## DEPARTMENT

## OF

## ELECTRONICS& COMMUNICATION

**LAB MANUAL (EC 6002)**

**“DIGITAL SIGNAL PROCESSING”**

***BACHELOR OF ENGINEERING (B.E.) COURSE***

***Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

***Semester: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

***Branch: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

***Enrollment No. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**DEPARTMENT OF ELECTRONICS**

**AND COMMUNICATION**

**LAB MONOGRAPH**

**DIGITAL SIGNAL PROCESSING (EC 6002)**

**INDEX**

**I. Background**

**II. Experiments as per RGPV syllabus**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No.** | **Name of Experiment** | **Date** | **Grade** | **Sign** |
| **1** | Implementation of unit impulse, unit step, unit ramp, exponential function, sine and cosine function. |  |  |  |
| **2** | Implementation of operation on sequences. |  |  |  |
| **3** | Implementation of LTI system and testing them for stability and causality. |  |  |  |
| **4** | Computation and plot of DTFT of sequences[1,2,-1]. |  |  |  |
| **5** | Computation and plot of Z-transform verification of properties of z-transform . |  |  |  |
| **6** | Write a MATLAB program to find residue, poles and zeros of z-domain signal and sketch the pole zero plot.. |  |  |  |
| **7** | Write a program for discrete/fast Fourier transform in 3D. |  |  |  |
| **8** | Write a matlab program for liner/circular convolution of two sequence, and plot their convolution output. |  |  |  |
| **9** | Write a program for filter design using window function. |  |  |  |
| **10** | Write a program for triangular, square, saw tooth wave. |  |  |  |

**EXPRIMENT NO-1**

**AIM: -** To plot the radiation pattern of Dipole Antennas.

#### APPARATUS REQUIRED: -

(1) S-45R Receiver

(2) S-45G Transmitter s

(3) BNC TO BNC probe

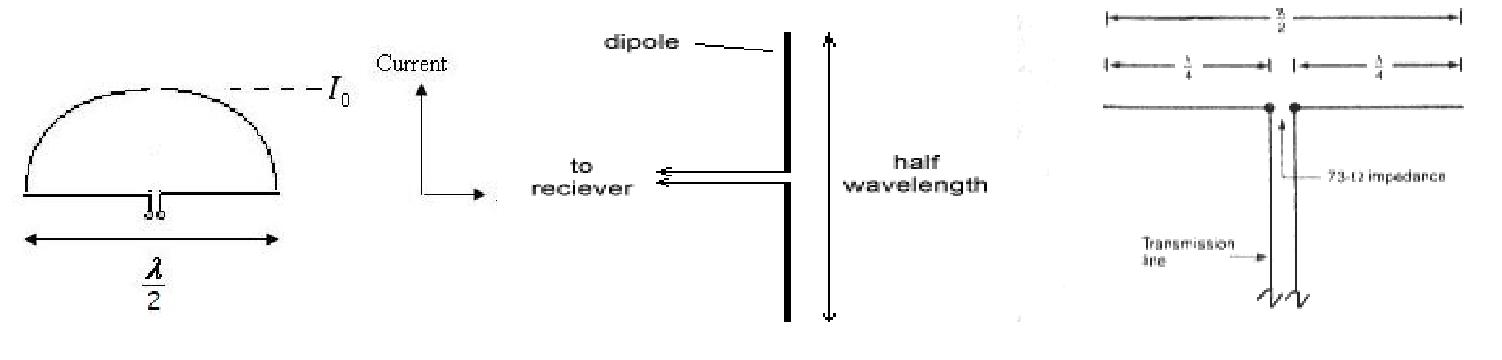
(4) Half wave dipole Antenna

(5) Power supply input – 12v DC

(6) Polar position & fixed clamp

**THEORY:-**

The dipole antenna or dipole aerial is one of the most important and commonly used types of RF antenna. It is widely used on its own, and it is also incorporated into many other RF antenna designs where it forms the radiating or driven element for the antenna. The dipole is a simple antenna to construct and use, and many of the calculations are quite straightforward. However like all other antennas, the in-depth calculations are considerably more complicated.



**The basic half wave dipole antenna**

Dipole antenna is an antenna that can be made by a simple wire. Typically a dipole antenna is formed by two quarter wavelength conductors or elements placed back to back for a total length of λ/2. This antenna consists of two linear wires with same length and distance between the wires (2 *λ*) is assumed to be infinitely small. The center of the antenna is located at the origin of the coordinate system and the dipole wire run along the z-axis.

Dipoles that are much smaller than the wavelength of the signal are called Hertzian, short, or infinitesimal dipoles. These have a very low radiation resistance and a high reactance, making them inefficient, but they are often the only available antennas at very long wavelengths. Dipoles whose length is half the wavelength of the signal are called half-wave dipoles, and are more efficient. In general radio engineering, the term dipole usually means a half-wave dipole (center-fed).

**PROCEDURE: -**

1. Mount the transmitting antenna (Half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (different dipole antennas) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array switch (5) and adjust the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Data array switch (5) again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2 (5 deg) on the disk. Press data array switch (5) again, the LCD indicates the level reading of dBµv at 5deg (reading no. 2).
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.

**RESULT**:**-**

Radiation pattern of Dipole antennas havebeen plotted.

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Insure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plot manually the radiation pattern of dipole antenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPRIMENT NO-2**

**AIM: -** To plot the radiation pattern of Monopole Antenna.

#### APPARATUS REQUIRED: -

(1) S-45R Receiver synthesize

(2) S-45G Transmitter synthesized

(3) BNC TO BNC probe

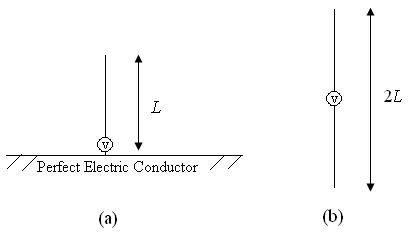
(4) Monopole Antenna

(5) Power supply input – 12v DC

(6) Polar position & fixed clamp

**THEORY:-**

A monopole antenna is one half of a dipole antenna, almost always mounted above some sort of ground plane. The case of a monopole antenna of length L mounted above an infinite ground plane is shown in Figure.



**Figure.Monopole above a PEC (a) and the equivalent source in free space (b)**

Using image theory, the fields above the ground plane can be found by using the equivalent source (antenna) in free space as shown in Figure 1(b). This is simply a dipole antenna of twice the length. The fields above the ground plane in Figure 1(a) are identical to the fields in Figure 1(b), which are known and presented in the [dipole antenna](http://www.antenna-theory.com/antennas/dipole.php) section. The monopole antenna fields below the ground plane in Figure 1(a) are zero.

The [radiation pattern](http://www.antenna-theory.com/basics/radPattern.html) of monopole antennas above a ground plane are also known from the dipole result. The only change that needs to be noted is that the impedance of a monopole antenna is one half of that of a full dipole antenna. For a quarter-wave monopole (L=0.25\* http://www.antenna-theory.com/basics/lambda.bmp), the impedance is half of that of a half-wave dipole, so Zin = 36.5 + j21.25 Ohms. This can be understood since only half the voltage is required to drive a monopole antenna to the same current as a dipole (think of a dipole as having +V/2 and -V/2 applied to its ends, whereas a monopole antenna only needs to apply +V/2 between the monopole antenna and the ground to drive the same current). Since Zin = V/I, the impedance of the monopole antenna is halved.

The [directivity](http://www.antenna-theory.com/basics/directivity.php) of a monopole antenna is directly related to that of a [dipole antenna](http://www.antenna-theory.com/antennas/dipole.php). If the directivity of a dipole of length 2L has a directivity of D1 [decibels], then the directivity of a monopole antenna of length L will have a directivity of D1+3 [decibels]. That is, the directivity (in linear units) of a monopole antenna is twice the directivity of a dipole antenna of twice the length. The reason for this is simply because no radiation occurs below the ground plane; hence, the antenna is effectively twice as "directive".

Monopole antennas are half the size of their dipole counterparts, and hence are attractive when a smaller antenna is needed. Antennas on older cell phones were typically monopole antennas, with an infinite ground plane approximated by the shell (casing) of the phone.

**Effects of a Finite Size Ground Plane on the Monopole Antenna**

In practice, monopole antennas are used on finite-sized ground planes. This affects the properties of the monopole antennas, particularly the radiation pattern. The [impedance](http://www.antenna-theory.com/basics/impedance.php) of a monopole antenna is minimally affected by a finite-sized ground plane for ground planes of at least a few wavelengths in size around the monopole. However, the radiation pattern for the monopole antenna is strongly affected by a finite sized ground plane. The resulting radiation pattern radiates in a "skewed" direction, away from the horizontal plane.

Note that the resulting radiation pattern for this monopole antenna is still omnidirectional. However, the direction of peak-radiation has changed from the x-y plane to an angle elevated from that plane. In general, the large the ground plane is, the lower this direction of maximum radiation; as the ground plane approaches infinite size, the radiation pattern approaches a maximum in the x-y plane.

**PROCEDURE: -**

1. Mount the transmitting antenna(half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.

1. Mount the receiving antenna (monopole) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
2. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
3. Press Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
4. Align the positioned such that the indicator is pointing to reading no. 2
5. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
6. Using 72 readings as on above plot the Radiation Pattern of Monopole antenna.

**RESULT**:**-**

Radiation pattern of Monopole Antenna has been plotted

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Insure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of monopole antenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-3**

**AIM:** - To plot the radiation pattern of Yagi-Uda antenna with 3 /5/ 7 elements

**APPARATUS REQUIRED: -**

1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC TO BNC probe
4. Yagi-Uda Antenna with 3/5/ 7 elements
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**THEORY: -**

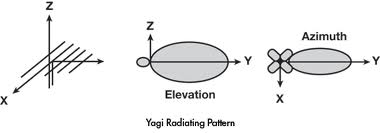
Radiation pattern The antenna is a reciprocal device that is it radiates or receives electromagnetic energy in the same way thus although the radiation pattern is identified with an antenna that is transmitting power the same properties would apply to the antenna even if it was receiving power Any difference between the received and radiated power 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 foresight and also receives 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 dimension. It is measured at a constant distance in the far field the radiation pattern of an antenna is usually plotted in terms of relative power. The power at bore sight, that is at the position of maximum radiated power, is usually plotted at 0 other words, the radiated power is normalized to the power at bore sight.The main reason for using dB instead of linear that the power at the nulls is often of the order of 10,000 times less than the power on the bore sight, which means that the scales would have to be very large in order to cover the whole range of values.

The radiation pattern is usually measured in the two principal planes, namely, the azimuth and the elevation planes. The radiated / received dB is plotted against the angel that is made with the bore sight direction. If the antenna is not physically symmetrical about each of its principal planes then one can also expect its radiation pattern in these polar or the rectangular/ Cartesian coordinates.

Half wave dipole or simply half wave dipole is one the simplest antenna and is frequently employed as element of a more complex directional system, e.g., antenna arrays etc. A λ/2 antenna is the fundamental radio antenna of metal road or tubing or thin wire which has a physical length of half wavelength in free space at the frequency of operation. A λ/2 antenna is also known as Hertz antenna or sometimes also called as half wave doublet. Dipole and doublet and mean the same thing as long as the electrical dimension of the two are the same. A dipole antenna may be defined may be defined as symmetrical antenna in which the two ends are at equal potential relative to mid point.

If three elements array is used, then such type of yagi-uda antenna is generally referred to as beam antenna. If has unidirectional beam of moderate directivity with light weight, low cost and simplicity in feed system design. With spacing of 0.1λ to 0.15 λ, a frequency band width of the order of 2% is obtained. It provides gain of the order of 8 db or front to back of about 20 db



**PROCEDURE:** -

1. Mount the transmitting antenna(half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.

2. Mount the receiving antenna (Yagi Uda 3 element) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.

3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.

4. Press Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.Align the positioned such that the indicator is pointing to reading no. 2

5. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.

6. Using 72 readings as on above plot the Radiation Pattern of Yagi Uda antennas.

7. Repeat the procedure for 5 and 7 element antennas.

**RESULT:-**

Radiationpattern of Yagi Uda Antenna has been plotted.

**PRECAUTIONS: -**

* 1. Switch off mobile phones and other wireless devices.
  2. Ensure that there is no any obstacle present in between the transmitter and receiver.
  3. Keep the transmitting and receiving antenna at same height.
  4. Don’t turn ON the Power supply until the circuit is completed.
  5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Yagi Udaantenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-4**

**AIM: -**To plot the radiation pattern of the Broad side array.

**APPARATUS REQUIRED: -**

1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC to BNC probes
4. Broad-side array
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**Theory:-**

Broadside array is the one in which a number of identical parallel antennas are set up along a line drawn perpendicular to their respective axis as shown in the figure. It is one of the important antenna arrays. In broadside array, individual antennas (or elements) are equally spaced along a line and each element is fed with current of equal magnitude, all in the same phase. By doing so, this arrangement fires in broadside direction (i.e. perpendicular to the line of array axis) where there are maximum radiations and relatively a small radiation in other directions and hence, the radiation pattern of broadside array is bi-directional. The broadside array is bi-directional which radiates equally well in either direction of maximum radiation. Thus, broadside array may be defined as “an arrangement in which the principle direction radiation is perpendicular to the array axis and also to the plane containing the array element

Bi-directional pattern of a broadside array can be converted into unidirectional by installing an identical array behind this array at distance ^/4 and exciting it by current leading the phase by 90°. Broadside array may also be arranged in vertical in which case the radiation pattern would be horizontal. In the figure elements are arranged horizontal and its radiation pattern is vertical, normal to the plane of element. A broadside couplet is said to be formed if two isotropic radiators operate in phase thereby they reinforce each other most strongly in the plane right angle to the line joining them.

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**PROCEDURE: -**

1. Mount the transmitting antenna (half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (broadside array) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Press Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
7. Using 72 readings as on above plot the Radiation Pattern of broadsidearray antenna.

**RESULT:-**

Radiation patternof Broadside Array Antenna has been plotted.

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Ensure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Broadside Array Antennaand compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-5**

**AIM: -**To plot the radiation pattern of the End-fire array.

**APPARATUS REQUIRED: -**

1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC to BNC probes
4. End-Fire array
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**THEORY: -**

The end fire array is nothing but broadside array except that individual elements are fed in, out of phase (usually 180 degrees). Thus in the end fire array, a number of identical antennas are spaced equally along a line and individual elements are fed with current of equal magnitude but their phases vary progressively along the line in such a manner that a progressive phase difference between adjacent elements becomes equal to the spacing between the elements. Therefore end fire array may be defined as “the arrangement in which the principle direction of radiation coincides with the direction of array axis”.

An end fire array may be bi-directional also. One such example is a two-element array fed with equal current 180 degrees out of phase. If two equal radiators are operated in phase quadrature at a distance of λ/4 apart, then an end fire array is said to be formed.

****

**PROCEDURE: -**

1. Mount the transmitting antenna (half wave dipole)on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (Endfire array) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
7. Using 72 readings as on above plot the Radiation Pattern of End fire antenna

**RESULT**:**-**

Radiation pattern of End fire Antenna has been plotted

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Ensure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Endfire Array Antenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-6**

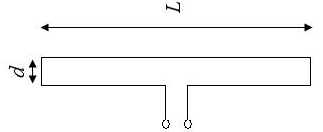
**AIM: -**To plot the radiation pattern of the Folded Dipole Antenna.

**APPARATUS REQUIRED: -**

1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC to BNC probes
4. Folded Dipole Antenna
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**THEORY: -**

A **folded dipole** is a dipole antenna with the ends folded back around. Typically, the width *d* of the folded dipole antenna is much smaller than the length *L*.



Because the folded dipole forms a closed loop, one might expect the input impedance to depend on the input impedance of a short-circuited transmission line of length *L*. However, you can imagine the folded dipole antenna as two parallel short-circuited transmission lines of length *L*/2 (separated at the midpoint by the feed in Figure 1). It turns out the impedance of the folded dipole antenna will be a function of the impedance of a transmission line of length *L*/2.

Also, because the folded 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](http://www.antenna-theory.com/antennas/dipole.php) of length *L*.

The folded dipole antenna is [resonant](http://www.antenna-theory.com/definitions/resonant.php)and radiates well at odd integer multiples of a half-wavelength (0.5λ, 1.5 λ ...), when the antenna is fed in the center as shown in Figure. The input impedance of the folded dipole is higher than that for a regular dipole, as will be shown in the next section.

The folded dipole antenna can be made resonant at even multiples of a half-wavelength ( 1.0λ, 2.0λ,...) by offsetting the feed of the folded dipole in Figure 1 (closer to the top or bottom edge of the folded dipole).

**PROCEDURE: -**

1. Mount the transmitting antenna (half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (Folded Dipole) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
7. Using 72 readings as on above plot the Radiation Pattern of Folded dipole antenna

**RESULT**:**-**

Radiation pattern of Folded Dipole Antenna has been plotted.

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Ensure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Folded Dipole Antenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-7**

**AIM: -**To plot the radiation pattern of the Log Periodic Antenna.

**APPARATUS REQUIRED: -**

1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC to BNC probes
4. Log Periodic Antenna
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**THEORY: -**

Log periodic antenna is a frequency independent antenna, which is defined only in terms of angle, should have characteristic of frequency independent. A frequency independent antenna may be defined as the antenna for which the impedance and pattern (hence the directivity) remain constant as a function of the frequency.

Thus in order that an antenna should expand or contract in proportion to the wavelength or if the antenna structure in not mechanically adjustable. The size of active or radiating region should be proportional to the wavelength the development on the frequency independent concept was the log periodic antenna.

Log periodic antenna are broad band antenna bandwidth of 10:1 is achieved easily and even 100:1 is feasible if the theoretical design closely approximated. The broadband characteristics of log periodic antenna include both impedance and pattern radiation pattern may be bi-directional or unidirectional of low to moderate directive gain. Much higher directive gain can be achieved by using them as element of an array. The geometry of log periodic antenna structure is so chosen that those electrical properties must repeat periodically with the logarithm of the frequency. Frequency independence can be obtained when the variation of the properties over one period and hence all the periods, is small.

Design of log periodic antenna involves basic geometry structure that is repeated but with a changing size of the structure. The structure size changing with each repetition by a constant scale factor so that the structure expands or contract. The log periodic principal can be understood by the “Log periodic dipole array”. As shown in the figure all the dimensions increase in proportion to the distance from the origin.

It has a no. of dipole of different lengths & spacing and is fed by a balanced two wire transmission line which is transposed between each adjacent pairs of dipoles. The dipole length increases along the antenna such that included angle (α) is constant. The lengths and spacing are graduated such a way that certain dimensions of adjacent element bear constant ration to each other.

These dimensions are length L and spacing R. the scale factor of design ratio is designed by τ whose values are less then 1.

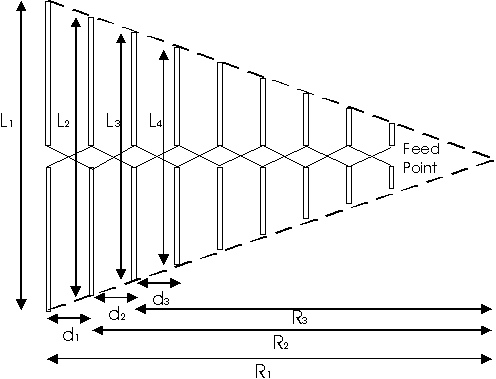
Thus,

R1/R2 = R2/R3 = …….. =Rn/Rn+1

τ =L1/L2 =L2/L3 = ……..= Ln/Ln+1

Rn/Rn+1 =τ = Ln/Ln+1

τ = design ratio/periodicity factor



If a graph is plotted between input impedance and frequency a repetitive variation will be observed. If this plot is made against the logarithm of the frequency, this variation will be periodic it is this behavior of the log periodic antenna that has given the named’’ Log periodic ‘’ which imply that impedance is a logarithmically periodic function of the frequency. All the electrical properties undergo similar periodic variation particularly radiation pattern, directive gain, side lobe level, beam width and beam direction. According to log periodic design equation if structures 0 to ∞. Obviously neither of these extensions are physically possible as (0 to ∞) frequency (∞ to 0) wavelength would require structures of sizes, infinitely large to microscopic fineness at the vertex end respectively. Transmission line for feeding has to be of infinitesimal conductor size and spacing.

Log – periodic structure must be terminated in either direction at some points. These terminated ends in either direction high and low cut – off frequency. Beyond these cut-off frequencies the log periodic properties ceases.

The magnitude of logarithms frequency period is found by the scale factor τ. In general, it may be given by (log 1/ τ). (Some times ½ log 1/ τ) therefore if two consecutive maximum of the impedance variation occurs at frequencies f1&f2 .

They are related as.

f1 /f2 =log 1/τ

f1 /f2 = 1/ τ

f1= τ f2 f2> f1

This indicates that whatever properties a log periodic antenna is having at frequency f1 the same properties will be repeated at frequencies given by (τnf) or at f/τn. Where n is an integer, provided these frequencies are within cut –off the antenna. When the log periodic antenna is operate at a given frequency. It is observed that all the structure doesn’t radiated but only a certain portion radiates known as “ active region” it is that region in which dipoles have nearly resonant length i.e. λ/2. The cut-off frequencies are that frequencies, at which the antenna is towards the apex (shorter element) for highest frequencies at middle for intermediate frequencies and near longest element for lowest frequencies.

**PROCEDURE: -**

1. Mount the transmitting antenna (half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (Log periodic) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
7. Using 72 readings as on above plot the Radiation Pattern of Log Periodic antenna

**RESULT**:**-**

Radiation pattern of Log Periodic Antenna has been plotted.

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Ensure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Log periodicAntenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-8**

**AIM: -**To plot the radiation pattern of the Square Loop Antenna.

**APPARATUS REQUIRED: -**

1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC to BNC probes
4. Square Loop Antenna
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**THEORY: -**

Loop antennas feature simplicity, low cost and versatility. They may have various shapes: circular, triangular, square, elliptical, etc. They are widely used in communication links up to the microwave bands (up to ≈ 3 GHz). They are also used as electromagnetic (EM) field probes in the microwave bands.

Loop antennas are usually classified as electrically small (*C*< 0.1*λ* ) and electrically large (*Cλ* ). Here, *C* denotes the loop’s circumference. Electrically small loops of a single turn have very small radiation resistance (comparable to their loss resistance). Their radiation resistance can be substantially improved by adding more turns. Multi-turn loops have better radiation resistance although their efficiency is still poor. That is why they are used mostly as receiving antennas provided losses are not important. The radiation characteristics of a small loop antenna can be additionally improved by inserting a ferromagnetic core. Radio receivers of AM broadcast are usually equipped with ferrite-loop antennas. Such antennas are used in pagers, too.

The small loops, regardless of their shape, have a far-field pattern very similar to that of a small electric dipole normal to the plane of the loop. This is expected because they are equivalent to a magnetic dipole. Note, however, that the field polarization is orthogonal to that of the electric dipole.

As the circumference of the loop increases, the pattern maximum shifts towards the loop’s normal, and when *C* ≈ *λ*, the maximum of the pattern is along the loop’s normal.

****

**PROCEDURE: -**

1. Mount the transmitting antenna (half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (Square loop) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
7. Using 72 readings as on above plot the Radiation Pattern of square loop antenna

**RESULT**:**-**

Radiation pattern of Square Loop Antenna has been plotted.

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Ensure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Square loopAntenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-9**

**AIM: -**To plot the radiation pattern of the SlotAntenna.

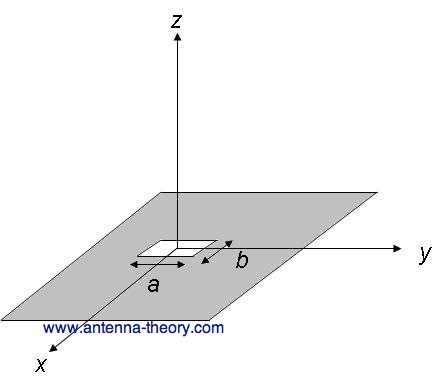
**APPARATUS REQUIRED: -**

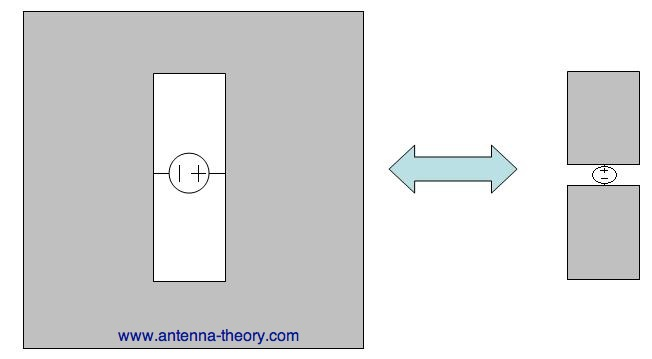
1. S-45R Receiver synthesize
2. S-45G Transmitter synthesized
3. BNC to BNC probes
4. Slot Antenna
5. Power supply input – 12v DC
6. Polar position & fixed clamp

**THEORY: -**

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

Consider an infinite conducting sheet, with a rectangular slot cut out of dimensions *a* and *b*, as shown in Figure. If we can excite some reasonable fields in the slot (often called the aperture), we have a slot antenna.





To gain an intuition about slot antennas, first we'll learn Babinet's principle (put into antenna terms by H. G. Booker in 1946). This principle relates the radiated fields and impedance of an aperture or slot antenna to that of the field of its dual antenna. The dual of a slot antenna would be if the conductive material and air were interchanged - that is, the slot antenna became a metal slab in space.

Note that a voltage source is applied across the short end of the slot antenna. This induces an E-field distribution within the slot, and currents that travel around the slot perimeter, both contributed to radiation. The dual antenna is similar to a [dipole antenna](http://www.antenna-theory.com/antennas/dipole.php). The voltage source is applied at the center of the dipole, so that the voltage source is rotated.

Hence, if we know the fields from one antenna we know the fields of the other antenna. Hence, since it is easy to visualize the fields from a [dipole antenna](http://www.antenna-theory.com/antennas/dipole.php), the fields and impedance from a slot antenna can become intuitive if Babinet's principle is understood.Note that the [polarization](http://www.antenna-theory.com/basics/antennapol.php) of the two antennas are reversed. That is, since the dipole antenna on the right in Figure 2 is vertically polarized, the slot antenna on the left will be horizontally polarized.

**PROCEDURE: -**

1. Mount the transmitting antenna (half wave dipole) on the stand connecting it to the S-45G transmitter generator and Connect the equipment to the 230 V mains and put it ON.
2. Mount the receiving antenna (slot antenna) on the positioner and connect it to the S-45 receiver synthesized. Connect the adapter to S-45R and connect it to 230 V Mains, put the equipment ON.
3. Press Data Array and adjusts the antenna to measure the reading no. 1. Align the positioned such that the indicator is pointing to reading no. 1(0deg) on the disk.
4. Data array again, the LCD indicates that the reading no. 1 has been stored in memory location no. 1 and now rotate the positioned to measure reading no. 2.
5. Align the positioned such that the indicator is pointing to reading no. 2
6. Continue in this sequence until the reading no. 72 (at 355 deg) is measured and stored in the memory.
7. Using 72 readings as on above plot the Radiation Pattern of Slot antenna

**RESULT**:**-**

Radiation pattern of Slot Antenna has been plotted.

**PRECAUTIONS: -**

1. Switch off mobile phones and other wireless devices.
2. Ensure that there is no any obstacle present in between the transmitter and receiver.
3. Keep the transmitting and receiving antenna at same height.
4. Don’t turn ON the Power supply until the circuit is completed.
5. Turn OFF the power supply given to the instruments when not in use.

**CONCLUSION:-**

Plotmanually the radiation pattern of Slot Antenna and compare with EM simulation software generated radiation pattern.

**OBSERVATION TABLE:-**

**Experiment No.\_\_\_\_\_\_\_\_\_\_\_\_\_ Name of Student\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Antenna: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** | **S NO.** | **DEG** | **dBµv** |
| 1 | **0** |  | 19 | **90** |  | 37 | **180** |  | 55 | **270** |  |
| 2 | **5** |  | 20 | **95** |  | 38 | **185** |  | 56 | **275** |  |
| 3 | **10** |  | 21 | **100** |  | 39 | **190** |  | 57 | **280** |  |
| 4 | **15** |  | 22 | **105** |  | 40 | **195** |  | 58 | **285** |  |
| 5 | **20** |  | 23 | **110** |  | 41 | **200** |  | 59 | **290** |  |
| 6 | **25** |  | 24 | **115** |  | 42 | **205** |  | 60 | **295** |  |
| 7 | **30** |  | 25 | **120** |  | 43 | **210** |  | 61 | **300** |  |
| 8 | **35** |  | 26 | **125** |  | 44 | **215** |  | 62 | **305** |  |
| 9 | **40** |  | 27 | **130** |  | 45 | **220** |  | 63 | **310** |  |
| 10 | **45** |  | 28 | **135** |  | 46 | **225** |  | 64 | **315** |  |
| 11 | **50** |  | 29 | **140** |  | 47 | **230** |  | 65 | **320** |  |
| 12 | **55** |  | 30 | **145** |  | 48 | **235** |  | 66 | **325** |  |
| 13 | **60** |  | 31 | **150** |  | 49 | **240** |  | 67 | **330** |  |
| 14 | **65** |  | 32 | **155** |  | 50 | **245** |  | 68 | **335** |  |
| 15 | **70** |  | 33 | **160** |  | 51 | **250** |  | 69 | **340** |  |
| 16 | **75** |  | 34 | **165** |  | 52 | **255** |  | 70 | **345** |  |
| 17 | **80** |  | 35 | **170** |  | 53 | **260** |  | 71 | **350** |  |
| 18 | **85** |  | 36 | **175** |  | 54 | **265** |  | 72 | **355** |  |

**EXPERIMENT NO-10**

**AIM: -**To Study Different Modes of Propagation

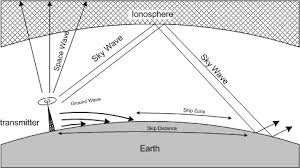
**THEORY: -**

When a radio wave is radiated from the transmitting antenna, it spreads in all direction decreasing in amplitude with increasing distance because of spreading of the electromagnetic energy through larger and larger surface areas. The electromagnetic wave propagates in ways that not only depend on their own property but are also dictated by the environment itself. the actual environment in which the radio waves are propagated may have obstacle discontinuities and propagation medium variations.

Free space is the space, which doesn’t interfere with the normal radiations and propagation of radio waves. In free space no magnetic of gravitational field or solid bodies or ionized particles are assumed to exist. The power radiated from a transmitter is ordinarily spread over a relatively large area and hence power available at most of the receiving antennas is only a small fraction of radiated power. In some cases losses may be very large so it is transmission loss between transmitting and receiving antennas which determines whether the received signal will be useful or not. The portion of received energy at a distant receiving point may travel over any of the possible mode of propagation:

The prominent modes of propagation are:

1. Ground wave or surface wave prop.
2. Sky wave or ionspheric propagation.
3. Space wave propagation.

[](https://www.rgpvonline.com/)

Modes of propagation largely depend upon the frequency in use. Propagation of radio waves are not only used in radio comm. for the transmission of intelligence over short and long distance, but also in RADAR, radio detection finding, control of machine from a distance. Electromagnetic waves are oscillations, which propagate with the velocity of light in free space. It consists of moving field of electric and magnetic forces. The radio waves from transmitting antenna may reach to receiving antenna following any of the given modes of propagation depending upon several factors like frequency of operation, distance between transmitting and receiving antenna etc.

1. **GROUND WAVE / SURFACE WOVE PROPAGATION -**

The ground wave or surface wave is of practical importance at broadcast and lower freq. i.e. for medium wave, long wave and very long wave Ground wave is the wave that is guided along the surface of the earth. Surface wave permits the propagation around the curvature of the earth. This mode of propagation exist when the transmitting and receiving antennas are closed to the surface of the earth and is supported at its lower edge by the presence of the ground. The ground wave is vertically polarized i.e. electric field vector of electromagnetic wave are vertical with respect to ground. The earth short-circuits any horizontal component of electric field in contact with the earth. The ground wave propagation along the surface of the wave, induce charges in the earth, which travel with the wave and hence constitute the current. While carrying this current the earth behaves like a capacitor and thus the earth can be represented as a resistance in shunt with a capacitor. When the surface wave glides over the surface of the earth energy is abstracted from the surface wave to supply the losses in the earth. Thus while passing over the surface of the earth, the surface wave losses some of its energy by absorption. Energy lost so, is replenished to a certain extent by the energy diffracted downward from the upper portion of the wave front present somewhat above the immediate surface of the earth. Therefore, ground wave suffers, varying amount of attenuation while propagating along the curvature of the earth, depending upon frequency, surface irregularities permitivity and conductivity.

As the frequency increases, earth’s attenuation increases hence this mode of propagation is suitable for low and medium freq. i.e. upto 2 MHz only. At higher freq. attenuation is much more. All the broadcast signals received during daytime are due to ground wave propagation. surface wave may also be attenuated due to diffraction. As the wave progress over the curvature of the curvature of the earth, the wave front start gradually tilting more and more. This increase in tilt of the wave causes more short circuit of the electric field component and hence the field strength goes on reducing. Ultimately at some appreciable distance from transmitting antenna in wavelength, the surface wave dies because of the losses. Maximum range of surface wave propagation depends not only on the frequency but power as well. Hence increasing the power of the transmitter in the VLF band can increase range of transmission.

**B . SKY WAVE / IONOSPHERE WAVE PROPAGATION -**

The sky wave is of practical importance at medium and high frequency for very long distance radio communications. In this mode of propagation electromagnetic wave reach the receiving point after reflection from the ionized region in the upper atmosphere called ionosphere situated between 50 km to 400 km above earth surface. Under favorable conditions. The ionosphere acts like a reflecting surface and is able to reflect back the electromagnetic wave of frequencies between 2 to 30 MHz. Sky wave propagation is suitable for freq. between 2 to 30 MHz, so this mode of propagation is called as “short wave propagation”. Since sky wave propagation takes place after reflection from the ionosphere, so it is also called as ionospheric propagation Extremely long distance i.e. round the globe comm. is also possible with the multiple reflections of sky wave. In a single reflection from the ionosphere the radio waves cover a distance not more than 4000 km. The signals received due to sky wave propagation are subjected to fading in which signal strength varies with time. Because at the receiving point a large no. of waves follows a different no. of paths.

**C. SPACE WAVE PROPAGATION: -**

The space wave propagation of practical importance at VHF bonds (between 30MHz to 300 MHz), UHF and microwave and communication like TV, RADAR, freq. modulation etc. utilize this mode of propagation. In this mode of propagation, electromagnetic waves from the transmitting antenna reach the receiving antenna either directly or after reflections from ground in the earth’s troposphere region. Troposphere is that region of the atmosphere which extends upto 16 km from the earth's surface space wave consists of at least 2 components e.g. direct component and indirect i.e. ground reflected component. In direct component wave reaches directly from the transmitting antenna to receiving antenna and in indirect component, the wave reaches the receiving antenna after reflection from the ground, where the phase change of 180o is also introduced due to reflection at the ground, in the ground reflected wave. Although both the waves leaves the transmitting antenna at the same time with the same phase but may reach the receiving antenna either in phase of out of phase, because the two waves travel different path lengths. The strength of the resultant waves at the receiving antenna may be stronger or weaker than the direct path alone depending upon whether the two waves are adding or opposing in phase. At receiving point the signal strength is the vector addition of direct and indirect waves. Space wave propagation is also called is Troposphere propagation because space wave propagates through troposphere. Beyond 30 MHz sky wave fails as the wavelength becomes too shorts to be reflected from the ionosphere and ground waves are propagating close to antenna only as attenuation is very high.

Space wave propagation is also called as line of sight propagation because at UHF, VHF and microwave frequencies, this mode of propagation is limited to the line of sight distance and is also limited by the curvature of the earth. Space wave propagates even slightly beyond the line of sight distance due to refraction in the atmosphere of the earth. In fact, line of sight distance i.e. range of comm. can also be increased by increasing the height of the transmitting and receiving antennas determines max. range of comm. through direct waves. In the given fig. with the height of transmitting antenna Ht and receiving antenna hr, the direct wave comm. range is TR. As the range increased a point is reached when line of sight distance up to which comm. is possible with the trans. & rec. antennas of height hr2& ht. It height of either antenna is increased than line of sight instance can be increased.

The line of sight distance has now been extended by what is known as space comm. or satellite comm. which has facilitated trans- oceanic propagation of microwaves with the potentiality of large bandwidth.

**CONCLUSION:-** Three different modes of propagation have been studied. It is observed that for frequencies below 2 MHz uses ground wave propagation, frequencies between 2 – 30 MHz uses Ionospheric wave propagation and frequencies above 30 MHz uses space wave propagation to propagate.