EC6712 OPTICAL AND MICROWAVE LABORATORY

OBJECTIVES:

The student should be made to:

1. Understand the working principle of optical sources, detector, fibers and microwave components
2. Develop understanding of simple optical communication link.
3. Learn about the characteristics and measurements in optical fiber
4. Know about the behavior of microwave components.
5. Practice microwave measurement procedures

LIST OF EXPERIMENTS

OPTICAL EXPERIMENTS

1. DC Characteristics of LED and PIN Photo diode
2. Mode Characteristics of Fibers
3. Measurement of connector and bending losses
4. Fiber optic Analog and Digital Link- frequency response(analog) and eye diagram (digital)
5. Numerical Aperture determination for Fibers
6. Attenuation Measurement in Fibers

MICROWAVE EXPERIMENTS

1. Reflex klystron or Gunn diode characteristics and basic microwave parameter measurement such as VSWR, frequency, wavelength.
2. Directional Coupler Characteristics.
3. Radiation Pattern of Horn Antenna.
4. S-parameter Measurement of the following microwave components (Isolator, Circulator, E plane Tee, H Plane Tee, Magic Tee)
5. Attenuation and Power Measurement

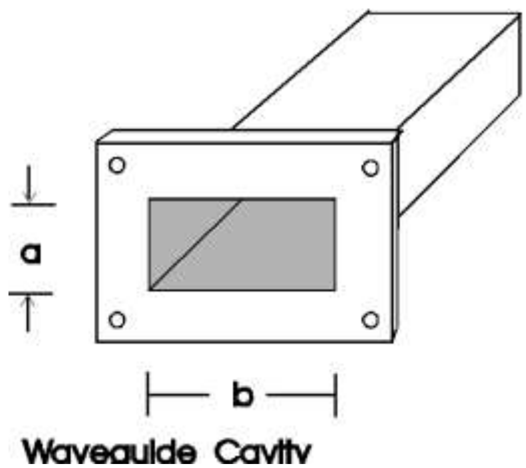
STUDY OF MICROWAVE COMPONENTS

AIM:

To study the various microwave components.

COMPONENTS:

RECTANGULAR WAVEGUIDE:



It is hollow metallic tube with a rectangular cross section. The conducting walls of the guide confines electromagnetic fields and thereby guide. A number of distinct field configurations or modes can exist in waveguides. When the wave travel longitudinally down the guide, the plane waves are reflected from wall to wall. This process results in components of either electric or magnetic field in the direction of direction of propogation of the resultant wave; therefore the wave is no longer a transverse electromagnetic (TEM) wave.

CIRCULAR WAVEGUIDE:

It is a tubular, circular conductor. A plane wave propogating through circular waveguide results in transverse electric (TE) or transverse magnetic(TM) mode. Several other types of waveguides, such as ellipitical and recentrant guides.

HORN ANTENNA:

It may be regarded as flared at or opened out waveguide. A waveguide is a couple of radiating, radiation into open space provided; the same is excited at one end and opened at another end.

If the flaring is done only in one direction, then sectorial horn is produced.

PLANE HORN:

If the flaring is in position of electric vertex, the sectorial E-plane horn is obtained.

H-PLANE HORN:

If the flaring is in direction of Magnetic field, the sectorial H-plane horn is obtained.

PYRAMIDAL ANTENNA:

If the flaring is in both the direction of electric and magnetic field, the pyramidal antenna is obtained.

BEND:

A bend is one which may be used in place where changes of direction are often required since there are discontinuities. VSWR will be increased because of different group velocity in piece of bend waveguide.

H-PLANE BEND:

H-plane is piece of waveguide bends in plane parallel to the magnetic field for the dominant mode.

E-PLANE BEND:

It is a piece of waveguide smoothly bends in a plane parallel to electric field for the dominant mode.

In order to keep the reflections in the bend small, its length is made several wavelengths.

90°TWIST:

A twist is one which is used when a range of polarization directions is required. A twist may be incorporated in a bend or in a waveguide. When the angle of twist is 90°, it is called 90° twist.

T-JUNCTION:

When it is required to combine two or more signals(or split a signal into two or more parts) in waveguide system, some part of multiple junction may be used. For simpler inter connection, T-shaped junctions are used whereas more complex junctions may be hybrid-T or hybrid rings.

H-PLANE TEE:

All three arms of H-plane Tee lies in plane of Magnetic field, which divides among the arms. This is current or parallel junctions.

E-PLANE TEE:

All three arms of E-plane Tee lie in the plane of electric field, which divides among the arms. This is voltage or series junction. It may be used for impedance matching.

MAGIC TEE:

If another arm is added either to T-junction, then hybrid T-junction, is symmetrical about an imaginary plane bisecting arm3&4 and has very useful property. Magic Tee may be used in front end of the microwave receiver. The basic property in that arm3 and 4 are both connecting to arms1 and 2 but not to each other. This applies for dominant mode only, provided each arm is terminated at the correct load.

ISOLATOR:

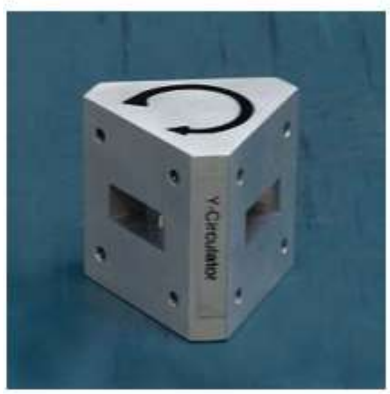
It is a two port device that allows un attenuated transmission of power in one direction, whereas power incident from other direction is completely absorbed inside isolator.

When the isolator is inserted between generator and load, the generator is coupled to the load.

CIRCULATOR:

It is a 4-port network which has peculiar property that each terminal is connected only to clockwise terminal. It is used in parametric amplifier, tunnel diode amplifiers and duplexer in RADAR.

High power circulators are similar to those of resonance isolator and handle power upto 30MW peak.



DIRECTIONAL COUPLER:

It is a 4-port network commonly used for sampling known fraction of microwave power flowing in particular direction.

It is 4 port waveguide consisting of primary main waveguide and secondary auxillary waveguide. They can be designed to measure incident power, received power, standing wave ratio, etc.

HELICAL ANTENNA:

It is a broadband VHF and UHF antenna which is used when it is desired to provide circular polarization characteristics.

The antenna has loosely wound helix packed up by a ground plane is simply screen made of ‘chicken’ wire. There are two modes of radiation, normal and axial. The normal mode is one in which radiations are at right angle to axis of helix. The axial mode is one in which broadband is provided fairly directional radiation in axial direction. The helical antenna is used either singly or in array for transmission and reception of VHF signals through ionosphere.

DISH ANTENNA:

This is also known as ‘Paraboloid’ or ‘microwave dish’. A parabola is 2D plane curve. A practical reflector is 3D plane curve surface. Therefore rotating parabola about its axis forms practical reflector. The surface so generated is known as ‘Paraboloid’ or’Parabolic reflector’.

MICROSTRIP ANTENNA:

In space craft or aircraft application, where size, weight, cost, performance, ease of installation and aerodynamic profile is constrains low profile antennas are required. In order to meet the specification, microstrip or patch antennas are used.

Microstrip or patch antennas are popular for low profile applications at frequencies above 10MHZ. the major disadvantage of patch or microstrip antennas.

RESULT:

Thus the various microwave components are studied.

EX.NO:1(a)

DATE:

CHARACTERISTICS OF REFLEX KLYSTRON

AIM

To study the mode characteristics of reflex characteristics and to determine the following:

1. Mode of oscillation
2. Transit time
3. Electronic tuning range (ETR)
4. Electronic tuning sensitivity (ETS)

EQUIPMENTS REQURED

Reflex klystron power supply, reflex klystron oscillator, isolator, variable attenuator, frequency meter, slotted line section with tunable probe, detector, VSWR meter/CRO

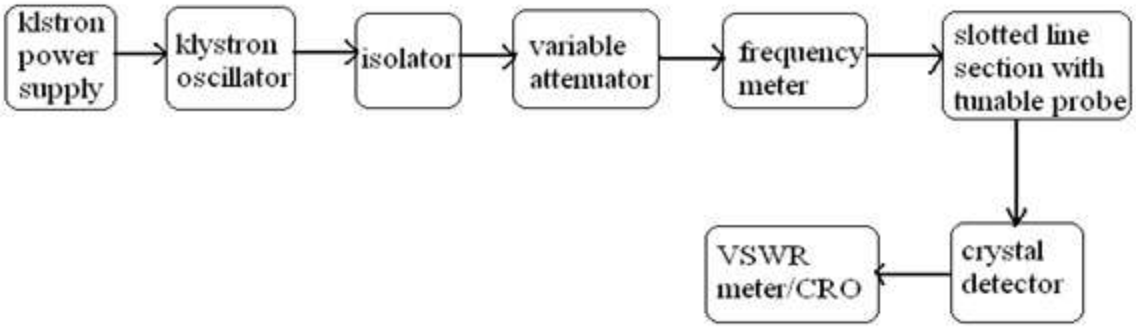
FORMULA USED

1. Mode of oscillation N =n+3/4
2. Transit time(t)=n+3/4/f_0 (sec)

   Where n=integer(n=1,2,3………..)

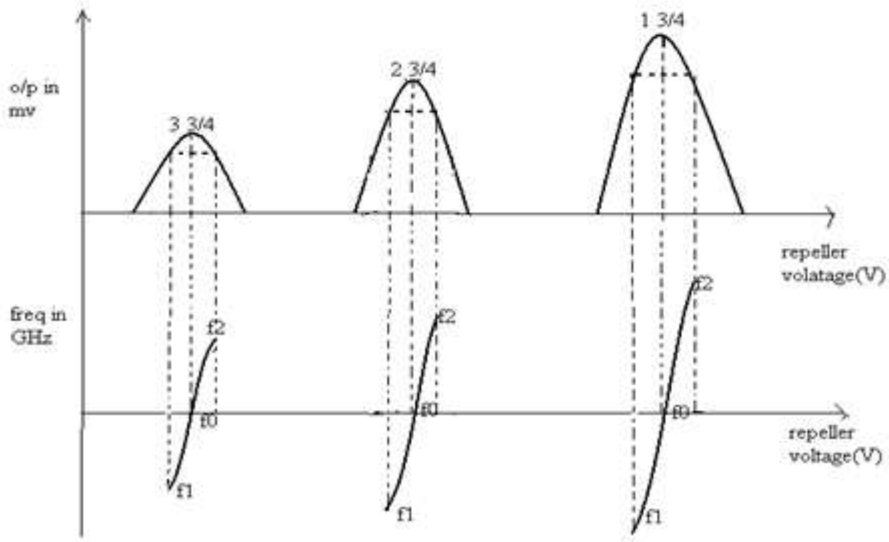
3. 3dB electronic bandwidth=f_2-f_1(GHz)
4. ETS=f_2=f_1/v_2-v_1(MHz/volt)
5. ETR=fmax-fmin(GHz)

BLOCK DIAGRAM



TABULAR COLUMN

MODE	REPELLER VOLTAGE (V)	O/P VOLTAGE (mv)	FREQUENCY (GHz)
1 2 3			



THEORY

When an electric field is applied across a gunn diode, oscillations at microwave frequencies are generated, at the voltage v, gunn GaAs diode exhibits negative resistance effect. When the gunn diode is biased, a disturbance is created at the cathode. This disturbance gives rise to a high field region which travels towards the cathode. When this high field domain reaches the anode it disappears and other domain is formed at the cathode and starts moving towards the anode and so on.

The time required for the domain to travel from cathode to anode (transit time) gives the oscillation frequency. When the diode is placed in resonant cavity, the oscillation frequency is determined by the cavity more than the diode itself.

The cavity consists of a waveguide section with movable short circuit section. It can be continually moved by tuning the knob and thus oscillation frequency is changed. Gunn diode can be amplitude modulated with the bias voltage and a separate PIN diode can also be used to obtain square wave modulation. A measure of the square wave modulation capability is the modulation depth.

PROCEDURE

1. Keep the control knob of klystron power supply as below

Beam knob : minimum

Mode switch : AM

Repeller voltage : maximum

AM amplitude knob: around maximum

FM frequency knob: around mid position

2. Switch ‘on’ klystron power supply and cooling fan switch

3. Switch ‘on’ the beam voltage and set the beam voltage to 300V

4. Adjust the reflex klystron voltage to get some deflection in VSWR meter

5. Maximize the deflection by tuning AM amplitude, freq control of power supply and reflector voltage.

6. Tune the frequency meter to get dip on VSWR scale and note down the frequency directly from frequency meter and then retune it.

7. Repeat the above steps for various modes and for various repeller voltage. Plot the graph between frequency and repeller voltage and between repeller voltage and the o/p voltage or o/p power.

RESULT

Thus the mode characteristics of reflex klystron are studied and the following determined

1.Mode of oscillation

2.Transit time

3.Electronic tuning range

4.Electronic tuning sensitivity

EX.NO:1(b)

DATE:

GUNN DIODE CHARACTERISTICS

AIM

a) To study the V-I characteristics of GUNN diode.
b) Measurement of wavelength and operating frequency of Gunn diode using slotted waveguide (without frequency meter).

EQUIPMENTS REQUIRED

GUNN power supply, GUNN oscillator, PIN modulator, isolator, variable attenuator, frequency meter, slotted line section, CRO or SWR meter, wave guide stands,

THEORY

When an electric field across the GUNN diode, oscillations at microwave frequencies are been generated, at the voltage V, GUNN diode establishes negative resistance effect. When the GUNN diode is biased, a disturbance is created at the cathode. This disturbance gives rise to a high field region, which travels towards the anode. When this high field domain reaches the anode, it dis appears and the other domain is formed at the cathode and starts moving towards the anode and so on.

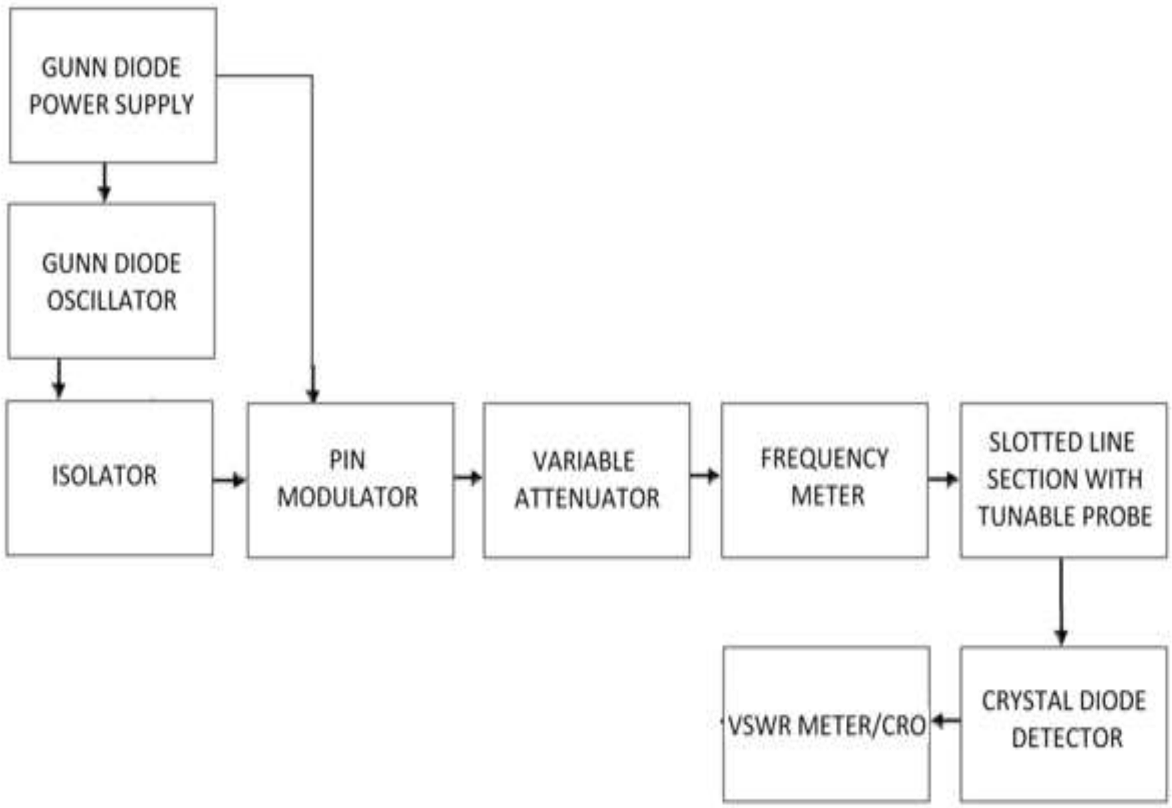
The time required for the domain to travel from cathode to anode gives the oscillation frequency. When the diode is placed in resonant cavity, the oscillation frequency is determined by the cavity more than the diode itself.

The cavity consists of a wave guide section with movable short circuit section. It can be continuously moved by tuning the knob and thus oscillation frequency is changed. A measure of square wave modulation capability is, the modulation depth.

PROCEDURE (a):

- Set up the test bench as shown.
- Obtain oscillations and the frequency using the general procedure.
- Increase the GUNN bias voltage in steps of 0,5V from 0V to 12V and note down the corresponding current values.
- Tabulate the readings and plot the graph of voltage Vs current.
- From the graph, note down the voltage V i.e., the minimum voltage at which the diode exhibits negative resistance.

BLOCK DIAGRAM:

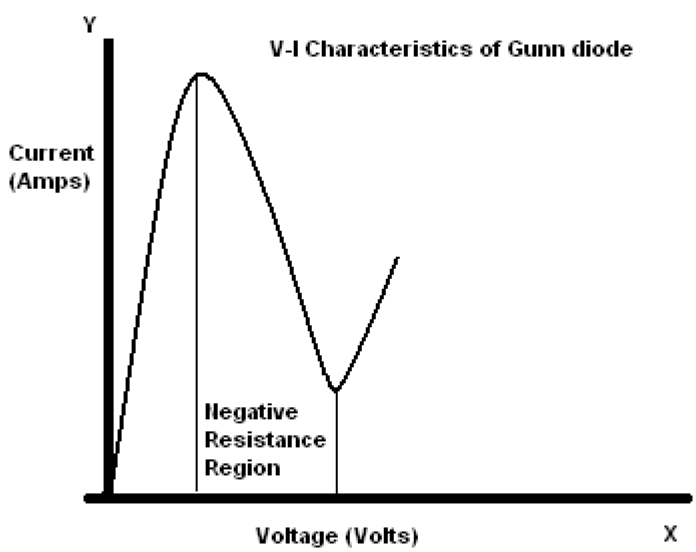


VI Characteristics:

S.No	Voltage(volts)	Current(amps)

Measurement of Wavelength:

S.No	Vernier reading (cm)	Distance between two successive minima (d)	Guide wavelength (cm) $2d=\lambda_g$	Free space wavelength (cm) λ_0	Frequency $f=c/\lambda_0$ (Ghz)



PROCEDURE (b):

- Set up the test bench as shown in the block diagram.
- Obtain oscillations and the frequency using the general procedure.
- Move the probe carriage of the slotted line section in one direction and notice minimum deflection in SWR meter.
- Note down the probe position corresponding to the minimum deflector.
- Move the probe carriage again in the same direction and follow the same procedure to obtain a number of minimum points

a) The difference between two successive minima gives the value of d and $2d=\lambda_g$

b) Calculate λ_0 and frequency f

RESULT

The V-I characteristics of GUNN diode is studied. The minimum voltage at which the diode exhibits negative resistance is ___________________V.

Frequency of oscillation _____________________________GHz.

EX.NO:1(C)

DATE:

FREQUENCY AND WAVELENGTH MEASUREMENT

AIM:

To determine the frequency and wavelength in a rectangular waveguide working in TE mode.

EQUIPMENT REQUIRED:

Using Reflex Klystron:
Klystron tube, Klystron power supply, Klystron mount, Isolator, Frequency meter, Variable attenuator, Slotted section waveguide, Tunable probe, VSWR meter, Waveguide stand, Movable short/matched termination.

Using Gunn diode:
Gunn oscillator, Gunn power supply, Pin modulator, Isolator, Frequency meter, Variable attenuator, Slotted section waveguide, Tunable probe, VSWR meter, detector mount, matched termination, SS tuner, cables, cooling fan.

THEORY:

For dominant TE mode rectangular waveguide I_0, I_g, and I_c, are related as below

$$\frac{1}{\lambda_o^{\ 2}} = \frac{1}{\lambda_g^{\ 2}} + \frac{1}{\lambda_c^{\ 2}}$$

where,

λ_0 is free space wavelength

λ_g is guide wavelength

λ_c is cutoff wavelength For TE mode, I =2a where “a” is broad dimension of waveguide

PROCEDURE:

Using Reflex Klystron:

1. Setup the components and equipments as shown in figure.

2. Setup variable attenuator at minimum attenuation position.

3. Keep the control knobs of VSWR meter as below:

Range-50db

Input switch- crystal low impedance

Meter switch-normal position

Gain(Coarse & Fine)- Mid position

4. Keep the control knobs of Klystron power supply as below

   Meter switch- 'OFF’

   Mod-switch-AM

   Beam voltage- OFF

   Beam Voltage knob-Fully anticlockwise

   Reflector Voltage- Fully clockwise

   AM- Amplitude knob- Around fully clockwise

   AM- Frequency knob – Around Mid position

5. Switch ‘ON’ the Klystron power supply, VSWR meter and cooling fan.
6. Rotate the meter switch of power supply to beam voltage position and set beam voltage at 300 V (you should not make beam voltage higher than 300V) with help of beam voltage knob (you should not touch this knob till the end of the experiment).
7. Adjust the reflector voltage to get some deflection in VSWR meter.
8. Maximize the deflection with AM amplitude and frequency control knob of power supply. 9. Tune the plunger of Klystron Mount for maximum deflection.
10. Tune the reflector voltage knob for maximum deflection.
11. Tune the probe for maximum deflection in VSWR Meter.
12. Tune the frequency meter knob to get a ‘dip’ on the VSWR scale and note down the frequency directly from frequency meter.
13. Replace the Termination with movable short, and detune the frequency meter.
14. Move the probe along the slotted line. The deflection in VSWR meter will vary. Move the probe to a minimum deflection position, to get accurate reading. If necessary increase the VSWR Meter range db switch to higher position. Note and record the probe position.

15. Move the probe to next minimum position and record the probe position again.

16. Calculate the guide wavelength as twice the distance between two successive minimum positions obtained as above.

17. Measure the waveguide inner broad dimension 'a' which will be around 22.86 mm for Xband.

18. Calculate the frequency by following equation

$$f = \frac{c}{\lambda_0} = c\sqrt{\frac{1}{\lambda_g^2} + \frac{1}{\lambda_c^2}}$$

where C=3×10^8 meter/sec (velocity of light)

19. Verify the frequency obtained by frequency meter.

20. Above experiment can be verified at different frequencies.

Using Gunn Oscillator:

1. Setup the components and equipments as shown in figure.

2. Setup variable attenuator at minimum attenuation position.

3. Keep the control knobs of the Gunn power supply as below:

    Meter switch- OFF

    Gunn bias knob-Fully anticlockwise

    PIN bias knob- Fully clockwise

    PIN mode Frequency– Any position

4. Keep the control knobs of VSWR meter as below:

    Meter switch- Normal

    Input switch- Low impedance

    Range dB switch- 40dB

    Gain control knob- Fully clockwise

5. Set the micrometer of Gunn Oscillator for required frequency of operation.

6. Switch 'ON' the Gunn Power Supply, VSWR Meter and Cooling fan.

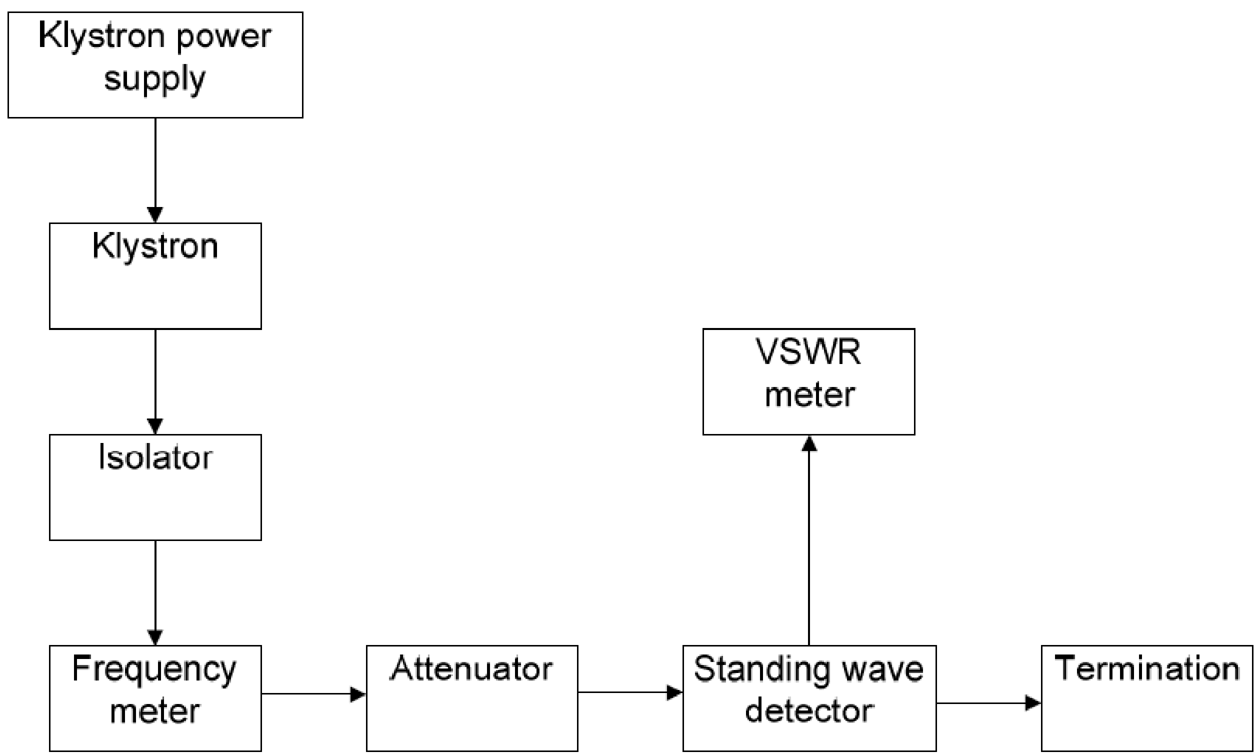
A. Output power and frequency as a function of bias voltage:

1. Turn the meter switch of the Gunn power supply to voltage position.
2. Increase the Gunn bias control knob.
3. Rotate PIN bias knob to around maximum position.
4. Tune the output in the VSWR meter through frequency control knob of modulation.
5. If required then change the range dB switch of VSWR meter to high Db position to get deflection on VSWR meter. Any level can be set through variable attenuator and gain control knob of VSWR meter.
6. Measure the frequency by frequency meter and detune it.
7. Reduce the Gunn bias voltage in the interval of 0.5V to 10 V and note down corresponding reading of output at VSWR meter \and frequency meter.
8. Use the reading to draw the power V_s voltage and frequency V_s voltage graph.
9. Measure the pushing factor (in MHz/Volt) which is frequency sensitivity against variation in bias voltage for an oscillator. The pushing factor should be measured around 8 volt bias.

B. SQUARE WAVE MODULATION

1. Keep the meter switch of GUNN power supply to volt position and rotate Gunn bias voltage slowly for maximum output not more than 10 V.
2. Tune the PIN modulator bias voltage and frequency knob for maximum output on the oscilloscope.
3. Chanced the bottom of square wave oscilloscope to some reference level and notedown the micrometer reading of variable attenuator.
4. Now with the help of variable attenuator changed the square wave to same reference level and note down the micrometer reading.
5. Connect the VSWR to detector mount and note down te dB reading in VSWR meter for both the micrometer reading of the variable attenuator.
6. The difference of both dB reading in VSWR meter gives the modulation depth of PIN modulator.

BLOCK DIAGRAM: EXPERIMENTAL SET UP FOR FREQUENCY AND WAVELENGTH MEASUREMENT



EX.NO:1(D)

DATE:

VSWR MEASUREMENT

AIM:

To determine the Voltage Standing Wave Ratio and Reflection Coefficient of a waveguide.

APPARATUS:

Klystron Power Supply, Klystron Tube, Klystron Mount, Isolator, Frequency Meter, Variable attenuator, Slotted Line, Tunable Probe, SS Tuner, Detector Mount, Wave Guide Stand, VSWR Meter, Oscilloscope, BNC Cable

THEORY:

The electromagnetic field at any point of transmission line may be considered as the sum of two traveling 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 traveling waves, give 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 or maximum is half the guide wavelength on the line. The ratio of electrical field strength of reflected and incident wave is called reflection coefficient. The voltage standing wave ratio is defined as ratio between maximum and minimum field strength along the line. VSWR is denoted by S and is given as

$$S=\frac{E_{max}}{E_{min}}$$

$$=\frac{|E_i|+|E_r|}{|E_i|-|E_r|}$$

where,

E_i= Incident Voltage

E_i = Refected Voltage

Reflection co.efficient $\rho = \frac{E_r}{E_i} = \frac{Z_L - Z_0}{Z_L + Z_0}$

where,

Z_L= load impedance

Z_0= characteristics impedance

The above equation gives the following equation

$$\rho = \frac{S-1}{S+1}$$

PROCEDURE:

1. Set up the components and equipments as shown in figure.
2. Keep the variable attenuator in the minimum attenuation position.
3. Keep the control knobs of VSWR meter as below
   - Range dB - 40 db/50db
   - Input Switch - Low Impedance
   - Meter Switch - Normal
   - Gain (Coarse- Fine) - Mid Position Approx.
4. Keep the control knobs of Klystron Power Supply as below
   - Beam Voltage - OFF
   - Mod- Switch - AM
   - Beam Voltage Knob - Fully Anticlockwise
   - Reflector Voltage Knob - Fully Clockwise
   - AM-Amplitude Knob - Around Fully Clockwise
   - AM- Frequency 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 the beam voltage at 300V.
7. Rotate the reflector voltage knob to get deflection in VSWR meter.
8. Tune the output by turning the reflector voltage knob, amplitude and frequency of AM Modulation.
9. Tune the plunger of Klystron Mount and Probe for maximum deflection in VSWR meter.
10. If required, change the range db- switch variable attenuator position and gain control knob to get maximum deflection in the scale of VSWR meter.

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

A. **Measurement of Low and Medium VSWR**

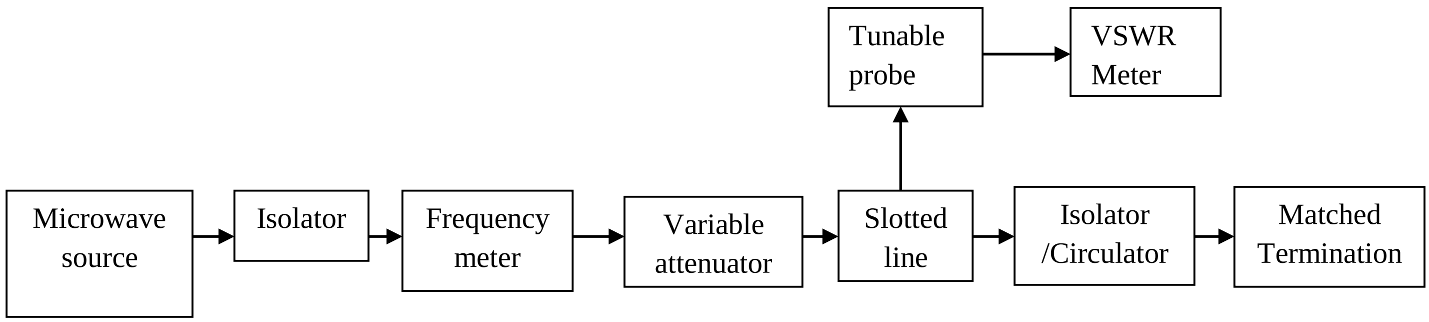
1. Move the probe along the slotted line to get maximum deflection in VSWR meter.
2. Adjust the VSWR meter gain control knob or variable attenuator until the meter indicates 1.0 on normal VSWR meter scale.
3. Keep all the control knobs as it is, move the probe to the next minimum position. Read the VSWR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

B. **Measurement of High VSWR(Double Minima Method)**

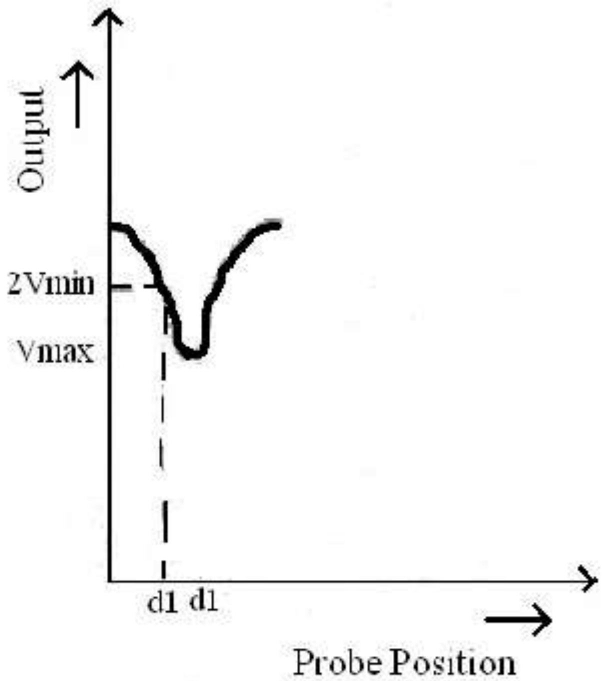
1. Set the depth of SS Tuner slightly more for maximum VSWR.
2. Move the probe along with slotted line until a minimum is indicated.
3. Adjust the VSWR meter gain control knob and variable attenuator to obtain a reading of 3db in the normal dB scale (0 to 10dB) of VSWR meter.
4. Move the probe to the left on the slotted line full scale deflection is obtained on 0-10dB scale. Note and record the probe position on slotted line. Let it be d_1.
5. Repeat the steps 3 and then move the probe right along the slotted line until full scale deflection is obtained on 0-10 dB in normal dB scale. Let it be d_2.
6. Replace the SS Tuner and termination by movable short.
7. Measure the distance between the successive minima positions of the probe. Twice this distance is guide wavelength λ_g.
8. Compute SWR from the following equation

$$SWR = \lambda_g/\pi\ (d_1-d_2)$$

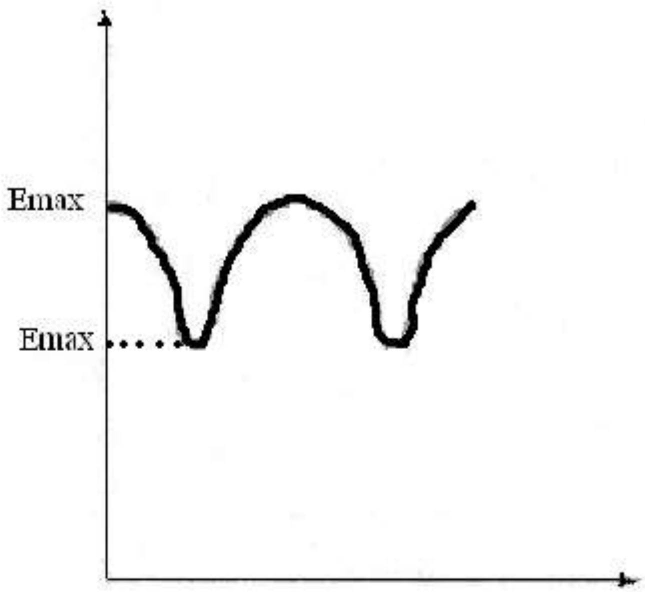
BLOCK DIAGRAM – VSWR MEASUREMENT



MODEL GRAPH



Double Minima Method



Standing wave

OBSERVATIONS:
Beam Voltage =
Repeller Voltage =
Low VSWR
Reading on VSWR meter =
High VSWR
Position of first minima =
Position of second minima =

Distance between two minima=

Calculations:

VSWR= $\frac{\lambda_g}{\pi(d_1-d_2)}$

ρ = $\frac{S-1}{S+1}$

RESULT: Voltage standing wave ratio has been calculated by direct reading and double minima method.

EX.NO:2

DATE:

CHARACTERISTICS OF DIRECTIONAL COUPLER

AIM

To measure the coupling factor and directivity of the directional coupler.

REQUIREMENTS

Klystron power supply, klystron source, isolator, variable attenuator, directional coupler, tunable detector, VSWR/CRO meter, waveguide stands.

FORMULA USED

Coupling factor

It is the ratio of power (dB) entering at the input of main arm to the power coupled at output of auxiliary arm.

Coupling factor (dB) = 10 log (Pi / Paf)

Directivity

It is the ratio of power output in coupled auxiliary arm to the power in uncoupled auxiliary arm.

Directivity (dB) = 10 log (Paf / Par)

Transmission loss

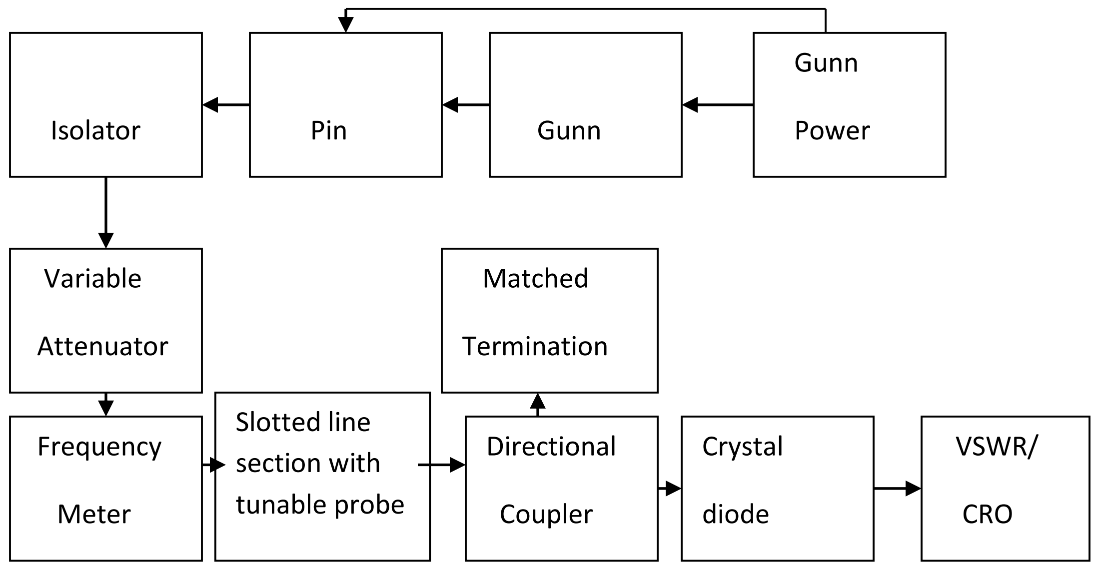
Transmission loss = 10 log (Pi / Po)

= 20 log (Vi / Vo)

THEORY

Directional coupler is a hybrid waveguide joint and a 4 port device which couples power in an auxiliary waveguide arm in one direction. A matched load by the manufacturers terminates one port. It is a device with which it is possible to measure the incident and reflected wave separately. It consist of two transmission lines the main arm and the auxiliary arm, electromagnetically coupled to each other. The power entering port1 in main arm divides between port2 and port3 and almost no power comes out in port4. Power entering port2 is divided between port1 and port4.

BLOCK DIAGRAM



TABULATION

	P1 (V)	P2 (V)	P3 (V)	P4 (V)
Forward Direction Reverse Direction				

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

$$\text{Loss} = 10 \log (P1 / P2)$$

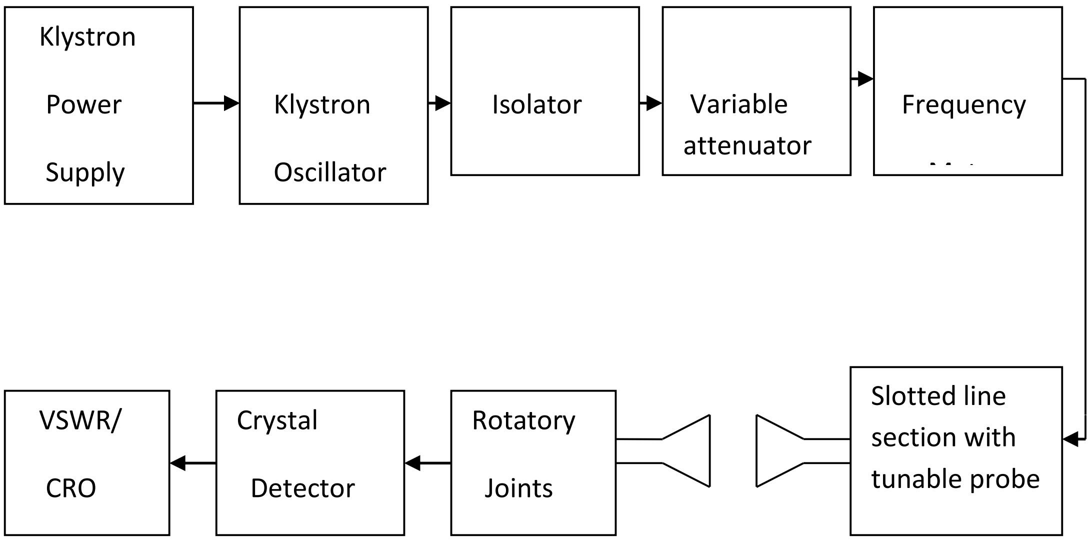
when power is entering at port1.

PROCEDURE

1. Set up the equipments as shown in block diagram.
2. Obtain the oscillations using the general procedure and determine the frequency of oscillation.
3. Set the reference voltage in CRO with the help of variable attenuator and gunn power supply.
4. Connect directional coupler in forward direction between slotted line section and detector mount keeping input port P1 to slotted line section, output port P2 to detector mount and P4 is terminated (P3 is permanently matched). Measure the output voltage V0 at port2.
5. Similarly keeping P1 to slotted line section, P4 to detector mount and port2 is terminated. Measure the voltage P_{af}at P4.
6. Keeping P2 to slotted line section. P4 to detector mount and P1 is terminated. Measure the voltage P_{ar} at P4.
7. Calculate coupling factor, directivity and transmission loss (dB) using Pi, Po, Paf, Par.

RESULT: Thus the characteristics of directional coupler were studied and the directivity and coupling factor were determined.

BLOCK DIAGRAM: Horn antenna



TABULATION:

ROTATING RECEIVER (degrees)	RECEIVED VOLTAGE (V)	
	LEFT SIDE (mV)	RIGHT SIDE (mV)

EX.NO:3

DATE:

RADIATION PATTERN OF HORN ANTENNA

AIM:

To measure the radiation pattern of horn antenna and to draw its field pattern.

EQUIPMENTS REQUIRED:

Klystron power supply, klystron oscillator, isolator, variable attenuator, frequency meter, horn antenna and VSWR/CRO.

THEORY:

Gain of an antenna:

It is the power intensity at the maximum achieved from imaginary omni-directional antenna with same power fed to antenna.

Antenna gain can be measured by using two identical antennas, one as transmitter and the other as receiver. But should be kept away from each other with minimum distance R.

$R_{min} = 2D^2/\lambda_0$ [for rectangular horn antenna]

D – Size of broad wall of horn antenna

λ_0 – Free space wavelength

Gain of transmitting antenna is,

$$G = (4\Pi R_{min}/ \lambda_0) * (P_r/ P_b)$$

Field pattern:

It is the diagram of field strength or power density as the function of transmitter at constant distance from radiating antenna.

As antenna pattern is 3D but it is given as 2D pattern on paper. For rectangular horn antenna there are E and H plane pattern. The major power is concentrated in main lobe and is desirable to keep the power load and back lobe as low as possible.

PROCEDURE:

1. Set up the equipment as shown.
2. Obtain oscillation using general procedure and determine frequency of oscillation.

3. Set the reference voltage in CRO using variable attenuator, power supply and tuners.
4. Remove the detector mount from slotted line section without disturbing the position of the set up.
5. Connect transmitting and receiving horn antenna between slotted line section and detector mount.
6. Rotate the receiving horn to left in steps of 5˚ and note the corresponding voltages.
7. Rotate the receiving horn to right as in step6.
8. Tabulate the reading and draw the graph for transmitting and receiving voltages.

RESULT:

Thus the gain and field pattern of horn antenna were obtained.

Ex.NO:4

DATE:

S-PARAMETER MEASUREMENT

AIM:

- To measure the insertion loss and isolation loss of a given isolator and circulator.
- To study the characteristics of E-plane tee, H-plane tee and magic tee

EQUIPMENT REQUIRED:

Isolator and Circulator:

Gunn power supply, Gunn oscillator, Pin modulator, Isolator, Variable attenuator, Frequency meter, Slotted line section with tuneable probe, Diode detector, Circulator, VSWR meter/ CRO, Waveguide stands

E-plane tee, H-plane tee and magic tee:

Microwave source, Isolator, variable attenuator, frequency meter,E-plane Tee, H-plane Tee,magic tee, Matched terminator, detector mount, slotted line section with tunable probe,VSWR/CRO.

THEORY:

ISOLATOR:

The isolator is a two port device with small insertion loss n forward direction and a change in reverse attenuation.

CIRCULATOR:

The circulator is a multiport junction that permits transmission in certain ways. A wave incident in port 1 is coupled to port 2 only, an incident wave at port 2 is coupled to port 3 only and so on. Following is the basic parameters of isolator and circulator for study.

E-plane Tee:

In E-plane Tee, the auxiliary arm is parallel to the plane of electric field. E-arm is input arm. Input power is equally distributed between arms 1 and 2. But the output at arm1 is 180® out of phase. So, E-plane is also called ‘subtractor’.

H-Plane Tee:

In the H-plane Tee, auxiliary arm is parallel to plane of magnetic field. If the input is applied for H-plane, power gets divided equally between arm1 and 2 and power at same phase. So H-plane is also called 'adder'.

Magic tee:

Magic tee is a combination of E and H plane Tee. Arm 3, the H-arm forms H-plane tee. Arm 4, E-arm forms E-plane tee, in combination of arm 1 and arm 2 as side or collinear arms. If the power is fed to arm 3(H-plane), electric field divided equally between arm 1 and 2 with same phase. If the power is fed to arm 4(E-plane), the electric field is divided equally between arm 1 and 2 with opposite phase. Further if the power is fed from arm 1 and 2, it is added in arm 3(H-plane) and is subtracted in arm 4(E-plane).

INSERTION LOSS:

The ratio of power supplied to the input port to the power detected by the detector in the coupling arm.

ISOLATION LOSS:

It is the ratio of power fed to input arm and the power detected at no coupled port with the other port terminated in the matched load.

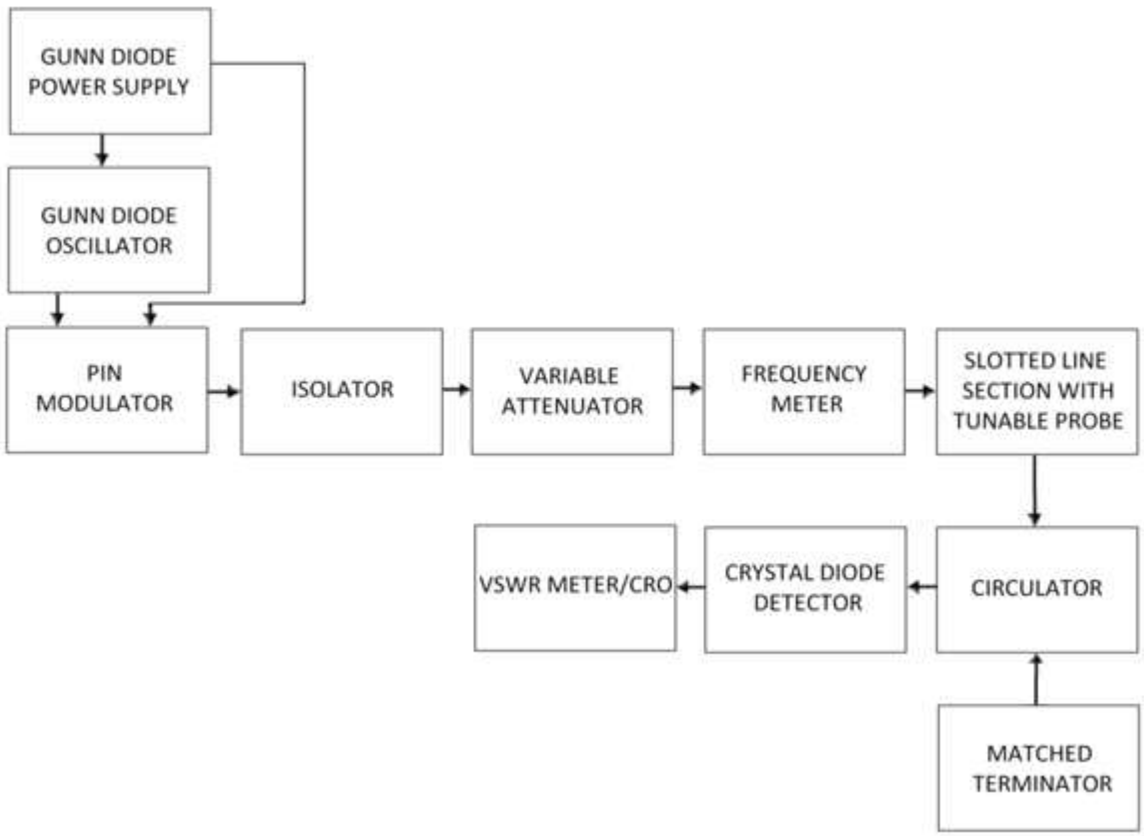
INPUT VSWR:

The input VSWR of an isolator or circulator is the ratio of voltage maximum to voltage minimum of the standing wave existing on the line, when one port of it terminates the line, and the other have matched termination.

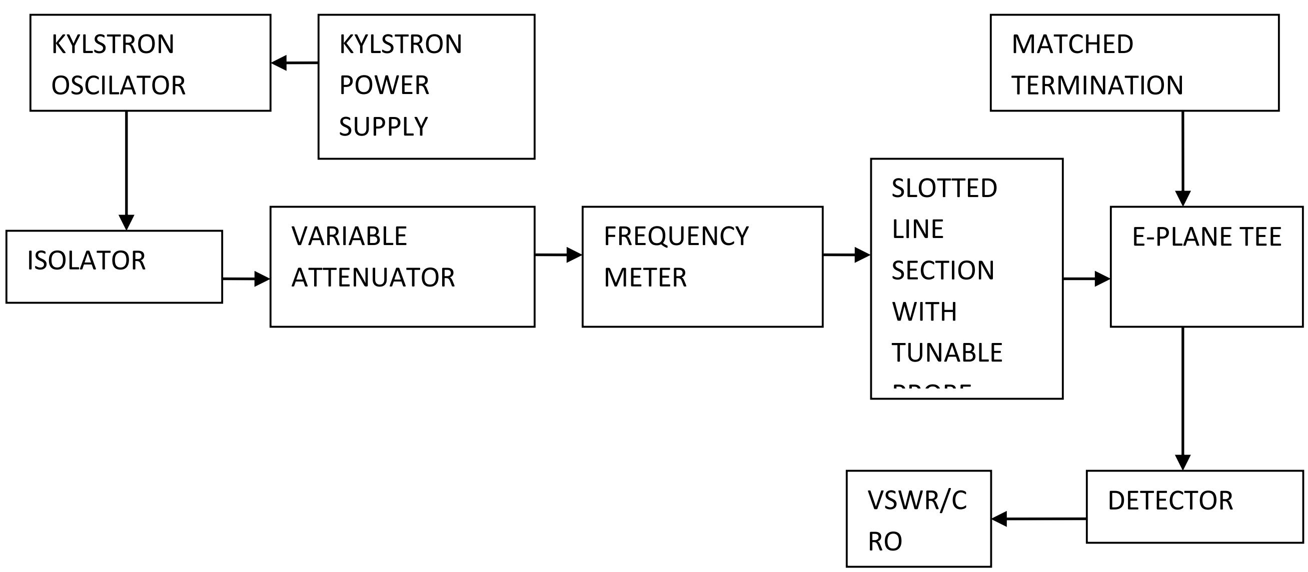
When port which is not coupled to input port is terminated by matched termination in a circulator, then it makes an isolator (2 ports device).

BLOCK DIAGRAM:

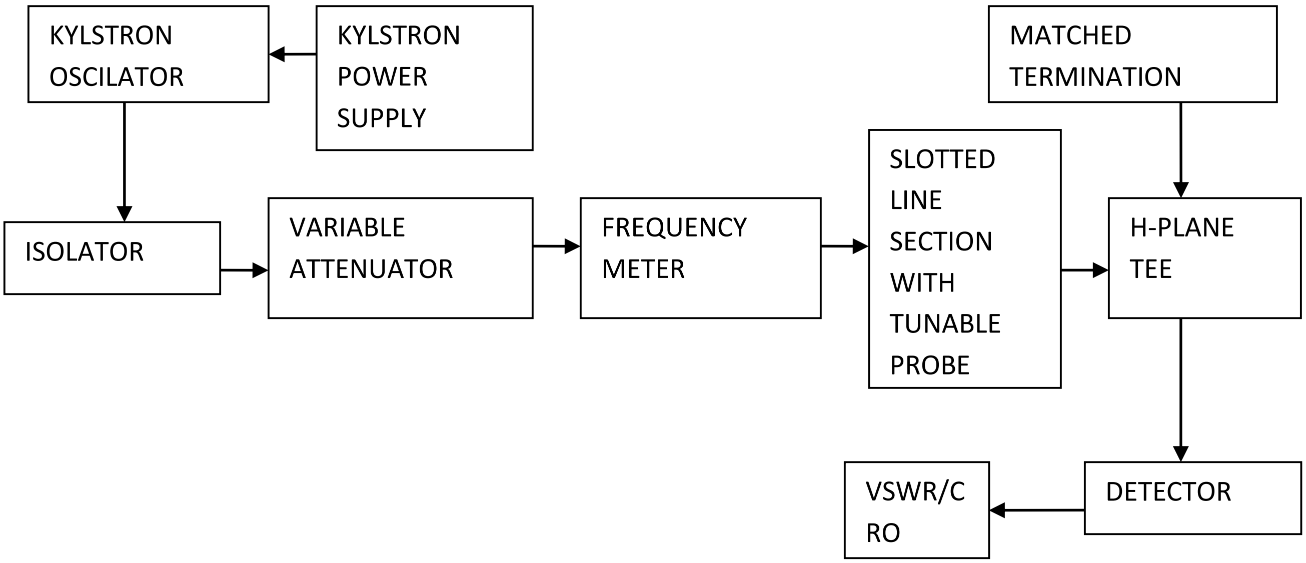
CIRCULATOR:



E-PLANE TEE



H-PLANE TEE


KYLSTRON
OSCILATOR
KYLSTRON
POWER
SUPPLY
MATCHED
TERMINATION
SLOTTED
LINE
SECTION
WITH
TUNABLE
PROBE
ISOLATOR
VARIABLE
ATTENUATOR
FREQUENCY
METER
H-PLANE
TEE
VSWR/C
RO
DETECTOR

FORMULAE USED:

INSERTION LOS:

It is the ratio of power (dB) supplied by a matched source to arm 1 to the power detected by matched detector in coupling arm 2.

Insertion loss = 10 log (P1/P2) (dB)

= 20 log (V1/V2) (dB)

ISOLATION LOSS:

It is the ratio of power fed to arm 2 by a matched source to the power detected in arm 1 by matched detector.

Isolation loss = 10 log (P2/P1) (dB)

= 20 log (V2/V1) (dB)

PROCEDURE :

ISOLATOR :

1. Set up the equipment as shown in block diagram.

2. Obtain oscillations using general procedure and determine frequency of oscillation.

3. Set the reference voltage in CRO with variable attenuator and Gunn diode power supply.

4. Connect isolator in forward direction between slotted line section and detector mount keeping input port P1 to slotted line section and output P2 to detector mount.

5. Measure to output voltage at port 2 and calculate insertion loss (dB).

6. Measure the isolation loss, connect isolator in reverse direction and measure output voltage at P1.

CIRCULATOR:

1. Set up the equipment as shown in block diagram.

2. Obtain oscillations using general procedure and determine frequency of oscillation.

3. Set the reference voltage in CRO with variable attenuator and Gunn diode power supply.

4. To measure the insertion loss, connect circulator in forward direction between slotted line section and detector mount keeping P1 to slotted line section P2 to detector and P3 is terminated.

5. Measure to output voltage at port 2 and calculate insertion loss (dB).

6. Connect the circulator in reverse direction, keeping P2 to slotted line section P1 to detector and P3 is terminated.

7. Measure output voltage at P1 and calculate isolation loss.

8. Steps 4 to 7 are repeated for ports 2 and 3 also for ports 3 and 1

E-PLANE TEE and H-PANE TEE:

1. Set up the circuit as shown in the block diagram.

2. Obtain the frequency of oscillation using general procedure.

3. Set any reference value of power in CRO with the help of variable attenuator and Gunn power supply.

4. Connect E-plane and H-plane between slotted line section and detector mount.

5. Port 3 is always input port. Connect port2 to slotted line section and port 1 to detector mount .

6. Similarly connect port 1 to slotted line and port 2 to detector mount.

7. Step 5 is done for E and H plane Tee. In both junctions, port 3 junctions are impedance.

MAGIC TEE:

1. Set up the circuit as shown in the block diagram.

2. Obtain the oscillation using general procedure and determine the frequency of oscillation.

3. Set the reference voltage in the CRO (P_i) with the help of variable attenuator and gunn power supply.

4.Connect magic tee between slotted line section and detector mount with any two ports terminated, one of the port is connected to slotted line section and other port is connected to detector mount.

5. Measure the output voltage.

6. Repeat step 4 by interchanging ports for all other 12 combinations.

7. Measure input and output voltage for 12 sets and are tabulated. Using tabulated values scalculate isolation between ports and coupling coefficient.

RESULT :

Thus the insertion loss and isolation loss for given circulator and isolator were measured.

TABULAR COLUMN :

ISOLATOR :

Reference voltage : ________

Input Port	Output Port	Output voltage (mV)	Insertion loss 20*log(V1/V2) (dB)	Isolation loss 20*log(V2/V1) (dB)
P1	P2			
P2	P1			

CIRCULATOR :

Reference voltage : ________

Input Port	Output Port	Output voltage (mV)	Insertion loss 20*log(V1/V2) (dB)	Isolation loss 20*log(V2/V1) (dB)
P1 P2	P2 P1			
P2 P3	P3 P2			
P3 P1	P1 P3			

E-PLANE TEE

PORT	AMPLITUDE (mV)	TIME(ms)

H-PLANE TEE

PORT	AMPLITUDE (mv)	TIME(ms)

MAGIC TEE:

P1	P2	P3	P4	ATTENUATION IN dB	COUPLING COEFFICIENT C

MODEL GRAPH

E-PLANE TEE