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A NOVEL COST EFFECTIVE DIRECTIONAL WI-FI BOOSTER ANTENNA

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ABSTRACT

People expect more convenient ways to access the network. In this scenario, Wireless (WLAN) offers tangible benefits over traditional wired networking. Antenna a key element used to get better coverage. In this paper we are going to design a solution to replace the traditional Omni directional antenna with proposed Double Bi-quad antenna which is cost effective high gain, directivity and easy to fabricate. Current high gain antennas on the market that meet these specifications are expensive and cannot cover a larger distance. The proposed antenna consists of four equally sized squares radiating element on a printed circuit board with 50 ohm SMA connector which produces high directivity and peak gain of 12.9 dBi and works at 5.8 GHz.

Keywords: access point (AP), wireless fidelity (Wi-Fi), wireless local area network (WLAN), double bi-quad, omni-directional antenna.

1. INTRODUCTION

In President Obama's State of the Union address in January of 2011, the president set a goal to have reach 98% of all Americans to be able to access to wireless internet , with the hope of bringing every part of America into the digital age by 2016 [4]. In this scenario, Wireless (WLAN) offers tangible benefits over traditional wired networking. Wi-Fi (Wireless Fidelity) is a generic term that refers to the IEEE communication standards for Wireless Local Area Networks (WLANs). The wireless network is formed by connecting all the wireless clients to the Access Point (AP). Single access point can support up to 30 users and can function within a range of 100 – 150 and 300 feet indoors and outdoors respectively. The AP has the traditional Omni directional antenna. The coverage area depends on the location of the access point is actually placed. Omni directional antenna can operate over narrow bandwidth and requires tuning and phasing. Omni-directional antennas radiate roughly the same pattern all around the antenna in a complete 360° pattern. Directional or directive antennas are antennas in which the beam width is much narrower than sectorial antennas and they have the highest gain and are therefore used for long distance links. It should be noted that when an antenna transmits the signal in a certain direction stronger than in the other directions, it also receives the signal in that direction better than in the other directions due to its reciprocal property [1]. A directional antenna is designed not solely for range extension. It can be utilized for interference reduction (signal quality improvement) due to the fact that a directional antenna transmits and receives in a certain direction better than in the other directions; thus, both transmission and reception of signals in the unwanted directions are minimized. Moreover, a directional antenna can be deployed to limit the coverage area of the AP to a desired area. This is beneficial when users, who want to connect to the network, are concentrated in a certain area. For example, it is useless to radiate the signal to the outside of the building while the users are inside the building.

It is clearly seen that the role of an antenna is important. With directional antennas, network performance can be significantly improved in terms of range, signal quality, and coverage area. There are many companies selling highly-directional (high-directivity) antennas in the market. However, many of those commercial antennas can be constructed in a workshop at home. This leads to the main objective of this paper, which is to design a double biquad 5.8GHz antenna.

2. PARAMETERS OF ANTENNA

Before going to design of antenna one must know about the parameters of antenna, they are radiation pattern, beam width, power, directivity, gain, aperture, radiation resistance. In the field of antenna design the term radiation pattern (or antenna pattern or far-field pattern) refers to the directional (angular) dependence of the strength of the radio waves from the antenna or other source [1]. The beam width of an antenna is a very important figure of merit and often is used as a trade-off between it and the side lobe level; i.e, as the beamwidth decreases, the side lobe increases and vice versa. The beamwidth of the antenna is also used to describe the resolution capabilities of the antenna to distinguish between two adjacent radiating sources or radar targets. Antenna directivity (usually in dB) is the parameter that quantifies how strongly the antenna radiates in a particular direction. Antenna Gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source [2]. The radiation pattern is independent of the distance between the observation point and the antenna position provided that the distance is sufficiently long (far-field region) [1]. Consequently, the radiation pattern of the considered antenna is a function of only two angular parameters, the zenith angle θ, and the azimuth angle φ. The last important parameter is polarization is just the direction of the electric-field vector of the radiated electromagnetic wave. Generally, the antennas at both ends of the communication systems must be polarization-matched to avoid the penalty called polarization loss factor

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(PLF) [1]. The antenna polarization can be obtained by examining the current directions along the antenna wire.

3. PROPOSED METHOD

Our design consists of four squares of the same size of 1⁄4 wavelength as a radiating element and a metallic plate, the diameter of copper wire is about 1mm, the vertical and horizontal length of the reflector is about 5.2cm and 9.1cm, respectively. The design procedure of antenna is follows; ensure each side of the element is as straight and symmetrical as desirable. The element sides are rectangular and widths are 1.3 cm, measured from wire centre to wire centre. The more accurate you do the better as the analysis shows a huge impact in element dimensions. Leave a ~1.5 mm gap between the element wires cross over's and solders and connect the N-connector in the centre of reflector, maintain correct spacing between the element and the reflector. The model of the double biquad antenna is shown in Figure-1.

Figure-1. Design model of double Biquad antenna.

4. DESIGN AND SIMULATION

The double bi-quad antenna was first created and simulated in NEC software before designing the antenna. The Numerical Electromagnetic Code (NEC) is a popular antenna modeling software package for wire and surface antennas. The physical design of the simulated antenna can be seen in Figure-2.

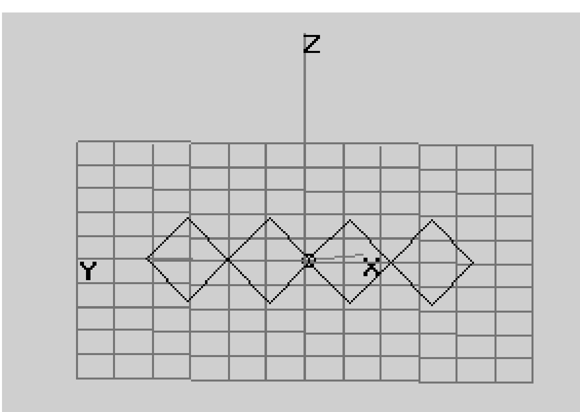

Figure-2. Double bi-quad antenna simulated in NEC.

The simulated parametric study results and return losses for the proposed antenna are obtained. Simulation of the antenna at 5.8GHz showed a peak gain of 12.9 dBi in the Vertical plane, Horizontal plane and very good directivity. Impedance of the antenna was reported at 49.7 + j 0.8 ohms. The simulated radiation pattern of antenna can be seen in Figure-3 & 4.

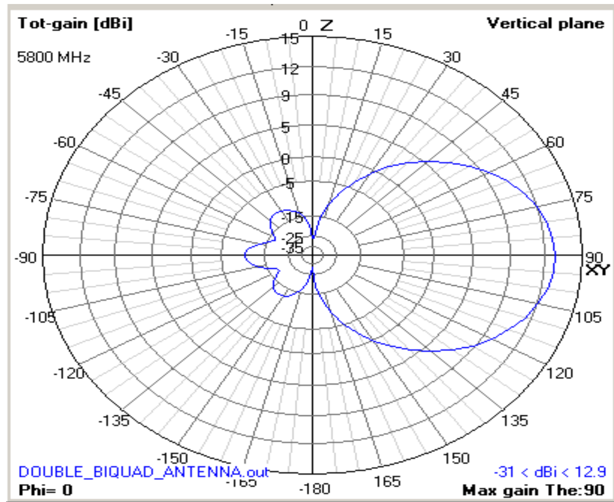

Figure-3. Vertical pattern of simulated antenna.

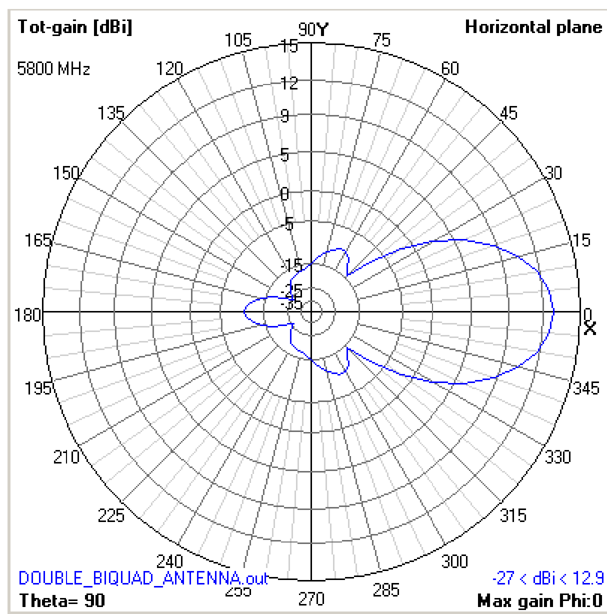

Figure-4. Horizontal pattern of simulated antenna.

The value of simulated Return loss on desired frequency band along vertical and horizontal plane is -31dB and -27 dB respectively whereas SWR is 1.02.The 3D model of double bi-quad antenna with overlaid 3D radiation pattern and simulation characteristics from NEC is shown in Figure-5 & 6, respectively.

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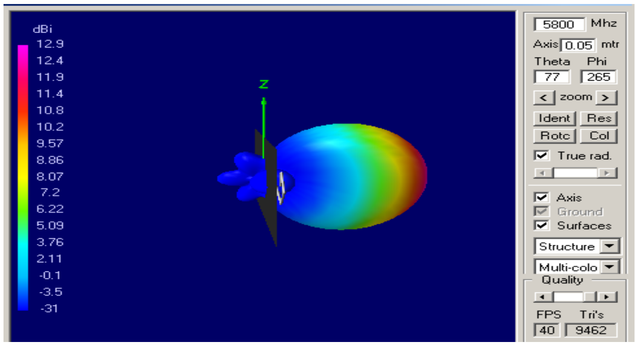
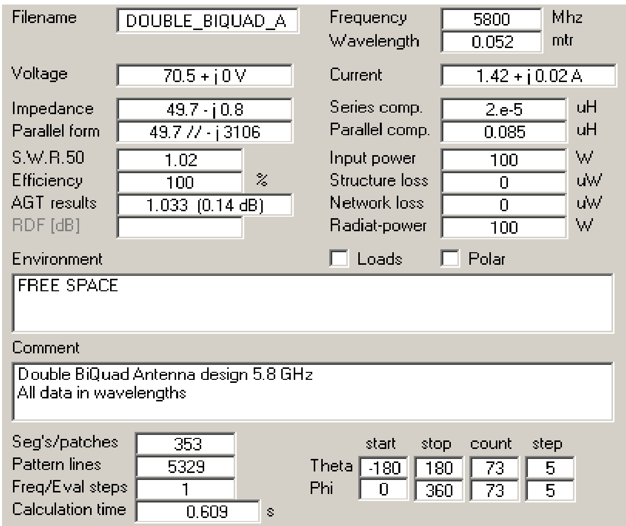
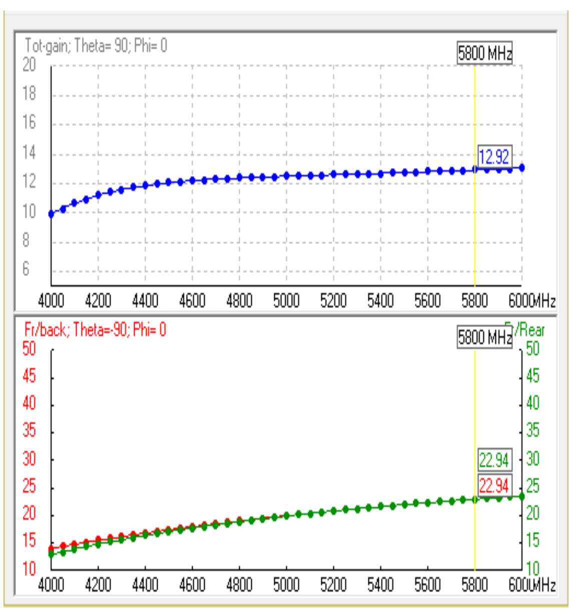


Figure-5. 3D radiation pattern.



Figre-6. Simulation characteristics.

The Gain and SWR plot of the proposed antenna is shown in Figure-7.



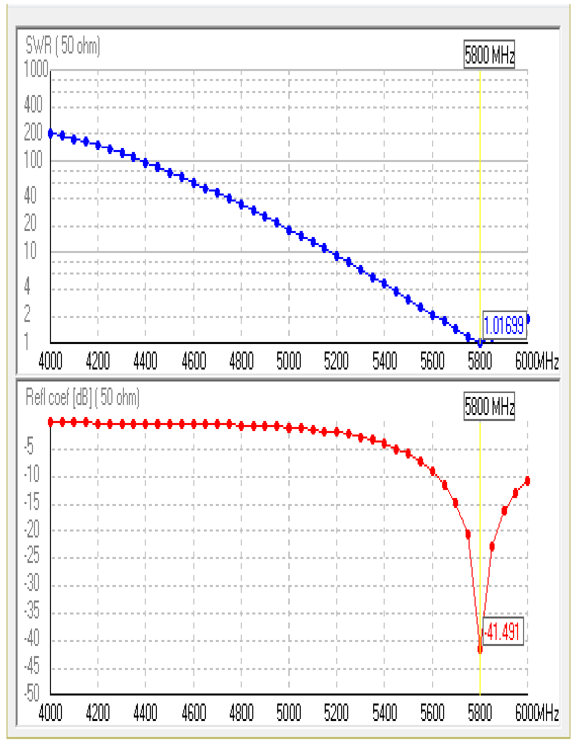


Figure-7. Gain and SWR plot.

5. CONCLUSIONS

The goal of this project was to design a highly directional antenna that was economical and easy to manufacture. Current high gain antennas on the market that meet these specifications are expensive and cannot cover a larger distance. The development of a lower cost supplement with high performance would attract consumers.

The use of a directional antenna allows the electromagnetic waves to be focus towards a particular section. This allows wireless connections at greater distance from the router than a traditional omnidirectional antenna. In addition, higher data rate can be achieved at greater distances. This antenna would be useful in both rural and urban environments. The overall design meets all of our design criteria developed during market research. The Double biquad antenna light weight and can be mount flush to buildings and walls. The gain of the antenna was measured to be 12.9dBi and this project can be extended to get even better signal strength by using other directional antennas to cover a wide area.

6. FUTURE SCOPE

This work can be extended to get even better signal strength by using other directional antennas to cover a wide area.

REFERENCES

[1] Antennas and Wave Propagation. 2001. - K.D. Prasad, Satya Prakashan, Tech India Publications, New Delhi, India.

[2] Antennas and Wave Propagation. 2006. Fourth Edition. Author, John D Kraus, Ronald J Marhefka, Ahmad S Khan. Publisher, Tata McGraw Hill.

[3] Zhi Ning Chen, Fellow IEEE, Xianming Qing, Member IEEE, Terence Shie Ping See, Member IEEE, and Wee Kian Toh, Member IEEE. 2012. Antennas for WiFi Connectivity. Proceedings of the IEEE. Vol. 100, No. 7.

[4] Susmita Das. 2008. "Smart Antenna Design For Wireless Communication Using Adaptive Beam-Forming Approach".

[5] Antenna Theory - C.A. Balanis, John Wiley & Sons, 3rd ed.. 2005.

[6] Vrushali V. Kadu, V. A. Gulhane. "An Overview of Wi-Fi booster antenna" Vol. 2, No. 1, pp. 047-051, ISSN: 2230-7818.

[7] Vrushali V. Kadu and D. S. Adane. 2012. "Maximizing Range of Signal Strength by Home made Wi-Fi Booster Antenna"Vol. 978-1-4673-4805-8/12/$31.00┐ c.