International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Design of Dual Band Monopole Antenna Using Defected Ground Structure

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Abstract: ***A novel dual band monopole antenna using defected ground structure is proposed. DGS is used to increase bandwidth, the designed antenna operate at the frequency range 1.92- 3.04 GHz, 4.6 -5.8 GHz which suitable for WLAN and WiMAX application. The proposed antenna has a small size and can be easily fed by 50 ohm microstrip line. The designed proposed geometry is simulated by using HFSS software. The simulation result shows that the antenna gives the monopole like radiation pattern and it achieves return loss -20.3 and -19 dB at 2.4 and 5.3 GHz frequency respectively with FR4 substrate. The result gives the satisfactory performance.***

Keywords: Monopole antenna, WLAN, WiMAX, Microstrip line feed, Return loss

1. Introduction

With the rapid development of wireless communication, the demand for the design of an antenna with multiband operation has increased. For this demand, the planar monopole antenna has become a candidate because of its attractive characteristics, such as low profile, simple structure, compact size, and easy integration with circuit. Also, the planar monopole antenna is capable of integrating both wireless local area network (WLAN) and worldwide interoperability for microwave access (WiMAX) into one single system. Currently, numerous printed multiband monopole antennas have been proposed by employing various promising feed structures such as the microstrip [1-5] and the coplanar waveguide (CPW) [6-10]. In these proposed monopole antennas, a large solid ground plane having the shape of a square, rectangle, circle, or ellipse is usually adopted. Different from these antennas, a novel ground structure named DGS has recently been investigated and found to be a simple and effective method to reduce the antenna size as well as excite additional resonance modes [11-15].

In this paper, a novel Dual-band monopole antenna with defected ground structure is proposed. The antenna consists of a radiating element with a pair of inverted L-shaped protruding strips, and the ground modified by loading it with a I-shaped strip. By properly selecting the dimensions of the proposed antenna, it can provide two resonance mode at 2.4 and 5.3 GHz for the operating frequency band 1.92-3.04 GHz, 4.6-5.8 GHz respectively. The antenna is simulated using HFSS software. The simulated results give the satisfactory performance.

2. Antenna Design

The proposed dual-band antenna with DGS is shown in Figure. It is designed on a 1.6mm thick FR-4 substrate with relative permittivity of 4.4, and the overall dimensions are only 26x30 mm2. The radiating patch of the antenna, which is printed on the top of the substrate, consists of a rectangular patch with dimensions of l6 x h3 and dual inverted L-shaped strips located two sides of rectangular patch. Each of the inverted L-shaped strips comprises both the vertical and horizontal strips with dimensions of l1 x h1.The antenna is fed by a 50- microstrip feed line with dimensions of l7 xh4. In regard to the defected ground plane, it consists of I shape with dimension of l3 x h5. For design of rectangular microstrip patch antenna there is need of three parameter such as Resonant frequency, Dielectric constant and Height of substrate.

2.1 The width of the MPA is given as:-

$$W = \frac{c}{2 f_0 \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

2.2 Effective dielectric constant is given as:-

$$\varepsilon_{re} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$$

2.3 The effective length is given as:-

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{re}}}$$

2.4 Length Extension (ΔL) is given as:-

$$\Delta L = 0.412h\frac{\left(\varepsilon_{re} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{re} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

2.5 The actual length is given as:-

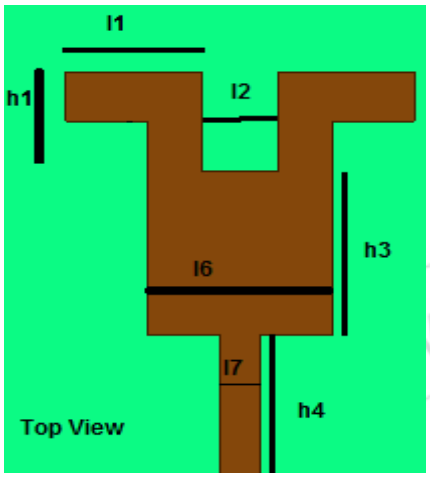
$$Leff = L + 2\Delta L$$

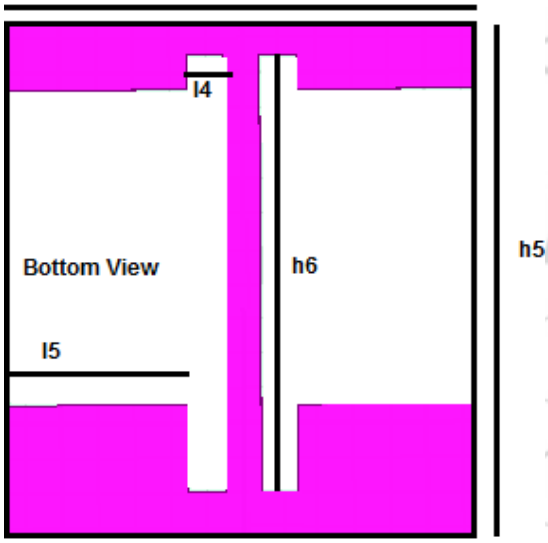
2.6 Calculation of Substrate dimension:-

For this design this substrate dimension would be
Ls=L+2*6h
Ws=W+2*6h

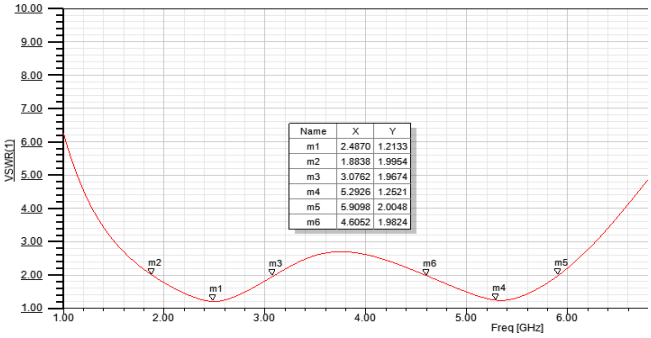
From the calculation dimensions are l1-7, l2-4, l3-26, l4-2, l5-10, h1-6, h3-10, h4-9.6, h5-30, h6-25 in mm.

3. Geometry of Proposed Antenna

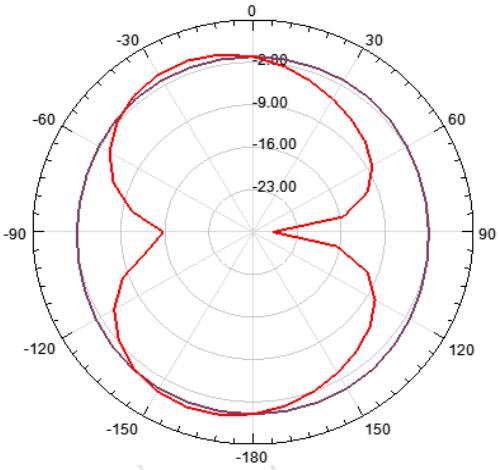




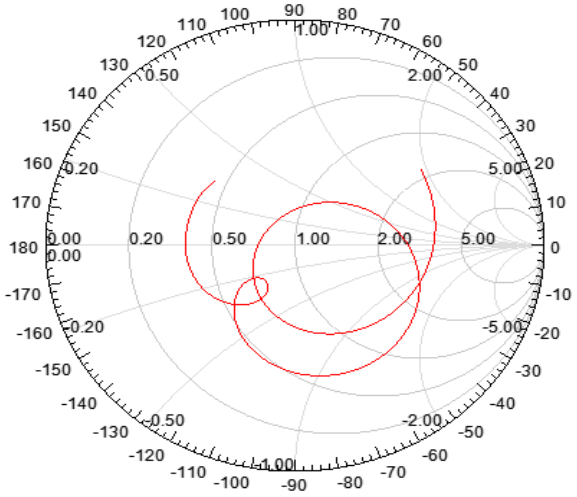
Geometry of proposed antenna



VSWR

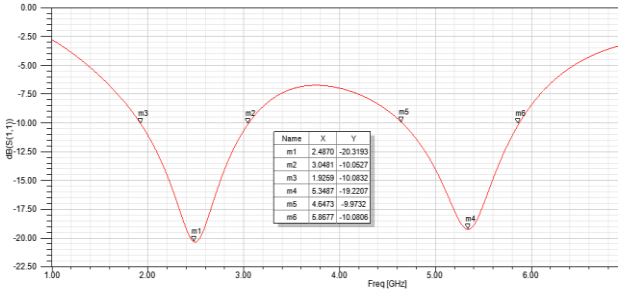


Radiation Pattern

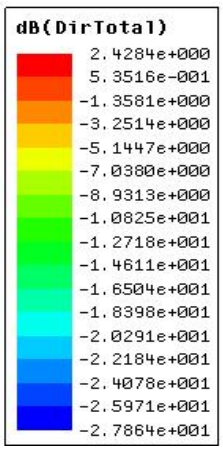


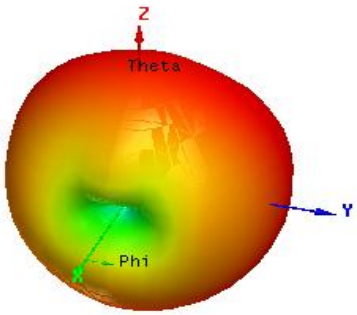
Smith Chart

4. Simulation Results

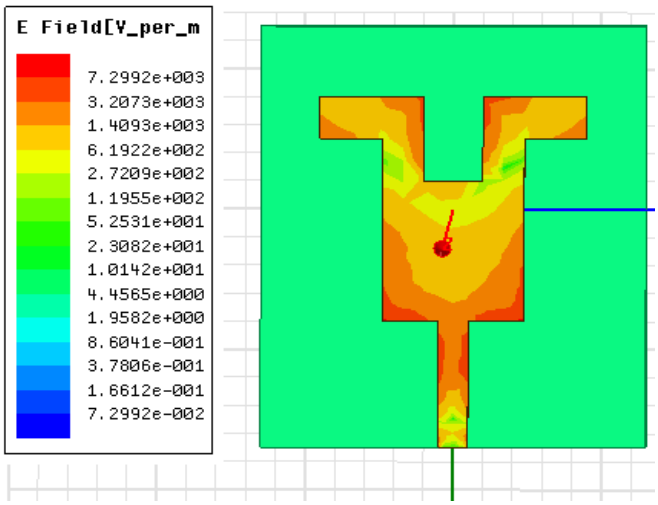


Return Loss





3D Polar plot



Current Distribution

5. Conclusion

A dual band microstrip fed monopole antenna using defected ground structure for WLAN and WiMAX communication system has been designed. The simulation result obtained by HFSS software shows good results. It is shows that the proposed antenna covers band 1.92 to 3.04 GHz and 4.6 to 5.8 GHz, and resonant at 2.4 GHz 5.3 with -20.3 dB and -19 dB return loss which is suitable for WLAN and WiMAX application.

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