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A Planar Monopole Antenna for Dual band Application

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Abstract— This paper describes the design of a small dual band planar antenna to operate in the ISM (2.4-2.48 GHz) and WLAN (5-6 GHz) band. Dual band operation is achieved by choosing proper microstrip radiator shape and reduced ground plane which becomes a monopole antenna. Simulation of the antenna is carried out using CST Microwave Studio. The simulated results in terms of return loss and radiation patterns are studied. The designed antenna can be suitable for the ISM band (2.4–2.48 GHz) and WLAN (5-6 GHz) band.

Index Terms— Ground plane effect, slot, monopole antenna, dual band, current distribution**.**

1 Introduction

The planar antennas are very easy to manufacture, low-cost, and can be easily integrated within the printed circuit boards (PCBs) of notebook computers, mobile terminals, and other wireless networking equipment. The planar monopole antenna [1]–[4] has attracted the most attention since it can be integrated with other devices in the system. The ground-plane effects on planar monopole antennas are an important issue and have been investigated by some researchers in the past [5]–[8]. It was shown that the ground plane has significant effects on antenna properties, such as impedance bandwidth, radiation pattern etc. This is due to the fact that the ground plane may introduce extra resonant modes and change the current distribution on the antenna structure, hence to distort its performance. In this design a method of cutting slots on the ground plane is introduced to reduce ground-plane effects on antennas. Here a big rectangular slot is cut from the top edge of the ground plane to confine the current distribution on the ground around the radiator so as to reduce the effects from other part of the ground plane. This method has advantages of being general and easy to implement.

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2 Antenna Structure Design

Fig. 1 shows the structure of monopole antenna investigated in this letter. This antenna is built using a standard FR4 substrate (dielectric constant=4.5) with a thickness of 1.6 mm. The antenna consists of a C shaped radiator connected to a 50 ohm microstrip feed line of width 3 mm. The antenna has a size of 40 mm x 20 mm and a portion of ground material is removed which makes it monopole antenna with a ground plane of a size 32 mm x 15 mm. The antenna can resonates at dual band with a reflection coefficient below -10 dB. The reduced ground plane makes the antenna structure compact and so it can be easily integrated with the packaging device. For the radiator microstrip line of width 3 mm is used.

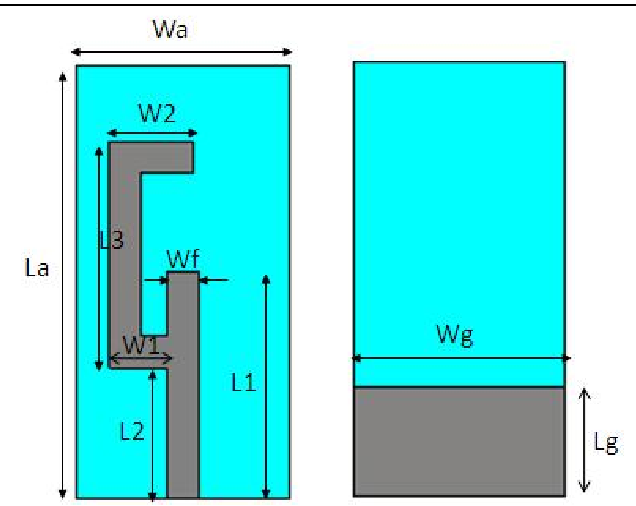


Fig.1. Antenna geometrical configuration

TABLE 1:- DIMENSION OF ANTENNA PARAMETERS

Wa	20 mm
Wg	20 mm
La	40 mm
Lg	10 mm
L1	21 mm
L2	12 mm
L3	21 mm
W1	5.5 mm
W2	8 mm
Wf	3 mm

3 SIMULATION RESULTS

3.1 Return Loss

The antenna is simulated with reducing the ground plane and varying the radiator length. Position of slot on ground plane and radiator dimension adjusted accordingly in order to achieve proper impedance bandwidth with dual band characteristics. Here the ground plane effect in terms of return loss plot is studied. The ground plane is reduced from 40 mm to 10 mm and simulated. Finally the dual band is achieved from the geometry given in Fig. 1.

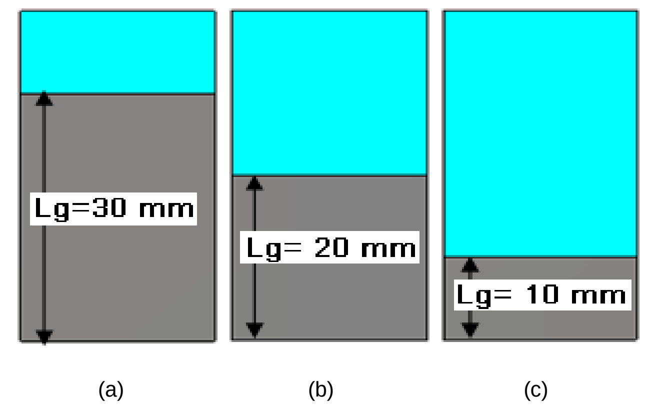


Fig.2. Antenna geometrical configuration

The simulated results in terms of return loss plots for the structures shown in fig.2 with reducing ground plane are shown in fig.3.

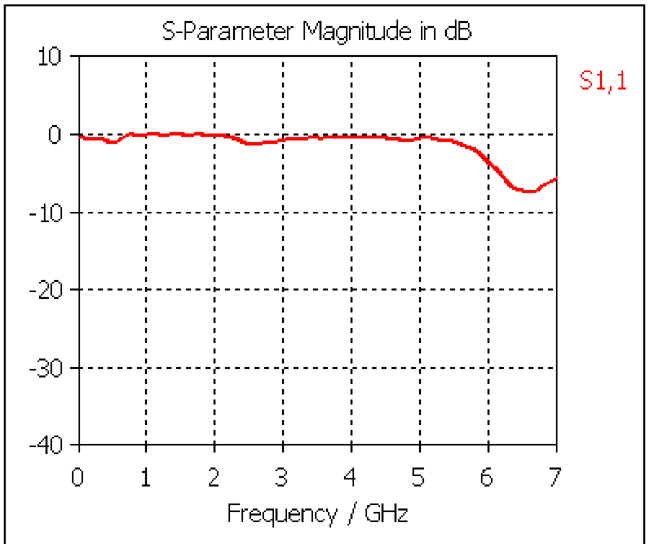


Fig 3.a. Simulated return loss Plot with Lg=30 mm

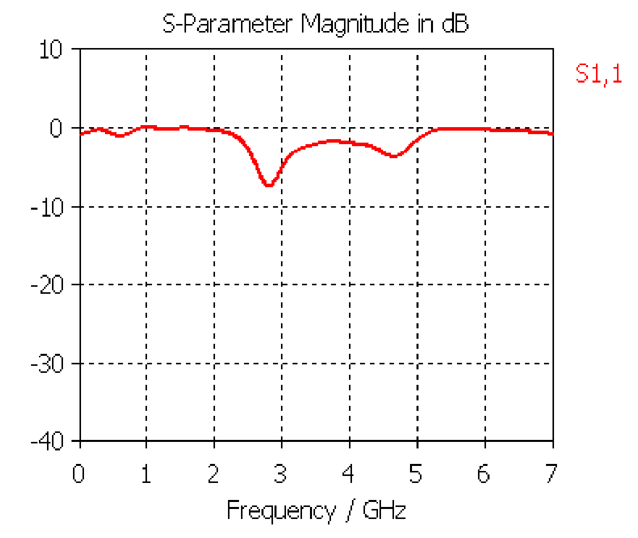


Fig 3.b. Simulated return loss Plot with Lg=20 mm

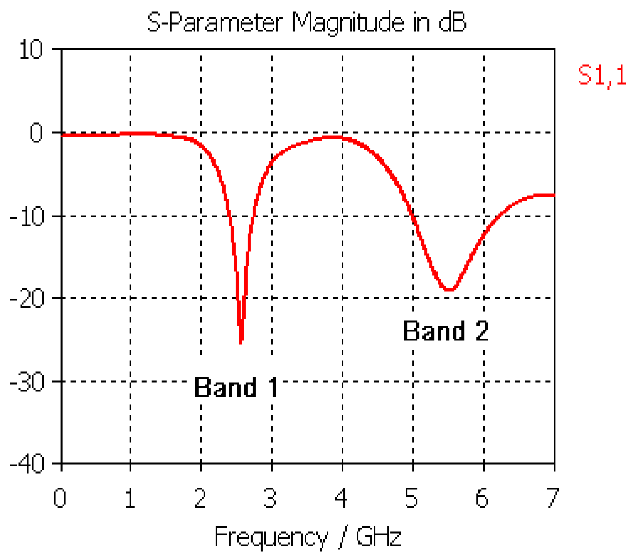
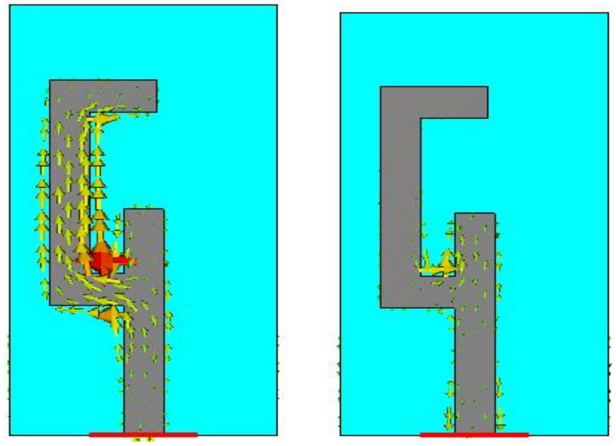


Fig 3.c. Simulated return loss Plot with Lg=10 mm

From the simulation results in terms of return loss plot it is observed from fig. 3.c that the ground plane reducing is effective to meet the dual band operation of antenna at frequencies 2.56 GHz & 5.5 GHz. The simulation result indicates a response at 2.56 GHz with return loss = - 25.45 dB and 5.5 GHz with return loss = -19.10 dB. The bandwidth of the designed antenna is 2.396-2.734 GHz and 4.98-6.22 GHz respectively.

3.2 Current Distribution

The current distribution shows the physical behavior of the antenna. In simulation, antennas with different ground-plane widths, with and without slots, are investigated at various frequencies. The surface current distributions at 2.56 GHz and 5.5 GHz are studied which are given in Fig. 4 (a, b).



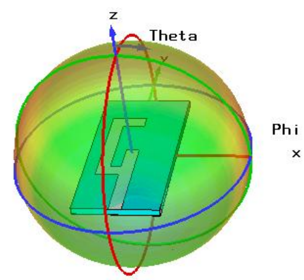
(a) 2.56 GHz (b) 5.5 GHz

Fig.4. Surface current distribution at 2.56 GHz and 5.5 GHz

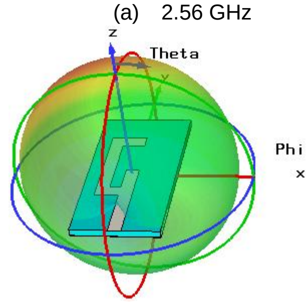
It is observed from Fig.4 that the surface current distribution is more towards the C shaped radiator which is responsible for the lower resonant mode (2.396-2.734 GHz) and the simple feed line is for the higher frequency (4.98-6.22 GHz).

3.3 Radiation Patterns

The far field radiation patterns in terms of 3D and polar plot for the proposed antenna are shown in Fig. 5 and 6 at frequencies 2.56 GHz and 5.5 GHz respectively.

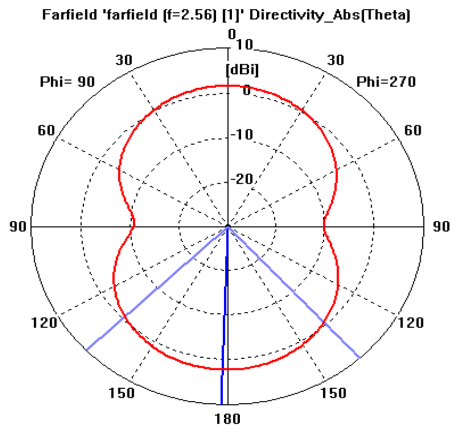


(a) 2.56 GHz

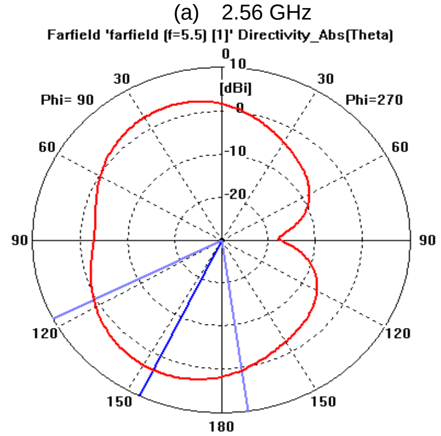


(b) 5.5 GHz

Fig.5. 3D Radiation patterns at 2.56 and 5.5 GHz



(a) 2.56 GHz



(b) 5.5 GHz

Fig.6. Radiation pattern polar plots at 2.56 and 5.5 GHz

4. Conclusion

The C-shaped radiator shape and ground plane reducing effects are investigated to achieve dual band operation. The antenna resonates at 2.56 GHz and 5.5 GHz with good impedance bandwidth. The designed antenna is compact in structure and can be suitable for the dual band application in the ISM band (2.4-2.48 GHz) and WLAN band (5-6 GHz).

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