SRM UNIVERSITY
Department of Telecommunication Engineering

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ANTENNA & PROPAGATION LAB

INTRODUCTION:

Antennas are a fundamental component of modern communications systems. By Definition, an antenna acts as a transducer between a guided wave in a transmission line and an electromagnetic wave in free space. Antennas demonstrate a property known as reciprocity, that is an antenna will maintain the same characteristics regardless if it is transmitting or receiving. When a signal is fed into an antenna, the antenna will emit radiation distributed in space a certain way. A graphical representation of the relative distribution of the radiated power in space is called **a radiation pattern**.
The following is a glossary of basic antenna concepts.

Antenna

An antenna is a device that transmits and/or receives electromagnetic waves. Electromagnetic waves are often referred to as radio waves. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be tuned to the same frequency band that the radio system to which it is connected operates in, otherwise reception and/or transmission will be impaired.

Wavelength

We often refer to antenna size relative to wavelength. For example: a half-wave dipole, which is approximately a half-wavelength long. Wavelength is the distance a ra dio wave will travel during one cycle. The formula for wavelength is shown on the next page.

$$\lambda = \frac{c}{f}$$

Where:

λ is the wavelength, and is expressed in units of length, typically meters, feet, or inches.

c is the speed of light, 29,979,307,700 centimeters/second, or 11,802,877,050 inches/second.

f is the frequency

For example: the wavelength in air at 825 MHz is: $\frac{11.803 \text{ X } 10^{9} \text{ in/sec.}}{825 \text{ X } 10^{6} \text{ cycles/sec.}} = 14.307$ in/cycle

Note: The length of a half-wave dipole is slightly less than a half-wavelength due to end effect. The speed of propagation in coaxial cable is slower than in air, so the wavelength in the cable is shorter. The velocity of propagation of electromagnetic waves in coax is usually given as a percentage of free space velocity, and is different for different types of coax.

Impedance Matching

For efficient transfer of energy, the impedance of the radio, the antenna, and the transmission line connecting the radio to the antenna must be the same. Radios typically are designed for 50 ohms impedance and the coaxial cables (transmission lines) used with them also have a 50 ohm impedance. Efficient antenna configurations often have an impedance other than 50 ohms, some sort of impedance matching circuit is then required to transform the antenna impedance to 50 ohms.

VSWR and Reflected Power

The Voltage Standing Wave Ratio **(VSWR)** is an indication of how good the Impedance match is. VSWR is often abbreviated as SWR. A high VSWR is an indication that the signal is reflected prior to being radiated by the antenna. VSWR and reflected power are different ways of measuring and expressing the same thing. A VSWR of 2.0:1 or less is considered good. Most commercial antennas, however, are specified to be 1.5:1 or less over some bandwidth. Based on a 100 watt radio, a 1.5:1 VSWR equates to a forward power of 96 watts and a reflected power of 4 watts, or the reflected power is 4.2% of the forward power.

Bandwidth

Bandwidth can be defined in terms of radiation patterns or VSWR/reflected power. The definition used in this book is based on VSWR. Bandwidth is often expressed in terms of percent bandwidth, because the percent bandwidth is constant relative to frequency. If bandwidth is expressed in absolute units of frequency, for example MHz, the bandwidth is then different depending upon whether the frequencies in question are near 150, 450, or 825 MHz. A mathematical analysis of bandwidth is provided on the next page.

Percent bandwidth is defined as:

$$BW = 100\ \frac{F_H - F_L}{F_C} \quad \text{where:}$$

F_H is the highest frequency in the band
F_L is the lowest frequency in the band

F_C is center frequency of the band $\quad F_C = \frac{F_H + F_L}{2}$

Example: If you need an antenna that operates in the 150 - 156 MHz band, you need an antenna that covers at least a $\frac{156-150}{153}100 = 3.9\%$ bandwidth.

The problem might need to be worked a different way, if the antenna is tuned to 460 MHz and provides a 1.5:1 VSWR bandwidth of 5%, what are FL and FH. The equations above can be solved for FH and FL:

$$F_H = F_C\left(1 + \frac{BW}{200}\right) \text{ and } F_L = F_C\left(1 - \frac{BW}{200}\right)$$

Plugging the numbers into the equations: and the answers are

$$F_H = 460\left(1 + \frac{5}{200}\right) = 471.5\text{MHz}$$

$$F_L = 460\left(1 - \frac{5}{200}\right) = 448.5\text{MHz}$$

Directivity and Gain

Directivity is the ability of an antenna to focus energy in a particular direction when transmitting or to receive energy better from a particular direction when receiving. The relationship between gain and directivity: *Gain = efficiency/Directivity*.

Gain is given in reference to a standard antenna. The two most common reference Antennas are the isotropic antenna and the resonant half-wave dipole antenna. The isotropic antenna radiates equally well in "all" directions. Real isotropic antennas do not exist, but they provide useful and simple theoretical antenna patterns with which to compare real antennas. An antenna gain of 2 (3 dB) compared to an isotropic antenna would be written as 3 dBi. The resonant half-wave dipole can be a useful standard for comparing to other antennas at one frequency or over a very narrow band of frequencies. To compare the dipole to an antenna over a range of frequencies requires an adjustable dipole or a number of dipoles of different lengths.

Gain Measurement

One method of measuring gain is by comparing the antenna under test against a known standard antenna. This is technically known as a gain transfer technique. At lower frequencies, it is convenient to use a 1/2-wave dipole as the standard. At higher frequencies, it is common to use a calibrated gain horn as a gain standard, with gain typically expressed in dBi. Another method for measuring gain is the 3 antenna method. Transmitted and received power at the antenna terminals is measured between three arbitrary antennas at a known fixed distance. The Friis transmission formula is used to develop three equations and three unknowns. The equations are solved to find the gain expressed in dBi of all three antennas.

Antenna Placement

Correct antenna placement is critical to the performance of an antenna. An antenna mounted on the roof will function better than the same antenna installed on the hood or trunk of a car. Knowledge of the vehicle may also be an important factor in determining what type of antenna to use. You do not want to install a glass mount antenna on the rear window of a vehicle in which metal has been used to tint the glass. The metal tinting will work as a shield and not allow signals to pass through the glass. When installing antennas at a base station, a stainless steel mast should be used to properly pass stray RF current away from the antenna and provide proper support.

Radiation Patterns

The radiation or antenna pattern describes the relative strength of the radiated field in various directions from the antenna, at a fixed or constant distance. The radiation pattern is a "reception pattern" as well, since it also describes the receiving properties of the antenna. The radiation pattern is three-dimensional, but it is difficult to display the three dimensional radiation pattern in a meaningful manner, it is also time consuming to measure a three-dimensional radiation pattern. Often radiation patterns are measured that are a slice of the three-dimensional pattern, which is of course a two-dimensional radiation pattern which can be displayed easily on a screen or piece of paper. These pattern measurements are presented in either a rectangular or a polar format.

Near-Field and Far-Field Patterns

The radiation pattern in the region close to the antenna is not exactly the same as the pattern at large distances. The term near-field refers to the field pattern that exists close to the antenna; the term far-field refers to the field pattern at large distances. The far-field is also called the radiation field, and is what is most commonly of interest. The near-field is called the induction field (although it also has a radiation component).Ordinarily, it is the radiated power that is of interest, and so antenna patterns are usually measured in the far-field region. For pattern measurement it is important to choose a distance sufficiently large to be in the far-field, well out of the near-field. The minimum permissible distance depends on the dimensions of the antenna in relation to the wavelength. The accepted formula for this distance is:

$$r_{min} = \frac{2D^2}{\lambda}$$

Where:

r_{min} is the minimum distance from the antenna

D is the largest dimension of the antenna

λ is the wavelength

When extremely high power is being radiated (as from some modern radar antennas), the near-field pattern is needed to determine what regions near the antenna, if any, are hazardous to human beings.

Beamwidth

Depending on the radio system in which an antenna is being employed there can be many definitions of beamwidth. A common definition is the half power beamwidth. The peak radiation intensity is found and then the points on either side of the peak represent half the power of the peak intensity are located. The angular distance between the half power points traveling through the peak is the beamwidth. Half the power is — 3dB, so the half power beamwidth is sometimes referred to as the 3dB beamwidth.

Antenna Polarization

Polarization is defined as the orientation of the electric field of an electromagnetic wave. Polarization is in general described by an ellipse. Two often used special cases of elliptical polarization are linear polarization and circular polarization. The initial polarization of a radio wave is determined by the antenna that launches the waves into space. The environment through which the radio wave passes on its way from the transmit antenna to the receive antenna may cause a change in polarization.

With linear polarization the electric field vector stays in the same plane. In circular polarization the electric field vector appears to be rotating with circular motion about the direction of propagation, making one full turn for each RF cycle. The rotation may be righthand or left-hand.

Choice of polarization is one of the design choices available to the RF system designer. For example, low frequency (< 1 MHz) vertically polarized radio waves propagate much more successfully near the earth than horizontally polarized radio waves, because horizontally polarized waves will be canceled out by reflections from the earth. Mobile radio systems waves generally are vertically polarized. TV broadcasting has adopted horizontal polarization as a standard. This choice was made to maximize signal-to-noise ratios. At frequencies above 1 GHz, there is little basis for a choice of horizontal or vertical polarization, although in specific applications, there may be some possible advantage in one or the other. Circular polarization has also been found to be of advantage in some microwave radar applications to minimize the "clutter" echoes received from raindrops, in relation to the echoes from larger targets such as aircraft. Circular polarization can also be used to reduce multipath. The majority of the antennas utilized in this experiment are vertically polarized because of their predominance in antenna applications.

Performance Analysis of Half Wave Dipole

Pre Lab Questions:

1. Define Antenna.
2. Give antenna parameters.
3. Define Impedance Matching.

1. Performance Analysis of Half Wave Dipole

Aim:

To analyze the performance of Half Wave Dipole antenna and determine its Radiation Pattern.

Apparatus Required:

Half Wave Dipole Antenna

THEORY

The half wave dipole is perhaps the simplest and most fundamental antenna design possible. Hertz used a dipole antenna during his initial radio experimentation. This is why a dipole is often referred to as the “hertz dipole” antenna. The dipole is so practical that it is utilized (in some form) in at least half of all antenna systems used today. Here are some key principles of the dipole antenna:

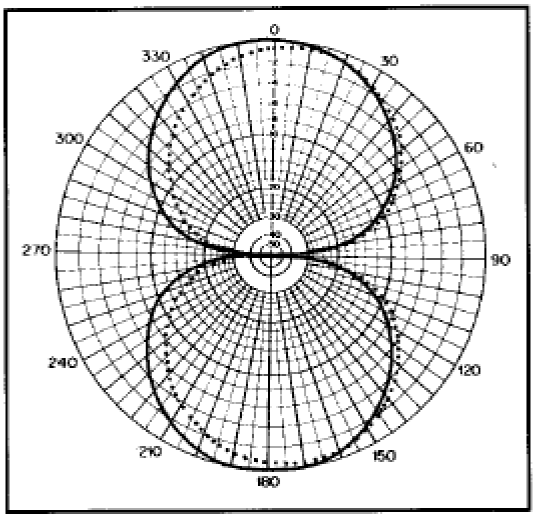
1.) A dipole antenna is a wire or conducting element whose length is half the transmitting wavelength.To calculate the length of a half wave dipole in free space, one may use the following equation:
length (ft) = 492 / frequency (MHz)

2.) A dipole antenna is fed in the center.
By using a piece of coaxial cable transmission line, one may feed the center conductor of a transmission line to a ¼ wavelength piece of wire. The outer shield or ground of the cable may be connected to the remaining ¼ wavelength piece of wire. Thus, you have a dipole antenna, fed in the center, with an overall length of ½ wavelength. The total ½ wavelength of wire is to be stretched out evenly, being perpendicular to the transmission line. How exactly does the signal come out of the cable and emanate from the wires into space? The ¼ wavelength wire which is fed by the center conductor of the transmission line is known as the hot portion. One quarter of the wave leaks from the attached wire, and the remaining quarter of the wave “hops” over to the grounded second ¼ wavelength wire. Since these two pieces of ¼ wavelength wire work together to emit the wave, we often refer to a dipole as a perfect resonant antenna. Why is this important? If an antenna is resonant, it will be matched to the transmission line and/or transmitter and the bulk of the signal will actually be transmitted, not reflected back and wasted as heat (i.e. Standing Wave Ratio SWR). It should be noted that a dipole has an impedance of 75 ohms, not 50 ohms. Ordinarily a mismatch could cause a problem, but the mismatch of 50 ohm cable feeding a 75 ohm antenna is minimal with a resultant SWR of 1.5:1. This corresponds to roughly a 5% waste of power.

3.) The dipole antenna has a unique radiation pattern.The radiation pattern of a dipole antenna in free space is strongest at right angles to the wire. This pattern, when the

antenna is positioned horizontally over the ground, resembles a figure eight. This figure eight pattern will be verified during the experiment. Let's assume we shift the antenna around and make it vertical (perpendicular to the ground). The ends of the wire which emit the least amount of energy are now directed towards both the earth and the sky. This results in a vertically polarized signal which is focused quite evenly across the reception zone. This brings up an important concept: antenna radiation patterns can be quite different horizontally and vertically. This concept will be verified when the dipoles are tested. Also, it is important to note that for a signal to be received effectively, the receiving antenna must be in the same plane as the transmitting antenna. If these are mismatched, a large portion of the signal will be lost or
distorted. This concept will be verified as well.

4.) The dipole antenna is extremely flexible.What changes can one make to a dipole to subsequently alter its radiation pattern? Thereare limitless modifications that can be made. For instance: Instead of keeping the ½ wavelength elements perpendicular to the transmission line, let's bend them or "slope" them by 45 degrees. This simple change will modify the radiation pattern. What happens when we stack two dipoles on top of each other, separated by one full wavelength of space, and feed them in phase? This is known as a stackable phased array. This focuses more of the radiated power towards the horizon, where it is most useful. Stacking antennas for this purpose produces gain. Gain is useful because it improves the strength of the signal that is transmitting or receiving. For instance: if a signal is fed into an antenna with 3db (decibels) of gain. The transmitted signal will appear on the receiving end twice as strong as it would have been if the transmitting antenna had no gain. This can be quite beneficial to a communications engineer. It is very costly to produce high powered transmitters. Gain offers a good compromise. A 10 watt signal fed into an antenna with 3dB of gain will result in an effective radiated power (ERP) of 20 watts. By
introducing an antenna with gain, an engineer can avoid having to use a 20 watt signal and an antenna with no gain. Examples of gain will be demonstrated in the lab. Gain and radiation patterns go hand in hand. If we were to place three dipoles in a row, the radiation pattern would be projected into a forward direction. This is known as forward gain.

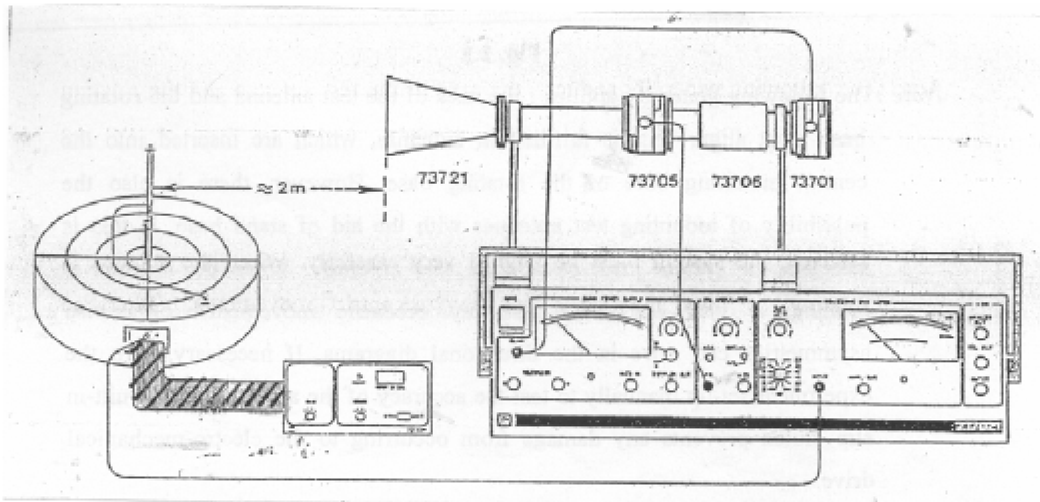


a picture of the ideal radiation pattern of a half-wave dipole in free space. This is the radiation pattern with the antenna mounted horizontally. Observe the figure eight pattern. Notice the dotted lines. The pattern is a little distorted because of the antenna mast and ground distort the pattern. It is inevitable that external factors will make the real world radiation patterns less than perfect, however, the antenna radiation patterns will still resemble their theoretical counterparts.

Specific procedures for testing the dipole antennas:

You will be testing the dipoles initially. You should have two dipoles connected. The one on the transmitting antenna apparatus is made of PVC pipe and will be shifted between horizontal and vertical. The dipole on the receiving antenna apparatus is a professional grade dipole made of metal. This is the one whose radiation pattern is being plotted. The radiation pattern of the dipoles mounted vertically is to be tested first. Make sure the transmitting PVC dipole antenna is vertical (with the arrow pointing towards the sky). Mount the metal dipole in the vertical position as well, as seen in the background section of the lab manual. Make sure that the extra metal bar (gamma match) on the antenna is on the top side of the antenna, facing the sky. Once you have both of the antennas mounted vertically, the cables connected to them and the remaining systems in place, it is time to take the readings. Follow the general procedure when doing this. Make sure the antenna is facing forward towards the transmitting antenna at your 0 degree position. Once omplete, it is time to measure the dipoles radiation pattern when it is mounted horizontally. To do so, you must rotate the PVC dipole antenna so that it is positioned horizontally, as seen in the background section of the lab. Once this is done, you will be required to mount the metal receiving dipole horizontally as well. Simply duplicate the mounting picture in the background section. Once everything is re-mounted, follow the general procedure and take your readings. You should notice that these readings are slightly different from the last set.This is to be expected.

Experimental Set up



PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount Half wave dipole 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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:

S.No	**Angle in Degrees**	**Detector reading(mA)**	**Gain in dB**
	10		
	20		
	30		
	40		
	50		
	60		
	70		
	80		
	.		
	.		
	.		
	.		
	330		
	340		
	350		

Result:

Thus the performance of Half Wave Dipole antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define half wave dipole.
2. Draw the radiation pattern of half wave dipole antenna.
3. Give the application of half wave dipole antenna.
4. Write the frequency range of RF signal

Performance Analysis of Folded Dipole Antennas

Pre Lab Questions:

1. Define Folded Dipole Antenna
2. Define VSWR.
3. Relationship bandwidth Directivity & gain
4. What is need for radiation pattern?

2. Performance Analysis of Folded Dipole Antennas

Aim:

To analyze the performance of Folded Dipole antenna and determine its Radiation Pattern.

Apparatus Required:

Folded Dipole Antenna

Theory

A folded dipole is a dipole antenna, with the ends folded back around and connected to each other, forming a loop as shown in Figure 1.

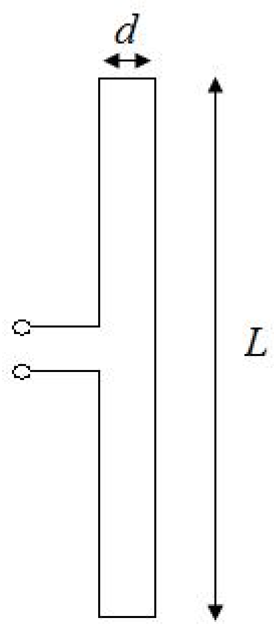


Figure . Folded dipole of length *L*.

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 Z_d represent the impedance of a dipole antenna and Z_t 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 folded dipole is resonant and radiates well at odd integer multiples of a half-wavelength (0.5 λ , 1.5 λ , ...). The input impedance is higher than that for a regular dipole.

The antenna impedance for a half-wavelength folded dipole antenna can be found from the above equation for ZA; the result is ZA=4*Zd. At resonance, the impedance of a half-wave dipole antenna is approximately 70 Ohms, so that the input impedance for a half-wave folded dipole is roughly 280 Ohms.

Because the characteristic impedance of twin-lead transmission lines are roughly 300 Ohms, this dipole is often used when connecting to this type of line, for optimal power transfer.

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

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 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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:

S.No	Angle in Degrees	Detector reading(mA)	Gain in dB
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	.		
	.		
	.		
	.		
	330		
	340		
	350		

Result:

Thus the performance of Folded Dipole antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define folded dipole.
2. Draw the radiation pattern of folded dipole antenna.
3. Give the application of folded dipole antenna.
4. Write the frequency range of RF signal

Performance Analysis of Yagi-Uda Antenna

Pre Lab Questions:

1. Define Impedance Matching.
2. Define VSWR.
3. Relationship bandwidth Directivity & gain.
4. What is need for radiation pattern?

3. Performance Analysis of Yagi-Uda Antenna

Aim:

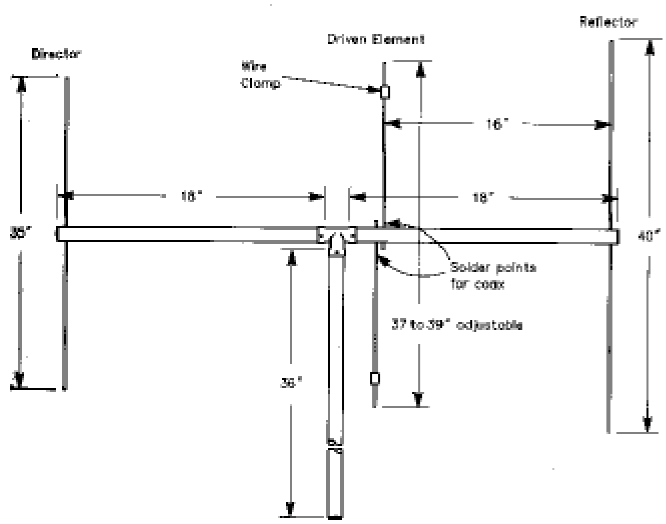
To analyze the performance of Yagi-Uda antenna and determine its Radiation Pattern.

Apparatus Required:

Yagi-Uda Antenna

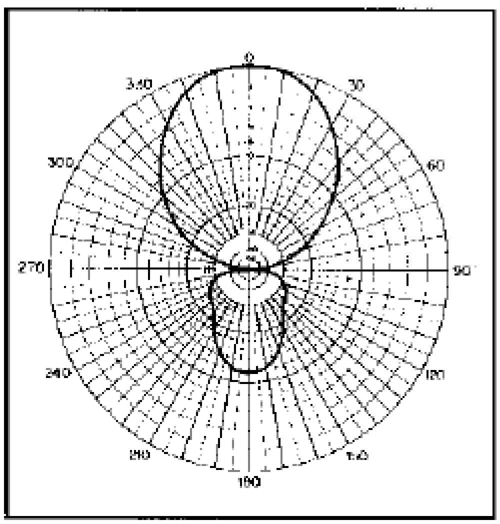
Theory:

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:

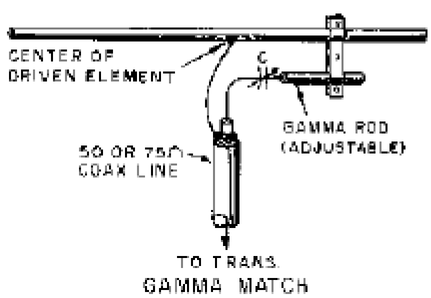


Notice that the driven element is in the center and is nothing more than a center fed dipole. To the right of the driven element is the reflector. The reflector is slightly longer than the driven element to allow for proper tuning. The reflector is simply a passive piece of metal slightly longer than ½ wavelength. At the front of the antenna is the director. It is electrically and physically shorter than the driven element. These elements work together to pr oject a radiation pattern in the forward direction. This forward radiation pattern has gain. This type of system is ideal for television broadcasts. Let’s assume you want to receive CBS’s channel 2 signal from Mount Wilson. You could simply use a pair of rabbit ears (which is a dipole) to pick up the signal, but it probably would come in snowy. This is where a Yagi can come into play. A three element Yagi in free space can have a maximum gain of around 9dB. This means the signal will be amplified by about 16 times by the antenna. Also, the radiation pattern of the antenna tends to transmit or receive the bulk of the signal from the forward direction. Thus, aiming a Yagi at Mount Wilson would receive a strong focused signal, resulting in a much better picture. Like a dipole, a Yagi can be placed either vertically or horizontally. Although this could shift the radiation pattern slightly, the concepts of gain and directivity still remain.

Below is a picture of the radiation pattern of a three element Yagi in free space. Is it what you would expect from the information provided about Yagi antennas? Notice the principles of forward gain and directivity? Note: the forward facing pattern is known as the forward lobe. The backward facing pattern is known as the backward lobe. This is an ideal radiation pattern measured in a special chamber. When the Yagi antenna is tested in the experiment, the radiation pattern will not be perfectly aligned with the theoretical model, but the concepts of gain and directivity should be evident from the plot.



A Yagi antenna often has an impedance of 200 ohms and needs to be matched down to standard 50 ohm cable. A method used to correct this mismatch is to insert a gamma match between the feedline and the antenna. A picture of this match is shown below.



Specific procedures for testing the Yagi antenna:

The Yagi antenna is to be tested after the dipole because its design is based heavily on the basic Hertz dipole. It will also expose you to a very different set of readings. Youwill notice some rapid changes in your measurements. This is normal, because the Yagioffers a very focused radiation pattern. The Yagi is a vertical antenna. When you installit on the receiving apparatus, be sure to follow the mounting picture in the backgroundsection of the lab. Also, make sure that the metal bar (gamma match) on the antenna isfacing upwards.Make sure the PVC dipole on the transmitting antenna apparatus is also in the vertical position, with the arrow pointed to the sky. You will want the Yagi to be facing forward towards the transmitting antenna when the rotator is at its 0 degree position. Follow the general procedure and take the readings.

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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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.
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11. Using conversion chart convert mA readings into db.
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	.		
	.		
	330		
	340		
	350		

Result:

Thus the performance of Half Wave Dipole antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define Yagi Uda Antenna.
2. Draw the radiation pattern of Yagi Uda antenna.
3. Give the application of Yagi Uda antenna.
4. Write the frequency range of RF signal

Performance Analysis of Helix Antenna

Pre Lab Questions:

1. Define Isotropic Antenna
2. What is Antenna Beamwidth?
3. Need for Impedance Matching.
4. Define VSWR.
5. Relationship bandwidth Directivity & gain
6. What is need for radiation pattern?

4. Performance Analysis of Helix Antenna

Aim:

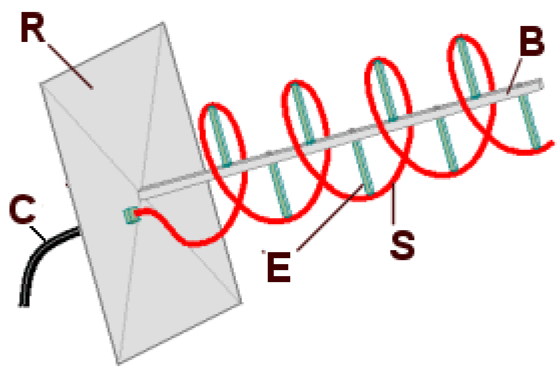
To analyze the performance of Helix antenna and determine its Radiation Pattern.

Apparatus Required:

Helix Antenna

Theory:

A **helical antenna** is an antenna consisting of a conducting wire wound in the form of a helix. In most cases, helical antennas are mounted over a ground plane. Helical antennas can operate in one of two principal modes: normal (broadside) mode or axial (or end-fire) mode.



B: Central Support,
C: Coaxial Cable,
E: Spacers/Supports for the Helix,
R: Reflector/Base,
S: Helical Aerial Element

In the *normal mode*, the dimensions of the helix are small compared with the wavelength. The far field radiation pattern is similar to an electrically short dipole or monopole. A Tesla coil as a secondary coil is also an example.

PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount Half wave dipole 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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:

S.No	Angle in Degrees	Detector reading(mA)	Gain in dB
	10		
	20		
	30		
	40		
	50		
	60		
	70		
	80		
	.		
	.		
	.		
	.		
	330		
	340		
	350		

Result:
Thus the performance of Helix antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define HELIX Antenna.
2. Draw the radiation pattern of HELIX antenna.
3. Give the application of HELIX antenna.
4. Write the frequency range of RF signal

Performance Analysis of Slot Antenna

Pre Lab Questions:

1. Define Antenna
2. Give antenna parameters
3. Define Impedance Matching.
4. Define VSWR.
5. Relationship bandwidth Directivity & gain
6. What is need for radiation pattern?

5. Performance Analysis of Slot Antenna

Aim:

To analyze the performance of Slot antenna and determine its Radiation Pattern.

Apparatus Required:

Slot Antenna

Theory:

Slot antennas are used typically at frequencies between 300 MHz and 24 GHz. These antennas are popular because they can be cut out of whatever surface they are to be mounted on, and have radiation patterns that are roughly omnidirectional (similar to a linear wire antenna, as we'll see). The polarization is linear. The slot size, shape and what is behind it (the cavity) offer design variables that can be used to tune performance.

A **slot antenna** consists of a metal surface, usually a flat plate, with a hole or slot cut out. When the plate is driven as an antenna by a driving frequency, the slot radiates electromagnetic waves in similar way to a dipole antenna. The shape and size of the slot, as well as the driving frequency, determine the radiation distribution pattern. Slot antennas are often used instead of line antennas when greater control of the radiation pattern is required. Slot antennas are often found in standard desktop microwave sources used for research purposes.

A slot antenna's main **advantages** are its size, design simplicity, robustness, and convenient adaptation to mass production using PC board technology.

PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount Half wave dipole 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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:

S.No	**Angle in Degrees**	**Detector reading(mA)**	**Gain in dB**
	10		
	20		
	30		
	40		
	50		
	60		
	70		
	80		
	.		
	.		
	.		
	.		
	330		
	340		
	350		

Result:

Thus the performance of Slot antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define SLOT Antenna.
2. Draw the radiation pattern of SLOT antenna.
3. Give the application of SLOT antenna.
4. Write the frequency range of RF signal

Performance Analysis of Log Periodic Antenna

Pre Lab Questions:

1. Define Antenna
2. Give antenna parameters
3. Define Impedance Matching.
4. Define VSWR.
5. Relationship bandwidth Directivity & gain
6. What is need for radiation pattern?

6.Performance Analysis of Log Periodic Antenna

Aim:

To analyze the performance of Log Periodic antenna and determine its Radiation Pattern.

Apparatus Required:

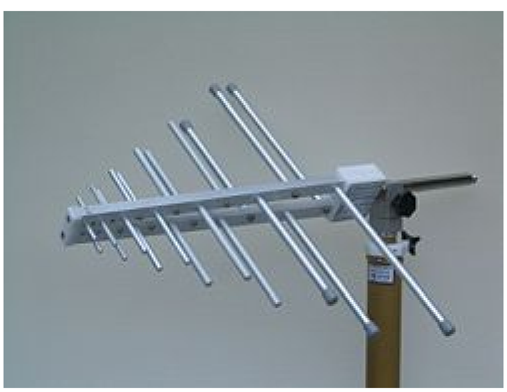
Log Periodic Antenna

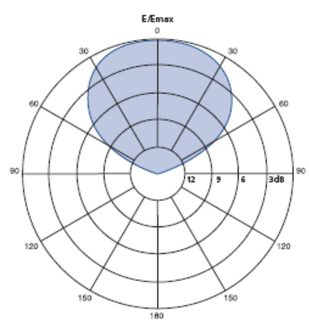
Theory:

In telecommunication, a **log-periodic antenna** (**LP**, also known as a **log-periodic array**) is a broadband, multi element, unidirectional, narrow-beam antenna that has impedance and radiation characteristics that are regularly repetitive as a logarithmic function of the excitation frequency. The individual components are often dipoles, as in a **log-periodic dipole array** (**LPDA**). Log-periodic antennas are designed to be self-similar and are thus also fractal antenna arrays.

It is normal to drive alternating elements with 180° (π radians) of phase shift from one another. This is normally done by connecting individual elements to alternating wires of a balanced transmission line.

The length and spacing of the elements of a log-periodic antenna increase logarithmically from one end to the other. A plot of the input impedance as a function of logarithm of the excitation frequency shows a periodic variation.





Typical Azimuth Radiation Pattern

Fig. Log.-Periodic Antenna, 250–2400 MHz

PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount Log Periodic 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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:

S.No	**Angle in Degrees**	**Detector reading(mA)**	**Gain in dB**
	10		
	20		
	30		
	40		
	50		
	60		
	70		
	80		
	.		
	.		
	.		
	.		
	330		
	340		
	350		

Result:

Thus the performance of Log Periodic antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define Logic period Antenna.
2. Draw the radiation pattern of Logic period antenna .
3. Give the application of Logic period antenna .
4. Write the frequency range of RF signal

Performance Analysis of Parabolic Antenna

Pre Lab Questions:

1. Define Antenna
2. Give antenna parameters
3. Define Impedance Matching.
4. Define VSWR.
5. Relationship bandwidth Directivity & gain
6. What is need for radiation pattern?

7. Performance Analysis of Parabolic Antenna

Aim:
To analyze the performance of Parabolic antenna and determine its Radiation Pattern.

Apparatus Required:

Parabolic Antenna

Theory:

A typical parabolic antenna consists of a parabolic reflector with a small feed antenna at its focus.The reflector is a metallic surface formed into a paraboloid of revolution and (usually) truncated in a circular rim that forms the diameter of the antenna. This paraboloid possesses a distinct focal point by virtue of having the reflective property of parabolas in that a point light source at this focus produces a parallel light beam aligned with the axis of revolution.

Fig .Parabolic Antenna

The feed antenna at the reflector's focus is typically a low-gain type such as a half-wave dipole or a small waveguide horn. In more complex designs, such as the Cassegrain antenna, a sub-reflector is used to direct the energy into the parabolic reflector from a feed antenna located away from the primary focal point. The feed antenna is connected to the associated radio-frequency (RF) transmitting or receiving equipment by means of a coaxial cable transmission line or hollow waveguide.

A **parabolic antenna** is a high-gain reflector antenna used for radio, television and data communications, and also for radiolocation (radar), on the UHF and SHF parts of the electromagnetic spectrum. The relatively short wavelength of electromagnetic (radio) energy at these frequencies allows reasonably sized reflectors to exhibit the very desirable highly directional response for both receiving and transmitting.

With the advent of TVRO and DBS satellite television, the parabolic antenna became a ubiquitous feature of urban, suburban, and even rural, landscapes. Extensive terrestrial microwave links, such as those between cell phone base stations, and wireless WAN/LAN applications have also proliferated this antenna type. Earlier applications included ground-based and airborne radar and radio astronomy.

However a term **dish antenna** is often used for a parabolic antenna instead, it connote a spheric antenna as well, which has a portion of spherical surface as the reflector shape.

Considering the parabolic antenna as a circular aperture gives the following approximation for the maximum gain:

$$\mathbf{G = (\pi^2 D^2) / \lambda^2}$$

(OR)

$$\mathbf{G = (9.87\ D^2) / \lambda^2}$$

where:

G is power gain over isotropic
D is reflector diameter in same units as wavelength
λ is wavelength

Practical considerations of antenna effective area and sidelobe suppression reduce the actual gain obtained to between 35 and 55 percent of this theoretical value. For theoretical considerations of mutual interference (at frequencies between 2 and c. 30 GHz - typically in the Fixed Satellite Service) where specific antenna performance has not been defined, a *reference antenna* based on Recommendation ITU-R S.465 is used to calculate the interference, which will include the likely sidelobes for off-axis effects.

PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount cut paraboloid 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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:

S.No	Angle in Degrees	Detector reading(mA)	Gain in dB
	10		
	20		
	30		
	40		
	50		
	60		
	70		
	80		
	.		
	.		
	.		
	.		
	330		
	340		
	350		

Result:

Thus the performance of Parabolic antenna is analzed and its Radiation Pattern is determined.

Post Lab Questions:

1. Define Parabolic Antenna.
2. Draw the radiation pattern of Parabolic antenna .
3. Give the application of Parabolic antenna .
4. Write the frequency range of RF signal

ANTENNA ARRAYS

An antenna array (often called a 'phased array') is a set of 2 or more antennas. The signals from the antennas are combined or processed in order to achieve improved performance over that of a single antenna. The antenna array can be used to:

- increase the overall gain
- provide diversity reception
- cancel out interference from a particular set of directions
- "steer" the array so that it is most sensitive in a particular direction
- determine the direction of arrival of the incoming signals
- to maximize the Signal to Interference Plus Noise Ratio (SINR)

PROCEDURE

1. Arrange the setup as given in the block diagram
2. Mount two element antenna array 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 steel structure ,pipes, cables etc.
5. Keep the RF level and FS adjust to minimum and unidirectional coupler switch to FWD(Forward adjustment 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

Post Lab Questions:

1. Define Antenna Arrays.
2. Draw the radiation pattern of antenna Arrays.
3. Give the application of antenna Arrays.
4. Write the frequency range of RF signal