ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

A Wideband Printed LPDA for Surveillance Applications

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ABSTRACT: Log periodic antennas are an important class of wideband antennas and they have same operating characteristics over a very wide passband. So they are suitable for a variety of applications such as satellite communication, military applications, direction finding etc. Log periodic antennas are multi-element, narrow-beam antennas which are extensively used due to their frequency independent nature and straight forward design procedure. The proposed antenna is a log periodic dipole array with a very wide bandwidth and operates in the frequency band 2-18GHz.

KEYWORDS: Wideband antenna; surveillance applications; Log periodic dipole array; HFSS

I. INTRODUCTION

Wireless communication has a tremendous growth over the past few decades. But with the increasing demand of satellite communication, surveillance applications, radio astronomy etc. to transmit high quality data antennas with wide bandwidth is required. Multiband antennas are a solution to this problem, but they cannot cover a large number of bands. Antennas with compact size which are designed to operate for the entire frequency band of the given system is desirable in such a scenario. In 1950s there was a major breakthrough in the broadband antenna revolution which is the frequency independent antennas. They have an extended bandwidth as 40:1 or more and their electrical characteristics vary over a wide range. Common types are spiral and log periodic antennas.

Log periodic dipole array is the most recognized structure which was introduced by D.E Isbell in 1960[1]. LPDA(Log periodic dipole array) is a broadband, multi element antenna which gives a very wider bandwidth compared to other antennas. The proposed antenna is a printed LPDA which is more desirable for handheld and portable devices due to their ease of integration into a system. The proposed design works for the frequency range of 2-18GHz which includes S band, C band, X band and Ku band. So the antenna effectively operates for the applications such as space communications, long-distance radio telecommunication, RADAR applications, satellite communication, GPS etc. Since it is a linearly polarized antenna with moderate and constant gain over the entire frequency range it is very suitable to operate as an earth station antenna.

II. RELATED WORK

In [2] a printed log-yagi dipole array (PLYDA) is designed. Here several parasitic dipoles which are served as director cells are added to the shorter dipole end of LPDA to enhance the gain. Since the designed antenna is a combination of LPDA and quasi-yagi antenna it is called PLYDA. Rogers 5880 with thickness 0.5mm is used as the substrate. Since it has low dielectric constant it gives good performance at high frequencies. A dual- band dual-polarized log periodic dipole array is designed for MIMO WLAN applications in [3]. The system contains 12 antennas; six for horizontal polarization and six for vertical polarization. To obtain linear polarizations and beam switching horizontal elements are placed with equal inclination of 60^0 to form a symmetrical structure and vertical antennas are inserted in T-shaped slots. Inorder to reduce the mutual coupling between the horizontal antennas six pairs of slits are also introduced in proposed system. In[4] substrate integrated waveguide(SIW) is used to provide the excitation for the printed LPDA. In SIW the upper and lower metal plates of the substrates are connected by via-holes. They provide baluns with considerably wide bandwidth, broad dominant mode bandwidth. low insertion loss and so on. To

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miniaturize the size of log periodic antenna quasi-fractal concept is used in [5]. Proposed antenna is a vertically polarized antenna operating in 3-6 GHz band. By the fractal concept the height of antenna is reduced to 1/8th of wavelength. The designed log periodic zigzag antenna have good front to back ratio and constant radiation characteristics.

III. ANTENNA DESIGN

The proposed design is a printed LPDA which operates in the frequency band 2-18GHz. Number of dipole elements in the design is 30. Two important design parameters for LPDA are geometric ratio τ and spacing factor σ. As τ and σ increases bandwidth and gain of antenna can be increased but at the expense of increase in antenna size. The antenna is printed on substrate RT Durroid 5880 having dielectric constant 2.2 and thickness 1.58mm. Antenna is excited using microstrip transmission lines. Design equations for LPDA are given below;
Let f_l be the lowest frequency and f_n be the highest operating frequency.

(1)Operating bandwidth= $\frac{f_n}{f_l}$

(2)Choose τ and σ

(3)Apex half angle α; cot α =$\frac{4\sigma}{1-\tau}$

(4) Active region bandwidth, Bar = 1.1 + 7.7(1- 2τ^2)cotα

(5)Array Bandwidth, Bs = B*Bar

(6)Maximum wavelength, λ_{max}=$\frac{984}{f_l}$

(7)Boom length, L =(1-$\frac{1}{B_s}$)*cotα*$\frac{\lambda_{max}}{4}$

(8)Number of elements, N = 1+$\frac{logBs}{log\frac{1}{\tau}}$

(9)Longest element length; l_{1ft} =$\frac{492}{f_l}$

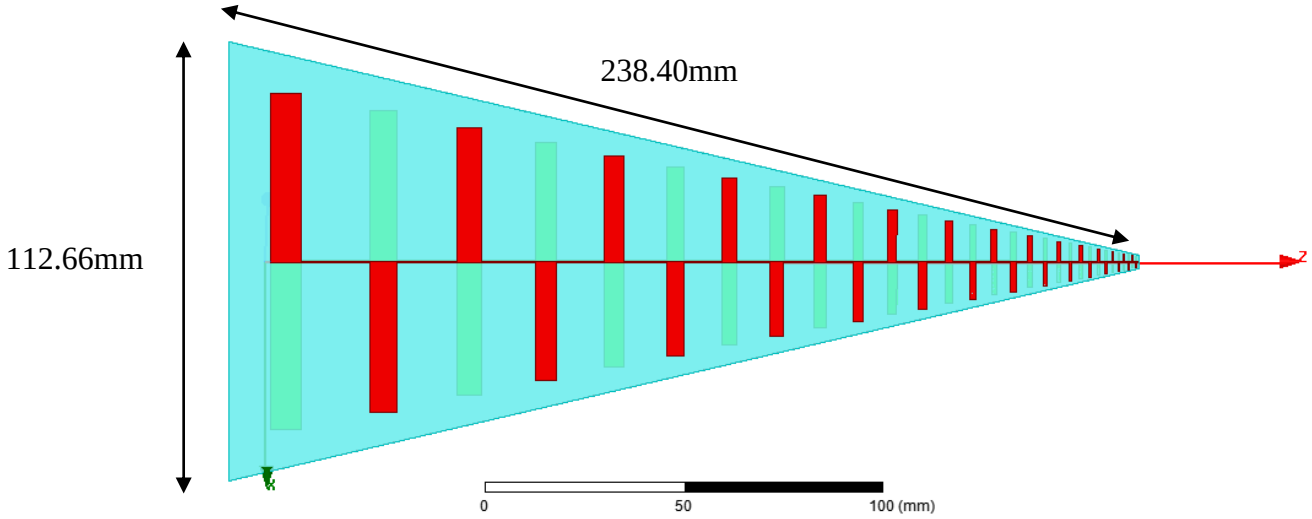

Figure 1:Antenna Geometry (a) Front view

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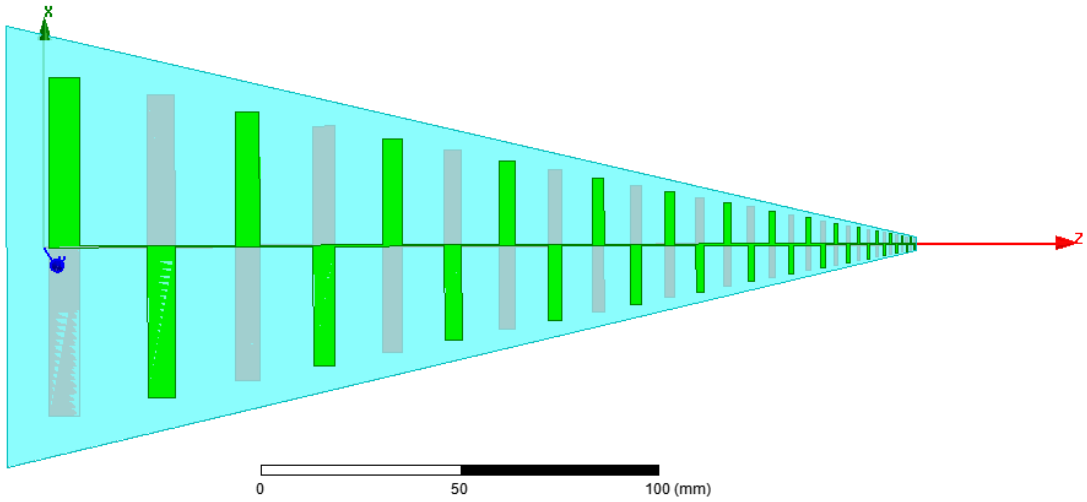

(b) Back view

IV. SIMULATION RESULTS

The designed antenna is simulated using Ansoft HFSS13.0 software which is based on FEM (Finite Element Method) method. From the obtained simulation results it is clear that antenna is well suited for surveillance applications.

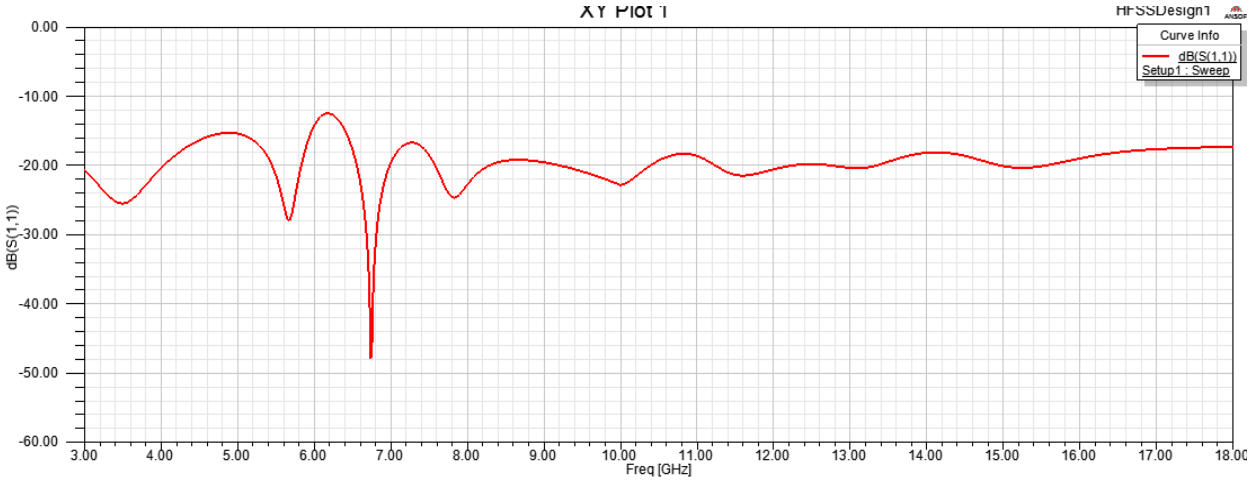

Figure 2: Return loss

Figure 1 shows the return loss graph of the proposed antenna. For the entire operating range return loss is less than -10dB, so the antenna radiates well in the 2-18GHz band.

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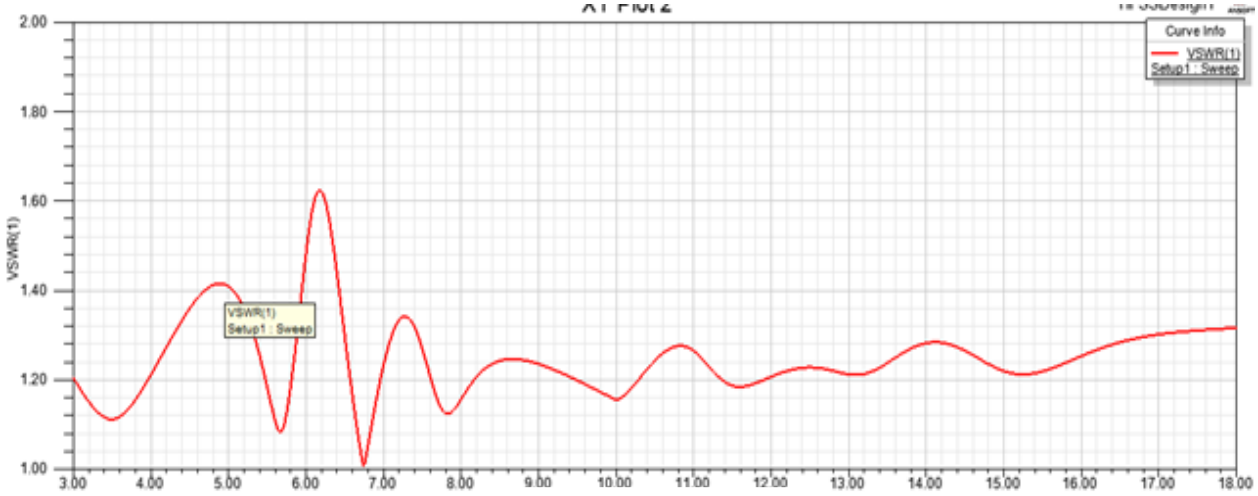

Figure 3: VSWR plot

Figure 2 shows the VSWR plot of the proposed LPDA. For the 2-18GHZ band VSWR of designed antenna is less than 1.62.

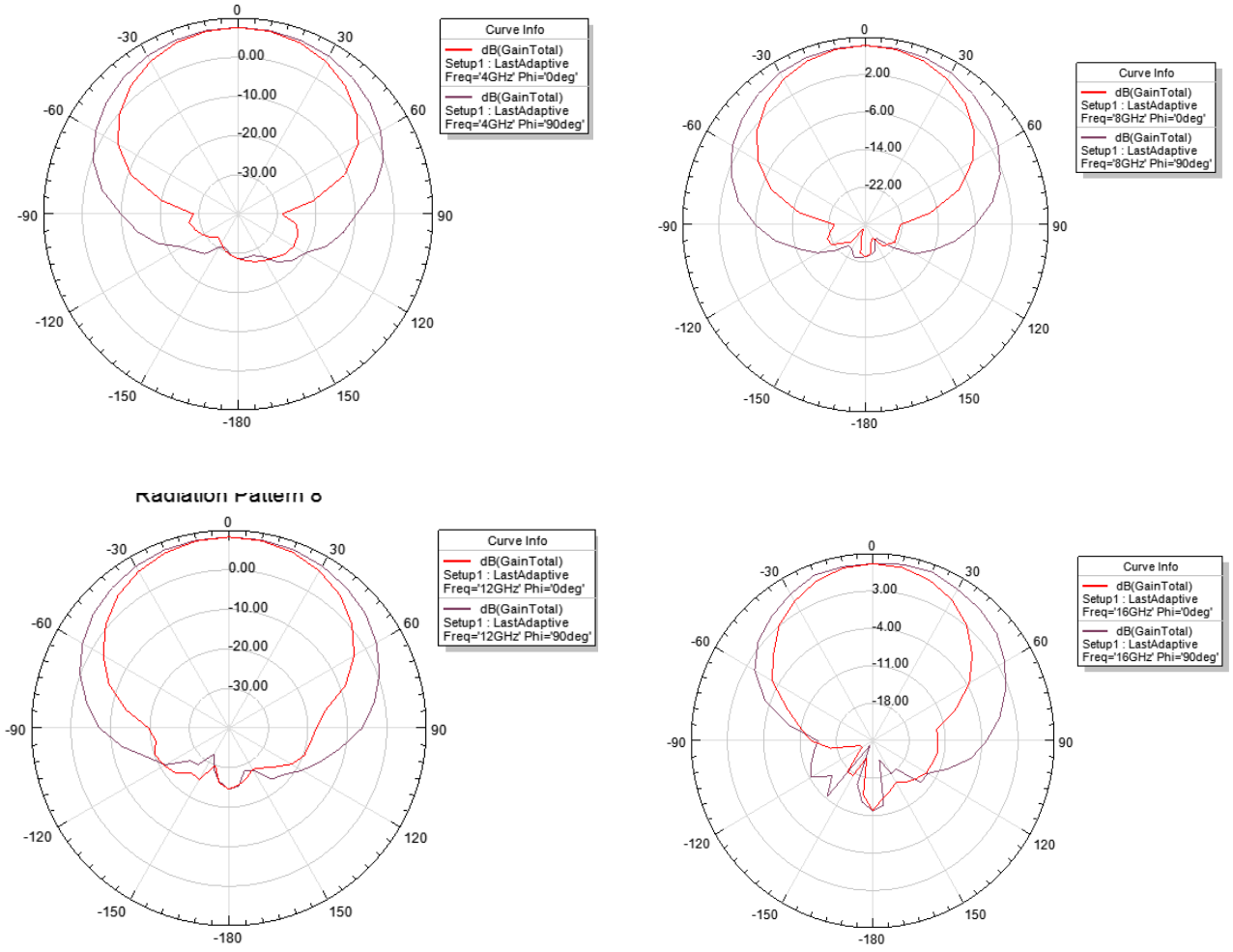

Figure 4: Radiation pattern at 4GHz,8GHz,12GHz and 16GHz

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Log periodic dipole array is a directional antenna. Figure 4 shows the radiation pattern of proposed antenna for different frequencies within the operating range.

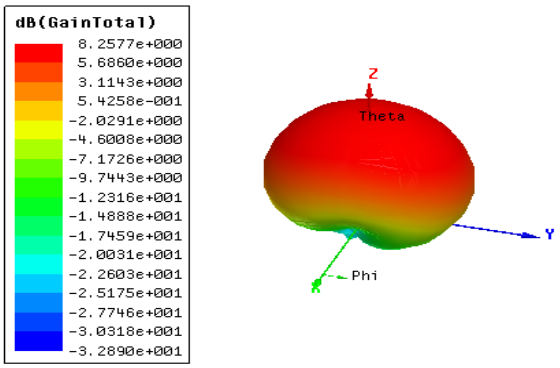

Figure 5: Gain of antenna

From the figure 5 it is clear that proposed antenna provides an average gain of 8.25dB. So all the operating characteristics shows that antenna is best suited for surveillance applications due its high gain and wide operating bandwidth.

V. CONCLUSION AND FUTURE WORK

The simulation results showed that the proposed antenna is best suited for the surveillance applications. The antenna operates well for a wide bandwidth of 15 GHz with good gain and directional radiation pattern. Since the size of antenna is small compared to other wideband antennas it is well suited for handheld devices also. Antenna size can be further decreased by fractal concept without degrading the performance of the antenna.

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BIOGRAPHY

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