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Design of Compact Slot Antenna For WLAN Application

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Abstract- A microstrip fed slot antenna is proposed for wireless local area network (WLAN) operation is designed and simulated using ADS software. Microstrip feed line have been widely used as feeding networks. This paper presents the simulated results of the antenna composed of rectangular patch element embedded with slots, with good impedance matching. The overall dimension of the antenna is 25mm × 21mm×4mm . The antenna is characterized by measuring radiation pattern, directivity, return loss and gain. The antenna operates in broad frequency bands from 4 GHz to 6 GHz covering wireless local area network (WLAN) band. The maximum gain of the designed antenna is 6.94dBi at 5.26 GHz frequency band.

Keywords- Coplaner waveguide(CPW)-fed antenna, WLAN, ADS, Radiation Pattern.

I. INTRODUCTION

The demand for wireless communication is ever increasing all over the world. In recent days microstrip fed slot antennas are very popular for modern wireless communication methods because of their low profile, low manufacturing cost, simple feeding and easy-to-integrate. The capability of the antenna mostly depends upon the parameters. The result can be improved by proper design of antenna elements and choosing appropriate array element configuration. The fast development of wireless techniques, particularly the WLAN application, that includes all the frequency bands of 5.8/5.2/2.4 GHz and , have induced more concentration in the area of research in antennas with single band or multiple bands. In both military and commercial applications there have been ever growing demands for antennas. A simple arrangement of a microstrip feeding method has become very famous in WLAN systems . In this article the antenna design with slots has been used to achieve the required WLAN bands. The proposed design is capable of providing maximum bandwidth to cover WLAN operations at the 5.2 GHz frequency . Various slots are shaped in the radiating patch to manage the current flow on the antenna surface. Slot dimensions are varied to improve the various parameters like gain, return loss.

II. ANTENNA DESIGN AND STRUCTURE

The design of the antenna is shown in figure1. It is designed using the substrate material RT_Duroid 6002 with thickness h= 4mm and dielectric constant Єr = 2.93 and one side has conductor and the other side has no metal contact. The electric field of microstrip lines is mainly normal to the substrate material . A microstrip is used for feeding the antenna which contains the width W_f. E-shaped tuning slot is located at the center of the antenna, where the antenna is symmetrical along the center, *x*-axis. The final geometric parameters of the designed antenna are given as: length of microstrip $L_f = 17.8$ mm, width of rectangular patch $W_f = 3$ mm.

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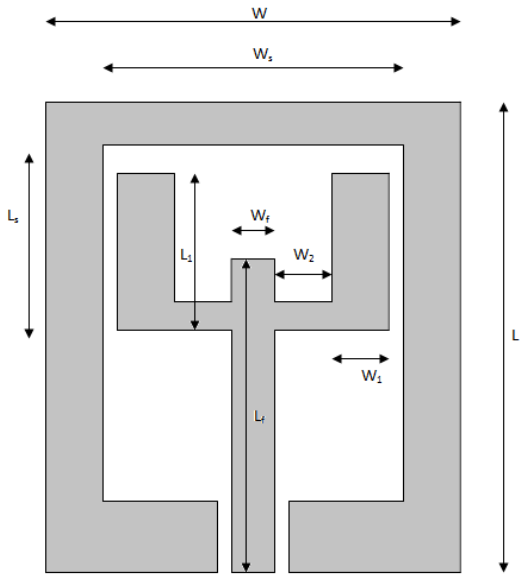

Fig 1 . Geometry of the slot Antenna

TABLE 1. THE DESIGNED VALUES SIZE OF SLOT ANTENNA

Parameter	Value	Parameter	Value
L	25mm	L_1	8mm
W	21mm	L_2	6mm
w_f	3mm	W_1	4.5mm
L_f	1mm	W_2	2.5mm
L_s	1.1mm	W_s	13.2mm

III. RESULTS AND DISCUSSION

The simulation of the design is carried out by the method of moment's technique (ADS software). The radiation pattern of the microstrip antenna is shown in Fig.2. Fig.3 gives the simulated return loss of the microstrip antenna which is -21.93db at 5.2GHz . The radiated power of the proposed antenna is shown in fig5. The simulated gain and directivity of this microstrip antenna is shown in Fig.6 &Fig.7 which clearly indicates that maximum gain is 6.94dBi. Fig.8 shows effective area of the microstrip antenna. The gain, return loss, directivity, and efficiency of different antenna configurations are shown in table 2. A parametric study is conducted and it c learly shows that the following parameters have made changes on the performance of the designed antenna in terms of bandwidth. The slot length is varied and the simulations were done for the various values of slot length.

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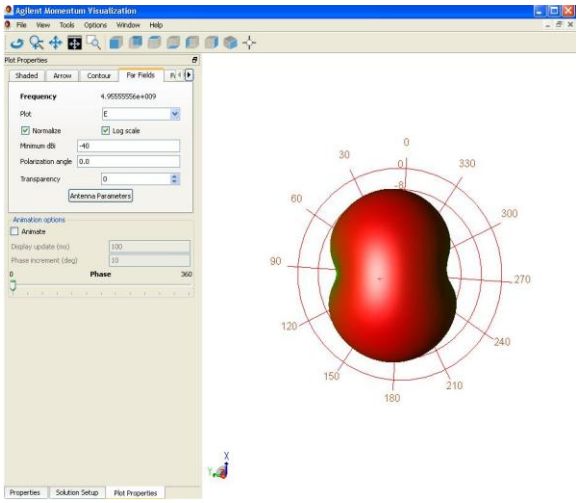

Fig 2 Radiation pattern of slot antenna

The Radiation Pattern shows the antenna radiates more power in a certain direction than another direction.

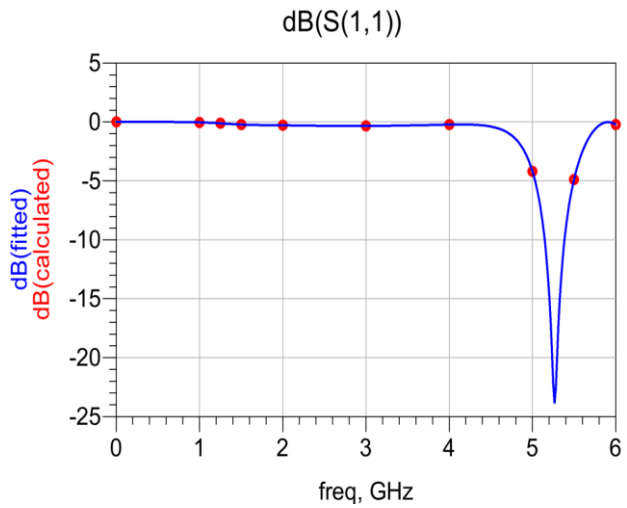

Fig 3 Simulated return loss of the designed antenna

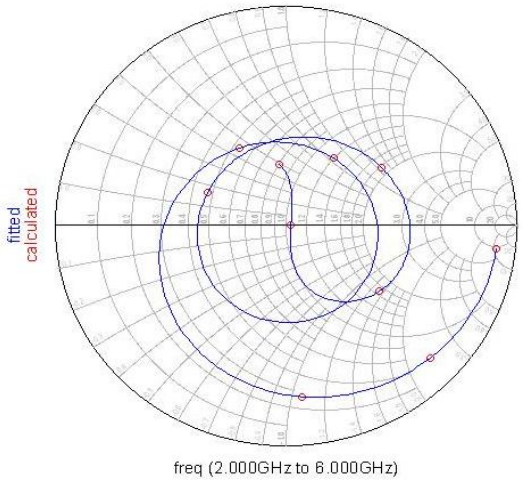

Fig 4 Smith chart for Designed Antenna

The return loss for the designed microstrip feed slot antenna is -23.9db which is obtained at 5.26GHz. Figure 3 shows that the antenna is tuned at 5.26 GHz frequency. Figure 4 shows smith chart of designed antenna which is a representation of all possible complex impedances with respect to coordinates defined by complex reflection coefficient. The voltage standing wave ratio(VSWR) for the designed antenna is 3 and reflection coefficient is 0.5.

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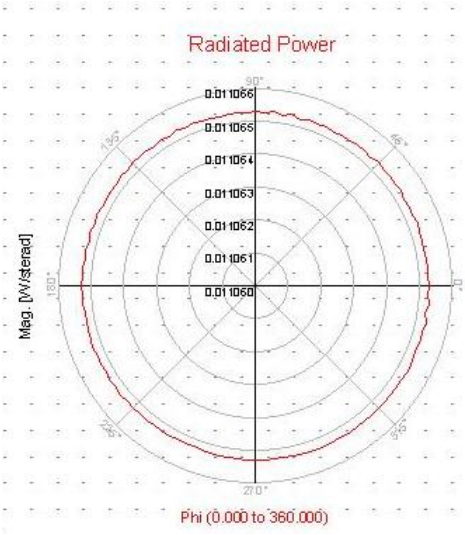

Fig 5 Radiated power of the slot antenna

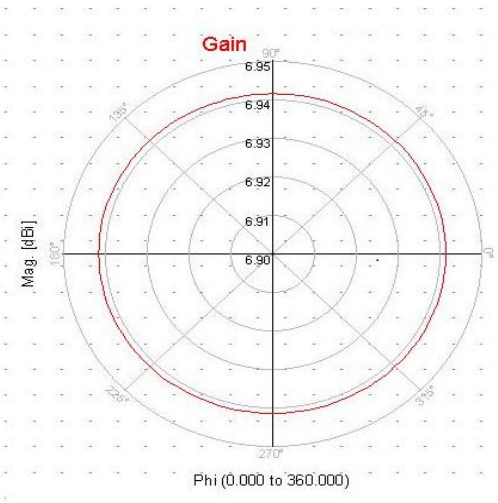

Fig 6 Simulated gain of the designed antenna

The above graph 5 shows the radiated power of the antenna which is the measure of how much power is radiated by an antenna when the antenna is connected to an actual radio (or transmitter). Here radiated power is obtained as 0.011064 watts.

Antenna gain is defined as the ratio of the power produced by the antenna from a far-field source on the antenna's beam axis to the power produced by a hypothetical lossless isotropic antenna, which is equally sensitive to signals from all directions. Hence we obtain the gain as 6.94dBi which is shown in figure 6.

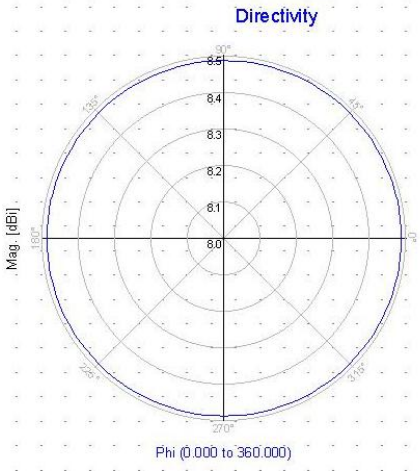

Fig 7 Simulated directivity of the designed antenna

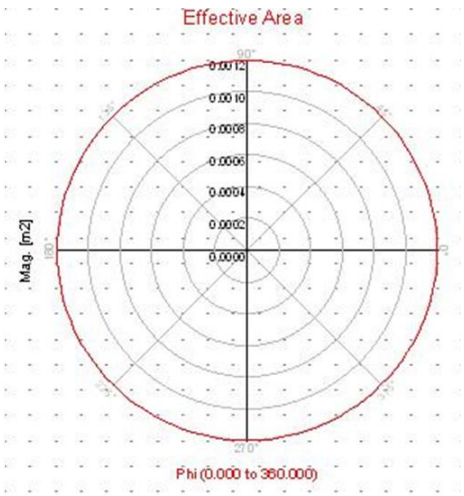

Fig.8 Effective Area of Designed Antenna

The directivity of the antenna is the maximum gain of the antenna compared with its gain averaged in all direction. The directivity obtained for the designed antenna is 8.5dBi, Which is shown in Figure 7.

Figure 8 shows the effective area of the antenna which can be defined as functionally equivalent area from which an antenna directed toward the source of the received signal gathers or absorbs the energy of an incident electromagnetic wave. Here we we obtain the effective area as 0.00012 $m^{2.}$

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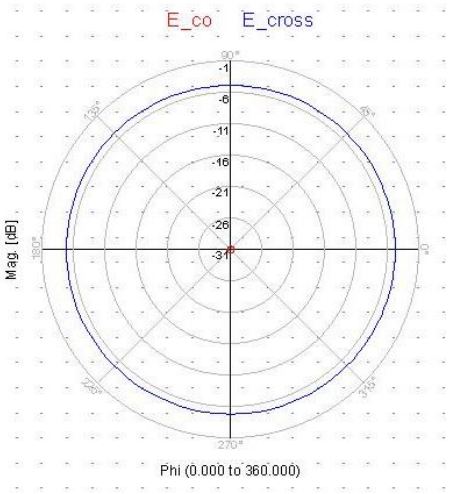

Fig 9 Linearly Polarized Electric field pattern of designed antenna

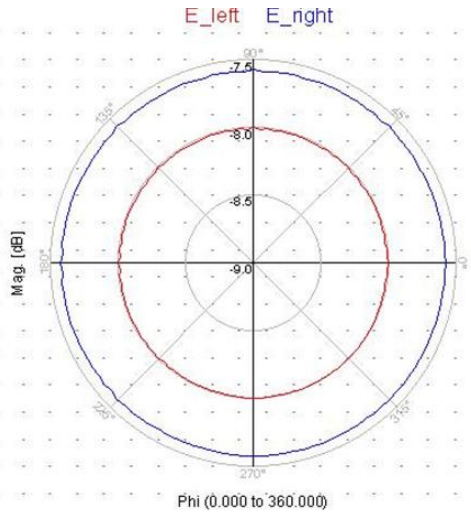

Fig 10 Circularly Polarized pattern of designed antenna

The linear polarization of the antenna which is the radiates wholly in one plane containing the direction of propagation is shown in figure 9.

The above figure 10 shows the circular polarization of the antenna which can be defined as the polarization in which the electric field of the passing wave does not change strength but only changes direction in a rotary type manner.

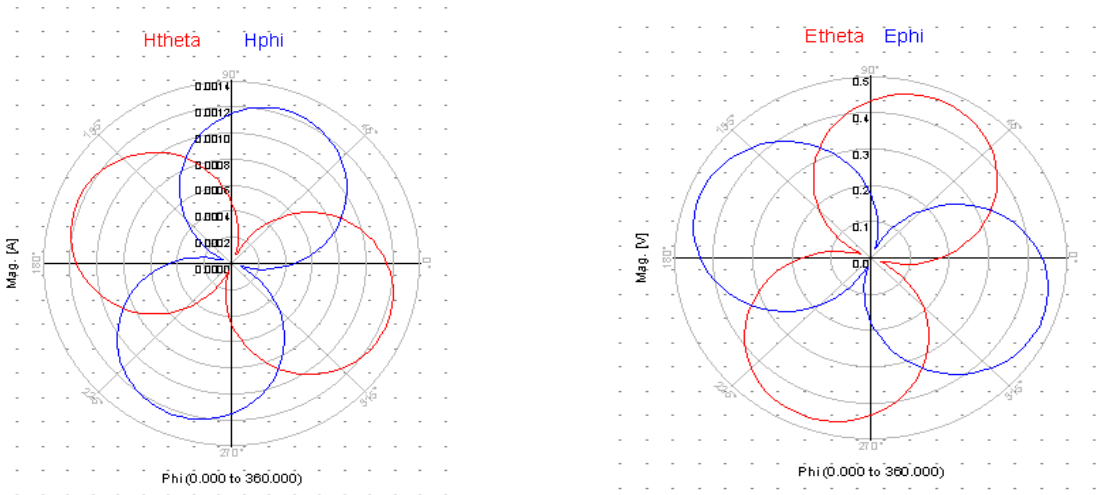

Fig .11 Absolute field pattern of slot antenna

The above graph shows the absolute fields of the antenna .Theta is the swept parameter of the planer cut and phi is the swept parameter of the conical cut. E Theta and E phi are the absolute E field strength of theta and phi far field components. H Theta and H phi are the absolute H field strength of theta and phi far field components.

TABLE 2. SIMULATED RESULTS OF SLOT ANTENNA IN DIFFERENT CONFIGURATION

Antenna parameters	Value
Radiated power (watts)	0.011064
Effective angle (sterdians)	1.4995
Gain (dBi)	6.94
Directivity(dBi)	8.5
Maximum intensity (watts/sterdian)	0.0131761
Angle of U Max (theta,pi)	15,51
E (theta) max (mag,phase)	2.608 , 122.978
E (phi) max (mag,phase)	1.7757 , 114.745
E (X) max (mag,phase)	029307 , 165.377
E (Y) max (mag,phase)	3.06398 , 119.984
E (Z) max (mag,phase)	0.67365 , 57.0016

IV. CONCLUSION

An optimal Microstrip feed slot antenna with an extended rectangular shape is designed. The required frequency band for the designed antenna is obtained by using a coplaner waveguide feed structure. S parameter calculation has been performed for the designed antenna.It is clear that the designed antenna has been radiated in the prescribed range of frequency defined for Wireless Local Area Network (WLAN) Applications. The antenna has small size and easy to integrate with in microwave ICs, resulting in reduction of required volume and fabrication cost of the whole system. The simulated result shows a broad impedance bandwidth ranging from 4GHz to 6 GHz, with respect to the tuning frequency at 5.26GHz. Further the antenna parameters such as gain, directivity, effective area, absolute fields, axial ratio, linear polarization and circular polarization of the designed antenna is plotted and analyzed. The stable radiation patterns and good antenna gain over the operating bands has been obtained.

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