LABORATORY MANUAL

ELECTRO MAGNETIC WAVE THEORY

ELECTRONICS & COMMUNICATION ENGINEERING

COLLEGE OF ENGINEERING AND MANAGEMENT, KOLAGHAT

Revised January 2025

Vision

Pursuing Excellence in Teaching-Learning Process to Produce High-Quality Electronics and Communication Engineering Professionals.

Mission

To enhance the employability of our students by strengthening their creativity with different innovative ideas by imparting high-quality technical and professional education with continuous performance improvement monitoring systems.

To carry out research through constant interaction with research organizations and industry.

Program Educational Objectives (PEOs)

PEO-1	Attain a solid foundation in electronics & communication engineering fundamentals with an attitude to pursue continuing education and to succeed in industry / technical profession through global education.
PEO-2	Ability to function professionally in an increasingly international and rapidly changing world due to the advances in emerging technologies and concepts.
PEO-3	Exercise excellent leadership qualities on multi-disciplinary and multi-cultural teams, at levels appropriate to their experience, which addresses issues in a responsive, ethical, and innovative manner.
PEO-4	Contribute to the needs of the society in solving technical problems using electronics & communication engineering principles, tools, and practices.

Program Outcomes (POs)

1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using the 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 with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage:** Create, select, and apply appropriate techniques,

	resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	**The engineer and society:** Apply reason informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7	**Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO-1	An ability to design and conduct the experiments, analyse and interpret the data using modern software or hardware tools with proper understanding (basic conceptions) of Electronics and Communication Engineering.
PSO-2	Ability to identify, formulate & solve problems and apply the knowledge of electronics and communication to develop techno-commercial applications

Department of
Electronics and Communication Engineering
College of Engineering and Management, Kolaghat

Electromagnetic Theory & Transmission Line Lab

Course Outcomes of Electromagnetic Waves Lab (EC591)
CO1: Measure and verify the design requirements for proper signal propagation circuits and systems.
CO2: Understand to determined unknown impedance using coaxial slotted transmission line for different condition.
CO3: Acquire the knowledge of radiation patterns and determine the gain of the different antenna.
CO4: Acquire the knowledge of Smith chart and the basics of drawing of a Smith chart.

Exp. No.	Experiments Title	CO's
Module I		
1	To study the characteristic of Gun-Oscillator (Micro-Wave Source).	1, 2
2	Study of Smith chart on Matlab platform.	4
Module II		
3	Radiation Pattern of dipole Antenna.	3
4	Radiation Pattern of a folded-dipole Antenna.	3
5	Radiation pattern of a 2-element Yagi-Uda Antenna.	3
6	Beam width, gain and radiation pattern of a 3-element Yagi-Uda Antenna.	3
7	Beam width, gain and radiation pattern of a 5-element Yagi-Uda Antenna	3
8	Radiation Pattern of a Printed (Rhombus Antenna) Antenna.	3
9	Radiation pattern, Gain, Directivity of a Pyramidal Horn Antenna.	2, 3
Content beyond the syllabus		
1	Study of microstrip based antenna, filter, and reflector with design procedure and simulation characteristics.	3

EN: *Experiment No.*
FA: *File Assessment*
*PRFM: *Performance-*
E = Excellent (10), G = Good (8),
F = Fair (6), P = Poor (4),
AB = Absent (4), NS = Not Submitted (2)

Electronics and Communication Engineering Department
<u>Continuous Lab assessment for 4ECE</u>
Electromagnetic Wave Theory Lab [EC 591]

SL.	Roll No.	Name	UNIV Roll No.	Week-			Week-			Week-			Week-			Week-		
				EN	FA	*PRFM	EN	FA	*PRFM	EN	FA	*PRFM	EN	FA	*PRFM	EN	FA	*PRFM
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			Name of the Teacher															
			Signature with date															

Exp. No.	Experiment Details	Performed in

LABORATORY NAME: ....

NAME: .... **COLLEGE ROLL NO.** ....

Index Sheet

SL	Title of the Experiment	Exp. No.	Date of Experiment	Date of Submission	Page No.	Grade	Teacher's Signature
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	
						☐ E ☐ G ☐ F ☐ P ☐ NS	

** E: Excellent G: Good F: Fair P: Poor NS: Not Submitted

1. Objective (s):

To study the V-I characteristics of Gunn oscillator to observe the variation of power & frequency with the biasing voltage .

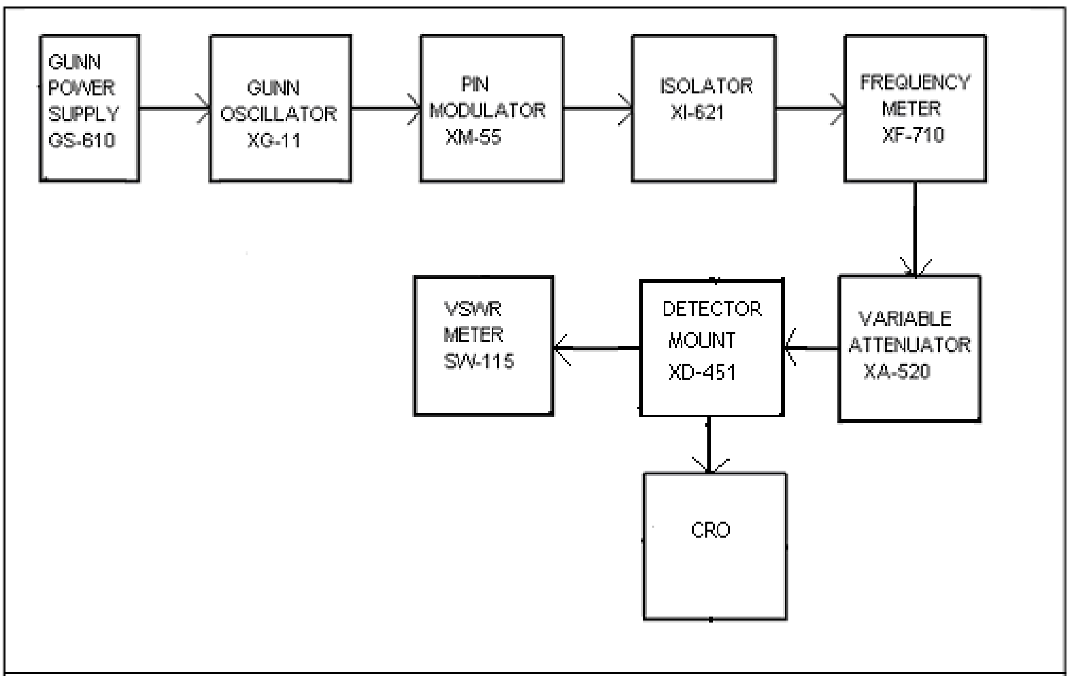
2. Theory:

The Gunn oscillator is biased on negative differential conductivity effect in bulk semiconductors which has two conduction bands separated by an energy gap (greater than thermal energies). A disturbance at the cathode gives rise to high field region which travels towards the anode. When this field domain reaches the anode, it disappears and another domain is formed at the cathode and starts moving towards anode and so on. The time required for domain to travel from cathode to anode (transit time) gives oscillation frequency.

In a Gunn oscillator, the Gunn diode is placed in a resonant cavity. The oscillation frequency is determined by cavity dimensions.

Although Gunn oscillator can be amplitude modulated with the bias voltage. We have used a PIN modulator for square wave modulation of the signal coming from Gunn diode.

3. Block Diagram:



3. SET UP FOR THE STUDY OF THE GUNN OSCILLTOR.

4.Apparatus/Components Required:

1. Gunn power supply GS-610
2. Gunn oscillator- XG-11
3. Pin modulator- XM-55
4. Isolator- XI-621
5. Frequency meter- XF-710
6. Variable Attenuator- XA-520
7. Slotted line- XS-651
8. Tunable Probe- XP-655
9. Detector Mount- XD-451
10. Matched Termination- XL-400
11. VSWR meter- SW-115
12. BNC and TNC cable.
13. Wave-guide stands and Accessories
1. Oscilloscope

5. Procedures:

1. Assemble the setup as shown in the figure.
2. Initially set the variable attenuator (XA-520) for minimum attenuation.
3. Keep the control knobs of Gunn power supply as below
   a. Meter switch 'OFF'
   b. Gunn bias knob 'FULLY ANTICLOCKWISE'.
   c. PIN bias knob 'FULLY ANTICLOCKWISE'.
   d. PIN mode frequency 'ANY POSITION'.

2. Keep the control knobs of VSWR meter as below
   a. Meter switch 'NORMAL'.
   b. Input switch 'LOW IMPEDANCE'.
   c. Range dB switch '40 dB'.
   d. Gain control knob 'FULLY CLOCKWISE'.

3. Set the micrometer of Gunn oscillator for required frequency of operation.
4. Switch on the Gunn power supply and cooling fan.

6. Observation:

A. *(For V-I characteristics of Gunn Diode)*

1. Increase the Gunn bias voltage from 0 to 9.5 V in step of 0.5 Volt & measure the Gunn diode current corresponding to the various Gunn bias voltages through the digital panel meter and meter switch. (Do not exceed the bias voltage above 9.5 Volts.)
2. Plot the voltage and current readings on the graph.
3. Measure the Threshold voltage which corresponds to maximum current.

NOTE: ***Do not keep Gunn bias knob position at Threshold position for more than 10-15 seconds, reading should be obtained as fast as possible. Otherwise due to excessive heating, Gunn diode may burn.***

B. *(For Output Power and Frequency as a Function of Bias Voltage)*

1. Switch on the Power meter & CRO. Adjust both of them for the measurement of power suitably.
2. Turn the meter switch of Gunn power supply to voltage position.
3. Increase the Gunn bias control knob and set it at **9.5 volt** maximum.
4. Rotate PIN bias knob to around maximum position.
5. Observe the maximum output from CRO and measure the power by using a power meter.

6. Tune frequency meter knob to get a ‘dip’ and note down the frequency directly from frequency meter & detune it.
7. Reduce the Gunn bias voltage in the interval of 0.5 Volt and note down corresponding reading of frequency from frequency meter & output power at Power meter following the procedure given in step 5.
8. Use the reading to draw the power Vs voltage and frequency Vs voltage graph.

7. Experimental Data:

(Table 1)

SL. NO	Gunn Bias voltage(volt)	Current through the Gunn diode (mA)

1. Objective (s):

1.1. To study the Radiation Pattern & measurement of 3 dB Beam width.

1.2. To measure Gain

1.3 Study the current distribution along antenna length

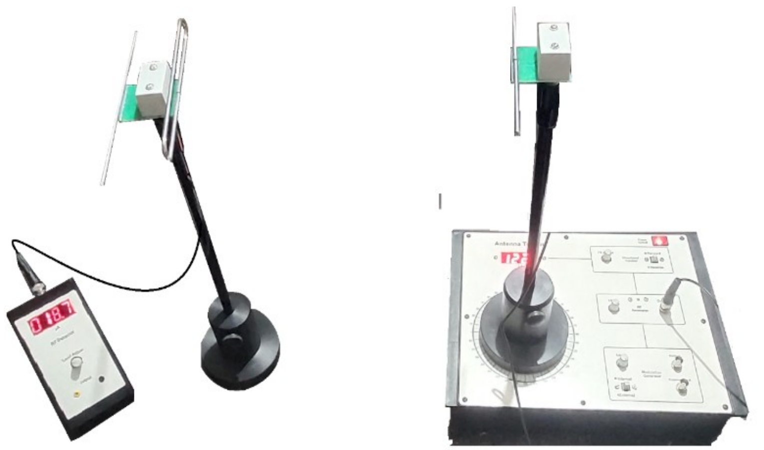
1.4. Measurement of Front to back Ratio

2. Theory:

The antenna is a reciprocal device i.e. it radiates or receives electromagnetic energy in the same way. Thus although the radiation pattern is identified with an antenna that is transmitting power, the same properties would apply to the antenna even if it was receiving power. Any difference between received & radiating powers can be attributed to the difference between the feed networks and the equipment associated with the receiver and transmitter. The antenna radiates the greatest amount of power along its bore sight and also receiver's power along its bore sight and also receiver's power most efficiently in this direction.

The radiation pattern of an antenna is peculiar to the type of antenna and its electrical characteristics as well as its physical dimensions. It is measured at a constant distance in the far field. The power at bore sight that is at the position of maximum radiated power is usually plotted at 0^0, thus the power in all other positions appear as a negative value. In other words the radiated power is normalized to the power at bore sight. The main for using dB instead of linear power is that the power at the nulls is often to the order of 10000 times less than the power on bore sight, which means that the scales would have to be very large in order to cover the whole range of power values.

3. Block Diagram:



4. Apparatus/Components Required:

Antenna Trainer Kits .

5. Procedures:

5.1 Arrange the Setup as per given Figure.

5.2 After arrange setup power cable in transmitter and 12V DC adapter in Detector.

5.3 Set all knob anticlockwise.

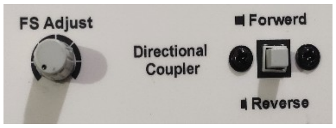
5.4 Set goniometer scale stand cursor in 0° position and lock screw.

5.5 Connect transmitter antenna **BNC** in **RF OUT** Connector**.**

5.6 Switch on power supply.

5.7 Now set RF Level Knob fully clockwise.

5.8 Now set transmitter 100 µA in transmitter display help to FS(full scale) Adjust.



5.9 Set directional couple switch in forward position.

5.10 Now maintain distance approx. 2 feet between transmitter and receiver antenna.

5.11 Now set detector display around 60-70 µA level adjust knob fully

5.12 If power less than 60 reduce distance.

5.13 Now rotate transmitter antenna 5°-10° steps.

5.14 Now not down reading Angle vs. Power and put readings draw Graph.

6. Observation Table:

Name of the Antenna:

SL. NO	Angle In Degree	Current in Micro Amp.

7. Data Calculation:

7.1 Beam width and Gain of main lobe:

The beam width of an antenna is commonly defined in two ways. The most well known definition is the -3dB or half-power beam width, but the 10dB beam width is also used, especially for antennas with very narrow beams. The -3dB or half-power beam width of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value. The -10dB value is taken as the width in degrees on either side of the main beam where the radiated level is 10dB lower than the maximum lobe value.

7.2 Polar Plots:

In a Polar Plot the angles are plotted radially from the bore sight and the levels (dBµV/ dBµA) are plotted along the radius. The angles may be selected at any convenient interval. However 5 degrees or 10 degrees may be chosen. Choosing of 1 degree is also possible in the trainer but this does not serve any special purpose because the readings will not change much and will consume more time. The polar plot gives a pictorial representation of the radiation pattern of the antenna and is easier to visualise than the rectangular plots. The student will easily understand the polar plot drawn by them.

7.3 Front to Back Ratio:

The front-to-back ratio is a measure of the ability of a directional antenna to concentrate the beam in the required forward direction. In linear terms, it is defined as the ratio of the maximum power in the main beam (bore sight) to that in the back lobe.It is usually expressed in decibels, as the difference between the level on bore sight and at 180 degrees off bore sight. If this difference is say 35dB then the front-to-back ratio of the antenna is 35dB; in linear terms it would mean that the level of the back lobe is 3,162 times less than the level of the bore sight.

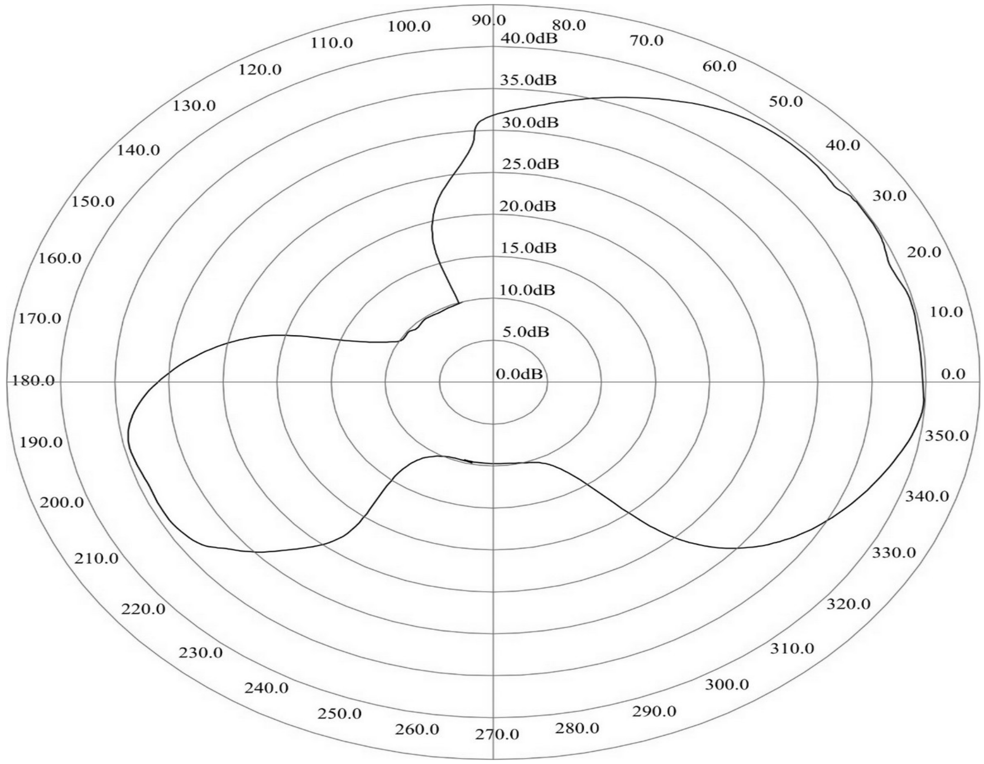
7.4 Plotting the Polar Graph for Normalized reading :

One can also plot the polar graph against normalized readings of RF Detector. The procedure to convert the Micro Amp in to normalize reading is given as follows:

Consider the maximum reading say N (When the RF Detector receives maximum radiations) as 0 dB.
Let say it is N=50 Micro Amp,
Convert next reading taken at the interval (5 or 10 degrees) say N1 by the following formula:
ln N1 / N = reading in dB
Let take N1=40 Micro Amp,
ln (40/50) = -0.22 dB
Follow the same procedure for the further readings thus the generalized formula will be:
10 Log (Nx / N) = readings in dB

Plot the radiation pattern of antenna with the new dB readings as usual.
1.Calculate the following with the help this graph

- Beam width.
- Front / Back ratio.
- Directive gain of antenna.



Polar Plot

8. Precautionary measure to be taken:

1. Don't mishandle the antenna.
2. During measurement don't put any obstacle in front of the antenna.
3. Handle the instruments carefully.

9. Some Sample questions:

1. What is Directivity?
2. What is radiation pattern of an antenna?
3. What is the significance of a dipole antenna?
4. What is the function of reflector in the Yagi Uda antenna?
5. What is the intrinsic impedance of air?
6. What is the Radiation Intensity of an Antenna?

1. Objective (s):

1.1. To study the Radiation Pattern & measurement of 3 dB Beam width.
1.2. To measure Gain
1.3 Study the current distribution along antenna length
1.4. Measurement of Front to back Ratio

2. Theory:

The antenna is a reciprocal device i.e. it radiates or receives electromagnetic energy in the same way. Thus although the radiation pattern is identified with an antenna that is transmitting power, the same properties would apply to the antenna even if it was receiving power. Any difference between received & radiating powers can be attributed to the difference between the feed networks and the equipment associated with the receiver and transmitter. The antenna radiates the greatest amount of power along its bore sight and also receiver's power along its bore sight and also receiver's power most efficiently in this direction.

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3. Block Diagram:

4. Apparatus/Components Required:

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5. Procedures:

5.1 Arrange the Setup as per given Figure.

5.2 After arrange setup power cable in transmitter and 12V DC adapter in Detector.

5.3 Set all knob anticlockwise.

5.4 Set goniometer scale stand cursor in 0° position and lock screw.

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5.6 Switch on power supply.

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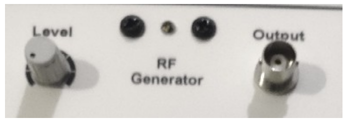
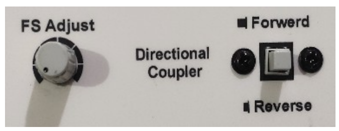


5.8 Now set transmitter 100 µA in transmitter display help to FS(full scale) Adjust.



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Let take N1=40 Micro Amp,

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Follow the same procedure for the further readings thus the generalized formula will be:

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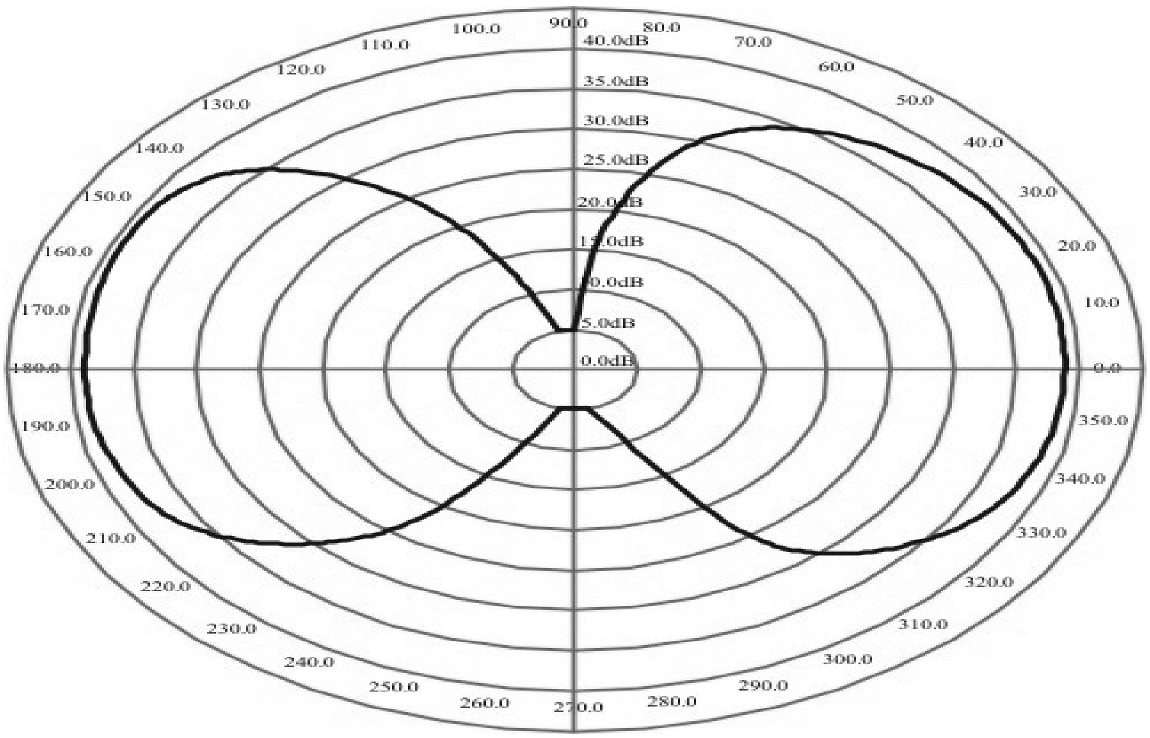

Polar Plot

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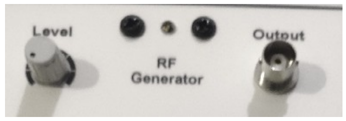

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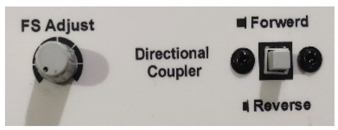

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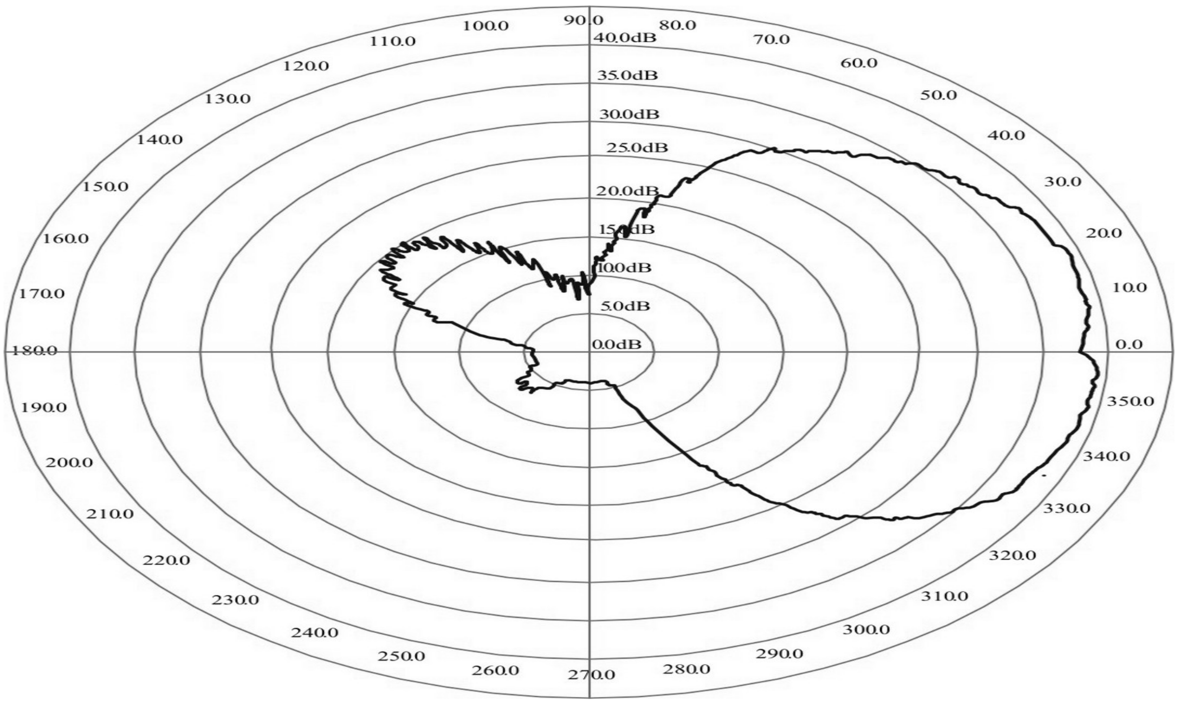

Polar Plot

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6. What is the Radiation Intensity of an Antenna?

1. Objective (s):

1.1. To study the Radiation Pattern & measurement of 3 dB Beam width.

1.2. To measure Gain

1.3 Study the current distribution along antenna length

1.4. Measurement of Front to back Ratio

2. Theory:

The antenna is a reciprocal device i.e. it radiates or receives electromagnetic energy in the same way. Thus although the radiation pattern is identified with an antenna that is transmitting power, the same properties would apply to the antenna even if it was receiving power. Any difference between received & radiating powers can be attributed to the difference between the feed networks and the equipment associated with the receiver and transmitter. The antenna radiates the greatest amount of power along its bore sight and also receiver’s power along its bore sight and also receiver’s power most efficiently in this direction.

The radiation pattern of an antenna is peculiar to the type of antenna and its electrical characteristics as well as its physical dimensions. It is measured at a constant distance in the far field. The power at bore sight that is at the position of maximum radiated power is usually plotted at 0^0, thus the power in all other positions appear as a negative value. In other words the radiated power is normalized to the power at bore sight. The main for using dB instead of linear power is that the power at the nulls is often to the order of 10000 times less than the power on bore sight, which means that the scales would have to be very large in order to cover the whole range of power values.

3. Block Diagram:

4. Apparatus/Components Required:

Antenna Trainer Kits.

5. Procedures:

5.1 Arrange the Setup as per given Figure.

5.2 After arrange setup power cable in transmitter and 12V DC adapter in Detector.

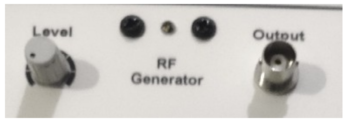
5.3 Set all knob anticlockwise.

5.4 Set goniometer scale stand cursor in 0° position and lock screw.

5.5 Connect transmitter antenna **BNC** in **RF OUT** Connector**.**

5.6 Switch on power supply.

5.7 Now set RF Level Knob fully clockwise.



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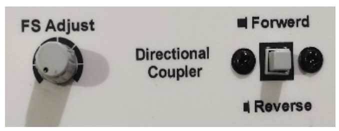

5.9 Set directional couple switch in forward position.

5.10 Now maintain distance approx. 2 feet between transmitter and receiver antenna.

5.11 Now set detector display around 60-70 µA level adjust knob fully

5.12 If power less than 60 reduce distance.

5.13 Now rotate transmitter antenna 5°-10° steps.

5.14 Now not down reading Angle vs. Power and put readings draw Graph.

6. Observation Table:

Name of the Antenna

SL. NO	Angle In Degree	Current in Micro Amp.

7. Data Calculation:

7.1 Beam width and Gain of main lobe:

The beam width of an antenna is commonly defined in two ways. The most well known definition is the -3dB or half-power beam width, but the 10dB beam width is also used, especially for antennas with very narrow beams. The -3dB or half-power beam width of an antenna is taken as the width in degrees at the points on either side of the main beam where the radiated level is 3dB lower than the maximum lobe value. The -10dB value is taken as the width in degrees on either side of the main beam where the radiated level is 10dB lower than the maximum lobe value.

7.2 Polar Plots:

In a Polar Plot the angles are plotted radially from the bore sight and the levels (dBµV/ dBµA) are plotted along the radius. The angles may be selected at any convenient interval. However 5 degrees or 10 degrees may be chosen. Choosing of 1 degree is also possible in the trainer but this does not serve any special purpose because the readings will not change much and will consume more time. The polar plot gives a pictorial representation of the radiation pattern of the atenna and is easier to visualise than the rectangular plots. The student will easily understand the polar plot drawn by them.

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7.4 Plotting the Polar Graph for Normalized reading :

One can also plot the polar graph against normalized readings of RF Detector. The procedure to convert the Micro Amp in to normalize reading is given as follows:

Consider the maximum reading say N (When the RF Detector receives maximum radiations) as 0 dB.

Let say it is N=50 Micro Amp,

Convert next reading taken at the interval (5 or 10 degrees) say N1 by the following formula:

ln N1 / N = reading in dB

Let take N1=40 Micro Amp,

ln (40/50) = -0.22 dB

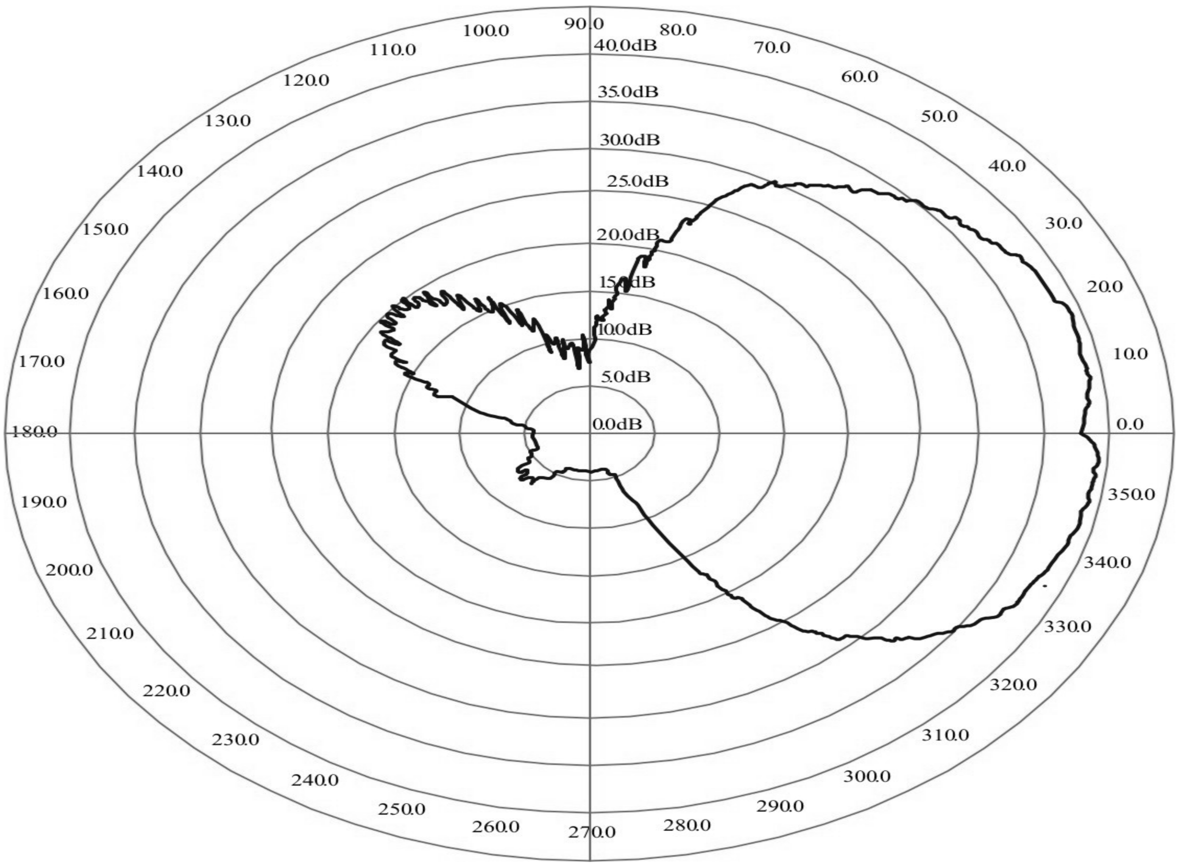
Follow the same procedure for the further readings thus the generalized formula will be:

10 Log (Nx / N) = readings in dB

Plot the radiation pattern of antenna with the new dB readings as usual.

1.Calculate the following with the help this graph

- Beam width.
- Front / Back ratio.
- Directive gain of antenna.



Polar Plot

8. Precautionary measure to be taken:

1. Don’t mishandle the antenna.
2. During measurement don’t put any obstacle in front of the antenna.
3. Handle the instruments carefully.

9. Some Sample questions:

1. What is Directivity?
2. What is radiation pattern of an antenna?
3. What is the significance of a dipole antenna?
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5.6 Switch on power supply.

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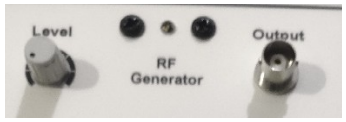

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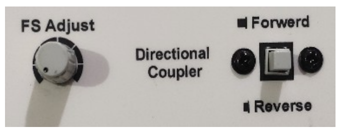

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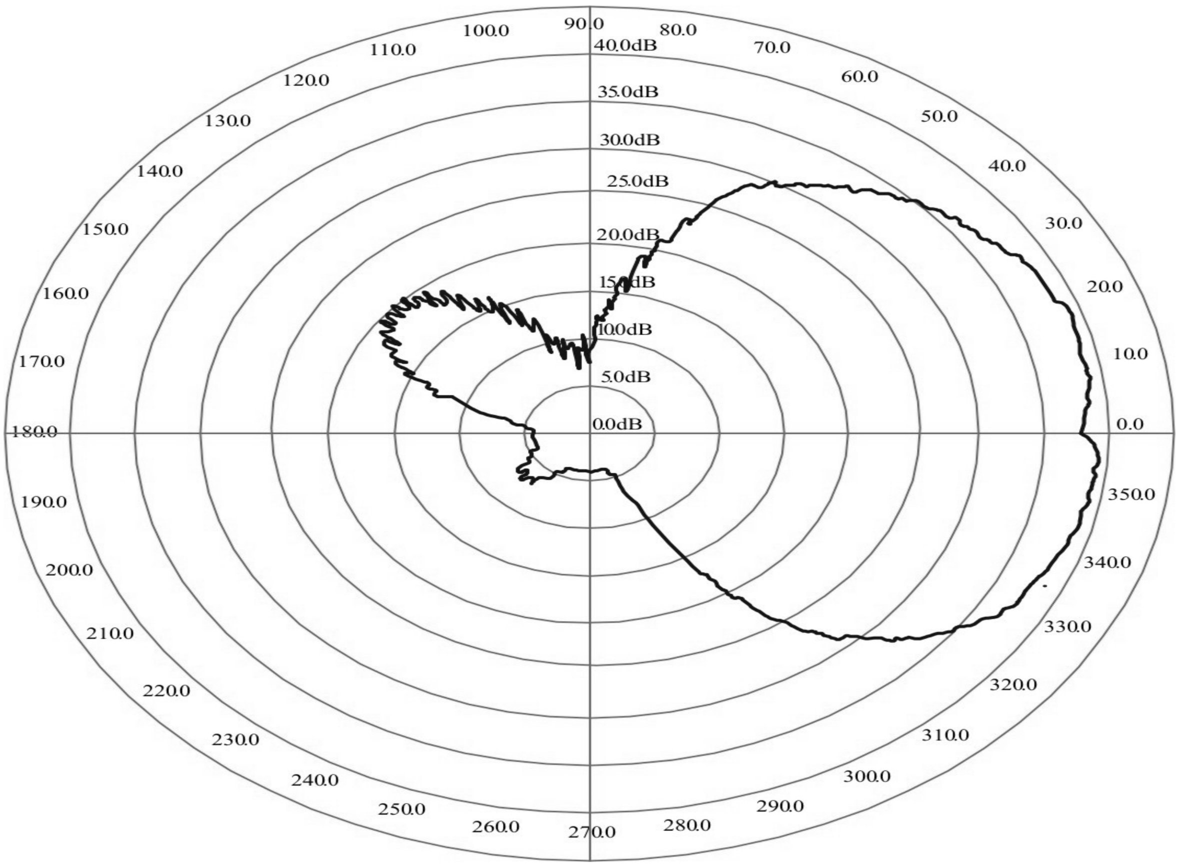

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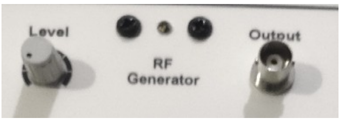

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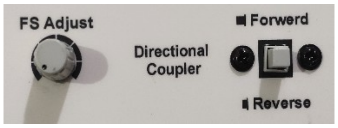

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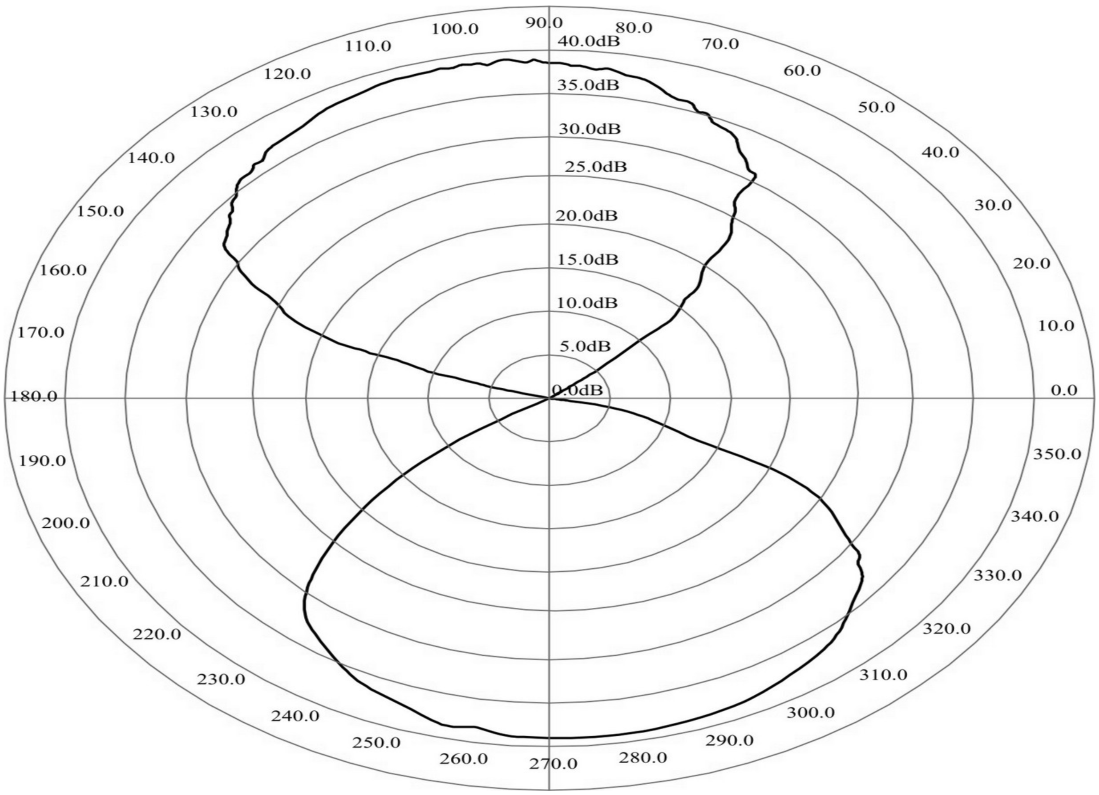

Polar Plot

8. Precautionary measure to be taken:

1. Don’t mishandle the antenna.
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9. Some Sample questions:

1. What is Directivity?
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5. What is the intrinsic impedance of air?
6. What is the Radiation Intensity of an Antenna?

1) Objective (s):

i). To study the Radiation Pattern (Polar Pattern & 3dB Beam width) of Horn Antenna.

ii). To measure the Gain of Horn Antenna.

2. Theory:

If a transmission line, propagation energy left open at one end, there will be radiation from this end. In case of a rectangular wave-guide this antenna presents a mismatch of about 2 and it radiates in many directions. The match will improve if the open wave-guide is a horn shape.

The radiation pattern of an antenna is a plot of field strength of the power intensity as a function of the aspect angle at a constant distance from the radiating antenna. An antenna is of course three dimensional but for practical reasons it is normally presents as a two dimensional pattern in one or several planes. An antenna pattern consists of several lobes, the main lobe, the side lobe and the back lobe. The major power is concentrated in the main lobe and it is required to keep the power in the side lobes and the back lobes as low as possible. The power intensity at the maximum in the main lobe compared to the power intensity achieved from an imaginary omni-directional antenna (radiating equally in all directions) with the same power fed to the antenna is defined as gain of the antenna. 3dB beam-width is the angle between the two points on a main lobe where the power intensity is half the maximum power intensity. The antenna pattern measurement is always done in far field region. Far field pattern is achieved at a minimum distance of $2D^2/\lambda_0$ (for triangular horn antenna) .

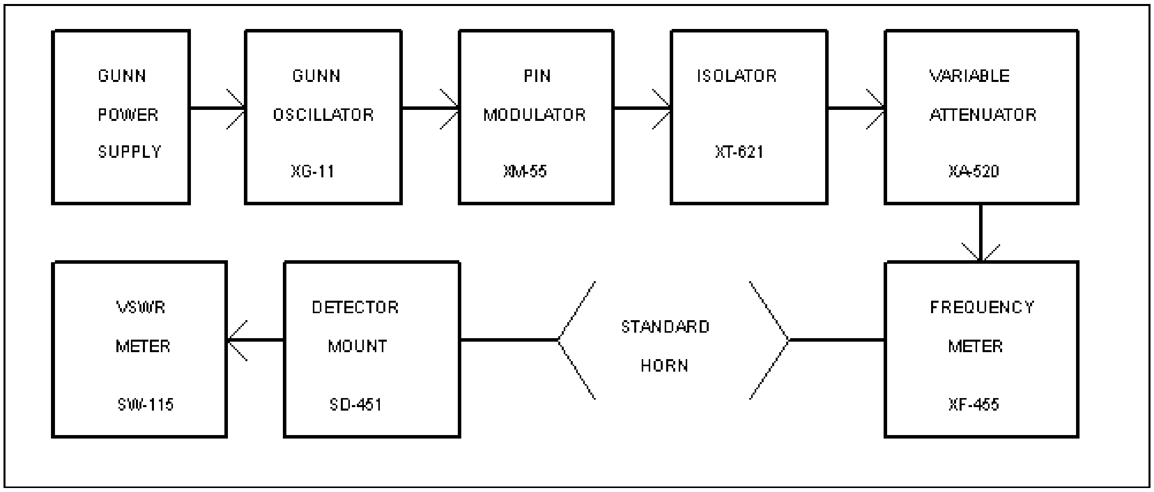
Where D is size of broad wall of horn aperture, λ_0 is the free space wavelength.

$G = 4\pi / (_H * _E)$ $\qquad$ $_H$ & $_E$ are in radian.

OR

$G = 41253 / (_H * _E)$ $\qquad$ $_H$ & $_E$ are in degrees.

3. Block Diagram:



4. Apparatus/Components Required:

1. Gunn power supply- GS-610
2. Gunn oscillator- XG-11
3. 3. Pin modulator- XM-55
4. 4. Isolator- XI-621
5. Frequency meter- XF-455
6. Detector mount- SD-451
7. H-Plane Horn- XH- 751
8. VSWR meter- SW-115
9. E-Plane Bend XU-535
10. Wave Guide Twist (90^0) XB-751
11. BNC to BNC and BNC to TNC cable.
12. Twin Table (Microprocessor Based).

5. Procedures:

1) Initially set the variable attenuator (XA-520) for minimum attenuation.

2) Keep the control knobs of Gunn power supply as below

a) Meter switch ‘OFF’

b) Gunn bias knob ‘FULLY ANTICLOCKWISE’.

c) PIN bias knob ‘FULLY ANTICLOCKWISE’.

d) PIN mode frequency ‘ANY POSITION’.

3) Keep the control knobs of VSWR meter as below

a) Meter switch ‘NORMAL’.
b) Input switch ‘LOW IMPEDANCE’.
c) Range dB switch ‘40 dB’.
d) Gain control knob ‘FULLY CLOCKWISE’.

4) Set the micrometer of Gunn oscillator for required frequency of operation.
5) Switch on the Gunn power supply,VSWR meter and cooling fan.
6) Turn the meter switch of Gunn power supply to voltage position.
7) Increase the Gunn bias control knob and set it at **9.5 volt** maximum.
8) Rotate PIN bias knob to around maximum position.
9) Tune the output in the VSWR meter through frequency control knob of modulation.
10) If required then change the range of dB switch of VSWR meter. Any level can be set through variable attenuator and gain control knob of VSWR meter.
11) Tune the probe for maximum deflection in VSWR meter.
12) Tune frequency meter knob to get a ‘dip’ on the VSWR scale and note down the frequency directly from frequency meter.
13) Set up the equipments as shown in the figure. Both antenna should be in line.
14) Set up the equipments as shown in the figure. Both antennas should be in line.
15) Energize the Gunn oscillator for maximum output at desired frequency with modulating amplitude and frequency of Gunn power supply and by tuning of detector.
16) Obtain full - scale deflection (0 dB) in VSWR meter on normal scale (0 to 10dB) at any convenient range switch position of VSWR meter or by variable attenuator.
17) Rotate the receiving Horn to the left in 1^0 steps up to 60^0 and note down the corresponding VSWR dB reading in normal dB range. When necessary, change the range switch to next higher range and add 10 dB to the observed value.
18) Repeat the above steps but this time turns the receiving Horn to the right and note down the readings.

19) Plot the polar pattern and find out $_E$ / $_H$ (3db beam width), when the electric field is parallel to ground it is $_E$ and when magnetic field is parallel to ground plane it is $_H$.

20) Replace the transmitting and receiving Horn put the 90^0 twist along with the horn and repeat 17-19 and measure the $_E$.

6. Observation:

1. Plot E & H plane Polar Pattern e.g. output Vs angle.
2. From the diagram determine 3 dB beam-width ($_E$ & $_{H)}$ of the Horn antenna.
3. Calculate the gain.

7. Observation Table:

SL. NO	Name of the Antenna	3db Beamwidth $_H$	3db Beamwidth $_E$	Gain	F in GHz

8. Precautionary measure to be taken:

1. Before switch ON the Gunn power supply Keep the control knobs of Gunn power supply as below:
   a. Meter switch ‘OFF’
   b. Gunn bias knob ‘FULLY ANTICLOCKWISE’.
   c. PIN bias knob ‘FULLY ANTICLOCKWISE’.
   d. PIN mode frequency ‘ANY POSITION’.
2. Don’t keep frequency meter in tuned condition for more than 30 second detuned immediately.

9. Some Sample questions:

1. Comment on the radiation pattern of a practical antenna and a theoretical antenna.
2. What is the different kind of antenna used for microwave transmission?
3. Can an open-ended waveguide act as an antenna?