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DESIGN AND DEVELOPMENT OF SERIES FED TWO DIPOLE ANTENNA FOR WLAN BASE STATION APPLICATIONS

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Abstract

Antenna design is the crucial process in the development of any devices in wireless communication Era. In this paper, Series-Fed Two Dipole Antenna is designed for the WLAN applications. The proposed antenna operates at 2.4GHz frequency band which is IEEE 802.11b, industrial, scientific and medical (ISM) band with reduced size and improved gain for providing effective access to wireless internet to the end users. A modified balun feeding is used for improving impedance matching. This antenna is designed over the FR4 substrate with dielectric permittivity of 4.4 and height of the substrate is 1.6mm to achieve lower return loss. The dimension of the proposed antenna is 105mm length 80mm width. This antenna is simulated in an integral based solver simulation software called CST Microwave studio v2017 and achieved best results such as VSWR 1.25, Return loss -19 dB and Bandwidth of 200MHz, Directivity of 6.71dBi, gain of 6.19dB. This antenna finds its applications in WLAN Base Stations and wireless access points.

Keywords:

WLAN, Series-Fed Two Dipole Antenna, Base Station Antenna, Patch Antenna

1. INTRODUCTION

The exponential increase in wireless communication between the consumer electronics requires the need for increased wireless coverage as much as possible. The WLAN is widely implemented in indoor and outdoor areas to provide wireless connection to the end users for this device like routers and wireless repeaters were used. The performance of these devices depends on the Capacity of antennas which decides the coverage and efficiency of the wireless network. The conventional STDA [4] is used in different base station applications for the mobile phone communications because of its capability to work as array with reduced mutual coupling losses and provide larger gain. It consists of two dipoles exited serially by balun feeding element. Here the conventional STDA is modified by reducing the height and width to 105mm and 80mm and the distance between the dipoles are reduced by 33 to 34mm. The simulation results are in accordance with the IEEE 802.11b guidelines for validating the parameters such as gain, Return loss, VSWR, directivity.

The software used in this research is CST Microwave studio version 2018. CST microwave studio is an Electromagnetic field simulation software which is based on finite integration technique and for analysis of patch antennas time domain solver is used. This CST microwave studio is selected based on its user interface, which is very simple and has the capability of simulating complex structures. From the literature review, it is found that different antennas are available for base station applications [4] - [6], which is a complex design and a series fed two dipole structure can be modified for required applications in this work. Further, a fundamental and series-fed two dipole antenna is modified in this proposed method to operate at 2.4GHz ISM band frequency for WLAN Base Station Applications.

2. LITERATURE REVIEW

The literature review deals with the fundamental design and analysis of antennas [1] - [3], fundamental Series-Fed Two Dipole Antenna [4] for different applications for understanding the various design methodologies and its applications. From the literature review, it is found that the different antennas are available for base station applications. A modified series-fed two-dipole-array antenna is used to reduce the size [5]. A bow-tie element is used to enhance gain and front-to-back ratio of series-fed two dipole array antenna in [6]. Compact MIMO antenna for Bluetooth, WiMAX, WLAN, and UWB applications is presented in [7]. A double dipole antenna is designed with enhanced usable bandwidth for wideband phased array applications is discussed in [8]. A Dual-band and Dual-polarized Fractal Antenna for WLAN Applications is presented in [9]. A low profile dual band dual polarized antenna with an AMC Surface for WLAN Applications is discussed in [10]. A dual band high gain antenna array for WLAN and WiMAX Base Station is presented in [11]. Wideband two bowtie dipole array antenna integrated with a tapered balun is discussed in [12]. A Compact MultiBand and Dual-Polarized Mobile Base-Station Antenna Using Optimal Array Structure is discussed in [13]. A Triple-Band High-Gain Base-Station Antenna for WLAN and Wi-MAX Application is presented in [14]. Recent development in WLAN patch antenna is discussed in [15], which involves in designing and analysis of microstrip patch array antenna for WLAN Applications. All the above-mentioned works are of complex in terms of design therefore in this research Series-Fed Two Dipole structure is modified for 2.4 GHz ISM band frequency for WLAN Base Station Applications.

3. ANTENNA DESIGN

This section presents the design of the proposed STDA for WLAN base station applications. The proposed antenna design is given in Fig.1 and Fig.2. The proposed Series-Fed Two Dipole Antenna Which contains two dipoles and a ground at the bottom end. The modified balun feeding is used to provide a better impedance matching the balun structure [5]. The gap of 1.6mm is made in the middle of the structure which gives enough isolation between the radiations from the side lobes. The size of the ground plane and the distance between the dipoles and the size of the dipoles and the gap in between the side lobes determines the frequency range of operation therefore these parameters are customized for the WLAN applications in this research.

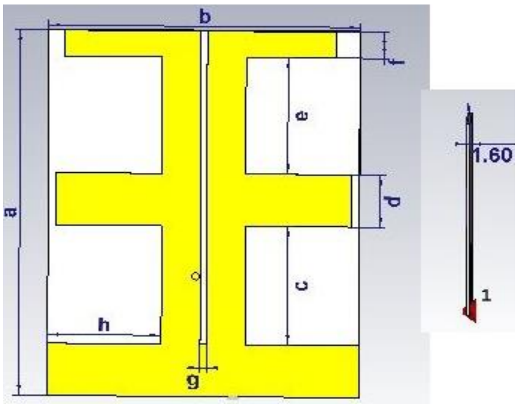

Fig.1. Front View of the Proposed Antenna

The antenna is designed in FR4 Substrate with permittivity of 4.3 and thickness 1.6mm. The patch is designed in copper material having electrical conductivity of $5.8e^7$ with a thickness of 0.035mm. There is a gap is introduced in the middle of the patch of 1.6 mm is also designed in the patch structure. The position of feeding point is found to 35.50mm above the ground after several iterations to achieve required performance of the antenna.

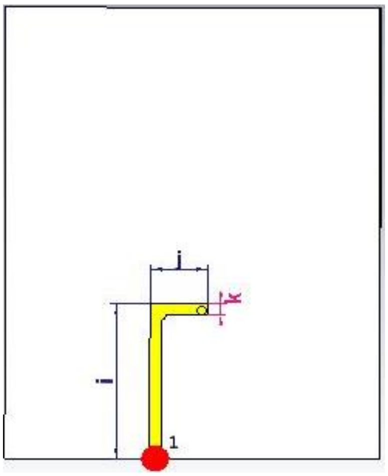

Fig.2. Back view of the Proposed Antenna

The Front and side view of the proposed antenna is given in Fig.2. The Design parameters are i = 36mm, j = 12.50mm, k = 2.50mm, the shorting pin of 1mm radius copper via is used to connect the feeing element with the series dipole elements is attached at the end of the balun feeding. The balun feed is modified at the joint as bending curve to provide perfect impedance matching. In CST Simulation, the discrete port is used with 50 Ω reference impedance. The overall size of the antenna is 105×80mm.

4. RESULTS AND DISCUSSION

Here the results and discussion section are presented. The design and simulation is done in CST microwave studio v2018 and its results such as return loss, VSWR, far field radiation and surface current, gain and efficiency were discussed.

4.1 RETURN LOSS

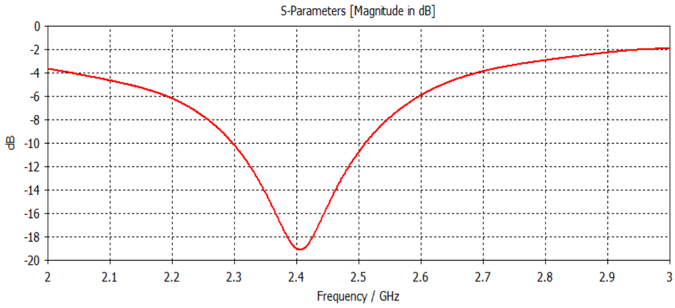

Fig.3. Return loss

The minimum return loss obtained at 2.4GHz is -19.01dB for the proposed antenna which is given in Fig.3. The -10dB Bandwidth obtained at 2.4GHz is 200MHz for the proposed antenna. This validates that the proposed design is well suitable for the WLAN applications.

4.2 VSWR

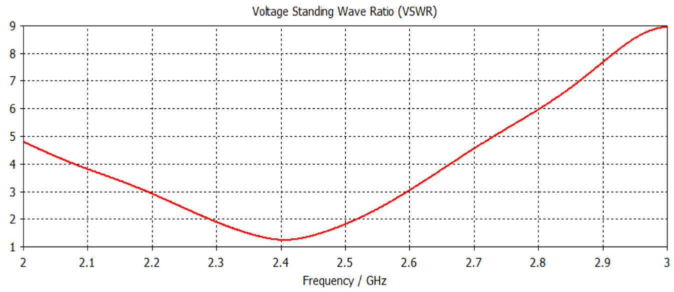

Fig.4. VSWR

The minimum VSWR (Voltage Standing Wave Ratio) obtained at 2.4GHz is 1.25 for the proposed antenna which is given in Fig.4. The VSWR value must be from 1 to 1.5 for the perfect antenna and the proposed design achieves the value of 1.25 which validates the proposed design will serve for better purpose.

4.3 FARFIELD AT 2.4GHZ

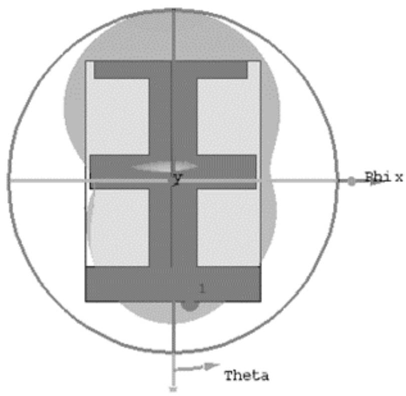

Fig.5. Farfield at 2.4GHz

A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna. The 3D far field radiation is given in Fig.5. The Maximum Efficiency obtained at 2.4GHz is 88% and the total Efficiency from 2 to 3GHz frequency range is 87% for the proposed antenna. The E and H Field Plots were given in Fig.6 shows that the antenna radiation in both E and H Plane were performing as expected directions.

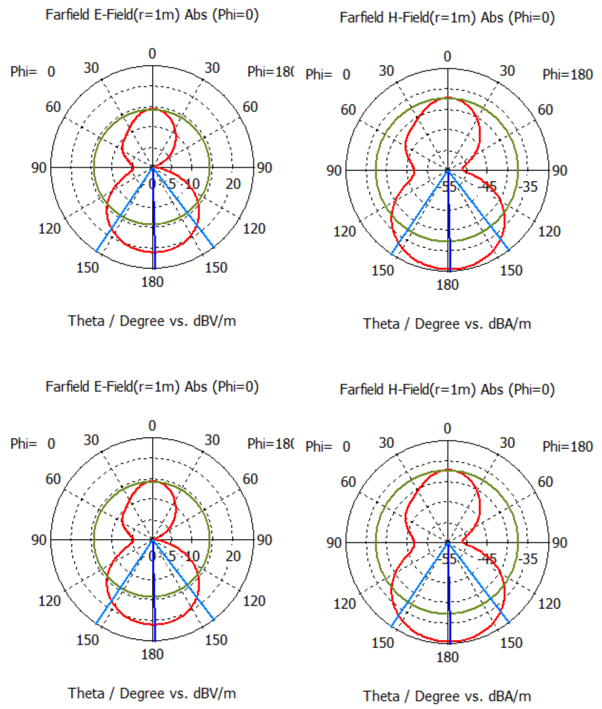

Fig.6. EH Fields

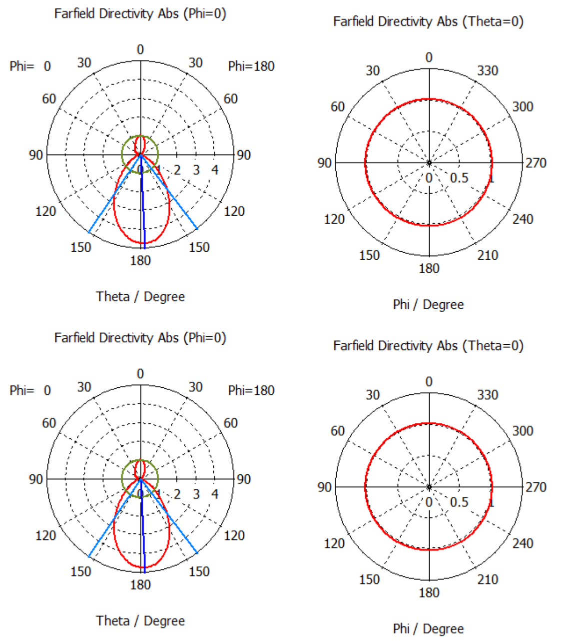

Fig.7. 2D Far field Plots

The far field directivity 2D plots at Phi = 0 and Theta = 0 is given in Fig.7. Shows that the radiation characteristics of the proposed antenna is good and performing well.

4.4 DIRECTIVITY

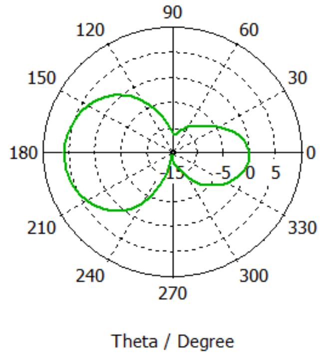

Fig.8. Directivity

The directivity plot at const Phi = 0 is given in Fig.8. The Front to Back Ratio is the ratio of power gain between the front and rear of a directional antenna. Front to back ratio at 2.4GHz is 6.74 for the proposed antenna.

4.5 SURFACE CURRENT DISTRIBUTION

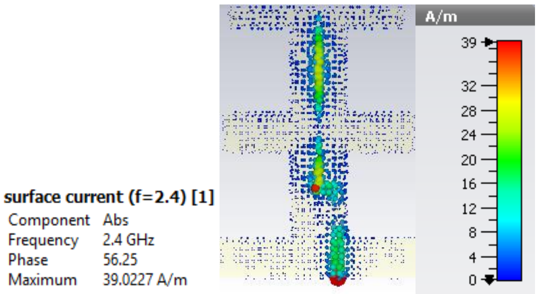

Fig 9. Surface Current Distribution

The current distribution can be a very useful plot for the analysis of design. The surface current distribution plot is given in Fig.9 obtained from the simulation shows the current distribution is starts from the feeding point through the Balun designed from the bottom to the top surface of the STDA. The overall results were tabulated here below.

Table.1. Overall Results

Parameter	Value
Frequency	2.4GHz
Return Loss	-19.01dB
VSWR	1.25
Gain	6.73dB
Efficiency	88%
Directivity	6.72
Bandwidth	200MHz
Front-to-back ratio	6.74
Angular 3dB width for const phi = 0	71.72 deg
Angular Beamwidth (3dB) at phi=0	71.8 deg
Angular Beamwidth (3dB) at phi=90	98.5 deg

5. CONCLUSION AND FUTURE WORK

The proposed Series-Fed Two Dipole Antenna is performing well in the simulation environment and the major parameters such as Return loss -19.01dB, VSWR 1.25, Gain 6.73dB and Bandwidth 200MHz are following the IEEE 802.11b guidelines for operating WLAN Applications in ISM Band frequency. This Series-Fed Two Dipole Antenna can be used in the WLAN outdoor base station applications for different coverage areas. Future work in this research will be focusing on fabricating and testing antenna in real time applications and developing an array of series-fed two dipole antennas and design of feeding networks for the improvement of its performance and applications.

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