QMP7.1 D/F

Channabasaveshwara Institute of Technology
(Affiliated to VTU, Belagavi & Approved by AICTE, New Delhi)
(NAAC Accredited & ISO 9001:2015 Certified Institution)
NH206(B.H.Road),Gubbi,Tumkur–572216.Karnataka.

Department of Electronics & Communication Engineering

Microwave Theory and Antennas(IPCC)

21EC62

(CBCS SCHEME)

B.E- VI Semester

Lab Manual 2023-24

Name:____

USN:____

Batch:________________________Section:__________________________

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Department of Electronics & Communication Engineering

Microwave Theory and Antennas

PRACTICAL COMPONENT OF IPCC

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INSTITUTE VISION

- **To create centres of excellence in education and to serve the society by enhancing the quality of life through value based professional leadership.**

INSTITUTE MISSION

- To provide high quality technical and professionally relevant education in a diverse learning environment.
- To provide the values that prepare students to lead their lives with personal integrity, professional ethics and civic responsibility in a global society.
- To prepare next generation of skilled professionals to successfully compete in the diverse global market.
- To promote campus environment that welcomes and honors women and men of all races, creeds and cultures, values and intellectual curiosity, pursuit of knowledge and academic integrity and freedom.
- To offer wide variety of off-campus education and training programmes to individuals and groups.
- To stimulate collaborative efforts with Industry,Universities,Government and Professional Societies.
- To facilitate public understanding of technical issues and achieve excellence in the operations of the institute.

Quality Policy

Our Organization delights customers (Student, Parents and Society) by providing value added quality education to meet the National and International requirements. We also provide necessary steps to train the students for placement and continue to improve our methods of education to the students through effective. Quality Management System, Quality Policy and Quality Objectives.

Department of Electronics & Communication Engineering

Department Vision

To create globally competent Electronics and Communication Engineering professionals with ethical and moral values for the betterment of the society.

Department Mission

- To nurture the technical/professional/engineering and entrepreneurial skills for overall self and societal upliftment through co-curricular and extra-curricular events.
- To orient the Faculty/Student community towards the higher education, research and development activities.
- To create the Centre of Excellence in the field of electronics and communication in collaboration with industries/Universities by training the faculty through latest technologies.
- To impart quality technical education in the field of electronics and communication engineering to meet over the current/future global industry requirements.

COURSE OBJECTIVES

This course will enable students to :

- Describe the microwave properties and its transmission media.
- Describe the microwave devices for several applications.
- Understand the basic concepts of antenna theory.
- Identify antenna types for specific applications.

COURSE OUTCOMES (CO's)

- Describe the use and advantages of microwave transmission
- Analyze various parameters related to transmission lines.
- Identify microwave devices for several applications.
- Analyze various antenna parameters and their significance in building the RF system.
- Identify various antenna configurations for suitable applications.

PROGRAM OUTCOMES(PO'S)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineeringproblems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs.
4. **Conduct investigations of complex problems:** An ability to design and conduct scientific and engineering experiments, as well as to analyze and interpret data to provide valid conclusions
5. **Modern tool usage:** Ability to apply appropriate techniques, modern engineering and IT tools, to engineering problems.
6. **The engineer and society:** An ability to apply reasoning to assess societal, safety, health and cultural issues and the consequent responsibilities relevant to the professional engineeringpractice
7. **Environment and sustainability:** An ability to understand the impact of professional engineering solutions in societal and environmental contexts
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Ability to function effectively as an individual, and as a member or leader in a team, and in multidisciplinary tasks.
10. **Communication:** Ability to communicate effectively on engineering activities with the engineering community such as, being able to comprehend and write effective reports and design documentation, make effective presentations.
11. **Project management and finance:** An ability to apply knowledge, skills, tools, and techniques to project activities to meet the project requirements with the aim of managing project resources properly and achievingthe project's objectives.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent andlife-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES(PEO's)

After Four Years of Graduation, our graduates are able to:

- Provide technical solutions to real world problems in the areas of electronics and communication by developing suitable systems.
- Pursue engineering career in Industry and/or pursue higher education and research.
- Acquire and follow best professional and ethical practices in Industry and Society.
- Communicate effectively and have the ability to work in team and to lead the team.

PROGRAM SPECIFIC OUTCOMES(PSO'S)

At the end of the B.E Electronics & Communication Engineering program ,students are expected to have developed the following program specific outcomes.

PSO1:Build Analog and Digital Electronic systems for Multimedia Applications, VLSI and Embedded Systems in Interdisciplinary Research / Development.

PSO2: Design and Develop Communication Systems as per Real Time Applications and Current Trends.

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Department of Electronics & Communication Engineering

SYLLABUS
Microwave Theory and Antennas
PRACTICAL COMPONENT OF IPCC
[As per Choice Based Credit System (CBCS) scheme] SEMESTER– VI (EC)

Subject Code :21EC62 **CIE Marks:20**
Hours/Week :12 Lab slots **Test Hours:03**

Sl. No	Experiments
1.	Study of characteristics of Magic Tee.
2.	Coupling and Isolation characteristics of micro strip directional coupler.
3.	Determination of power division of micro strip power divider.
4.	Determination of resonance characteristics of micro strip ring resonator and computation of dielectric constant of the substrate.
5.	Measurement of frequency, guide wavelength, power and attenuation in a microwave Test bench.
6.	Study of characteristics of E plane Tee / H plane Tee.
7.	To measure unknown impedance using Smith chart through test bench setup.
8.	Measurement of VSWR and reflection coefficient and attenuation in a microwave test bench setup.
9.	Obtain the radiation pattern of a Yagi-Uda Antenna array and calculate its directivity.
10.	Calculate the aperture of a Dipole Antenna.
11.	Obtain the near and far fields of a given antenna and compare the fields.
12.	Obtain the bandwidth of a given Antenna.

CIE for the practical component of the IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.** Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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Sl. No	Name of the Experiment	Date			Manual Marks(Max	Record Marks (Max.10)	Signature (Student)	Signature (Faculty)
		Conduction	Repetition	Submission of Record				
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
Average								

General Instructions to Students

1. Students should come with thorough preparation for the experiment to be conducted.
2. Students should take prior permission from the concerned faculty before availing the leave.
3. Students should come with formals and to be present on time in the laboratory.
4. Students will not be permitted to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiments conducted in the previous session.
5. Students will be permitted to attend the laboratory unless they bring the observation book fully completed in all respects pertaining to the experiments conducted in the present session.
6. They should obtain the signature of the staff-in –charge in the observation book after completing each experiment.
7. Practical record should be neatly maintained.
8. Ask lab Instructor for assistance for any problem.
9. Do not download or install software without the assistance of laboratory Instructor.
10. Do not alter configuration of system
11. Turn off the systems after use

EXPERIMENT NO 1

Study of characteristics of Magic Tee

Aim: To study of characteristics of magic tee

Magic Tee

An interesting type of T junction is the hybrid tee, commonly known as `magic tee' which is shown in fig. The device as can be seen from fig is a combination of the E arm and H plane tees. Arm3, the H arm forms an H plane tee and arm 4, the E arm, forms an E plane tee in combination with arms 1 and 2. The central lines of the two tees coincide and define the plane of symmetry, that is, if arms 1 and 2 are of equal length, the part of structure on one side of the symmetry plane shown by shaded area is the mirror image of that on the other. Arms1 and 2 are sometimes called as the side or collinear arms.

Magic Tee Parameter:

The basic properties and associated quantities to be measured for a magic tee are defined as follows:

a) Input VSWR

Corresponding to each port of a magic tee as load to the line, there is a value of VSWR. Thus there are four values of VSWR. VSWR is defined as the ratio of maximum voltage to minimum voltage of the standing waves existing on the line when one port of the tee terminates the line while other three ports are terminated in matched loads.

b) Isolations

The isolation between E-and H-arms is defined as the ratio of the power supplied by the matched generator connected to E-arms (port-4), to the power detected in H- arm (port-3) by a matched detector when collinear arms (1&2) are terminated in matched loads. It is expressed in db.

$I_{34} = 10 \log_{10} P_4/P_3$, $I_{34} = 20 \log_{10} (V_4 / V_3)$

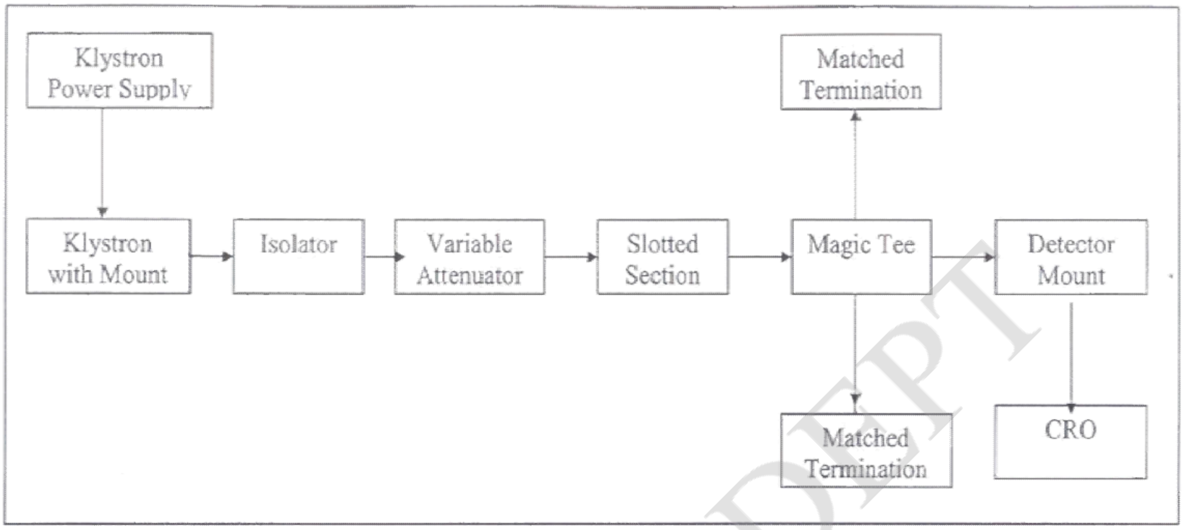
P_4 : power incident in port4(E-arm) P_3 : power detected in port3 (H-arm)

Similarly isolation between other ports may also be defined and measured.

c) Coupling Coefficient:

The voltage coupling coefficient from arm I to arm j is defined as $C_{ij} = 10^{-\alpha/20}$

Characteristics of Magic TEE



INPUT – VSWR : All other ports terminated with matched load termination except for the load.

Tabular Column

Input	output		
Port 1	P 2=	P3=	P4=
Port 2	P1=	P3=	P4=
Port 3	P1=	P2=	P3=
Port 4	P1=	P2=	P3=

RESULT :

EXPERIMENT NO 2

Coupling and isolation characteristics of micro strip directional coupler

Aim: To study coupling and isolation characteristics of micro strip directional coupler.

Micro strip directional couplers are four-port systems consisting of two parallel signal lines, with the electric and magnetic fields of a signal on one line inducing currents and voltages on the other.
Below is a simplified version of the list of the four ports of the directional coupler:

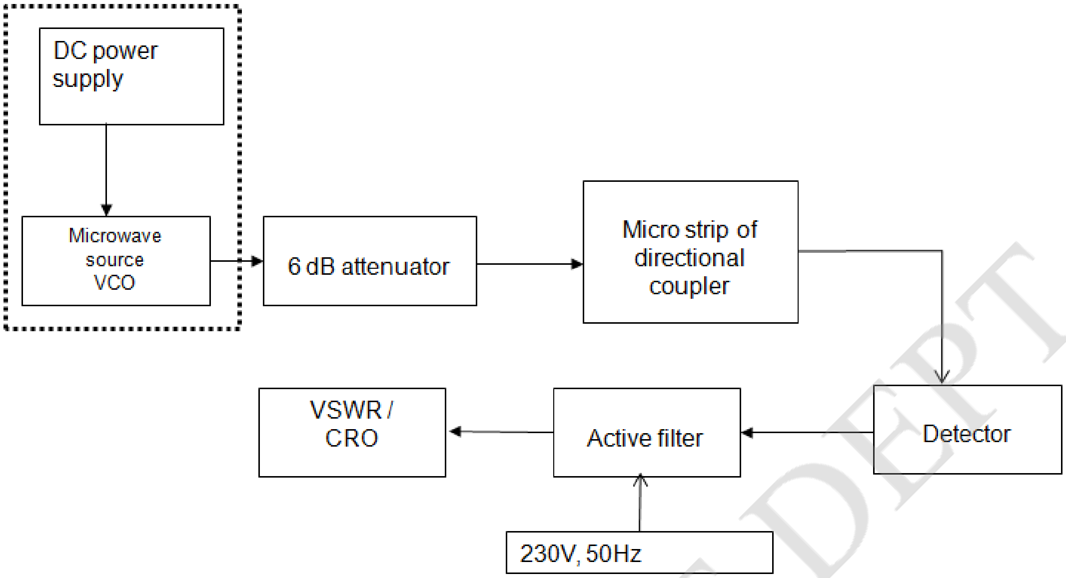
- Port 1 – The Input Port
- Port 2 – The Output Port
- Port 3 – The Coupled Signal Port
- Port 4 – The Isolated Port

Characteristics

- Coupling Factor: This indicates the fraction of the input power (at P1) that is delivered to the coupled port, P3
- Directivity: This is a measure of the coupler's ability to separate waves propagating in forward and reverse directions, as observed at the coupled (P3) and isolated (P4) ports
- Isolation: Indicates the power delivered to the uncoupled load (P4)
- Insertion Loss: This accounts for the input power (P1) delivered to the transmitted (P2) port, which is reduced by power delivered to the coupled and isolated ports.

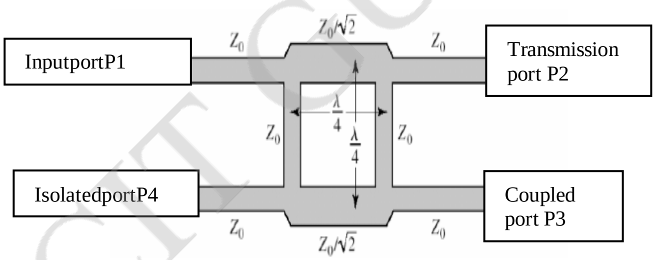
PROCEDURE

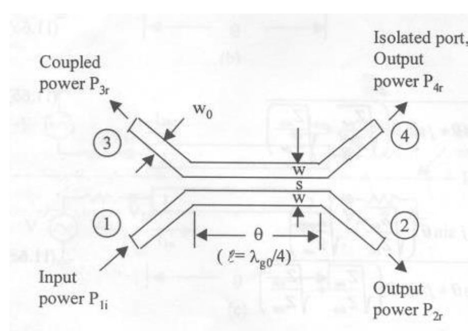
1. Setup the system as shown in circuit diagram-17.
2. Keeping the voltage at minimum ,switch on the power supply.
3. Insert a 50Ω transmission line and check for the output at the end of the system using a CRO/VSWR meter.
4. Vary the power supply voltage and check the output for different VCO frequencies.
5. Note down the output for different output frequencies.
6. Replace the 50Ω transmission line with branch line coupler.
7. Check the output at port2 (throughput), 3(Coupled output), 4(isolated output).
8. Calculate insertion loss ,coupling factor and isolation using the formulae given.



Calculation and observation:

	Insertion loss	Coupling factor	Isolation	Directivity
VSWR meter	P_1-P_2	P_1-P_3	P_1-P_4	P_3-P_4
CRO	$20\log(V_1/V_2)$	$20\log(V_1/V_3)$	$20\log(V_1/V_4)$	$20\log(V_3/V_4)$





a) b)

Figure : Ports of a directional coupler a)Branch line b)Parallel line

I/Pat port 1	O/Pat port 2	O/Pat port 3	O/Pat port 4	Insertion loss	Isolation	Coupling factor	directivity

RESULT :

EXPERIMENT NO 3

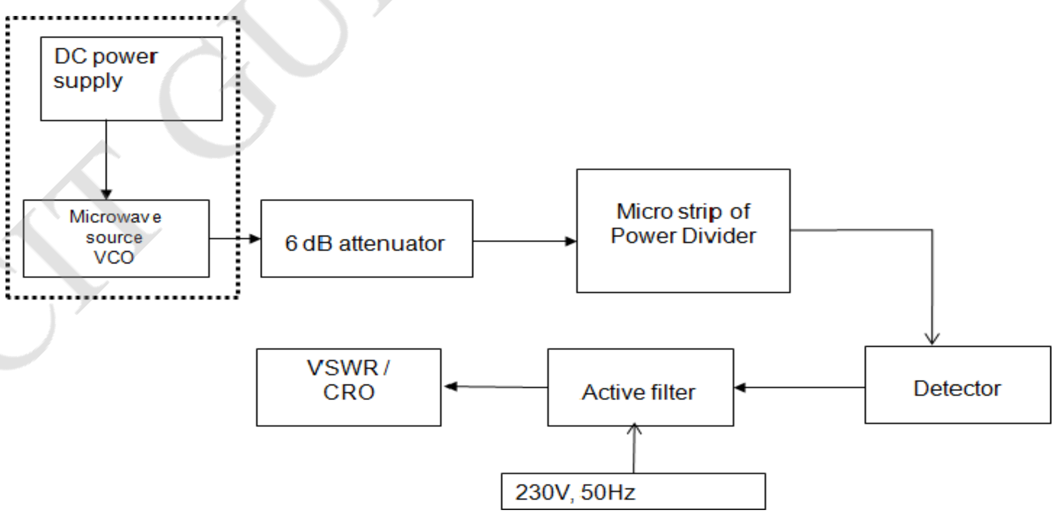
Determination of power division of micro strip power divider

Aim: To study determination of power division of micro strip power divider.

A power divider is a three-port microwave device that is used for power division or power combining. In an ideal power divider, the power going into port 1 is equally split between the two output ports, and vice versa for power combining. The output signals have a power level that is 1/N the input power level where N is the number of outputs in the divider. The signals at the outputs, in the most common form of power divider, are in phase.

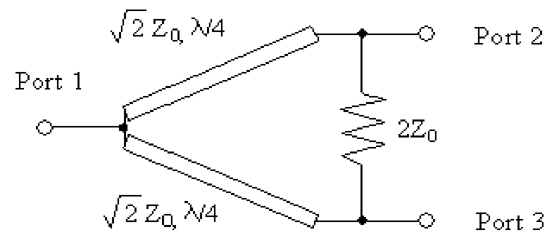
PROCEDURE

1. Set up the system as shown in circuit diagram-3.
2. Keeping the voltage at minimum, switch on the power supply.
3. Insert a 50Ω transmission line and check for the output at the end of the system using a CRO/VSWR meter
4. Vary the power supply voltage and check the output for different VCO frequencies. Set the frequency to the maximum output voltage.
5. Replace the 50Ω transmission lines with the Wilkinson power divider.
6. Tabulate the output at ports 2 and 3
7. Calculate insertion loss and coupling factoring each coupled arm
8. Calculate the isolation between ports2 and3 by feeding the input to port2 and measure output at port3 by terminating port1.
9. Set up to measure the characteristics of micro strip power divider.



Calculation and observations:

With VSWR meter:



Isolation in dB = P3-P2
Power division in dB at arm 3= P3-P1
Power division in dB at arm 2= P2-P1

With CRO:

Isolation between port 2 and 3 = 20 log(V3/V2)
Coupling factor in dB at arm 3= 20 log (V3/V1)
Coupling factor in dB at arm 2= 20 log (V2/V1)

Tabulation:

I/Pat port1	O/Pat port2	O/Pat port3	Isolation between port 2&3	Coupling factor at arm2	Coupling factor at arm3

RESULT :

EXPERIMENT NO 4

Determination of resonance characteristics of micro strip ring resonator and computation of dielectric constant of the substrate

Aim: To study determination of resonance characteristics of micro strip ring resonator and computation of dielectric constant of the substrate.

Ring resonators are the structure in which coupling between the two resonators with different resonating frequency is done in order to achieve a new resonating frequency which depends upon the coupling values of the two rings

PROCEDURE

Part(a)

1. Set up the system as shown in circuit diagram-2.
2. Keeping the voltage at minimum, switch on the power supply.
3. Insert a 50Ω transmission line and check for the output at the end of the system using a CRO/VSWR meter
4. Vary the power supply voltage and check the output for different VCO frequencies. Set the frequency to the maximum output voltage.
5. Replace the 50Ω transmission lines with ring resonator.
6. Vary the supply voltage ,tabulate VCO frequency vs. output.
7. Plot a graph frequency vs. output and find the resonant frequency.

Part(b)

1. Select a VCO frequency(say f1) where there is a measurable output. Note down the magnitude/powerlevel of the output.
2. Place the unknown dielectric material on top of the ring resonator. Ensure that there is no air gap between dielectric piece and the resonator surface.
3. Observe the change in magnitude/power level at the output. Now reduce the supply voltage till maximum power level before inserting the dielectric) is achieved. This is the new resonance condition due to the insertion of new dielectric material(eg:Teflon)
4. Note down the VCO frequency(say f_2) Calculate the dielectric constant of the unknown material by using the formula.

Tabular Column:

f_1	λ_1	f_2	λ_2	Effective dielectric constant of the unknown material, ϵ_r

Sample calculation:

For the known material:

f_1=5GHz,h=0.762mmw=1.836mmϵ_{r1}=3.2

$\lambda_1=c/f_1=3x10^{10}/$ $5x10^{09}$=6cm

$\epsilon_{eff1}=\epsilon_1$=[(3.2+1)/2] +[(3.2-1)/2] {[1+(12x0.762/1.836)]$^{-1/2}$}

=2.717

For the unknown material

f_2=4.6GHzh=0.762mmw=1.836mm

$\epsilon_{r2}=\lambda_2=c/f_2=3x10^{10}/4.6x10^{09}$=6.52cm

Using the values of $\boldsymbol{\lambda_1}$ and $\boldsymbol{\lambda_2}$ in equation4 calculate the effective dielectricconstant to f the unknown material

λ1/Є1=λ2/Є26/2.712=6.52/Є2Є2=2.947

Using this value in equation(3)

$\epsilon_{eff2}=\epsilon_2$=2.947=[($\epsilon_r$+1)/2]+([($\epsilon_r$-1)/2]{[1+(12x0.762/1.836)]$^{-1/2}$})

The effective dielectric constant of the unknown material, ϵ_{r2}=2.59

RESULT :

EXPERIMENT NO 5

Measurement of frequency, guide wavelength, power and attenuation in a microwave Test bench

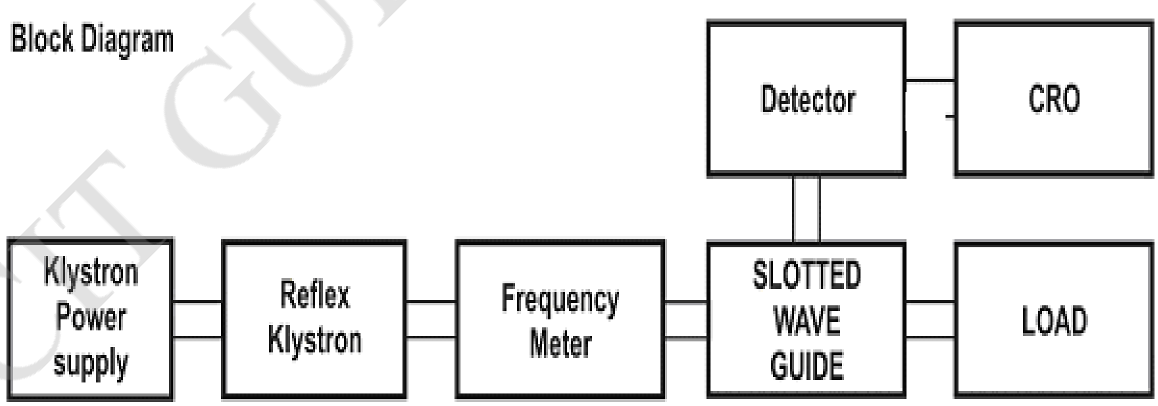
Aim: To measure of frequency, guide wavelength, power and attenuation in a microwave Test bench.

A Microwave Test Bench is a device that helps measure different values such as VSMR, frequency, impedance, guide wavelength, free-space wavelength, power measurements, etc. It is a technical device known to conduct and regulate microwave devices. Microwave Test Benches support providing preciseness about microwave systems by utilizing standard rectangular classification waveguide elements to encounter out the fundamental aspects of the appliance.

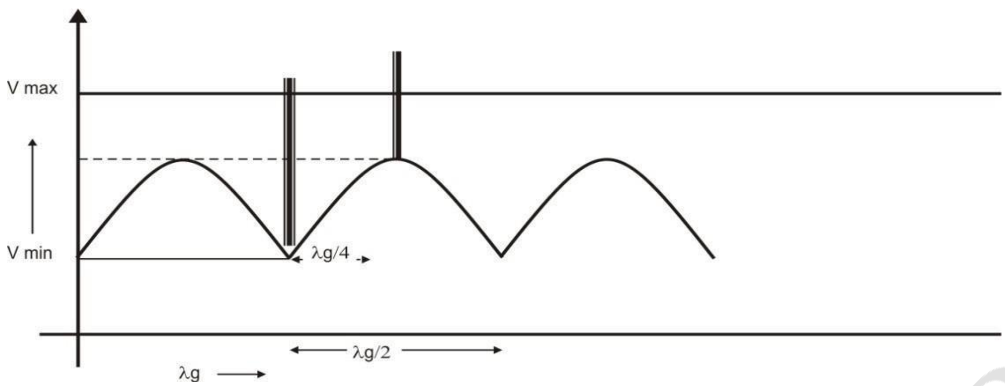
It is a classification of gear that consists of: A sensor and meter assistance monitor the outcome of the sensor.

- A signal generator.
- An Isolator.
- It has a wide range of elements such as frequency meter, standing wave indicator crystal detector, and more.

Circuit Diagram: Microwave test bench setup



Waveform:



Tabular Column:

Load	Vmax	Vmin	VSWR
Horn			
Short Circuit			
Open Circuit			
Match Termination			

X1=MSR+(CVDxLC) **LC=0.01cm** **λ_g=2($X_1 \approx X_2$)cm= ....,**

$\lambda o = \frac{(\lambda g \times \lambda c)\ 2}{(\lambda g2 \times \lambda c2}$

Load		X_1	X_2	λ_g	λc	λ_0	f_0 GHz
Horn							
Short Circuit							
Open Circuit							
Match Termination							

VSWR=Vmax/Vmin

RESULT :

EXPERIMENT NO 6

Study of characteristics of E plane Tee / H plane Tee

Aim: To study of characteristics of E plane Tee / H plane Tee.

H Plane Tee

The perpendicular arm is generally taken as input and other two arms are in shunt to the input and hence it is also called as shunt tee. Because of symmetry of the tee; equivalent circuit of H plane, when power enters the auxiliary arm, and the two main arms 1 and 2 are terminated in identical loads, the power supplied to each load is equal and in phase with one another. If two signals of equal amplitude and in same phase are fed into two main arms1 and2, they will be added together in the side arm. Thus H plane tee is an `adder'.

E Plane Tee

As indicated in fig, the two main guide arms are symmetrical with respect to the auxiliary guide arm. As such if power is fed from the auxiliary arm, it is equally distributed in the two arms 1 and 2 when they are terminated in equal loads. However as depicted in the field configuration, the power floeing out in arm 1 is 180 out of phase to the one in arm 2. As such t is tee is known as `subtracter' or `differencer'.

E Plane, H Plane Tee Parameter

Isolation

The isolation of a T junction is the ratio of power supplied froma matched generator to one of the arms, to the power coupled to a matched detector in any other arm when the remaining arm is terminated in a matched load.

Isolation between port 1 and 2 is

$I_{12} = 10 \log_{10} P_1 / P_2$ dB, $I_{12} = 20 \log_{10} (V_1 / V_2)$ dB,

And when matched load and detector are interchanged

$I_{13} = 10 \log_{10} P_1 / P_3$ dB, $I_{13} = 20 \log_{10} (V_1 / V_3)$ dB,

Similarly

$I_{31} = 10 \log_{10} P_3 / P_1$ dB, $I_{32} = 20 \log_{10} (V_3 / V_2)$ dB,

And when matched load and detector are interchanged,

$I_{33} = 10 \log_{10} P_3 / P_2$ dB, $I_{32} = 20 \log_{10} (V_3 / V_2)$ dB,

When arm 2 becomes the input, we will have other two values of isolation, I_{21} and I_{23}. Due to reciprocity Property, I_{21} will be the same as I_{12}. Therefore, we shall measure only the first four isolation coefficients.

Coupling coefficient

Corresponding to the values of isolation, we can compute The coupling coefficient by the formula

$C = 10^{-\alpha / 20}$

Where α is the attenuation in db between the input and detector arm when the third arm is terminated in a matched load. For example, the attenuation measured between arms 1 and 2 is3 dbwhen arm 3 terminated in matched load, that is, the coupling coefficient between arms 1 and 2,

$$C_{12} = 10^{-\alpha / 20} = 10^{-3 / 20} = 0.708 \text{ db}$$

H- PLANE WAVEGUIDE T- JUNCTION

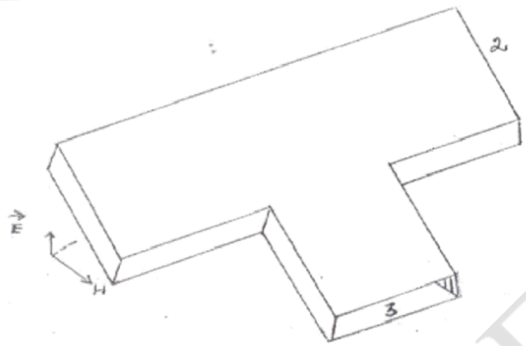


FIG. 1

E - PLANE WAVEGUIDE T-JUNCTION

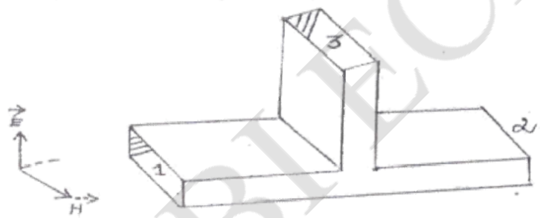


FIG. 2

E - H TEE OR MAGIC TEE

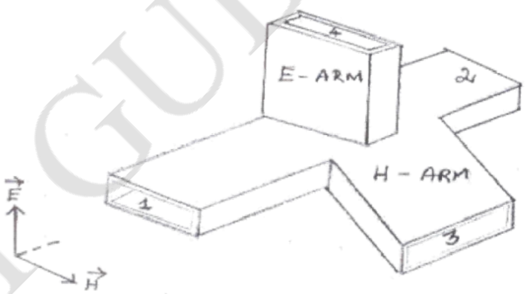
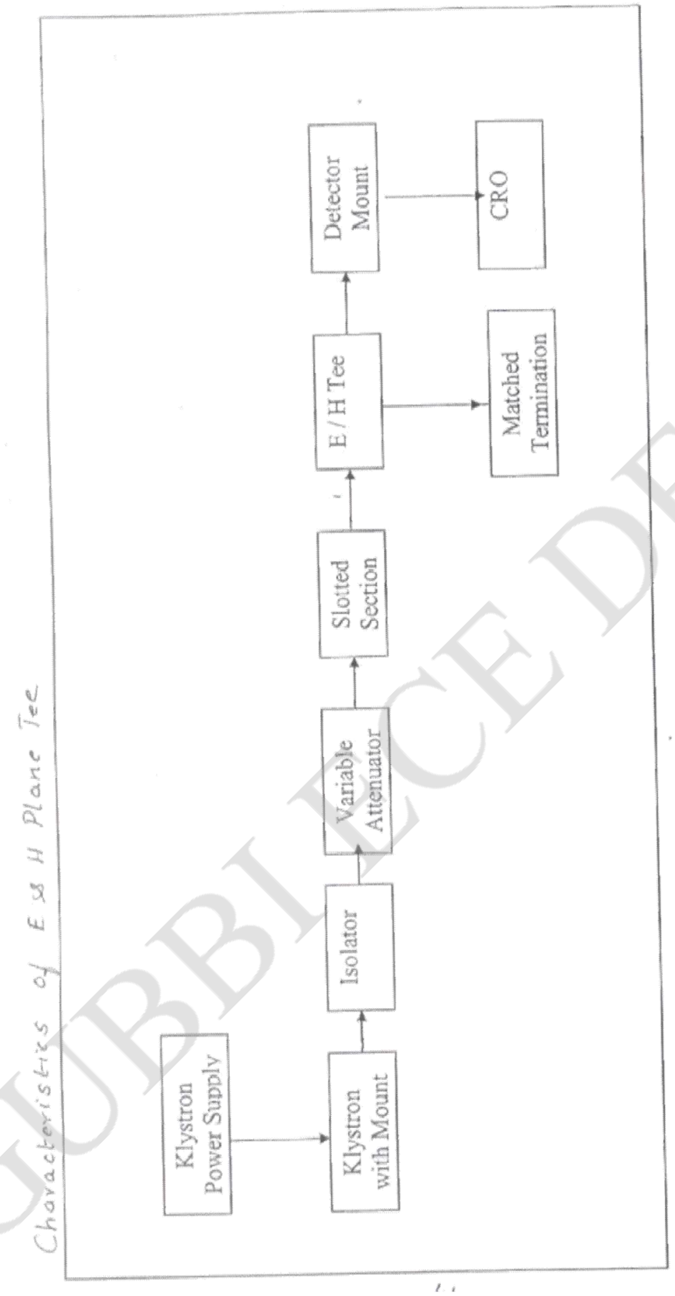


FIG 3


Characteristics of E & H Plane Tee
Klystron Power Supply
Klystron with Mount
Isolator
Variable Attenuator
Slotted Section
E / H Tee
Detector Mount
CRO
Matched Termination

Nature of Tee	Input	Output	Isolation
E – Plane			
H – Plane			

RESULT :

EXPERIMENT NO 7

To measure unknown impedance using Smith chart through test bench setup

Aim: To measure unknown impedance using Smith chart through test bench setup.

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=(1+|R|)/(1-|R|)
Where Reflection co-efficient R=(Z-Z0)/(Z+Z0)

Z0 is the Characteristic 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 minimum 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 two minima positions will be the guide wavelength. One of the minimums 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 center, 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. 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.

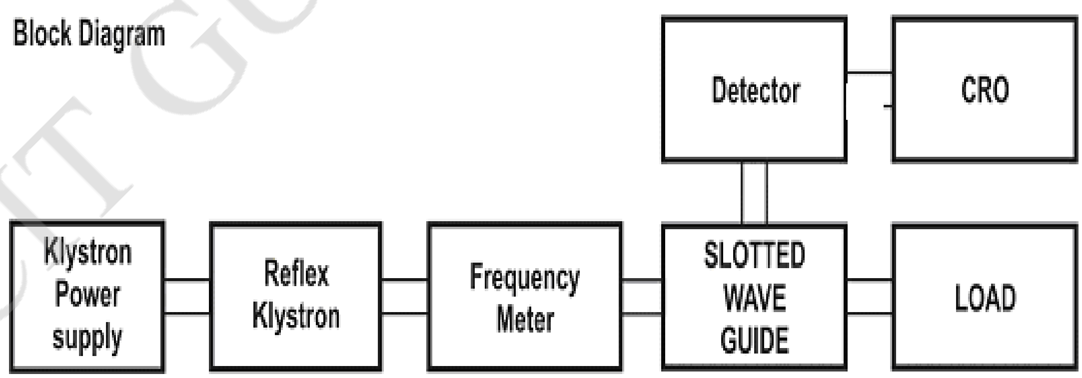


Fig: Set up for unknown impedance measurement

PROCEDURE

- Set up the components and equipment as shown in fig.
- Set the variable Attenuator at the minimum at position.
- Keep the control knobs of VSWR Meter as below:

  Range - 50db

  Input switch - crystal low impedance Meter switch - Normal position
  Gain - Mid position
- Keep the control knobs of klystron power supply as below

  Beam Voltage - OFF

  Mod switch - AM

  Beam voltage knob - fully anticlockwise

  Reflector Voltage - fully clockwise

  AM amplitude knob - around fully clockwise

  AM Frequency knob - Around mid
- Switch ON the klystron power supply, VSWR meter and cooling fan.
- Switch ON the beam voltage switch and rotate the beam voltage knob clockwise up to 200v deflection in meter.
- Rotate the reflector voltage knob to get deflection in VSWR meter.
- Rotate the AM-MOD amplitude knob to get the maximum output in VSWR meter
- Maximize the deflection with frequency knob to get the maximum output in VSWR meter
- Tune the probe for maximum deflection in VSWR meter
- Tune the frequency meter knob to get a „dip" on the VSWR meter scale and note down the frequency directly from the frequency meter
- Keep the depth of the S.S Tuner to around 3-4mm and lock it.
- Move the probe along the slotted line to get maxim deflection.
- Adjust VSWR meter gain control knob and variable attenuator until the meter indicates 1.0 on the normal db SWR scale.
- Move the probe to next minima position and note down the SWR „S0" on the scale.
- Also Note down the probe position, let it be d
- Replace the termination with movable short and detune the frequency meter
- By moving the probe along the slotted line. Vary the deflection on VSWR meter. Move the probe to a minimum deflection position. Note and record the probe position
- Move the probe to next minimum position and record the probe position again. Calculate guide wavelength as twice the distance
- Calculate $d/\lambda g$

OBSERVATIONS

Frequency from Frequency meter f_1 = ______________

Low VSWR(S_0) = ______________

First Minima d= _______________ d_1= __

d_2= ___________________

Guided Wavelength $\lambda_g = 2\ (d_1 \sim d_2)$ = __________ d/λ_g = __

$Z_L=(Z_L)_N * Z_o$

RESULT:

EXPERIMENT NO 8

Measurement of VSWR and reflection coefficient and attenuation in a microwave testbench setup

Aim: To study measurement of VSWR and reflection coefficient and attenuation in a microwave testbench setup.

The electromagnetic field at any point of transmission line, may be considered as the sum of 2 travelling waves: the "incident wave "which propagates from the generator and the "reflected wave" which propagates towards the generator. The reflected wave is set up by the reflection of incident wave from a discontinuity on the line or from the load impedance. The magnitude and phase of the reflected wave depends upon amplitude of phase of the reflected impedance. The presence of two travelling waves gives rise to standing waves along the line. The maximum field strength is found when the two waves are in phase and the minimum where the two waves add in opposite phase. The distance between two successive minima(or maxima) is half the guide wavelength of the line. The ratio of electrical field strength of reflected and incident waves is called reflection coefficient. The voltage standing wave ratio between maximum and minimum field strength along the line.

VSWR = VMAX/VMIN

Reflection coefficient , $|\delta| = (S-1)/(S+1)$

VSWR, $S = E_{MAX}/E_{MIN} = (E_I + E_R) / (E_I - E_R)$

$\delta = E_R/E_I = (Z-Z_O) / (Z+Z_O)$

Z is the impedance at a point on the line.

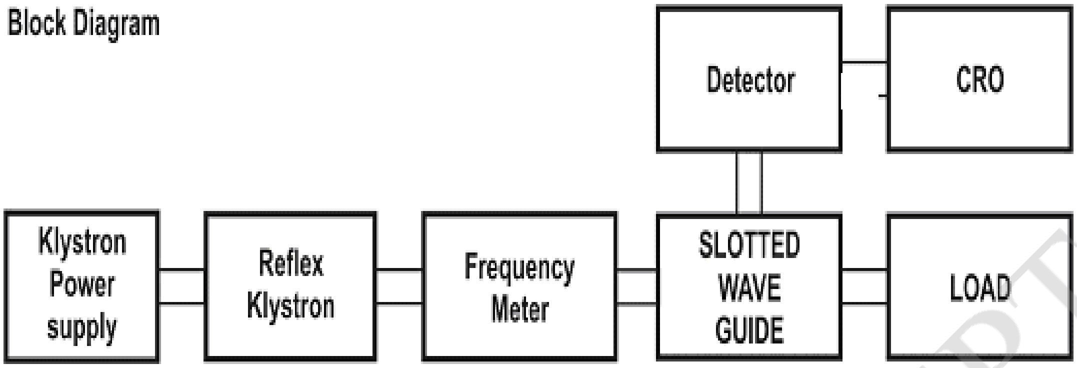
Z_O is the characteristic impedance

The equation above gives the following equation.

$|\delta| = (S-1)/(S+1)$

PROCEDURE

- Obtain the modulated square wave in the CRO.
- Calibrate the VSWR meter.
- Disconnect the VSWR meter and connect the CRO again the load whose VSWR is to be measured.
- Move the slotted section without disturbing the set up.
- Observe the maximas and minimas of the square wave and note down the amplitudes of various V_{max} and V_{min} from the CRO.
- Calculate VSWR and reflection coefficient for various loads by connecting the load to the slotted section, using the formula.



Load	Vmax	Vmin	VSWR	Reflection Coefficient	Attenuation
Open Circuit					
Short Circuit					

RESULT:

EXPERIMENT NO 9

Obtain the radiation pattern of a Yagi-Uda Antenna array and calculate its directivity.

Aim: To obtain the radiation pattern of a Yagi-Uda Antenna array and calculate its directivity.

The Yagi antenna is used frequently because it offers gain an directivity. The Yagi antenna was developed by a Japanese engineer Yagi-Uda. Its design is based exclu sively on dipoles. A quick glance at a standard TV antenna will show a series of dipoles in parallel to each other with fixed spacing between the elements. The number of elements used will depend on the gain desired and the limits of the supporting structure. A three element Yagi consists of a director, a driven element, and a reflector. Below is a picture of how these elements are configured:

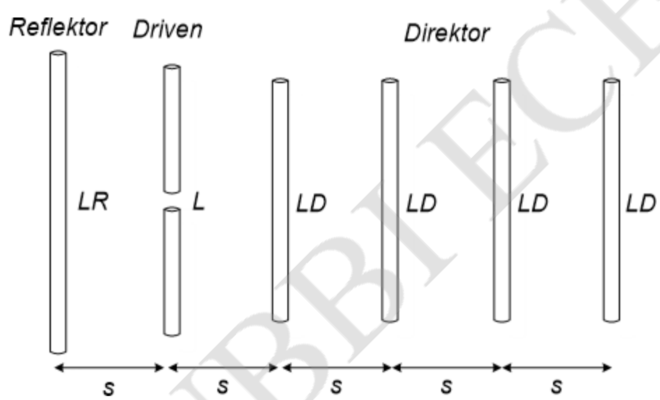
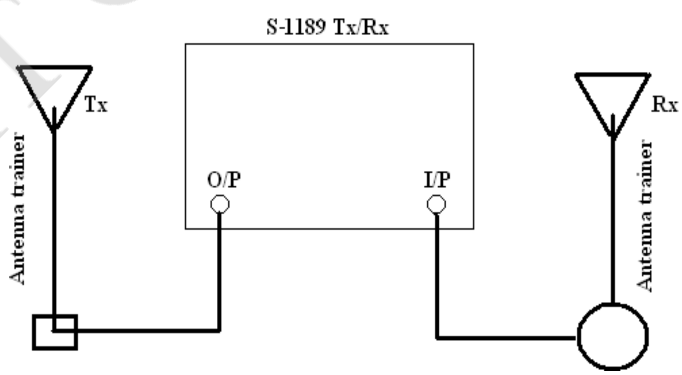


Figure : Six element Yagi antenna.

Block Diagram



PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount Yagi Uda antenna on the transmitter mask
3. Bring the detector assembly near to main and adjust the height of both transmitting and receiving antenna
4. Keep Detector assembly away from the main unit approximately 1.5 meter and align both of them .Ensure that there is no reflector sort things in the vicinity of the experiment such as a steelstructure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD (Forwardadjustment knob).
6. Keep detector level control in the centre approximately
7. Increase RF level gradually and see that there is deflection in the detector meter
8. Adjust RF level and detector level, so that the deflection in detector meter is approximately 30-35mA.
9. Align arrow mark on the disk with zero of the goniometer scale
10. Start taking the reading at the interval of 10 degree, and note the deflection on the detector assembly.
11. Using conversion chart convert mA readings into db.
12. Plot the polar graph in degrees of rotation of antenna against level in the detector in dBs

Tabulation

SL.No	Angle in Degrees	Detector reading(mA)	Gain in dB

RESULT:

EXPERIMENT NO 10

Calculate the aperture of a Dipole Antenna

Aim : To calculate the aperture of a Dipole Antenna.

A folded dipole is a dipole antenna, with the ends folded back around and connected to each other, forming a loop. Typically, the width *d* of the folded dipole is much smaller than the length *L*. Because the dipole is a closed loop, one would expect the input impedance to depend on the input impedance of a short-circuited transmission line of length *L* (although unfortunately it depends on a transmission line of length *L*/2, which doesn't quite make intuitive sense to me). Also, because the dipole is folded back on itself, the currents can reinforce each other instead of cancelling each other out, so the input impedance will also depend on the impedance of a dipole antenna of length *L*.

Letting Zd represent the impedance of a dipole antenna and Zt represent the transmission line impedance given by:

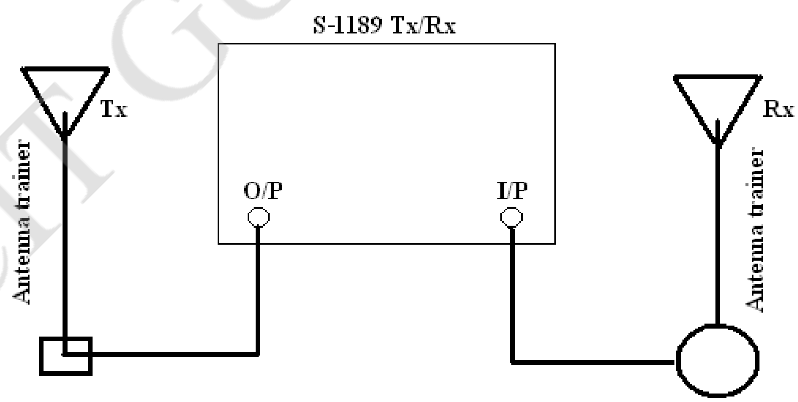
$$Z_t = jZ_0 \tan \frac{\beta L}{2}$$

The input impedance ZA of the folded dipole is given by:

$$Z_A = \frac{4Z_t Z_d}{Z_t + 2Z_d}$$

The radiation pattern of half-wavelength folded dipoles have the same form as that of half-wavelength dipoles.

Block Diagram



PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount folded dipole antenna on the transmitter mask
3. Bring the detector assembly near to main and adjust the height of both transmitting and receivingantenna
4. Keep Detector assembly away from the main unit approximately 1.5 meter and align both of them .Ensure that there is no reflector sort things in the vicinity of the experiment such as a steelstructure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD (Forwardadjustment knob).
6. Keep detector level control in the centre approximately
7. Increase RF level gradually and see that there is deflection in the detector meter
8. Adjust RF level and detector level, so that the deflection in detector meter is approximately 30-35mA.
9. Align arrow mark on the disk with zero of the goniometer scale
10. Start taking the reading at the interval of 10 degree, and note the deflection on the detector assembly.
11. Using conversion chart convert mA readings into db.
12. Plot the polar graph in degrees of rotation of antenna against level in the detector in dBs

Tabulation:

SL.No	Angle in Degrees	Detector reading (mA)	Gain in dB

RESULT:

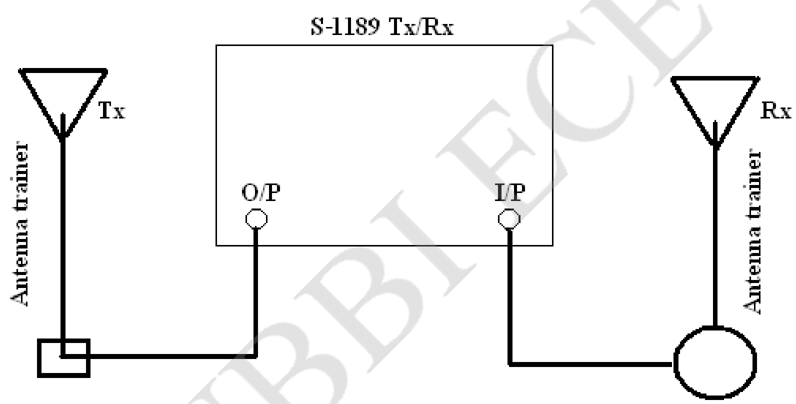
EXPERIMENT NO 11

Obtain the near and far fields of a given antenna and compare the fields

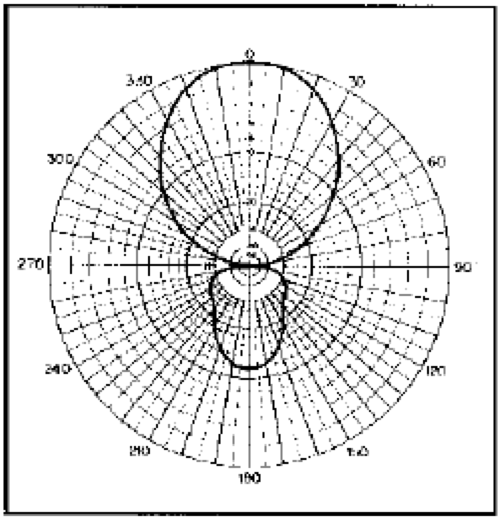
Aim : To obtain the near and far fields of a given antenna and compare the fields.

Near-Field Regions
The region next to the antenna is called the near-field region. The near-field region possesses an inductive effect, and is sometimes also referred to as the inductive field. In the near-field region, the antenna radiation pattern and strength of the fields vary with the distance from the antenna.

Far-Field Regions
The region furthest from the antenna is dominated by radiated electromagnetic fields and is called the far-field region or the Fraunhofer region. This region is immediate to the radiative near-field region.



SL.No	Angle in Degrees	Detector reading (mA)	Gain in dB



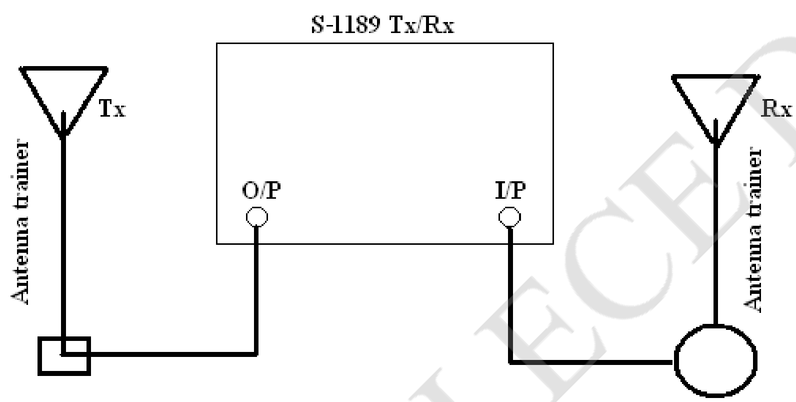
RESULT:

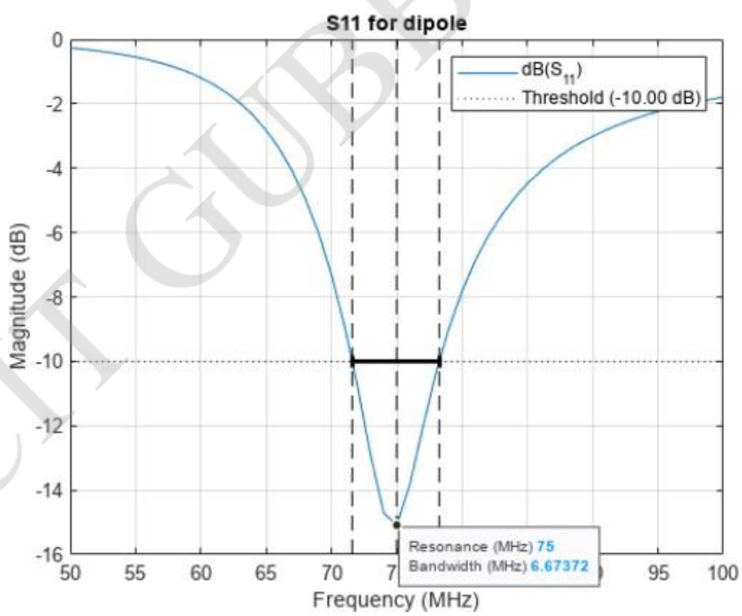
Experiment no 12

Obtain the bandwidth of a given Antenna

Aim : To obtain the bandwidth of a given Antenna.

The 'Bandwidth' of an antenna is considered for some given amount of return loss i.e -10dB or -15dB. While, 'Center Frequency' is the frequency of operation associated with the antenna. Eventually,
Impedance Bandwidth = (Bandwidth/Center Freq.) x 100.





Sl.no	Frequency	Power

RESULT: