Microstrip Patch Antenna with Defected Ground Structure & Offset Feed in the field of Communication

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Abstract—In order to improve return loss, compactness and efficiency of antenna defected ground structure has been used. The performance of antenna is characterized by the shape, dimension and location of defected structure at specific position of ground. This paper presents defected ground structure (DGS) implemented with rectangular strip in the ground plane. The design with DGS has been analyzed taking different dimensions of rectangular slot and achieve optimized dimensions with the help of HFSS (High Frequency structural simulator).

Index Terms—Microstrip patch Antenna (MSPA), Defected Ground Structure (DGS).

I. INTRODUCTION

Microstrip patch antenna [1] has been studied extensively over the past years because of its low profile, light weight, low cost and easy fabrication. They are extremely compatible for embedded antennas in handheld portable wireless devices such as cellular phones, pagers etc[6]. These low profile antennas are also useful in aircraft, satellite and missile application, where size, weight, cost, ease of installation and aerodynamic profile are strict constraint. But microstrip patch antenna suffers from drawbacks like narrow bandwidth and low gain. While using microstrip patch antenna the other problems which will occurs are high loss and surface wave in substrate layer, as the losses will always occurs in radiation as the antenna is transmitting the signal[4]. For some applications in wireless communications, it is quite desirable to design a patch antenna covering two or three frequency bands which are close to each other [3]. Wireless applications such a radar, telemetry and communication system require high gain, high efficiency, low profile, light weight and low cost along with the research in miniaturization of system devices being undertaken [5]. It is very difficult to get all such requirement in a single antenna. The high conductor loss reduces the gain and efficiency [8]. There are many approaches that can be implemented in order to enhance the Bandwidth of the microstrip patch antenna [2]. An individual microstrip patch antenna has a typical gain of about 6 dB. Several approaches have been used to enhance the bandwidth by perturbing the higher order mode by interpolating surface modification into patch geometry. The most unique technique to reduce the size of patch is to defect the ground. While comparing the antenna with the defected ground structure and the antenna without the defected ground, the antenna having defected ground structure reduces the size of antenna [4]. The percentage of reduction of size depends upon the ground area that is defected. Defected Ground Structure disturbs the shielded current distribution that depends on the dimension and shape of the defect. The current flow and the input impedance of antenna are then influenced by the disturbance at shielded current distribution due to the DGS structure. The DGS structure can also use to control the excitation and the electromagnetic waves propagating through the substrate layer [5].

Except of this, the conductor loss can be reduced by constructing the feed network using low transmission media such as microstrip line offset feed [12]. The advantage of this feeding technique includes significantly low attenuation and easy fabrication. In the edge feeding method, a conducting strip is connected directly to the edge of the radiating patch. This may be further considered as centre fed or offset fed according to the position where it is connected to patch antenna[11].

An efficient performance of the antenna requires a proper feeding structure, which here employs feed line on back side of ground [7]. One merit of this configuration is a good isolation between the incident radiation and the feeding circuits [5]. The width of feeding microstrip is W, corresponding to characteristic impedance of 50 Ω. Coupling between the microstrip and the slot is achieved with microwave open stub [9]. This paper introduces contacting feed method using off set microstrip feed line in which microstrip feeding line is slightly offset from the middle [10]. Results shows multiband operated microstrip patch antenna with VSWR<1.

II. ANTENNA CONFIGURATION

ANTENNA GEOMETRY

The proposed antenna structure consists of a cross-shaped microstrip feed line and multiple open slots in the ground surface. By properly selecting dimensions of slots various bands can be obtained. Initially no slots are cut on the ground and results are observed. Further by introducing slots on the ground, effects on bands are observed. A compact microstrip-fed slot antenna with multi band operation is presented for wireless communication system. Substrate used is FR4 with the relative dielectric constant of 4.4. Thickness of antenna is 1.6mm. The overall dimension of the proposed antenna is 34X14X1.6 mm3. Slots are cut on ground to introduce more bands. On the other hand, the slots are...
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Electromagnetically fed by a microstrip feed line on the other side of board. The modified feed line is shown further, which is protruded with stub of width W.

**A) Design I**

Fig. 1 shows the configuration of the proposed offset fed microstrip patch antenna. It consists of an L-shaped radiator with offset position and a ground with no slots. The first step of designing is to determine the size and dimensions of patch. The antenna is fabricated on a low cost FR-4 substrate with thickness of 1.6 mm, a relative permittivity of 4.4 and a total size of W X L. The radiated microstrip line has size W_p X L_p. The width of microstrip line is fixed at w_m to achieve 50 Ω characteristics.

![Fig. 1. Patch Antenna initial geometry](image1)

**Simulated Results**

The calculated result shows that the return loss reaches a minimum value of about 53 dB at 0.7 GHz of the offset fed slot antenna. The design gives bandwidth of 570% and 21%. The antenna is resonant at frequency 0.72, 3.5 & 6.5 GHz with dual band operation. This antenna proposes a microstrip line patch antenna for WIMAX, FWA & DBS applications.

![Fig. 2. Return Loss Calculation](image2)

**B) Design II**

Further to improve results, slots are cut in the ground plate. These slots in ground plate improves the result obtained.

![Fig. 6. Triple slots in ground plane](image3)

**Simulated Results**

Simulated results show bandwidth of 205, 57 & 23%. This band is resonated at 0.8, 3.7 & 6.5 GHz.

![Fig. 7. Return Loss Calculation](image4)

![Fig. 3. Radiation Pattern](image5)

![Fig. 4. 3D Radiation Pattern](image6)

![Fig. 5.](image7)

![Fig. 8. Radiation Pattern](image8)
Simulated results give bandwidth of 347%, 50% & 24% respectively, which is better than results of previous design. Antenna is resonated at frequencies 0.4, 3.8 GHz and 6.7 GHz. This antenna is suitable for applications in S and C bands. Also this antenna configuration is well suited for WIMAX application.

III. CONCLUSION

It is shown that in cases where the bandwidth of printed planar antenna is limited because of restricted ground plane size, the feed line asymmetry can significantly increase the bandwidth. For small size ground planes, the antenna bandwidth is unattractive unless feed-line asymmetry is used. The resultant antenna can achieve wide impedance bandwidth with multibands. Also the VSWR for each geometry results ≤1 for the resonated frequencies. These types of antennas are suitable to applications such as TV broadcasting, WIMAX, Mobile Phones, Wireless LAN, Bluetooth, GPS, Broadband Wireless, FWA, RF Powered System and various other applications.[5]

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REFERENCES


