meter. The attenuation is now adjusted to get full scale reading. Next the probe on the slotted line is adjusted to get minimum, reading on the meter. The ratio of first reading to the second gives the VSWR. The meter itself can be calibrated in terms of VSWR. Double minimum method is used to measure VSWR greater than 10. In this method, the probe is inserted to a depth where the minimum can be read without difficulty. The probe is then moved to a point where the power is twice the minimum.

PROCEDURE:

1. Set up equipment as shown in figure.
2. Keep variable attenuator in minimum attenuation position.
3. Keep control knobs of VSWR meter as below
 - Range dB = 40db / 50db
 - Input switch = low impedance
 - Meter switch = Normal
 - Gain (coarse fine) = Mid position approximately
4. Keep control knobs of klystron power supply as below.
 - Beam Voltage = OFF
 - Mod-Switch = AM
 - Beam Voltage Knob = fully anti clock wise
 - Reflection voltage knob = fully clock wise
 - AM-Amplitude knob = around fully clock wise
 - AM frequency and amplitude knob = mid position
5. Switch 'ON' the klystron power supply, VSWR meter and cooling fan.
6. Switch 'ON' the beam voltage switch position and set (down) beam voltage at 300V.
7. Rotate the reflector voltage knob to get deflection in VSWR meter.
8. Tune the O/P by turning the reflector voltage, amplitude and frequency of AM modulation.
9. Tune plunges of klystron mount and probe for maximum deflection in VSWR meter.
10. If required, change the range db-switch variable attenuator position and (given) 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 and medium VSWR:

1. Move the probe along the slotted line to get maximum deflection in VSWR meter.
2. Adjust the VSWR meter gain control knob or variable attenuator until the meter indicates 1.0 on normal VSWR scale.
3. Keep all the control knob as it is move the probe to next minimum position. Read the VSWR on scale.
4. Repeat the above step for change of S-S tuner probe depth and record the corresponding SWR.
5. If the VSWR is between 3.2 and 10, change the range 0dB switch to next higher position and read the VSWR on second VSWR scale of 3 to 10.

B. Measurement of High VSWR: (double minimum method)

1. Set the depth of 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 and variable attenuator to obtain a reading of 3db in the normal dB scale (0 to 10db) of VSWR meter.
4. Move the probe to the left on slotted line until full scale deflection is obtained on 0-10 db scale. Note and record the probe position on slotted line. Let it be d1.
5. Repeat the step 3 and then move the probe right along the slotted line until full scale deflection is obtained on 0-10db normal db scale. Let it be d2.
6. Replace S-S tuner and termination by movable short.
7. Measure distance between 2 successive minima positions of probe. Twice this distance is guide wave length λ_g .
8. Compute SWR from following equation

$$\text{SWR} = \frac{\lambda_g}{\pi (d1 - d2)}$$

OBSERVATION TABLE:

LOW VSWR

VSWR = _____

HIGH VSWR

Beam Voltage (v)	x ₁ (cm)	x ₂ (cm)	x ₁ (cm)	x ₂ (cm)	Avg (x ₁ -x ₂) = x (cm)	$\lambda_g=2x$ (cm)

$$\lambda_g = 6\text{cm}$$

d1 (cm)	d2 (cm)	d1-d2 (cm)	VSWR = $\lambda_g / \pi(d1-d2)$

RESULT: .

5. MEASUREMENT OF IMPEDENCE OF A GIVEN LOAD

AIM: To measure an unknown impedance using the smith chart.

EQUIPMENT REQUIRED:

1. Klystron tube 2k25
2. Klystron power supply Skps-610
3. Klystron mount XM-251
4. Isolator XF 62
5. Frequency meter XF 710
6. Variable attenuator XA – 520
7. Slotted line XS 565
8. Tunable probe XP 655
9. VSWR meter
10. Wave guide stand SU 535
11. S-S tuner (XT 441)
12. Movable short/termination

BLOCK DIAGRAM

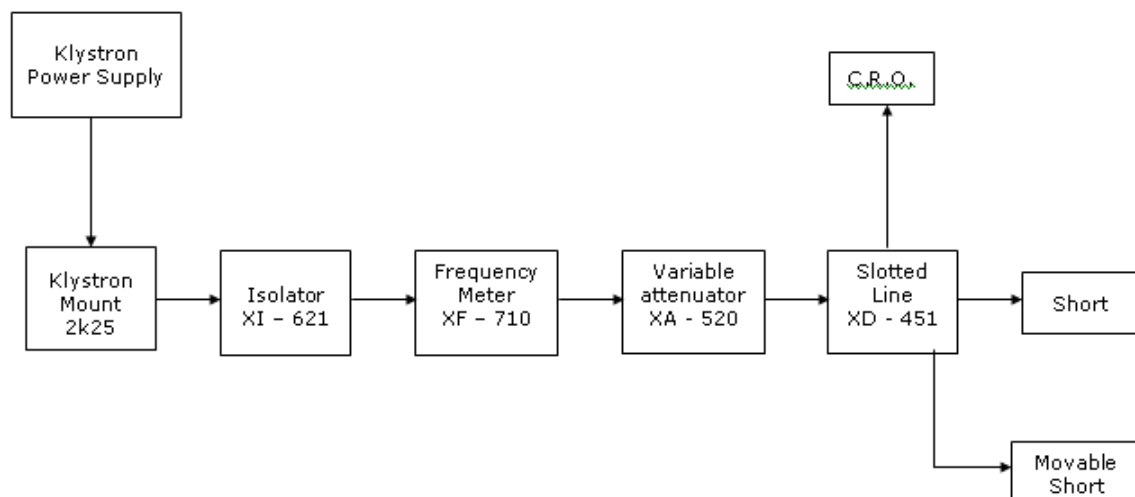


FIG: SET UP FOR IMPEDANCE MEASUREMENT

THEORY:

The impedance at any point on a transmission line can be written in the form $R+jx$.

For comparison SWR can be calculated as

$$S = \frac{1+|R|}{1-|R|} \quad \text{where reflection coefficient 'R'}$$

Given as

$$R = \frac{Z - Z_0}{Z + Z_0}$$

Z_0 = characteristics impedance of wave guide at operating frequency.

Z is the load impedance

The measurement is performed in the following way.

The unknown device is connected to the slotted line and the position of one minima is determined. The unknown device is replaced by movable short to the slotted line. Two successive minima positions are noted. The twice of the difference between minima position will be guide wave length. One of the minima is used as reference for impedance measurement. Find the difference of reference minima and minima position obtained from unknown load. Let it be 'd'. Take a smith chart, taking '1' as centre, draw a circle of radius equal to S. Mark a point on circumference of smith chart towards load side at a distance equal to d/λ_g .

Join the center with this point. Find the point where it cut the drawn circle. The co-ordinates of this point will show the normalized impedance of load.

PROCEDURE:

1. Calculate a set of V_{min} values for short or movable short as load.
2. Calculate a set of V_{min} values for S-S Tuner + Matched termination as a load.

Note: Move more steps on S-S Tuner

3. From the above 2 steps calculate $d = d_1 \sim d_2$
4. With the same setup as in step 2 but with few numbers of turns (2 or 3). Calculate low VSWR.

Note: High VSWR can also be calculated but it results in a complex procedure.

5. Draw a VSWR circle on a smith chart.
6. Draw a line from center of circle to impedance value (d/λ_g) from which calculate admittance and Reactance ($Z = R+jx$)

OBSERVATION TABLE:

Load (short or movable short)					
X ₁ (cm)	X ₂ (cm)	X ₁ (cm)	X ₂ (cm)	X ₁ (cm)	X ₂ (cm)

x = _____

λ_g = _____

Load (S.S. Tuner + Matched Termination)

S.S Tuner + Matched Termination	Short or Movable Short

d1= , d2 =

d = d1 ~ d2 =

Z = d/ λ_g =

RESULT:

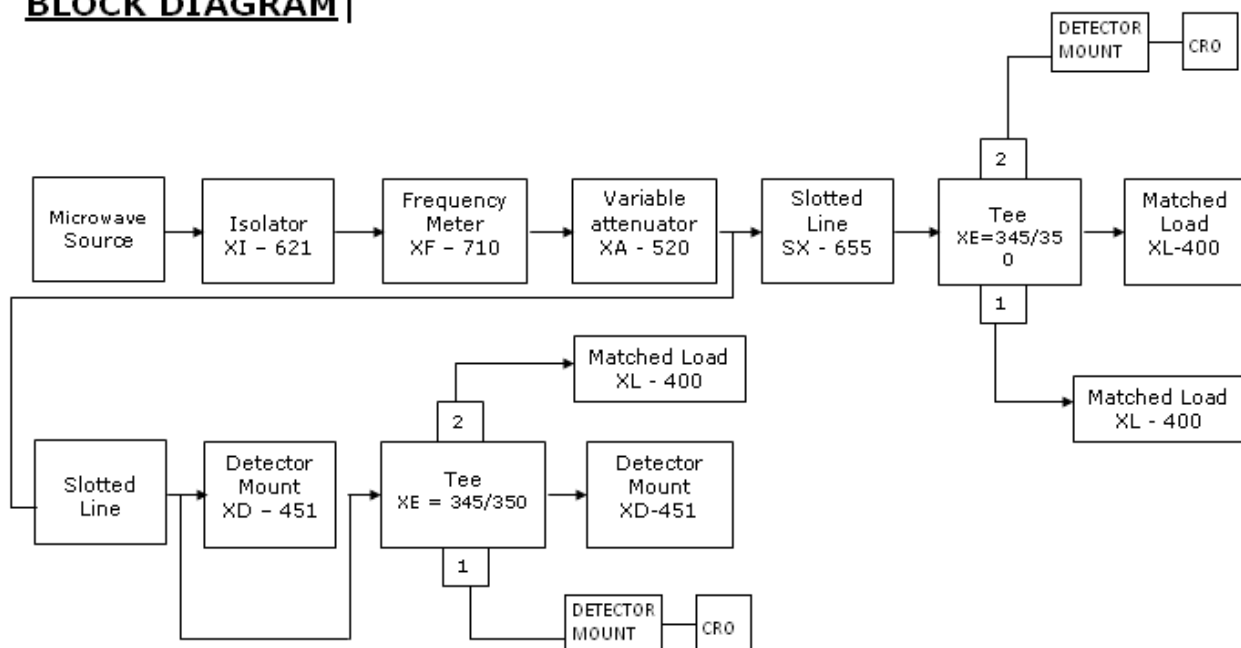
6. MEASURE MENT OF SCATTERING PARAMETERS OF MAGIC TEE

AIM: Study of Magic Tee.

EQUIPMENT REQUIRED:

1. Microwave source : Klystron tube (2k25)
2. Isolator (XI-621)
3. Frequency meter (XF-710)
4. Variable Attenuator (XA-520)
5. Slotted line (SX-651)
6. Tunable probe (XP-655)
7. Detector Mount (XD-451)
8. Matched Termination (XL-400)
9. Magic Tee (XE-345/350)
10. Klystron Power Supply + Klystron Mount
11. Wave guide stands and accessories

BLOCK DIAGRAM |



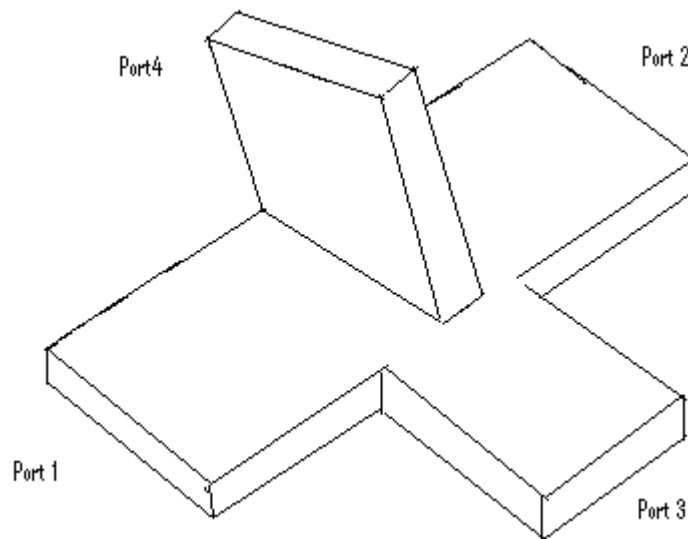


Fig: Magic Tee

THEORY:

The device Magic Tee is a combination of E and H plane Tee. Arm 3 is the H-arm and arm 4 is the E-arm. If the power is fed, into arm 3 (H-arm) the electric field divides equally between arm 1 and 2 with the same phase and no electric field exists in the arm 4. If power is fed in arm 4 (E-arm) it divides equally into arm 1 and 2 but out of phase with no power to arm 3, further, if the power is fed in arm 1 and 2 simultaneously it is added in arm 3 (H-arm) and it is subtracted in E-arm i.e., arm 4.

A. Input VSWR:

Value of SWR corresponding to each port as a load to the line while other ports are terminated in matched load.

B. Isolation:

The Isolation between E and H arm is defined as the ratio of the power supplied by the generator connected to the E-arm (port 4) to the power detected at H-arm (port 3) when side arm 1 and 2 terminated in matched load.

$$\text{Isolation (dB)} = 10 \log_{10} [P_4/P_3]$$

Similarly, Isolation between other ports may be defined.

C. Coupling Factor:

It is defined as $C_{ij} = 10 - \alpha/20$

Where ' α ' is attenuation / isolation in dB when 'i' is input arm and 'j' is output arm.

$$\text{Thus, } \alpha = 10 \log_{10} [P_4/P_3]$$

Where P_3 is the power delivered to arm 'i' and P_4 is power detected at 'j' arm.

PROCEDURE:

1. Setup the components and equipments as shown in figure. Keeping E-arm towards slotted line and matched termination to other ports.
2. Energize the microwave source for particular frequency of operation and tune the detector mount for maximum output.
3. With the help of variable frequency of operation and tune the detector mount for maximum output attenuator, set any reference in the CRO let it be V_3 .
4. Without disturbing the position of the variable attenuator, carefully place the magic tee after the slotted line, detector mount to E-arm and matched termination to arm-1 and arm-2.
5. Note down the amplitude using CRO let it be V_4 .
6. Determine the isolation between arm-1 and arm-2 as V_3-V_4 .
7. Determine the coupling co-efficient from the equation given in theory part.
8. The same experiment may be repeated for other arms also.

OBSERVATIONS:

Ports	Power (W)

PE =

PH =

$$PE-PH =$$

Coupling factor

$$PC2 =$$

$$\propto = PE - PC2$$

$$CEC2 =$$

RESULT:

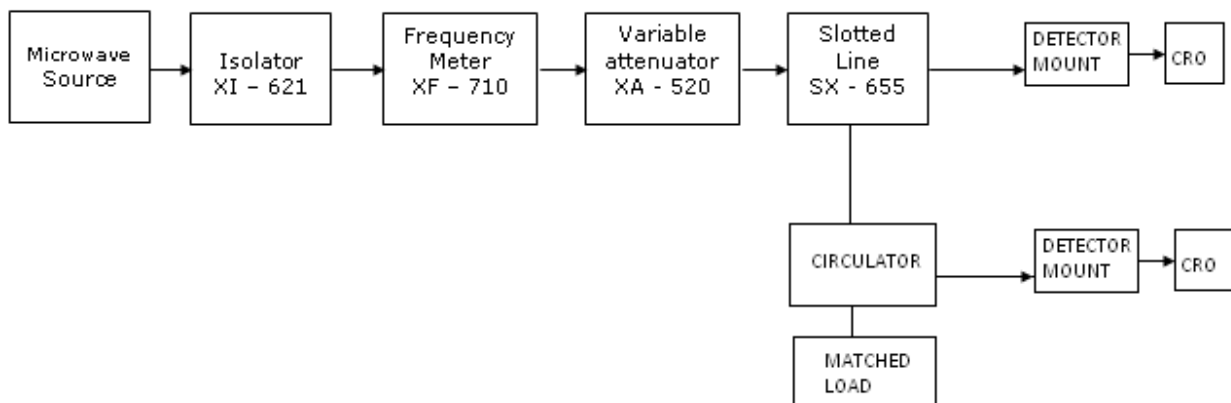
7. MEAUREMENT OF SCATTERING PARAMETERS OF CIRCULATOR

AIM: To study the Isolator and circulators.

EQUIPMENT REQUIRED:

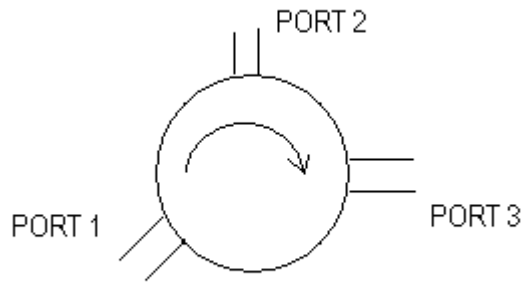
1. Microwave Source (Klystron or Gunn-Diode)
2. Isolator, Frequency Meter
3. Variable Attenuator
4. Slotted Line
5. Tunable Probe
6. Detector Mount Matched Termination
7. Circulator
8. Waveguide Stand
9. Cables and Accessories
10. VSWR Meter.

BLOCK DIAGRAM:



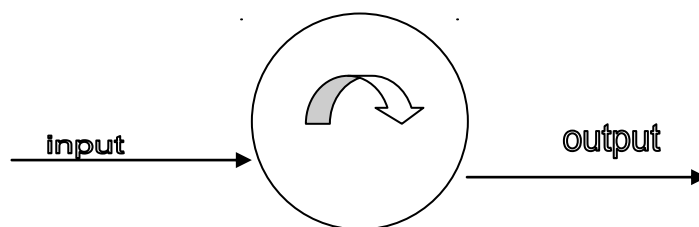
CIRCULATOR:

Circulator is defined as device with ports arranged such that energy entering a port is coupled to an adjacent port but not coupled to the other ports. This is depicted in figure circulator can have any number of ports.



ISOLATOR:

An Isolator is a two-port device that transfers energy from input to output with little attenuation and from output to input with very high attenuation.



The isolator, shown in Fig. can be derived from a three-port circulator by simply placing a matched load (reflection less termination) on one port.

The important circulator and isolator parameters are:

A. Insertion Loss

Insertion Loss is the ratio of power detected at the output port to the power supplied by source to the input port, measured with other ports terminated in the matched Load. It is expressed in dB.

B. Isolation

Isolation is the ratio of power applied to the output to that measured at the input. This ratio is expressed in db. The isolation of a circulator is measured with the third port terminated in a matched load.

C. Input VSWR

The input VSWR of an isolator or circulator is the ratio of voltage maximum to voltage minimum of the standing wave existing in the line with all parts except the test port are matched.

PROCEDURE:

Measurement of insertion loss and isolation.

1. Remove the probe and isolator or circulator from slotted line and connect the detector mount to the slotted section. The output of the detector mount should be connected with CRO.
2. Energize the microwave source for maximum output for a particular frequency of operation. Tune the detector mount for maximum output in the CRO.
3. Set any reference level of Maximum Amplitude with the help of variable attenuator, Let it be P_1 .
4. Carefully remove the detector mount from slotted line without disturbing the position of the set up. Insert the isolator/circulator between slotted line and detector mount. Keep input port to slotted line and detector its output port. A matched termination should be placed at third port in case of Circulator.
5. Record the reading of Amplitude in CRO, Let it be P_2 .
6. Compute insertion loss given as P_1-P_2 in db.
7. For measurement of isolation, the isolator or circulator has to be connected in reverse i.e. output port to slotted line and detector to input port with other port terminated by matched termination (for circulator).
8. Record the reading of Amplitude in CRO and let it be P_3 .
9. Compute isolation as P_1-P_3 in db.
10. The same experiment can be done for other ports of circulator.
11. Repeat the above experiment for other frequency if needed.

RESULT:

8.. ATTENUATION MEASUREMENT

AIM: To study insertion loss and attenuation measurement of attenuator.

EQUIPMENT REQUIRED:

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

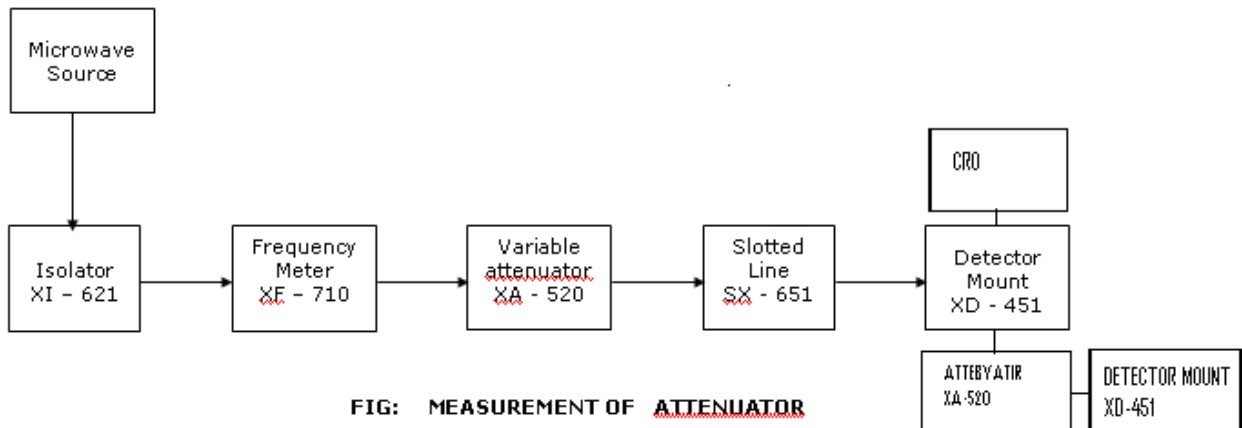


FIG: MEASUREMENT OF ATTENUATOR

THEORY:

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

$$\text{Attenuation } A \text{ (dB)} = 10 \log (P_1/P_2)$$

Where P_1 = Power detected by the load without the attenuator in the line

P_2 = Power detected by the load with the attenuator in the line.

PROCEDURE:

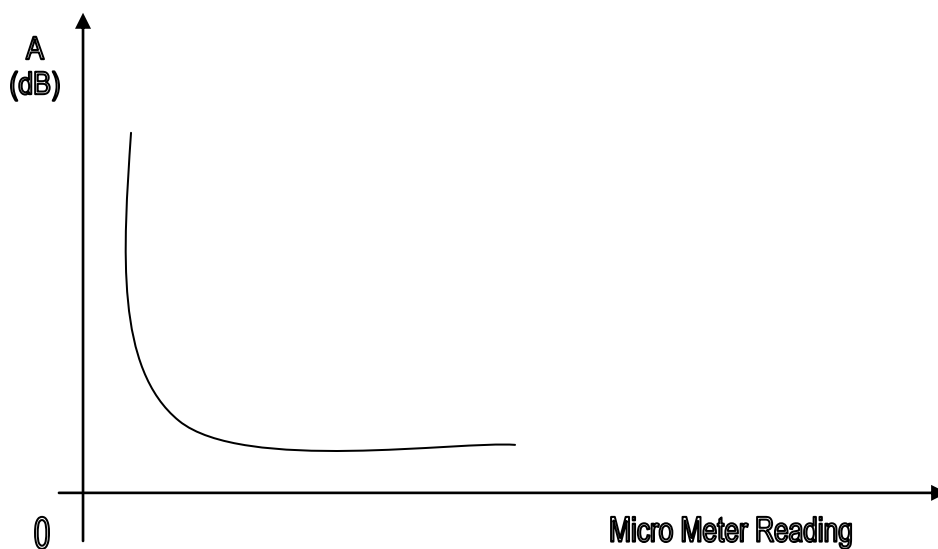
1. Connect the equipments as shown in the above figure.
2. Energize the microwave source for maximum power at any frequency of operation
3. Connect the detector mount to the slotted line and tune the detector mount also for max deflection on VSWR or on CRO
4. Set any reference level on the VSWR meter or on CRO with the help of variable attenuator. Let it be P_1 .
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. Keep the micrometer reading of test variable attenuator to zero and record the readings of VSWR meter or on CRO. Let it to be P_2 . Then the insertion loss of test attenuator will be P_1-P_2 db.
6. 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 P_3 then the attenuation value of variable attenuator for particular position of micrometer reading of will be $P_1 - P_3$ db.

7. 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.
8. 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:

9. MICRO WAVE FREQUENCY MEASUREMENT

AIM: To determine the frequency and wavelength in a rectangular wave guide working in TE_{10} 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

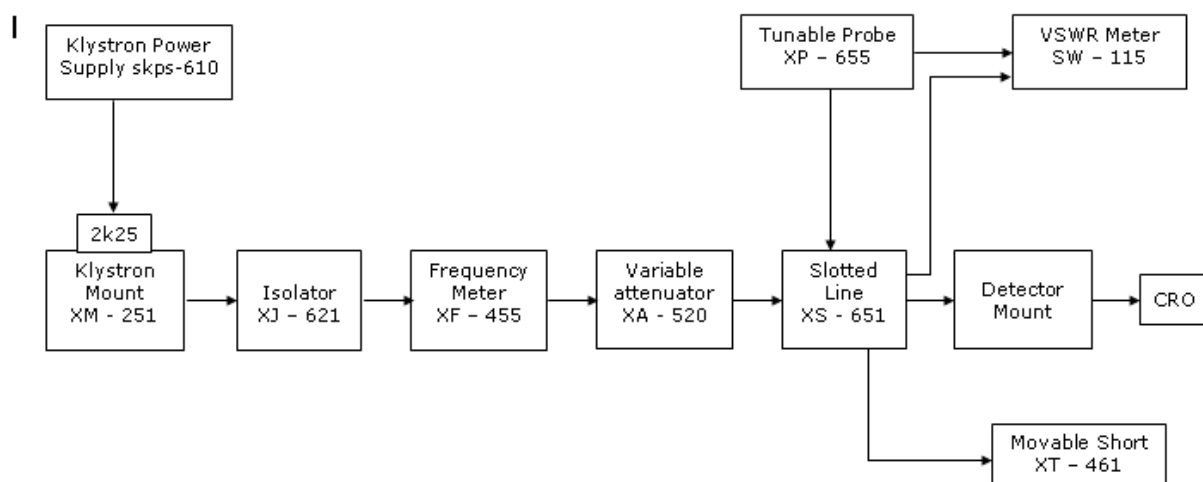


FIG: SET UP FOR FREQUENCY AND WAVELENGTH MEASUREMENT

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. TE_{10} mode is the dominant mode since for TM_{mn} modes, $n \neq 0$ or $n=0$ the lowest-order mode possible is TE_{10} , called the dominant mode in a rectangular wave guide for $a > b$.

For dominant TE_{10} mode rectangular wave guide λ_o , λ_g and λ_c are related as below.

$$1/\lambda_o^2 = 1/\lambda_g^2 + 1/\lambda_c^2$$

Where λ_o is free space wave length

λ_g is guide wave length

λ_c is cut off wave length

For TE_{10} mode $\lambda_c = 2a$ 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.

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

Where C = 3×10^8 meter/sec. i.e. velocity of light.

17. Verify with frequency obtained by frequency modes
18. Above experiment can be verified at different frequencies.

$$f_0 = C/\lambda_0 \Rightarrow C \Rightarrow 3 \times 10^{10} \text{ m/s (i.e., velocity of light)}$$

$$1/\lambda_0^2 = 1/\lambda_g^2 + 1/\lambda_c^2$$

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

$$\lambda_g = 2x\Delta_d$$

$$\text{For TE}_{10} \text{ mode} \Rightarrow \lambda_c = 2a$$

a → wave guide inner broad dimension

a = 2.286cm” (given in manual)

$$\lambda_c = 4.6\text{cm}”$$

OBSERVATION TABLE:

Beam voltage(v)	Beam current (mA)	Repeller voltage(v)	fo (using freq meter) (GHZ)	d1 (cm)	d2 (cm)	d3 (cm)	d4 (cm)	$\Delta d1 = d2 - d1$ (cm)	$\Delta d2 = D3 - d2$ (cm)	$\Delta d3$ (d4-d3) = x (cm)	$\Delta d = (\Delta d1 + \Delta d2 + \Delta d3)/3$	$\lambda_g = 2x \Delta d$	λ_o (cm)	fo (HZ)

RESULT:

PART-II: DIGITAL COMMUNICATIONS LAB

1. PULSE CODE MODULATION & DEMODULATION

AIM:

- a) To study 2-channel Time Division Multiplexing and Sampling of analog signal, and its pulse code modulation in None parity mode in the transmitter section and to study the Demultiplexing and the reconstruction of the analog signal in the receiver section.
- b) Study of Error Check Code Logic:
 1. Odd Parity Coding
 2. Even Parity Coding
 3. Hamming Coding

EQUIPMENTS:

1. Experiment kits DCL-03 & DCL-04.
2. Connecting chords.
3. Power supply.
4. 20 MHz Dual Trace Oscilloscope.

NOTE: KEEP THE SWITCH FAULTS IN OFF POSITION.

PROCEDURE: (for objective-a)

1. Refer to the Block Diagram (Fig. 1.1) & Carry out the following connections.
2. Connect power supply in proper polarity to the kits DCL-03 and DCL-04 and switch it on.
3. Connect sine wave of frequency 500Hz and 1 KHz to the input CH0 and CH1 of the sample and hold logic.
4. Connect OUT 0 to CH0 IN & OUT 1 to CH1 IN.
5. Set the speed selection switch SW1 to FAST mode.
6. Select parity selection switch to NONE mode on both the kit DCL-03 and DCL- 04 as shown in switch setting diagram (Fig. A).
7. Connect TXDATA, TXCLK and TXSYNC of the transmitter section DCL-03 to the corresponding RXDATA, RXCLK, and RXSYNC of the receiver section DCL-04.
8. Connect posts DAC OUT to IN post of Demultiplexer section on DCL-04.
9. Ensure that FAULT SWITCH SF1 as shown in switch setting diagram (Fig. A) introduces no fault.
10. Take the observations as mentioned below.
11. Repeat the above experiment with DC Signal at the inputs of the Channel CH 0 and CH 1.
12. Connect ground points of both the kits with the help of Connecting chord provided during all the experiments.

OBSERVATIONS:

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

ON KIT DCL-03

1. Input signal CH 0 and CH 1.
2. Sample and Hold output OUT 0 and OUT1
3. Multiplexer clock CLK 1 and CLK 2
4. Multiplexed data MUX OUT.
5. PCM Data TX DATA, TXCLK, TXSYNC

ON KIT DCL-04

1. RXCLK, RXSYNC, RXDATA
2. DAC OUT
3. Demultiplexer clock CLK 1 and CLK 2
4. Demultiplexed Data CH 0 and CH 1
5. Received signal OUT 0 and OUT 1

PROCEDURE: (for objective-b)

PART A: NONE PARITY MODE.

1. Refer to the Block Diagram (Fig. 4) & Carry out the following connections.
2. Connect power supply in proper polarity to the kits DCL-03 and DCL-04 and switch it on.
3. Connect DC input signal DC 1 to the input CH 0 and CH 1 of the Sample and Hold logic.
4. Set the speed selection switch SW1 to FAST mode.
5. Select parity selection switch to NONE mode on both the kit DCL-03 and DCL- 04 as shown in switch setting diagram (Fig. A).
6. Connect TXDATA, TXCLK and TXSYNC of the transmitter section DCL-03 to the corresponding RXDATA, RXCLK, and RXSYNC of the receiver section DCL-04.
7. Vary the amplitude of input DC signal from 0V to 4.96V and observe the variation on LED on the transmitter and receiver as mention below.
8. Create a single bit fault in any one of the 4 – MSB data bit by putting switch in below position of SF 1 and observe the status of PARITY ERROR.
9. Repeat the experiment in SLOW mode.

OBSERVATIONS:

Observe the sequence of data bit on the LED for each setting and note down on the paper.

ON KIT DCL-03

1. A/D CONVERTER
2. PARITY CODED DATA
3. ERROR CODE GENERATOR

ON KIT DCL-04

1. SHIFT REGISTER
2. DATA LATCH
3. D/A CONVERTER
4. PARITY ERROR

A/D CONVERTOR	ERROR CODE GENERATOR	SHIFT REGISTER (FAULT)	DATA LATCH	D/A CONVERTOR	PARITY ERROR

PART B: ODD PARITY MODE.

1. Refer to the Block Diagram (Fig. 4) & Carry out the following connections.

2. Connect power supply in proper polarity to the kits DCL-03 and DCL-04 and switch it on.
3. Connect DC input signal DC 1 to the input CH 0 and CH 1 of the Sample and Hold logic.
4. Set the speed selection switch SW1 to FAST mode.
5. Select parity selection switch to ODD mode on both the kit DCL-03 and DCL-04 as shown in switch setting diagram (Fig. A).
6. Connect TXDATA, TXCLK and TXSYNC of the transmitter section DCL-03 to the corresponding RXDATA, RXCLK, and RXSYNC of the receiver section DCL-04.
7. Vary the amplitude of input DC signal from 0V to 4.96V and observe the variation on LED on the transmitter and receiver as mention below.
8. Create a single bit fault in any one of the 4 – MSB data bit by putting switch in below position of SF 1 and observe the status of PARITY ERROR.
9. Repeat the experiment in SLOW mode.

OBSERVATION:

Observe the sequence of data bit on LED for each setting and note down on the paper.

ON KIT DCL-03

1. A/D CONVERTER
2. PARITY CODED DATA
3. ERROR CODE GENERATOR

ON KIT DCL-04

1. SHIFT REGISTER
2. DATA LATCH
3. D/A CONVERTER
4. PARITY ERROR BIT

OBSERVATION TABLE:

ODD PARITY MODE

A/D CONVERTOR	ERROR CODE GENERATOR	SHIFT REGISTER (FAULT)	DATA LATCH	D/A CONVERTOR	PARITY ERROR

We observe that the LSB of the A/D converter output is neglected in this mode of operations and the odd parity occupies the positions of LSB in transmission. Also the LSB of the D/A Converter is always zeroing as in that position odd parity bit was transmitted.

Whenever the transmission of data is error free, the error checks LED remains OFF. Whenever a single bit error occurs the parity check LED remains ON, indicating that a single bit error had occurred in transmission. Thus the Odd Parity check is able to detect the errors but unable to locate or correct the errors.

PART C: EVEN PARITY MODE.

1. Refer to the Block Diagram (Fig. 4) & Carry out the following connections.

2. Connect power supply in proper polarity to the kits DCL-03 and DCL-04 and switch it on.
3. Connect DC input signal DC 1 to the input CH 0 and CH 1 of the Sample and Hold logic.
4. Set the speed selection switch SW1 to FAST mode.
5. Select parity selection switch to EVEN mode on both the kit DCL-03 and DCL-04 as shown in switch setting diagram (Fig. A).
6. Connect TXDATA, TXCLK and TXSYNC of the transmitter section DCL-03 to the corresponding RXDATA, RXCLK, and RXSYNC of the receiver section DCL-04.
7. Vary the amplitude of input DC signal from 0V to 4.96V and observe the variation on LED on the transmitter and receiver as mention below.
8. Create a single bit fault in any one of the 4 – MSB data bit by putting switch in below position of SF 1 and observe the status of PARITY ERROR.
9. Repeat the experiment in SLOW mode.

OBSERVATION:

Observe the sequence of data bit on LED for each setting and note down on the paper.

ON KIT DCL-03

1. A/D CONVERTER
2. PARITY CODED DATA
3. ERROR CODE GENERATOR

ON KIT DCL-04

1. SHIFT REGISTER
2. DATA LATCH
3. D/A CONVERTER
4. PARITY ERROR BIT

OBSERVATION TABLE:

EVEN PARITY MODE

A/D CONVERTOR	ERROR CODE GENERATOR	SHIFT REGISTER (FAULT)	DATA LATCH	D/A CONVERTOR	PARITY ERROR

We observe that the LSB of the A/D converter output is neglected in this mode of operations and the odd parity occupies the positions of LSB in transmission. Also the LSB of the D/A Converter is always zeroing as in that position odd parity bit was transmitted.

Whenever the transmission of data is error free, the error check LED remains OFF. Whenever a single bit error occurs the parity check LED remains ON indicating that a single bit error had occurred in transmission. Thus the Even Parity check is able to detect the errors but unable to locate or correct the errors.

PART D: HAMMING PARITY MODE.

1. Refer to the Block Diagram (Fig. 4) & Carry out the following connections.
2. Connect power supply in proper polarity to the kits DCL-03 and DCL-04 and switch it on.
3. Connect DC input signal DC 1 to the input CH 0 and CH 1 of the Sample and Hold logic.
4. Set the speed selection switch SW1 to FAST mode.
5. Select parity selection switch to HAMMING mode on both the kit DCL-03 and DCL-04 as shown in switch setting diagram (Fig. A).
6. Connect TXDATA, TXCLK and TXSYNC of the transmitter section DCL-03 to the corresponding RXDATA, RXCLK, and RXSYNC of the receiver section DCL-04.
7. Vary the amplitude of input DC signal from 0V to 4.96V and observe the variation on LED on the transmitter and receiver as mention below.
8. Create a single bit fault in any one of the 4 – MSB data bit by putting switch in below position of SF 1 and observe the status of PARITY ERROR.
9. Repeat the experiment in SLOW mode.

We observe that the three LSB data bit of the A/D converter output is neglected in this mode of operations and three Hamming parity bit occupies the positions in transmission.

Also four MSB bit of the D/A converter forms the data and three LSB bit are always zero as in that position Hamming parity bit were transmitted.

Whenever the transmission of data is error free, all the LED of Error Detection/Correction logic remains OFF.

Whenever a single bit error occurs the corresponding bit position is indicated by LED of Error Detection/Correction Logic and corrected data bit are observed at the input of D/A Converter which are same as the A/D Converter output (4 MSB) Thus in Hamming Parity mode, single bit error is detected as well as corrected.

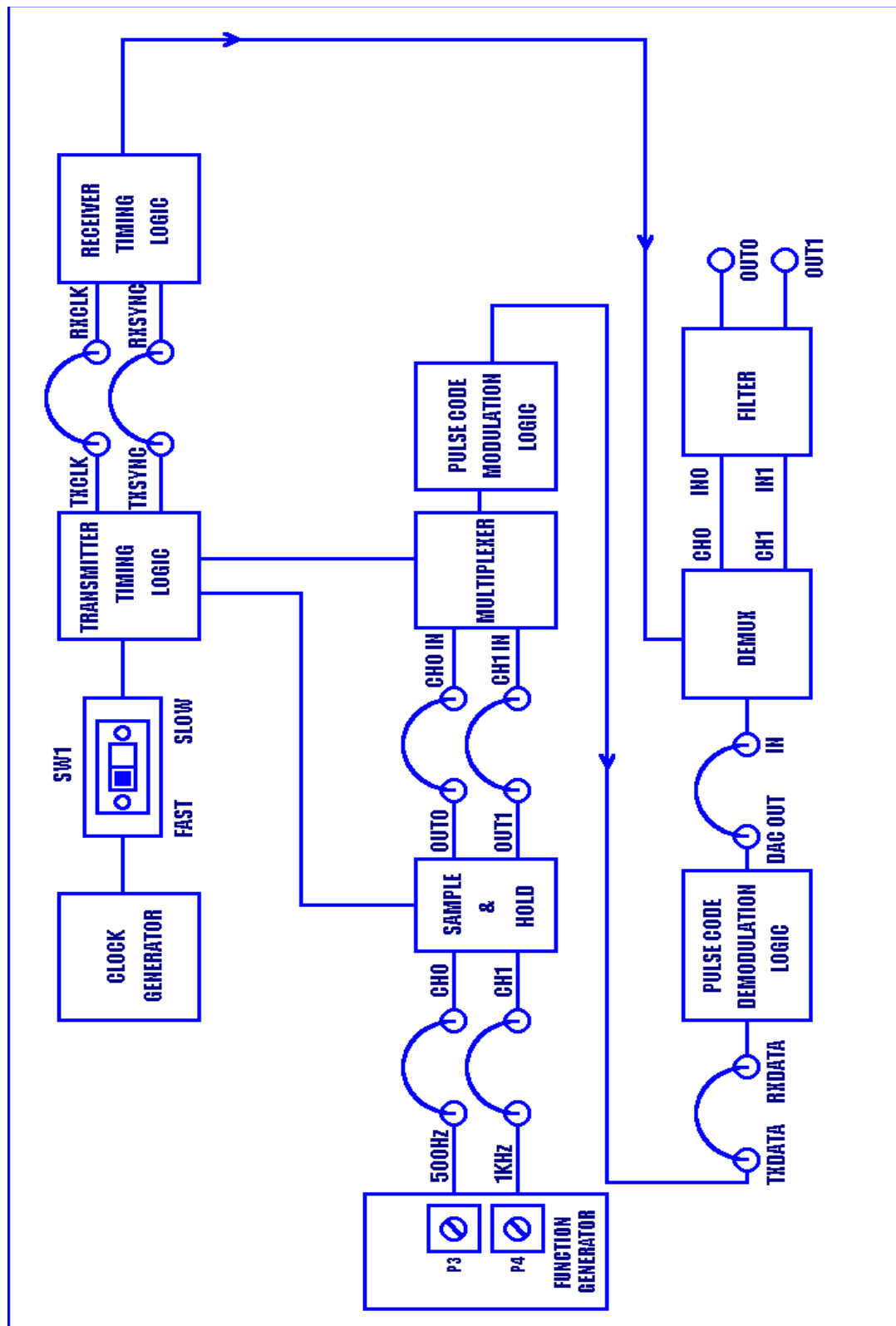
PRECAUTIONS:

1. Make sure that all the switch faults are in the OFF position initially.
2. Note the readings without parallax errors.
3. Make sure that all the LEDs of the power supply glow

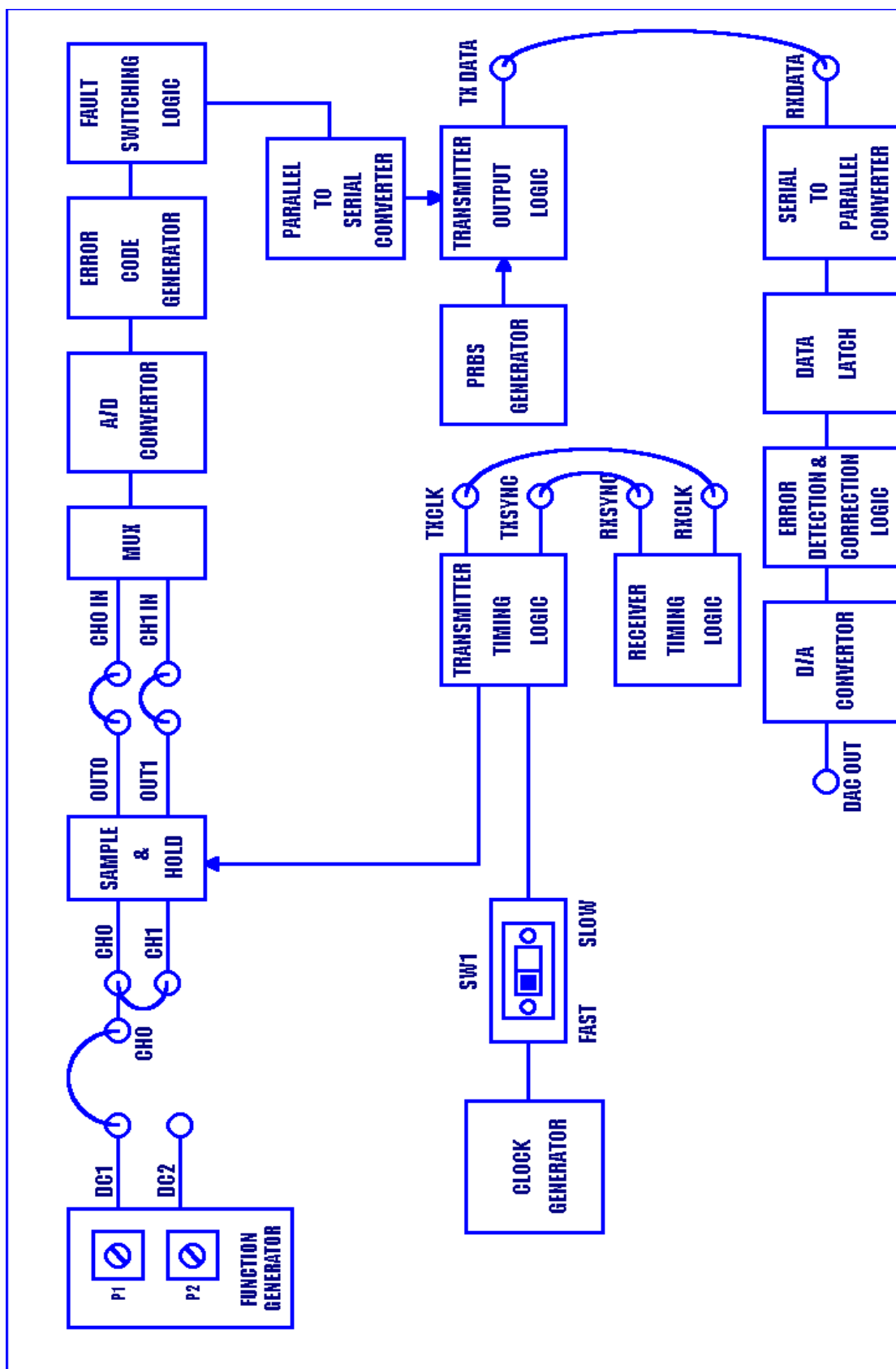
RESULT:

2-channel Time Division Multiplexing and Sampling of analog signal, and its pulse code modulation in None parity mode, odd parity mode, even parity mode and hamming code

in the transmitter section and the reconstruction of analog signal in the receiver section is studied and observed.



Experimental setup for Objective-a



Experimental setup for Objective-b

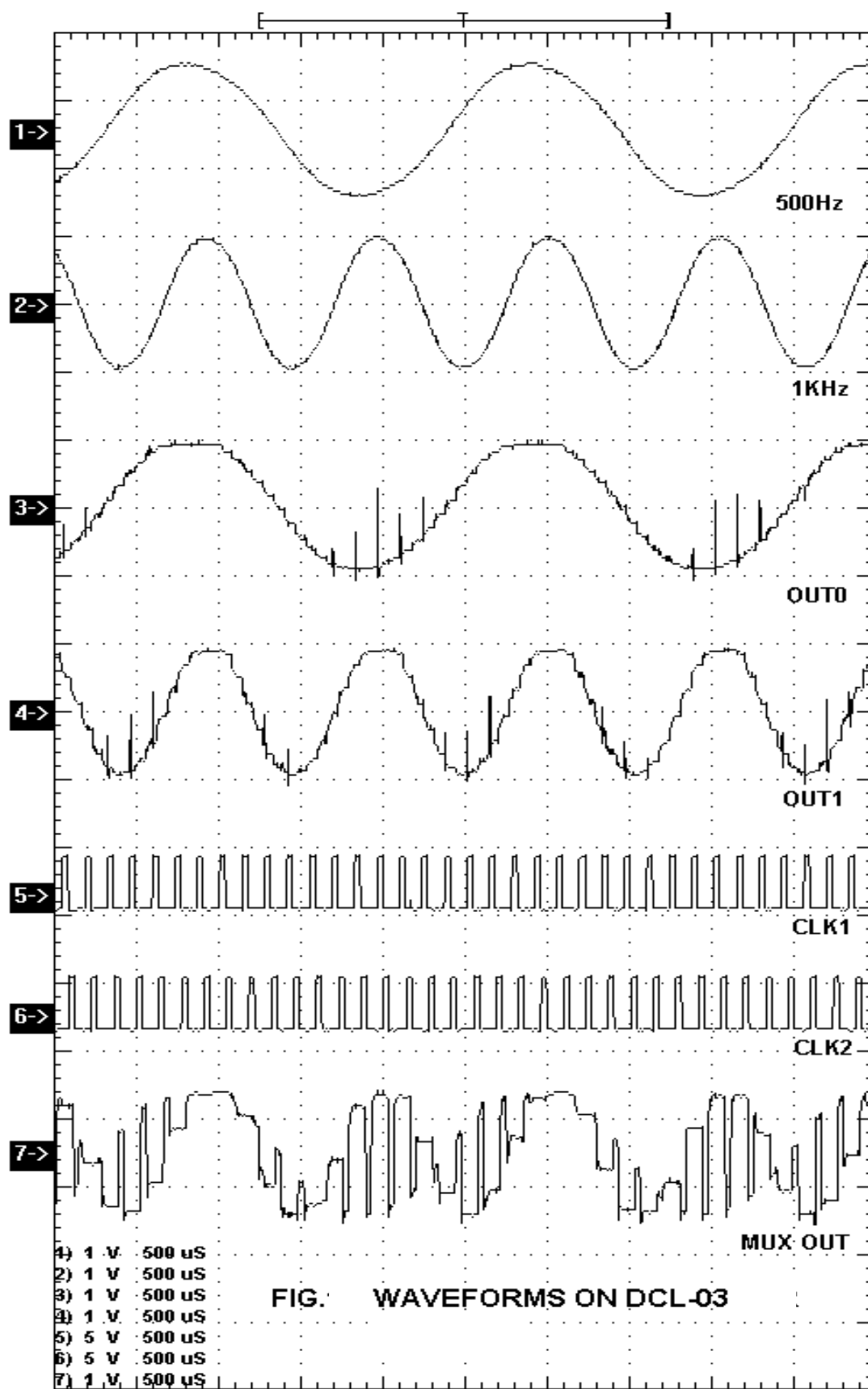


FIG. WAVEFORMS ON DCL-03

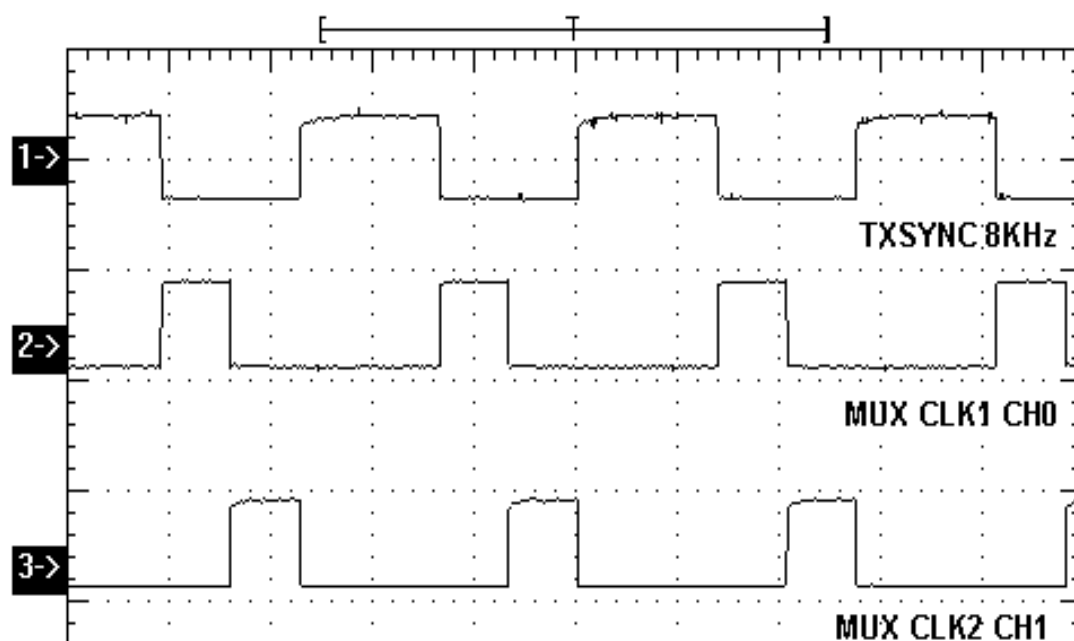


FIG.1.3 WAVEFORMS FOR TX TIMING

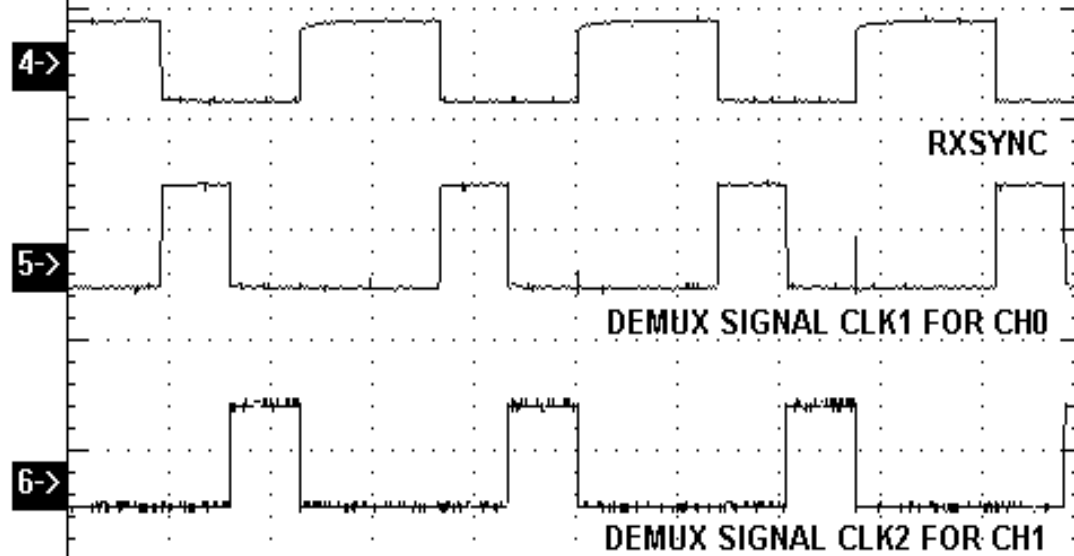


FIG.1.4 WAVEFORMS FOR RX TIMING

- 1) 5 V 50 μ S
- 2) 5 V 50 μ S
- 3) 5 V 50 μ S
- 4) 5 V 50 μ S
- 5) 5 V 50 μ S
- 6) 5 V 50 μ S

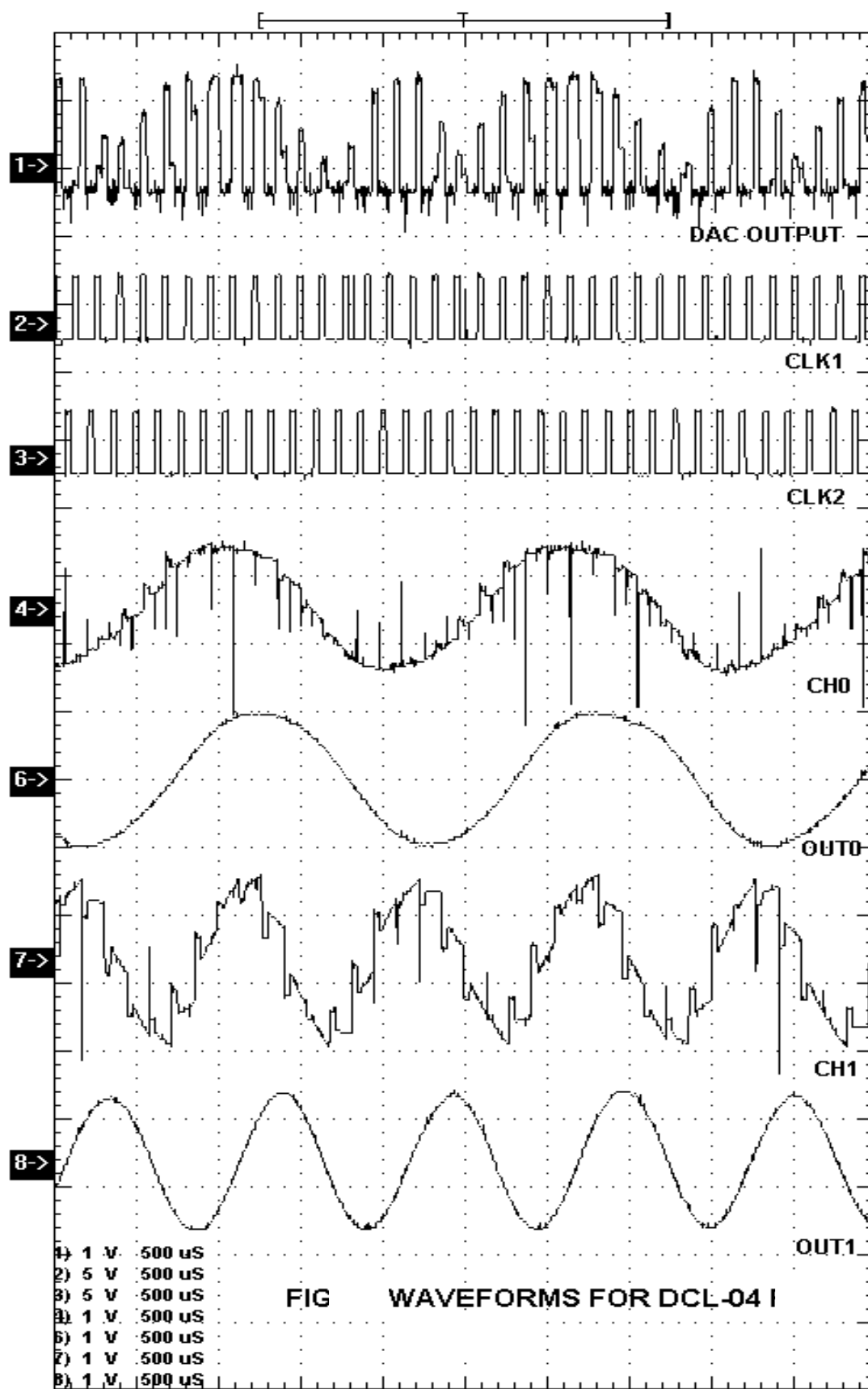


FIG WAVEFORMS FOR DCL-04 I

2. DIFFERENTIAL PULSE CODE MODULATION & DEMODULATION

AIM:

To study Differential Pulse Code Modulation and Demodulation by sending variable frequency sine wave and variable DC signal inputs.

APPARATUS:

1. DPCM Trainer Kit.
2. Cathode Ray Oscilloscope.
3. Connecting wires.
4. CRO Probes

CIRCUIT DIAGRAM:

PROCEDURE:

1. Switch on differential code modulation & demodulation trainer.
2. Apply the variable DC signal to the input terminal (sixth pin of 741) of DPC Modulation.
3. Observe the sampling signal output on Channel-1 CRO.
4. Observe the DPCM output on channel-2 of CRO, from 00000000 to 11111111 by adjusting DC voltage potentiometer.
5. Disconnect the DC voltage and apply AF oscillator output to the AF input of DPC Modulation.
6. Observe the DPCM output in synchronization with the sampling signal.
7. During demodulation, connect DPCM output to the data input of DPC demodulation.
8. Connect Clock Pulse output of DPC modulation to the CLK pulse input of DPC demodulation.
9. Observe the demodulated output.

PRECAUTIONS:

1. Avoid loose connections.
2. Observe wave forms carefully.

RESULT:

Differential Pulse Code Modulation and Demodulation is studied and corresponding waveforms are observed.





Model waveforms:

3. DELTA MODULATION

AIM:

Study of Delta Modulation and Demodulation.

EQUIPMENTS:

DCL -07 kit.
Connecting chords.
Power supply.
20MHz Dual Trace Oscilloscope.

NOTE: Keep All The Switch Faults (Switch Sf1 & Sf2) In Off Position.

PROCEDURE:

1. Refer to the block diagram (Fig. 1.3) and carry out the following connections.
2. Connect the power supply with the proper polarity to the Kit DCL-07 and switch it ON.
3. Select sine wave input 250Hz of 0V through pot P1 and connect post 250Hz to post IN of input buffer.
4. Connect output of buffer post OUT to Digital Sampler input post IN1.
5. Then select clock rate of 8 KHz by pressing switch S1 selected clock is indicated by LED glow.
6. Keep Switch S2 in Δ (Delta) position.
7. Connect output of Digital Sampler post OUT to input post IN of Integrator 1.
8. Connect output of Integrator 1 post OUT to input post IN2 of Digital Sampler.
9. Then observe the Delta modulated output at output of Digital Sampler post OUT and compare it with the clock rate selected. It is half the frequency of clock rate selected.
10. Observe the integrator output test point. It can be observe that as the clock rate is increased amplitude of triangular waveform decreases. This is called minimum step size. These waveforms are as shown in figure 1.4. Then increase the amplitude of 250Hz sine wave upto 0.5V. Signal approximating 250Hz is available at the integrator output. This signal is obtained by integrating the digital output resulting from Delta modulation.
11. Then go on increasing the amplitude of selected signal through the respective pot from 0 to 2V. It can be observed that the digital high makes the integrator output to go upward and digital low makes the integrator output to go downwards. Observe that the integrator output follow the input signal. The waveforms are as shown in the figure 1.5. Observe the waveforms at various test-points in the Delta modulator section.
12. Increase the amplitude of 250Hz sine wave through pot P1 further high and observe that the integrator output cannot follow the input signal. State the reason.
13. Repeat the above mention procedures with different signal sources and selecting the different clock rates and observe the response of Delta Modulator.
14. Connect Delta modulated output post OUT of Digital Sampler to the input of Delta Demodulator section post IN of Demodulator.
15. Connect output of Demodulator post OUT to the input of Integrator 3 post IN.
16. Connect output of Integrator 3 post OUT to the input of output buffer post IN.
17. Connect output of output buffer post OUT to the input of 2nd order filter post IN.
18. Connect output of 2nd order filter post OUT to the input of 4th order filter post IN.
19. Keep Switch S4 in HIGH position.

20. Then observed various tests points in Delta Demodulator section and observe the reconstructed signal through 2nd order filter and 4th order filter.
Observe the waveforms as shown in figure 1.5.

OBSERVATIONS:

Observe the following signal on oscilloscope and plot it on the paper. (Fig. 1.4 & Fig.1.5)

Sampling clock.

Input Signal.

Integrator 1 output at feedback loop for Delta modulator.

Digital sampler Output.

Demodulator Output.

Integrator 3 output

Filter Outputs.

PRECAUTIONS:

1. Make sure that all the switch faults are in the OFF position initially.
2. Note the readings without parallax errors.
3. Make sure that all the LEDs of the power supply glow

CONCLUSION:

Delta modulation and demodulation is studied and corresponding waveforms are observed.

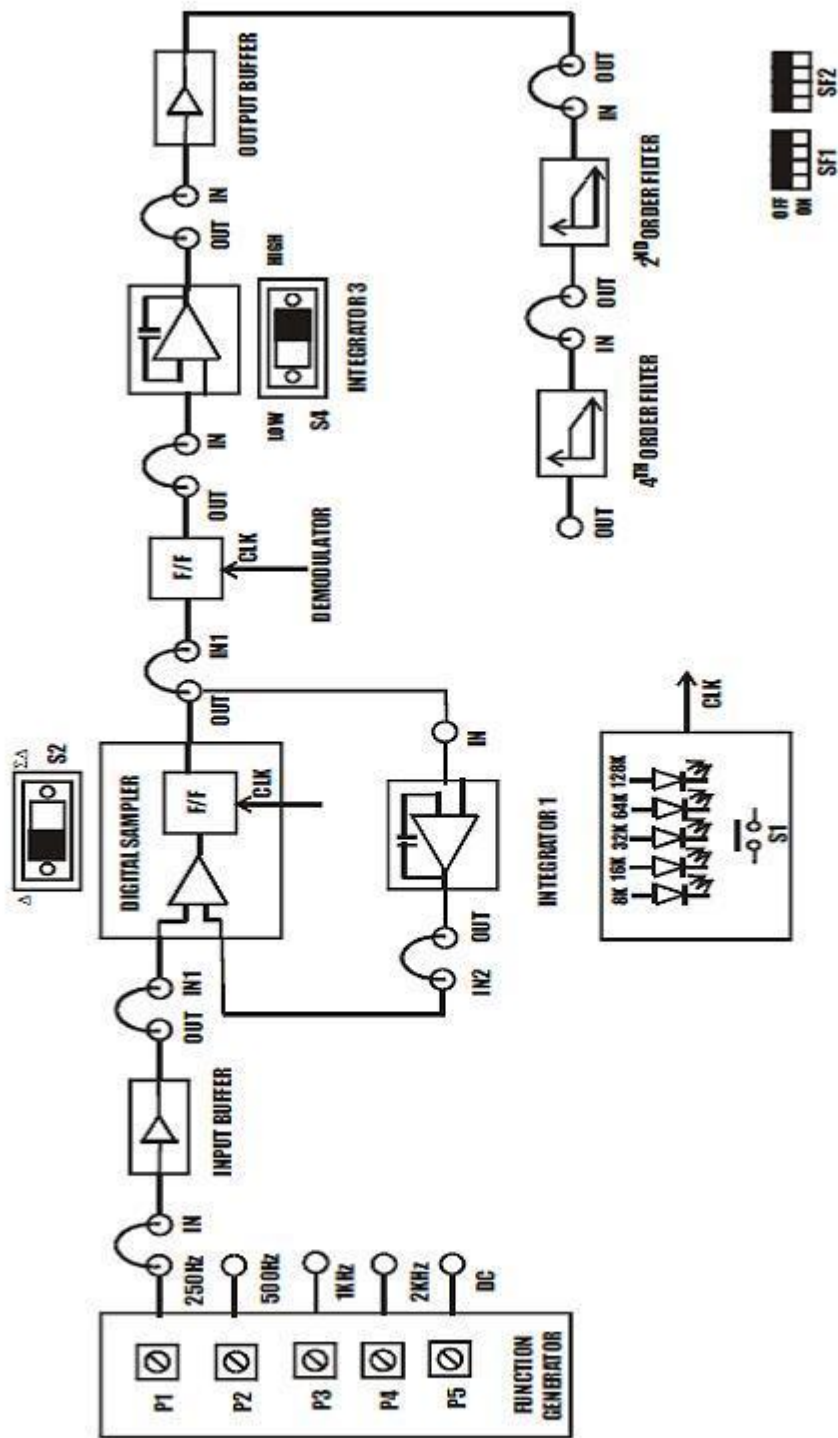


FIG. BLOCK DIAGRAM FOR DELTA MODULATION AND DEMODULATION

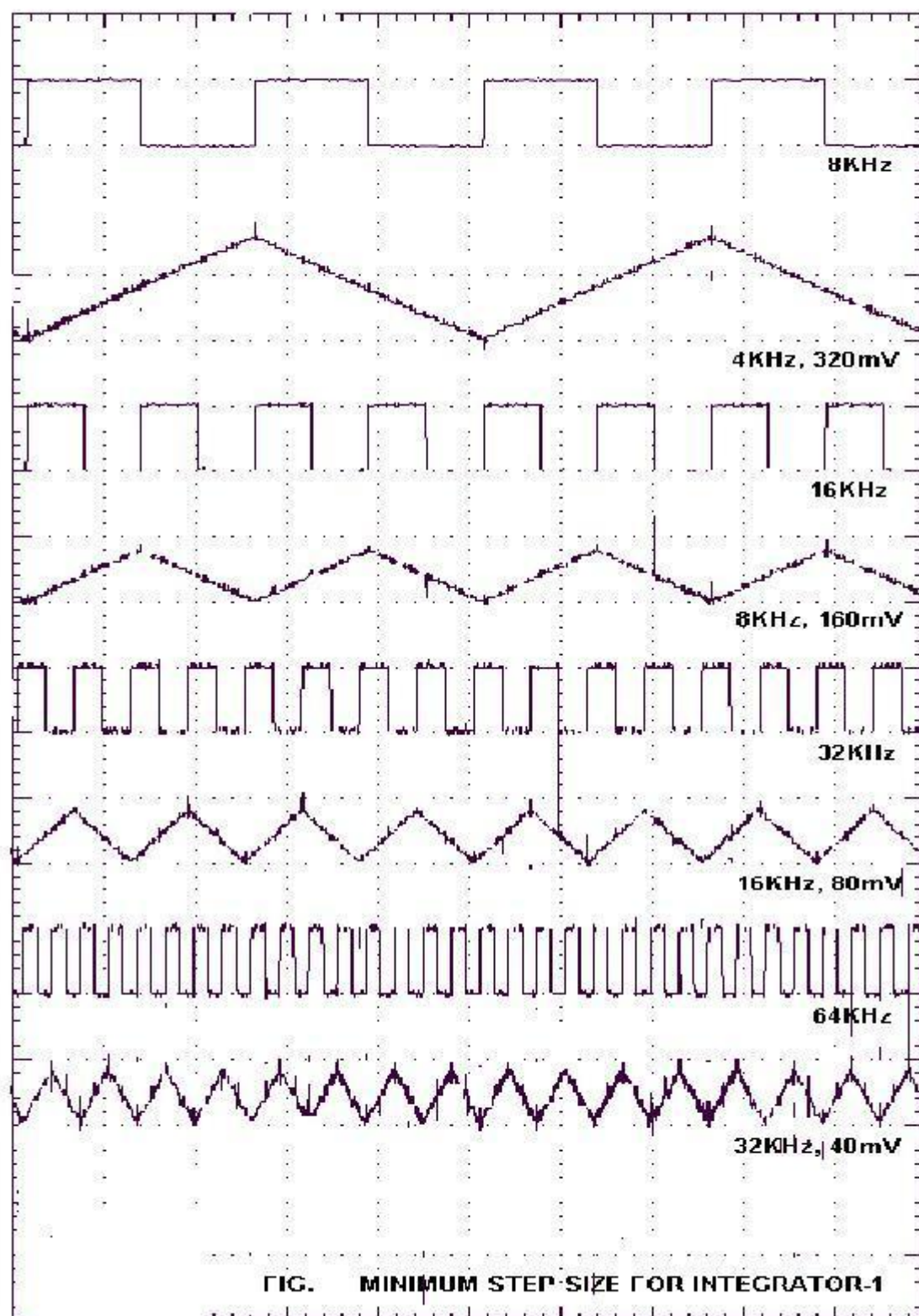
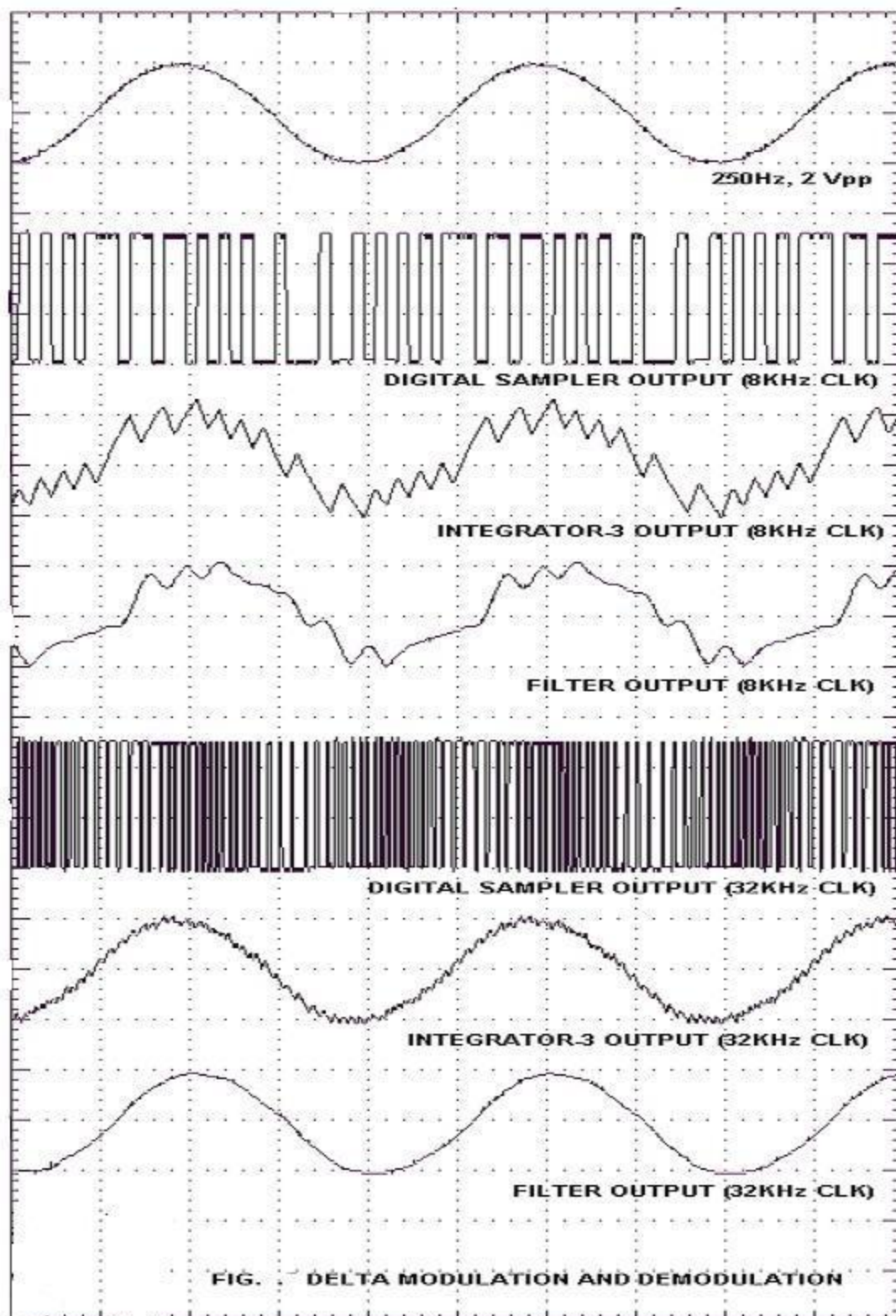
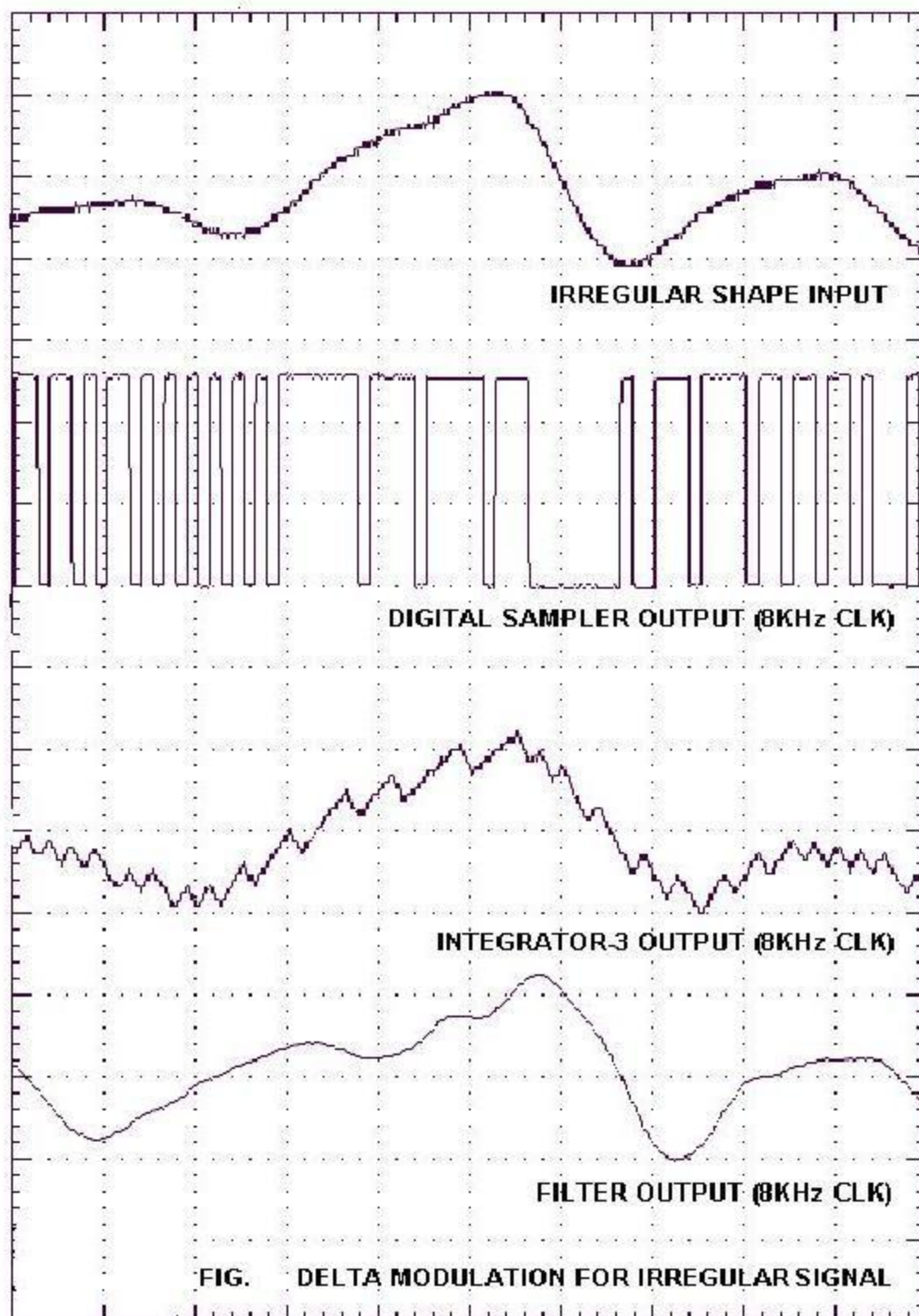


FIG. MINIMUM STEP SIZE FOR INTEGRATOR-1





4. TIME DIVISION MULTIPLEXING & DE-MULTIPLEXING

AIM:

To study Time Division Multiplexing and De multiplexing, using Pulse Amplitude Modulation and Demodulation and to reconstruct the signals at the Receiver, using Filters. The Transmitter Clock and the Channel Identification Information is linked directly to the Receiver.

EQUIPMENT REQUIRED:

Time Division Multiplexing & De-multiplexing trainer.

Oscilloscope-Dual channel.

Patch cards

CRO probes

CIRCUIT DIAGRAM:

PROCEDURE:

Multiplexing:

1. Connect the 4 channel inputs 250 Hz, 500 Hz, 1 KHz and 2 KHz to the input of transmitter CH₀, CH₁, CH₂ and CH₃ respectively.
2. See that all the amplitude pots must be in above middle positions.
3. Observe the Time Division Multiplexed wave form at the output.
4. Observe the four different signals placed in their respective time slots by varying the respective amplitude pots.

De-multiplexing:

1. Connect the TxD (transmitter data) to Rx D (Receiver data)
2. Connect Tx clock to Rx clock.
3. Connect the Tx CH0 to the Rx CH0.
4. Observe the de-multiplexed signals at the receiver across the output of fourth order LPF at CH0, CH1, CH2 and CH3 respectively.

OBSERVATIONS:

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

- a. Input Channel CH0, CH1, CH2, CH3.
- b. TX CLK and RX CLK.
- c. Multiplexer Output TXD.
- d. Demultiplexer Input RXD.
- e. Demultiplexer output CH0, CH1, CH2, and CH3.

f. Reconstructed signal OUT 0, OUT 1, OUT 2, OUT 3.

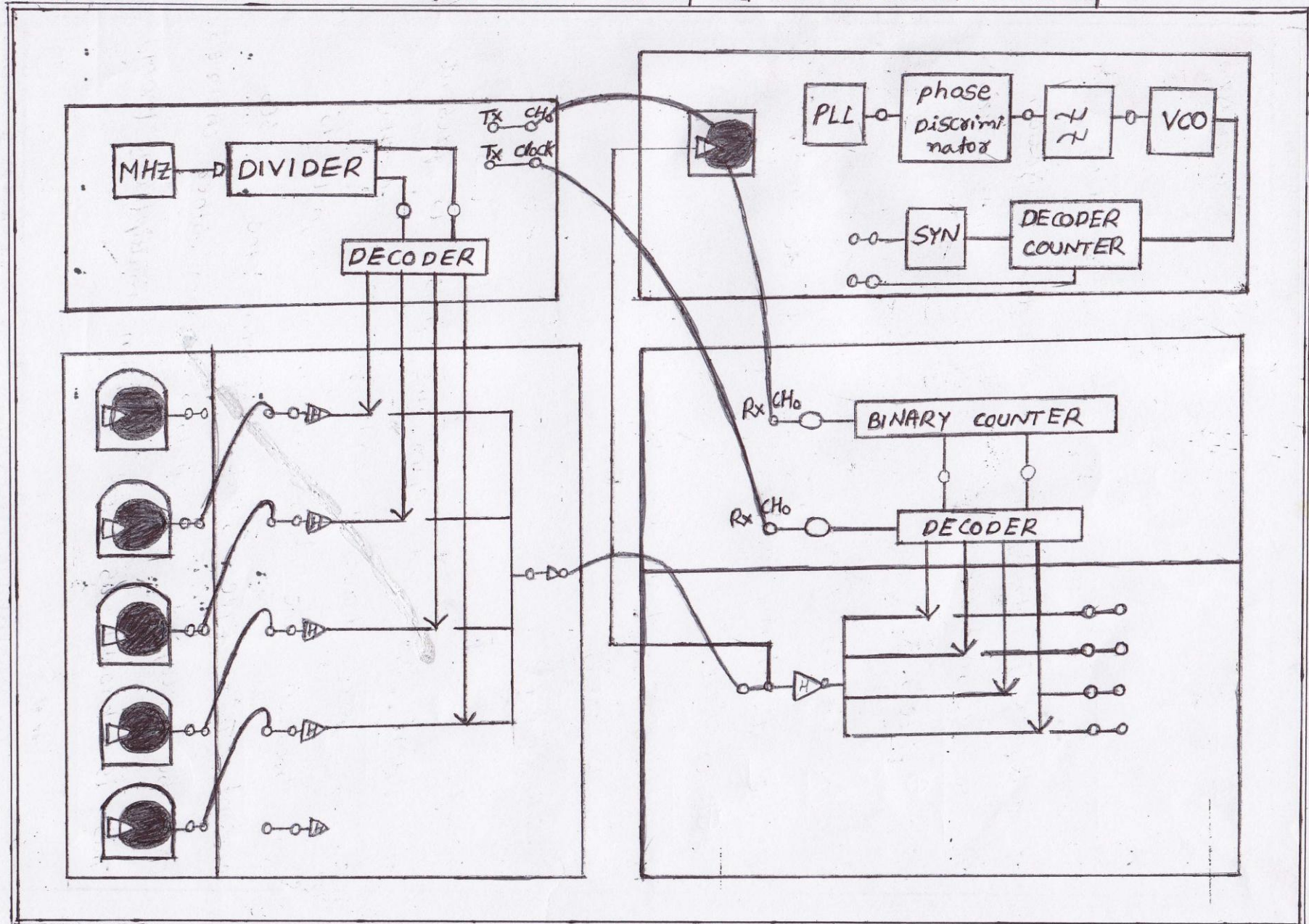
PRECAUTIONS:

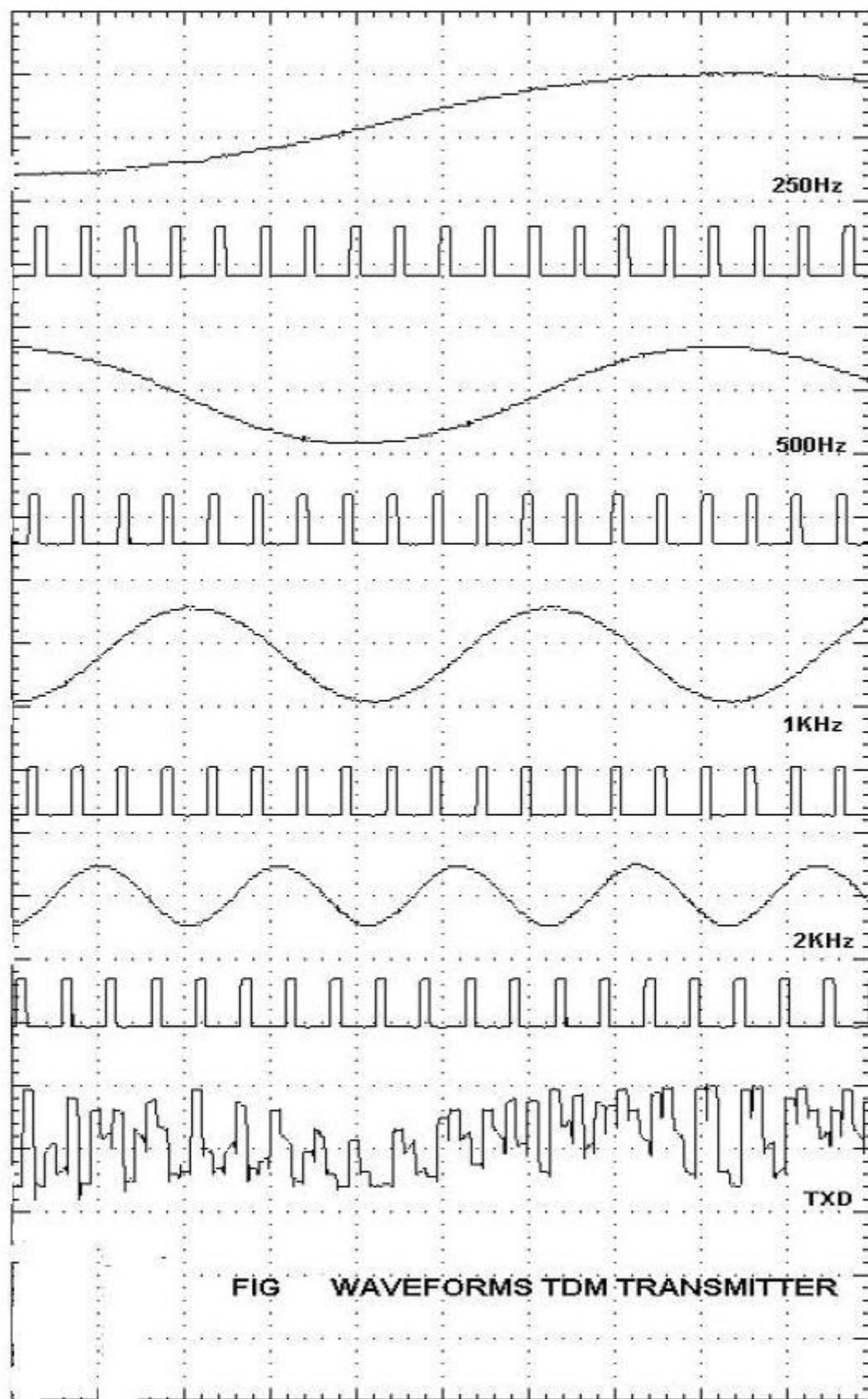
1. Avoid loose connections.
2. Observe the waveforms carefully.

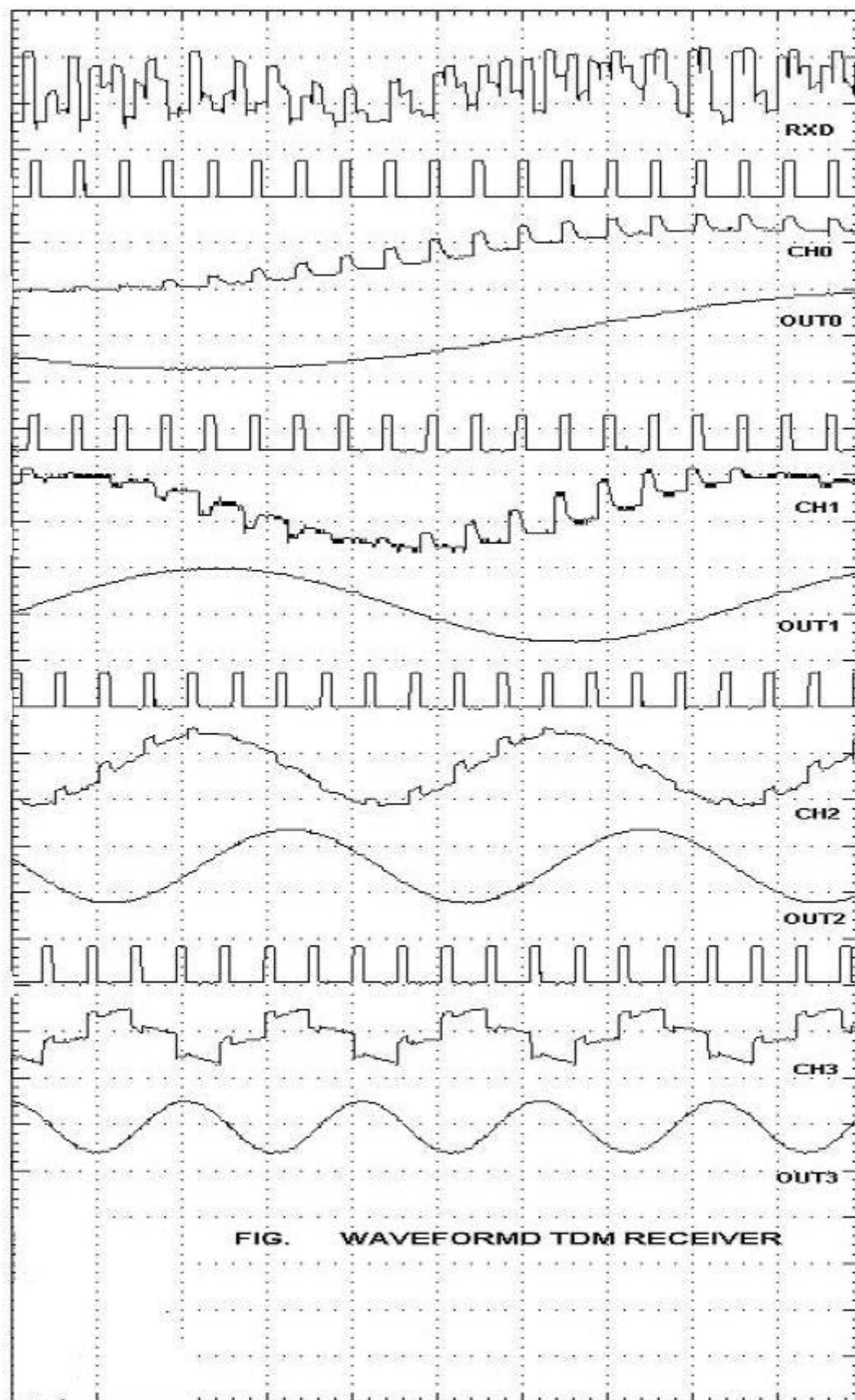
RESULT:

1. The Time division multiplexed and de multiplexed wave forms are observed.
2. The concepts about Time division multiplexing are studied.

TIME DIVISION MULTIPLEXING & DEMULTIPLEXING







5. FREQUENCY SHIFT KEYING

AIM:

Study of Carrier Modulation Techniques by Frequency Shift Keying method

EQUIPMENTS:

Experiment Kits DCL-05 & DCL-06

Patch Chords

Power supply

20MHz Dual Trace Oscilloscope

NOTE: Keep The Switch Faults In Off Position.

PROCEDURE:

1. Refer to the block diagram and carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kits DCL-05 and DCL-06 and switch it on.
3. Connect CLOCK and DATA generated on DCL-05 to CODING CLOCK IN and DATA INPUT respectively by means of the patch-chords provided.
4. Connect the NRZ-L data input to the CONTROL INPUT of the Carrier Modulator logic.
5. Connect carrier component SIN 1 to INPUT2 and SIN 2 to INPUT1 of the Carrier Modulator Logic.
6. Connect FSK modulated signal MODULATOR OUTPUT on DCL-05 to the FSK IN of the FSK DEMODULATOR on DCL-06.
7. Observe various waveforms as mentioned below.

OBSERVATION:

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

ON KIT DCL-05

1. Input NRZ-L Data at CONTROL INPUT.
2. Carrier frequency SIN 1 and SIN 2.
3. FSK modulated signal at MODULATOR OUTPUT.

ON KIT DCL-06

1. FSK Modulated signal at FSK IN.
2. FSK Demodulated signal at FSK OUT.
3. Observe output of PHASE DETECTOR, LPF, VCO on test points provided.

NOTE: In FSK demodulator PLL circuit used is very sensitive to input voltage level, because of which you may get blurred output signal if input power varies slightly. To get better results set the following bit pattern for INPUT DATA:

```
1 0 1 0 1 0 1 0
1 0 1 0 1 1 1 0
1 1 1 0 1 0 1 0
0 0 1 1 1 0 1 0
1 1 0 0 1 1 0 0
```

PRECAUTIONS:

1. Make sure that all the switch faults are in the OFF position initially.
2. Note the readings without parallax errors.
3. Make sure that all the LEDs of the power supply glow

CONCLUSION:

A small phase lag exists between the modulating data and the recovered data because of the limitation of tracking ability and the time response of PLL.

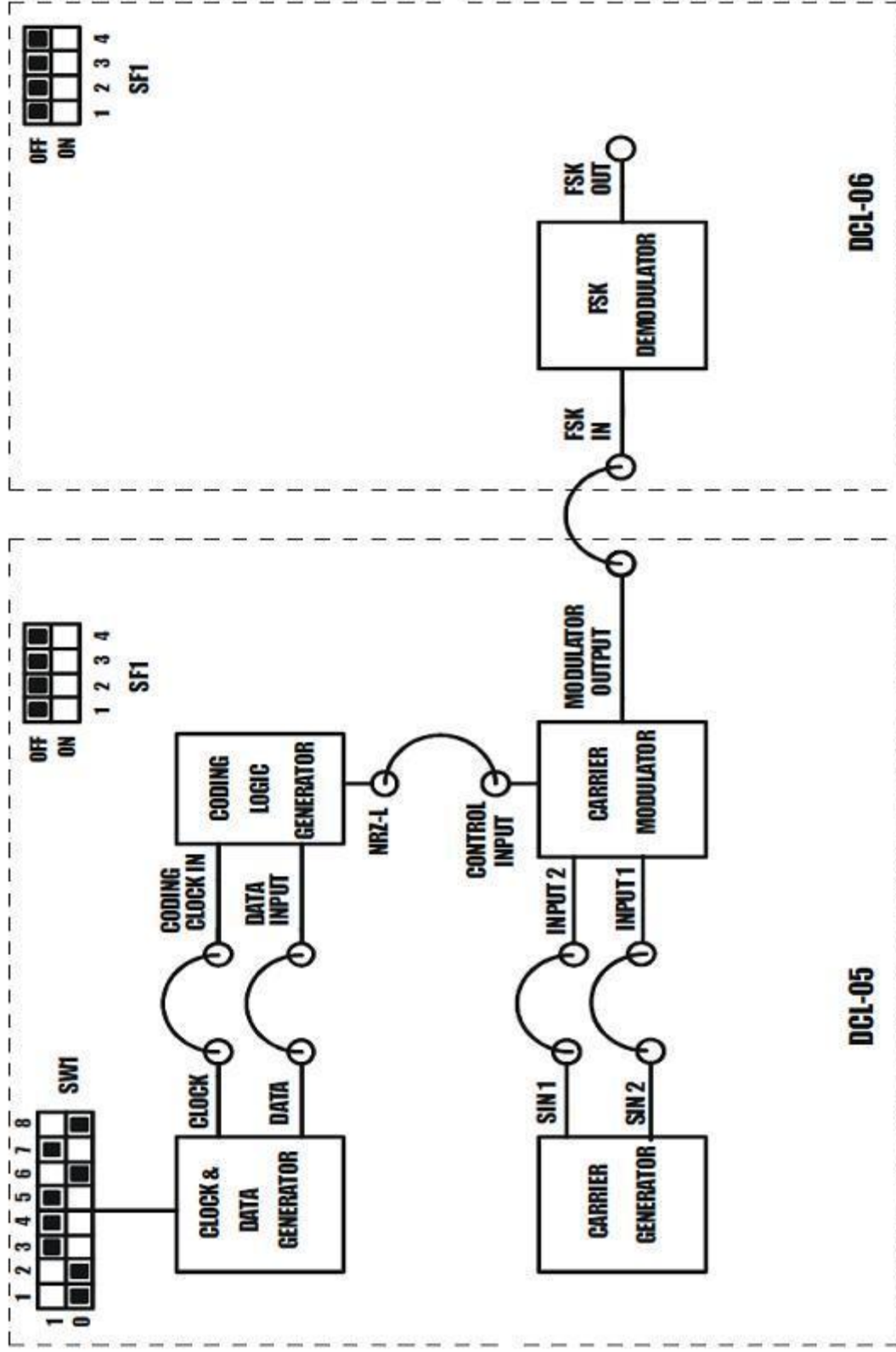
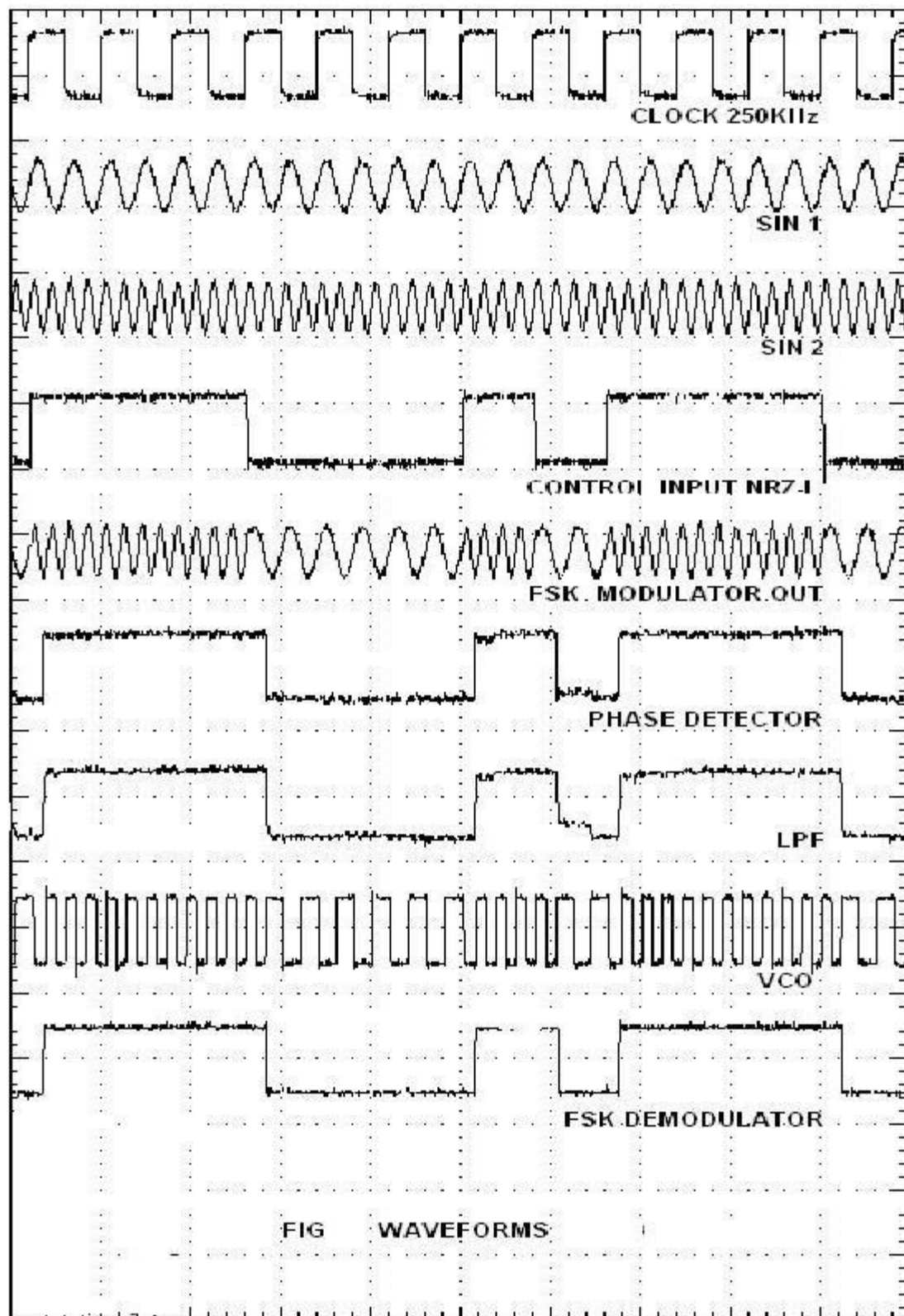


FIG BLOCK DIAGRAM FOR FREQUENCY SHIFT KEYING MODULATION TECHNIQUES



6. PHASE SHIFT KEYING

AIM:

Study of Carrier Modulation Techniques by Phase Shift Keying method.

EQUIPMENTS:

Experiment Kits DCL-05 & DCL-06.

Patch Chords.

Power supply.

20MHz Dual Trace Oscilloscope.

NOTE: KEEP THE SWITCH FAULTS IN OFF POSITION.

PROCEDURE:

1. Refer to the block diagram and carry out the following connections and switch settings.
2. Connect power supply in proper polarity to the kits DCL-05 and DCL-06 and switch it on.
3. Connect CLOCK and DATA generated on DCL-05 to CODING CLOCK IN and DATA INPUT respectively by means of the patch-chords provided.
4. Connect the NRZ-L data input to the CONTROL INPUT of the Carrier Modulator logic.
5. Connect carrier component SIN 2 to INPUT1 and SIN 3 to INPUT2 of the Carrier Modulator Logic.
6. Connect PSK modulated signal MODULATOR OUTPUT on DCL-05 to the PSK IN of the PSK DEMODULATOR on DCL-06.
7. Observe various waveforms as mentioned below.

OBSERVATION:

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

ON KIT DCL-05

1. Input NRZ-L Data at CONTROL INPUT.
2. Carrier frequency SIN 2 and SIN 3.
3. PSK modulated signal at MODULATOR OUTPUT.

ON KIT DCL-06

1. PSK Modulated signal at PSK IN.
2. PSK Demodulated signal at PSK OUT.

3. Observe output of SINE TO SQUARE CONVERTOR, SQUARING LOOP, DIVIDE BY 2 on test points provided.

PRECAUTIONS:

1. Make sure that all the switch faults are in the OFF position initially.
2. Note the readings without parallax errors.
3. Make sure that all the LEDs of the power supply glow

CONCLUSION:

It is observed that the successful operation of the PSK detector is fully dependent on the phase components of the transmitted modulated carrier. If the phase reversal of the modulated carrier along with the rising and falling edges of the data are not proper, then the efficient detection of data from PSK modulated carrier becomes impossible.

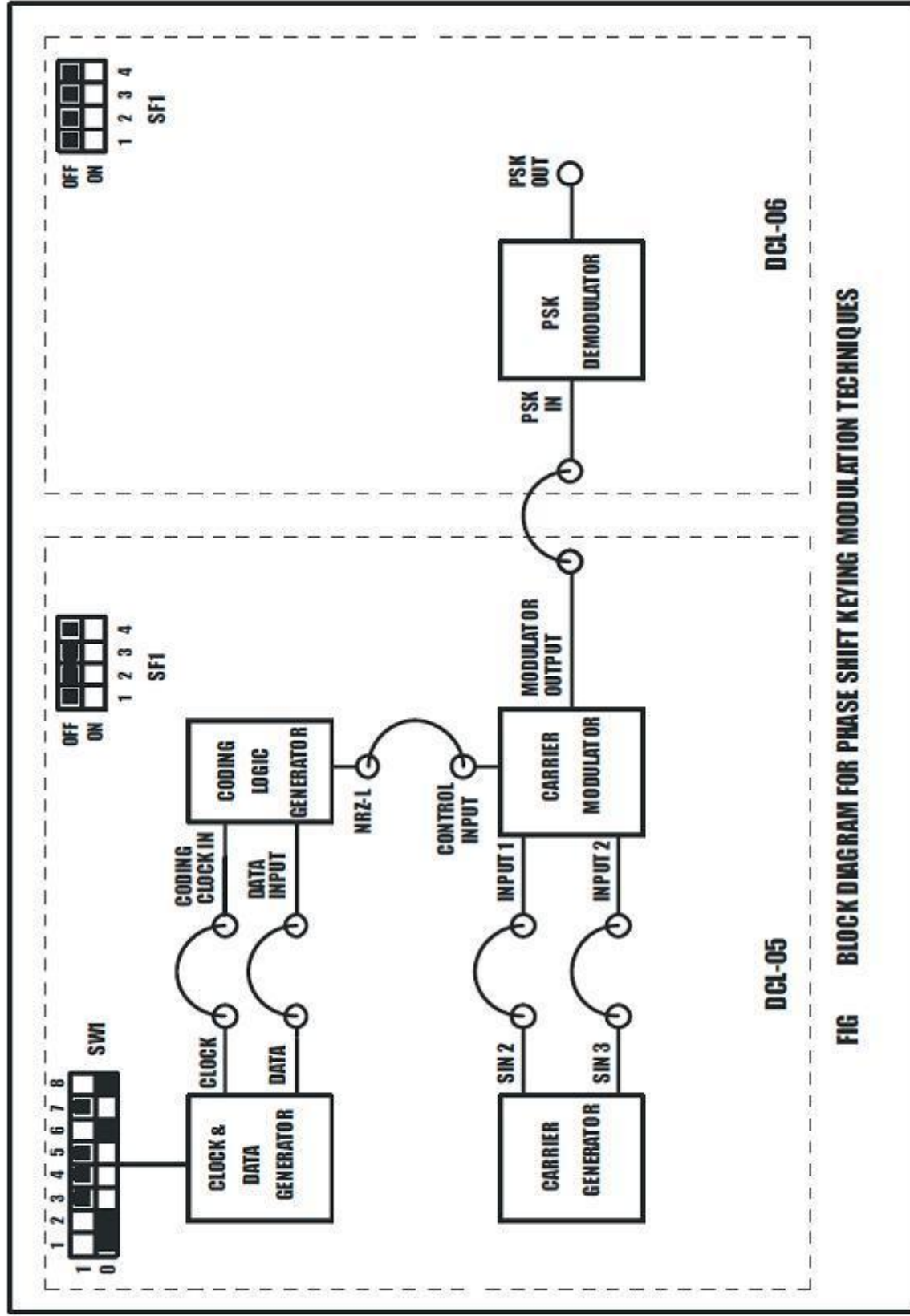
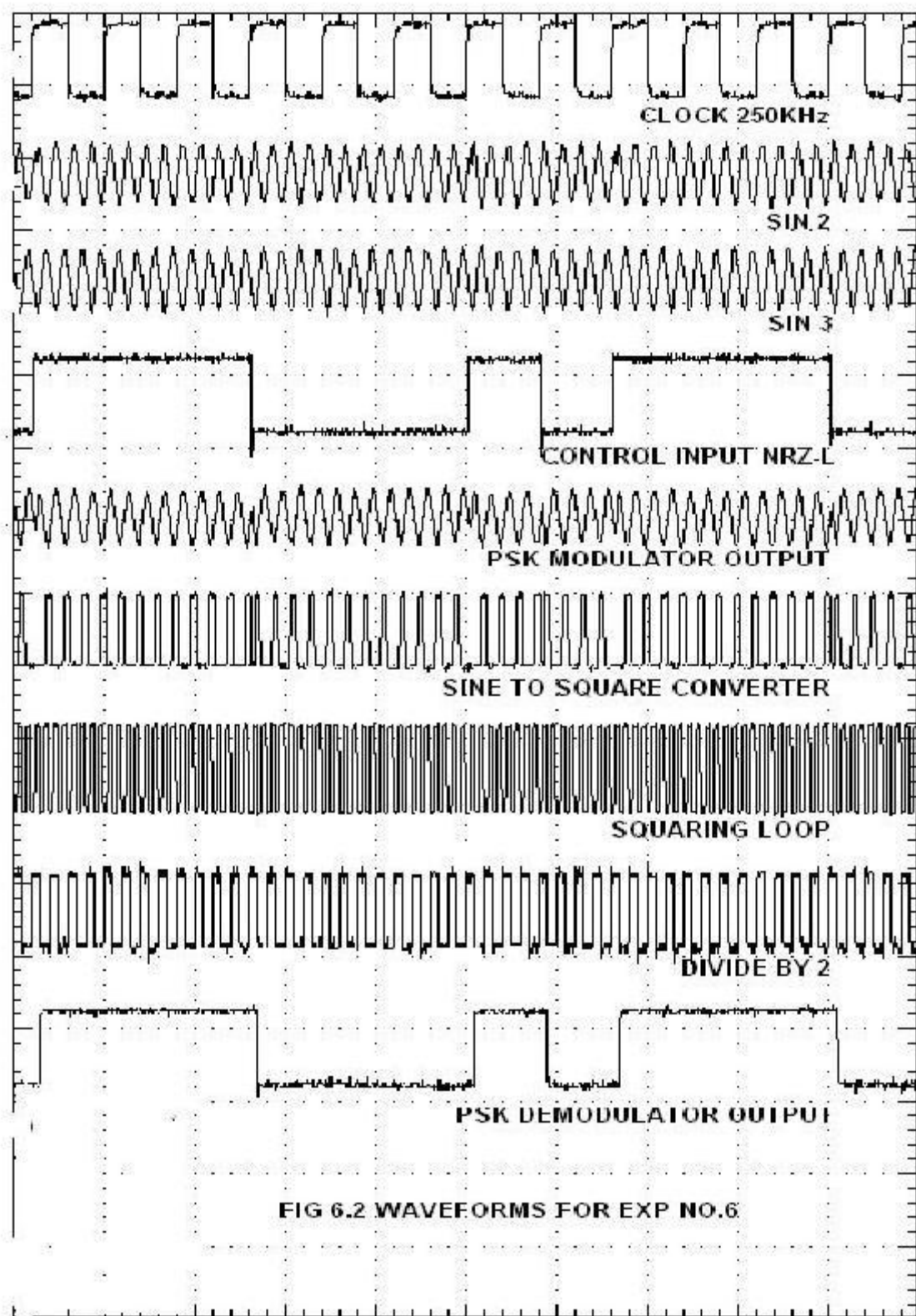


FIG BLOCK DIAGRAM FOR PHASE SHIFT KEYING MODULATION TECHNIQUES



7. DIFFERENTIAL PHASE SHIFT KEYING

AIM:

Study of Carrier Modulation Techniques by Differential Phase Shift Keying method

EQUIPMENT REQUIRED:

1. DPSK Trainer Kit.
2. Oscilloscope.
3. Patch Cards.
4. CRO Probes.

CIRCUIT DIAGRAM:

PROCEDURE:

Modulation:

1. Apply Carrier input signal from Carrier Generator to the PSK Modulator.
2. Observe the data from data source and feed it to the input of EX-nor gate(this is what, encoded data for the input source data).
3. Observe EX-NOR output and compare it with the Source data.
4. Give this encoded data to the PSK Modulator.
5. Observe the DPSK Modulated Waveform (data) at the output of PSK Modulator.

De-Modulation:

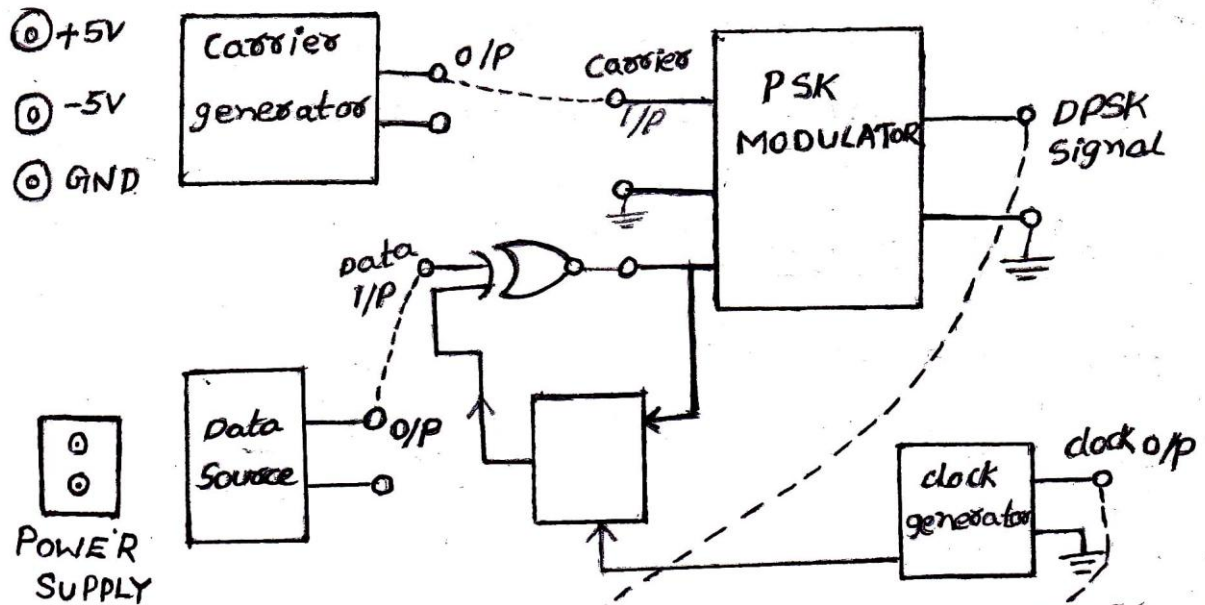
1. Connect the DPSK Modulator output to the input of DPSK demodulator.
2. Connect the clock output from clock generator of DPSK Modulator to the clock input of DPSK demodulator.
3. Short Circuit the clock generator and clock in Demodulator to get 1-bit delay.
4. Observe the encoded data from the corresponding pins at demodulator side and compare it with Transmitter's encoded data
5. Observe the delayed data with delay of 1-bit.
6. Observe the DPSK demodulated output w.r.t ground and compare with the original Source data.

RESULT:

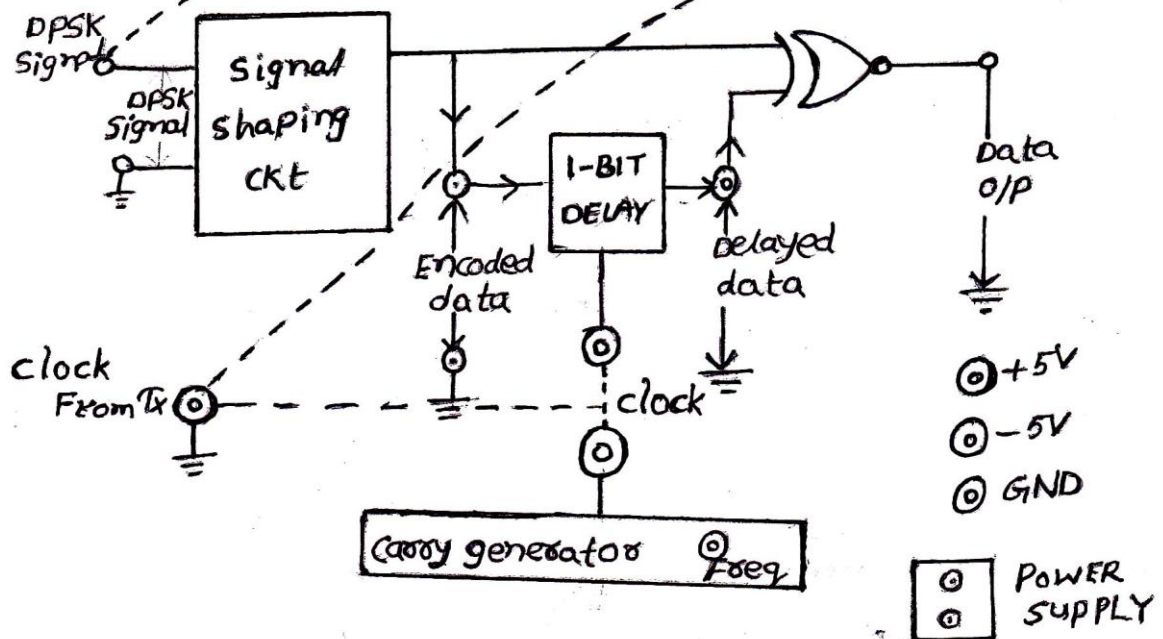
The differential coding of data to be transmitted makes the bit "1" to be transformed into carrier phase variation. In this way the receiver recognizes one bit "1" at a time which detects a phase shift of the modulated carrier, independently from its absolute phase. In this way the BPSK modulation, which can take to the inversion of the demodulated data, is overcome.

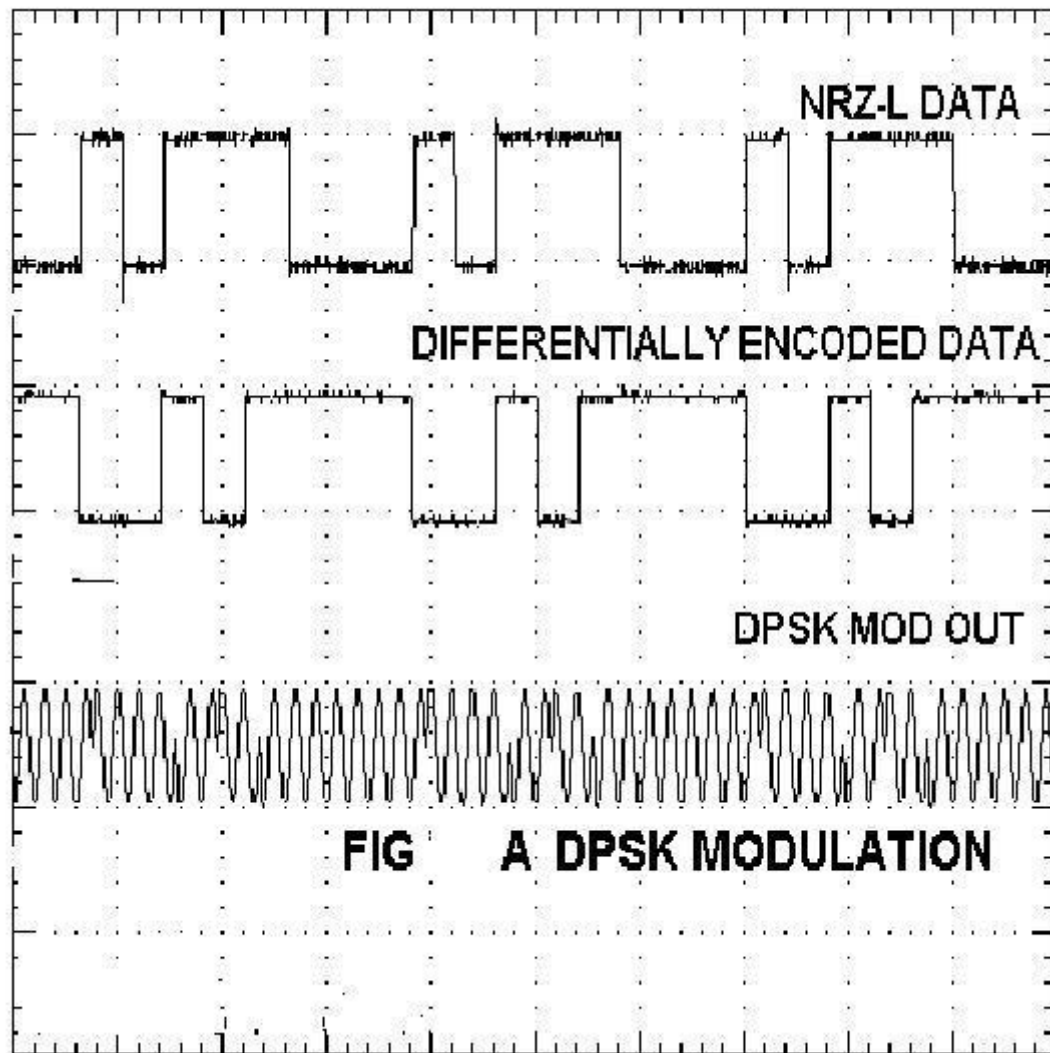
Differential Phase Shift Keying is studied and corresponding waveforms are observed.

DIFFERENTIAL PHASE SHIFT KEYING MODULATION



DIFFERENTIAL PHASE SHIFT KEYING DEMODULATION





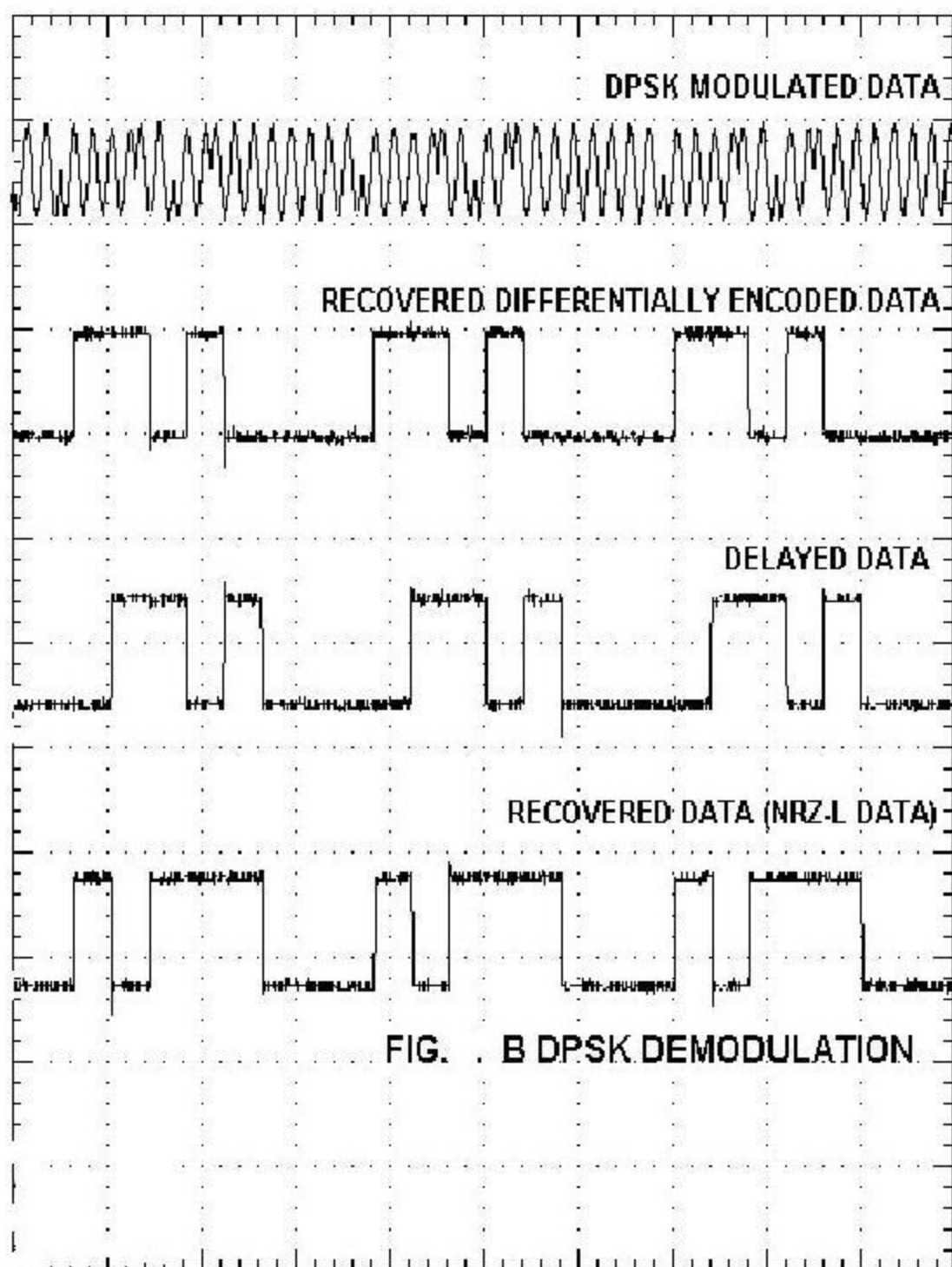


FIG. . B DPSK DEMODULATION

