Chapter 5

Elevation Patterns for LPDA in VHF Range Correlated with Three Satellites

5.1 Introduction

An effort has been made to analyze the elevation patterns for a Log Periodic Dipole Array (LPDA) within the VHF range of 50 to 300 MHz at Kalyani, West Bengal for monitoring solar radio bursts. The structure is composed of dual crossed logarithmic periodic dipole antennas, one of them placed in north-south direction while the other laid in east-west direction. The structure is built so that it develops into a very good wind proof system. The variation of elevation pattern and gain associated to three significant satellites at 172°, 193° and 204° azimuth related to the frequencies of 50 to 300 MHz are analyzed. In this chapter the simulation of elevation radiation patterns of LPDA have been examined. While discussing radiation from antennas, it is needed above all to state the coordinate arrangement for describing the antenna and the associated electromagnetic fields [1, 2]. The usual spherical coordinate scheme consists of a radial distance, an elevation angle and an azimuth angle [3]. A straight line from the origin to the point and Z-axis forms an angle known as the elevation angle while the projection of the referred line in the X-axis and X-Y plane creates the azimuthal angle. It is possible to recognize any location on the sphere by the typical directional angles $\theta$ and $\phi$ of the spherical coordinate arrangement. To explain in details the vital factors such as amplitude, phase, polarization, and directivity are usually plotted as a function of the spherical directional angles $\theta$, $\phi$.

The $\theta$ and $\phi$ angles of the spherical coordinate arrangement relate to the two axes and are usually known as the elevation and azimuth [4]. The radiation pattern of the antenna in elevation angle can be found out from 0 degree to 90 degrees where as the azimuth angle can be ascertained from 0 degree to 360 degrees. The necessities of particular radiation pattern generally cannot be obtained by a single antenna element, because a single element frequently shows relatively broad radiation patterns and small directivity. In order to design antennas with huge directivities, it is generally essential to enhance the electrical dimension of the antenna. Anyone can achieve this by increasing the electrical measurements of the selected single element. Yet, mechanical difficulties are typically related with large elements. Another technique to attain huge directivities, without enlarging the dimension of the particular elements, is to utilize numerous single elements to develop an array [5-10]. It is required to utilize the method of antenna arrays if we desire to tune the radiation pattern. Antenna array is an arrangement of several antennas organized to attain a specified radiation pattern [11]. The beamwidth of the major lobe with the side lobe level can be regulated by the comparative amplitude excitation between the components of the array.
5.2 Radiation Patterns

A graphical depiction or the mathematical function of the attributes of the antenna’s radiation as a function of space coordinates is called the antenna radiation pattern or antenna pattern [12]. This indicates that we determine the intensity of the radiated pattern while we rotate the antenna all around on two orthogonal axes. If we assume that an antenna is positioned at the origin of a spherical coordinate system, then its radiation pattern is provided by determining the intensity of the electric field located on a spherical surface having radius r. Two single orthogonal planes of the pattern are generally represented by engineers in order to ease the graphical depiction of radiation patterns. The antenna pattern is deemed to be a function of orientation angles (θ, Φ) for a single polarization, frequency, and a group of constant surrounding situations. Antenna radiation patterns are an indispensable tool for the antenna designer and also the user. Antenna plots will help in order to appropriately direct the antenna for optimal functioning on all the required signals. Basically due to complex nature, antenna radiation plot are three-dimensional. A cartesian coordinate method also known as a two-dimensional structure which refers to points in free space is commonly utilized to make antenna radiation plots easier and simpler.

In the axis of the antenna’s plane and in the plane at ninety degrees to the axis, the radiation plots which are seen are the azimuth or "E-plane" and the "H-plane" respectively. The elevation angle is the vertical angle created by the direction of movement of an electromagnetic wave emitted from an earth station antenna in the way of a satellite and the horizontal plane. The distance of a propagated wave which should pass through the Earth’s atmosphere is greater if the angle of elevation is smaller. Usually the smallest amount of suitable angle of elevation is regarded as 5°[13, 14]. The horizontal directing angle of the Earth station’s antenna is well-known as the Azimuth [15]. The angles of elevation and azimuth are both dependant on the latitude as well as the longitude of the earth station and also on the orbiting satellite. The azimuth radiation pattern explains the dependence of the field strength on the azimuth angle Φ for the elevation angle θ upon which the maximum spatial radiation distribution occurs. In some circumstances the radiation patterns of the antennas are considered for a definite shape in elevation. In case of a receiving antenna, antenna patterns show its response in azimuth and elevation and are utilized to ascertain the directions from which reception is the greatest or side lobe response is the least.

5.3 Simulation Results

The time-shared LPDA was built at Kalyani (22.98°N, 88.46°E) in the Department of Physics, the University of Kalyani in West Bengal [16]. In this chapter the simulated performance analysis of the elevation radiation pattern as well as the variation of gain of LPDA in between 50MHz -300MHz have been examined. The variation of Elevation
pattern at 172°, 193°, 204° Azimuth & different frequencies of: (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz are illustrated in Figures 5.1, 5.3, 5.5 respectively. Figures 5.2, 5.4 and 5.6 demonstrate the variation of Gain with elevation angle at different frequencies of (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz as well as 172°, 193° and 204° azimuth in case of Elevation pattern analysis. According to the location of the constructed LPDA in the Department of Physics, Kalyani University, Kalyani (22.98°N,88.46°E) in West Bengal, we have taken into consideration three important satellites such as 91.5 E MEASAT 3A/ MEASAT -3(Elevation 62.9°, Azimuth true 172.2 °), 83 E GSAT – 10 / GSAT - 12 / INSAT – 4 A (Elevation = 62.4° Azimuth true 193.8°) and 75.8 E THAICOMS (Elevation 60.8°, Azimuth true 204.1 °) for finding the Elevation and Azimuth true. In this case elevation is the angle at which the signal arrives to the antenna dish and which is needed to set it by following the scale on antenna dish. In the same manner Azimuth true indicates the necessity to rotate the dish about its vertical axis beginning from true north.

5.3.1 Elevation Pattern Analysis

Some remarkable variations were observed while considering the elevation patterns presented in the Figures from 5.1 to 5.6. Figure 5.1 shows the alteration of elevation patterns at 172° azimuth for various frequencies at 50 MHz, 100 MHz, 150 MHz, 200 MHz, 250 MHz and 300 MHz respectively. Figure 5.2 reveals the alteration of gain with elevation angle at 172° azimuth. The alteration of elevation patterns at 193° azimuth at different frequencies is illustrated in Figure 5.3. Figure 5.4 shows the variation of gain with elevation angle at 193° azimuth. A few remarkable changes of elevation pattern at 204° azimuth at different frequencies are exhibited in Figure 5.5. The alteration of gain with elevation angle at 204° azimuth is shown in Figure 5.6.
Figure 5.1 The variation of Elevation pattern at 172° Azimuth & different frequencies of: (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz respectively
Figure 5.2 The variation of Gain with Elevation angle at 172° Azimuth and different frequencies (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz
Figure 5.3 The variation of Elevation pattern at 193° Azimuth & different frequencies of: (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz, respectively
Figure 5.4 The variation of Gain with Elevation angle at 193° Azimuth & different frequencies of (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz
Figure 5.5 The variation of Elevation pattern at 204° Azimuth & different frequencies of: (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz, respectively
Figure 5.6 The variation of Gain with Elevation angle at 204° Azimuth& different frequencies of (a) 50 MHz (b) 100 MHz (c) 150 MHz (d) 200 MHz (e) 250 MHz (f) 300 MHz
5.4 Conclusion

The EZNEC software showed to be very useful for optimizing the length of the dipole elements and to investigate the behaviors like radiation patterns, return loss and gain for the constructed antenna. The radiation pattern of a distinctive antenna is not a perfect pulse but a curve consisting of a major lobe and considerable amount of side lobes. In the elevation plane, steady radiation patterns are ascertained by carrying on experiments in the complete operating frequency ranges [17]. The determined radiation patterns in 5° steps show steady patterns with no grating lobes and blindness. This functioning is ascribed to least mutual coupling outcomes of the LPDA. It is observed that the back lobe side level is greater in low frequency than in high frequency. The radiation pattern can maintain steady state when the low frequency band has a higher back lobe level. The attributes of the LPDA [18] are mainly high directivity and front–to-back ratio over a broad band of frequency.

The most significant advantage of LPDA is that in the design range its functioning is effectually independent of frequency with radiation pattern and also gain. The constructed antenna would be very useful for discovering and recording solar radio examinations particularly because of its wideband functioning, minimum cost, simple process of manufacturing, and excellent radiation patterns [19].

References