International Journal of Engineering & Technology, 7 (2.7) (2018) 952-954

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

Printed dipole antenna and its arrays for wireless applications

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Abstract

This paper proposes single element of micro-stripe antenna having wider bandwidth and also its arrays which are implemented for wireless applications. In contemplation of wide frequency range of operation, antenna is fed with integrated balun. The single element antenna works under frequency range of 34GHz to 46GHz where reflection loss is less than -10dB and the obtained gain is 2.1 dBi. The linear 8-element array of antenna has been implemented and to obtain low mutual coupling between the elements of antenna a rectangular stub has been implemented. By enforcing the array methodology the not only the overall gain of the antenna has increased but also results in wider scanning angle.

Keywords: Angled Dipole; Broad Band; Feed and Integrated Balun.

1. Introduction

In the contemporary world most of the wireless communication uses millimetric wave bands due to their larger bandwidth, high efficient operation, low cost and larger spectrum. From few decades, for wireless communications planar printed antennas are used for directional beam control by fluctuating each and every phase of the element. Among those planar printed antenna some have high impact such as Yagi-Uda antenna, Printed Dipole antenna and Angled Dipole antenna. The Yagi-Uda antenna is being projected at X-band phased array, printed di-pole is to be used as micro strip feed line at Ka band phased array, and angled dipole antenna is used for active phased array applications. Printed T dipole antenna is a sub type of planar printed dipole, mostly for wireless networks printed T dipole antenna is fed with an integrated balun which is an electric device converts balanced and unbalanced signals. It is operated at microwave frequencies and broad band, the only disadvantage is its large structure.

Dipole antenna is the one which produces radiation patterns used mostly in radio and telecommunications. It has two identical conductive elements as shown in Fig.1 known as antenna elements and the elements are separated by feeding mechanism. The current flows in the both the antenna sections and with the correlation of voltage and current electromagnetic wave occurs which result in radiation. The key factor of dipole antenna is that the length of the radiating element determines the impedance of the antenna.

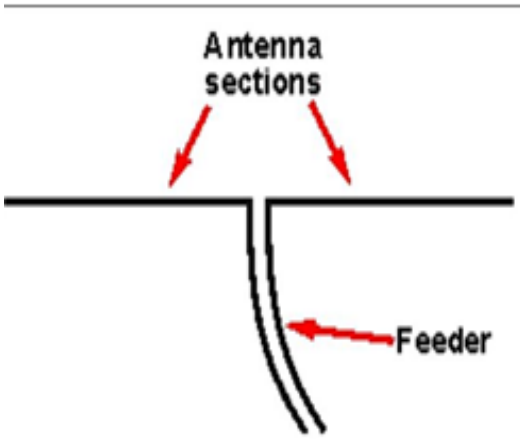


Fig. 1: Dipole Antenna.

In this paper we would use printed dipole antenna used for wireless communications. To work the antenna under broad-band range the dipole antenna is feed with integrated balun and beam forming angle is 45degrees i.e. to reduce the size of antenna. The main aim is to reduce mutual coupling between antenna elements and to reduce it we insert a stub between them so that stub removes the unwanted signals. To design the entire antenna we use electromagnetic designer and stimulator known as High Frequency Structure Simulator (HFSS).

2. Single element antenna design

In this paper, we design single element antenna with given measurement specifications, Fig.2 represents the antenna geometry of printed dipole. It was designed on both sides of Rogers RT/ Duroid 5880 substrate having a permittivity of 2.2 and thickness of 0.254mm and 50-Ω micro strip line feed and an integrated balun. From the single element design it can implicit that top layer is substrate and bottom layer contains both micro strip and ground

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plane, the dipole antenna present is feed with a slotted line having a characteristic impedance of around 116Ω-130Ω.

As the antenna works over broad band range frequencies there may be impedance mismatch so to avoid it a balun is used, it act as micro strip to the feed line where it is represented as Dr which is rectangular in shape. To acquire perfect matching of impedance the rectangular slot and feed line where balun is attached is to be adjusted. The portray of antenna is done in Ansys HFSS to clinch perfect impedance match and gain at 26-38 GHz. The following are the design parameters of the anten-na Wgnd = 10, D1 = 0.84, D2 = 0.7, D3 = 0.5, Dr = 0.6, Lr =0.8, Dcps = 0.4, Wd = 0.6, Ld = 1.6, l1 = 1.4, l2 = 1.8, l3 = 2, l4 =0.4, n = 0.2, gap = 0.3, Sd = 0.4.

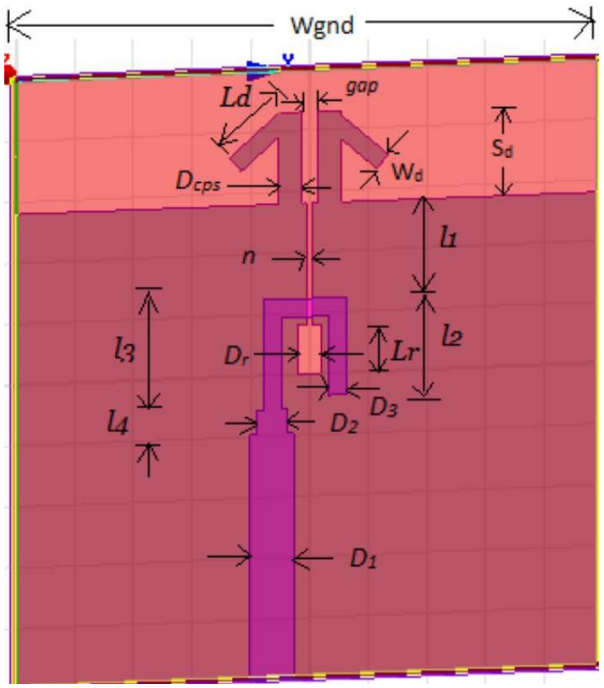


Fig. 2: Geometry of the Antenna.

2.1. Return loss

For any antenna, S11 parameters (Return Loss) are to be taken into consideration and for the proposed antenna the return loss obtained at operating frequency i.e38GHz is 15 dB and the fig.3 represents the Return loss of the antenna.

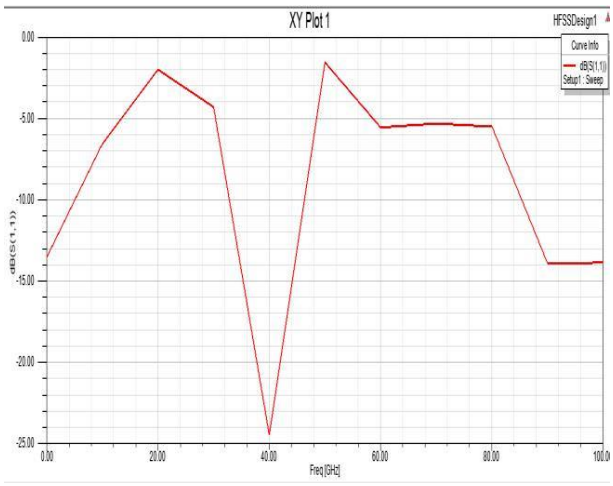


Fig. 3: Frequency vs. |S11| Plot.

2.2. Radiation pattern

The radiation of the dipole antenna determines the sensitivity along all the possible directions. Fig.4 represents the radiation pattern of the proposed antenna.

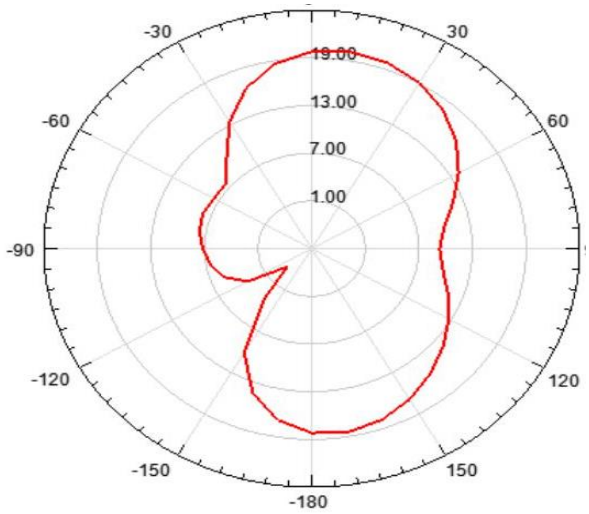


Fig. 4: Radiation Pattern of the Antenna.

2.3. Gain of the antenna

Fig.5 represents the 3D plot of gain and for the designed antenna the obtained gain is 2.1 db.

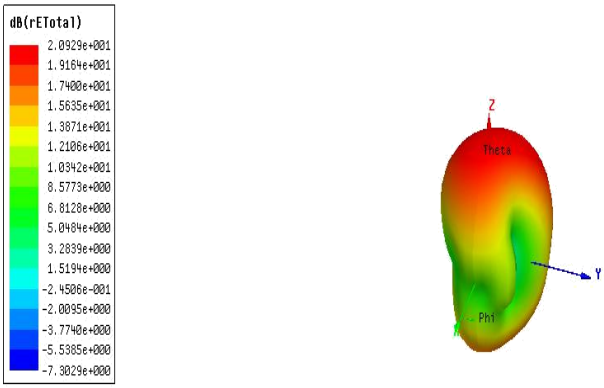


Fig. 5: Gain of the Antenna.

3. Characteristics of antenna arrays

The congregation of single element radiators in geometrical con-figuration under some conditions are known as antenna arrays. Among the different antennas such as linear, planar and circular we do use planar array antenna as it provides larger aperture so that by changing each element of antenna in an array the direc-tional beam can be controlled. Some major aspects that are to be taken into consideration while designing antenna arrays are that i) Geometrical specifications ii) Mini-mum spacing between the elements and iii) Excitation phase.

3.1. Geometrical specifications

Geometrical specifications describes the design of the antenna. It gives us information about the required Pattern, Aperture synthe-sis, First array synthesis, Final array synthesis, Sensitivity analysis and antenna siting.

3.2. Spacing between the elements

The minimum distance between antennas in the array are ‘λ/2’ and the maximum distance is ‘λ’. In the range of distance stated ‘λ/4’ is known as close spacing so that it is used to refrain close spacing of antenna array. A 4.8mm of center-center spacing is arranged. Fig.6 represents the array of elements and also a stub is inserted to avoid unnecessary radiations from other elements in order to achieve low mutual coupling.

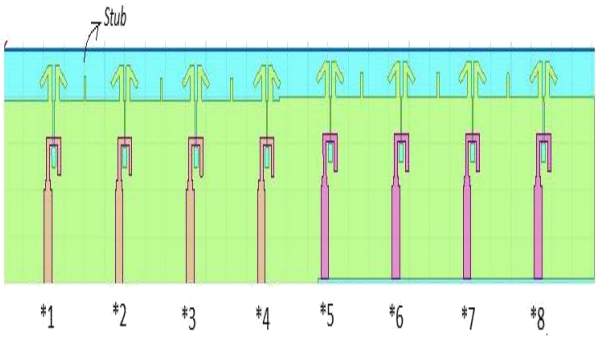


Fig. 6: Eight Element Linear Array Antenna.

3.3. Excitation phase

Excitation phase depends upon the design of the array antenna. Spacing between the elements play a major role in determining the excitation phase.
Fig.7 represents the overall gain for the eight element linear Antenna and it has a gain of 7.2dBi. Therefore, the overall gain and efficiency of the antenna increases by implementing array technique.

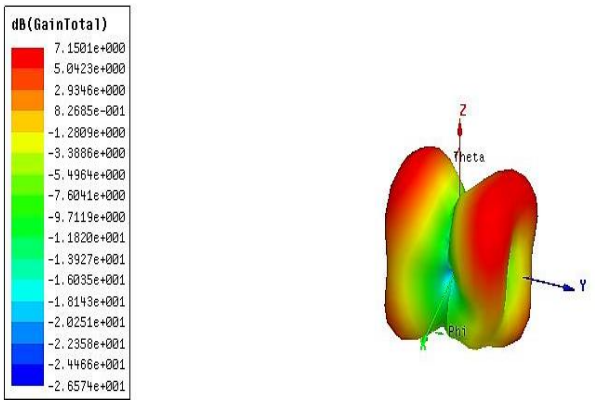


Fig. 7: Gain of the eight Element Linear Array Antenna.

4. Conclusion

The proposed dipole antenna has larger bandwidth with wide radiation pattern and high efficiency of radiation. In order to achieve high efficiency and more gain antenna array elements has been designed, to overcome mutual coupling a centre-centre spacing distance between elements is 4.8mm and also a microstrip stub is designed to get a low mutual coupling. By implementing array technique the overall performance of an antenna will be increased. From all the above applications and advantages the proposed antenna is used in wireless communications and millimetric applications.

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