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Comparative Analysis of Stack Shaped Microstrip Patch Antenna

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ABSTRACT

A compact stack antenna consisting of square patch, loop couplers and inset feed line is simulated in this paper. The proposed antenna have a stacked patch antenna with an arrangement of two substrates separated by an air gape, A coupling is provided using square loop structure. The simulation results obtained with stacked structure are discussed and comparative analysis of these parameters with reference antenna is done in this paper. Simulation results obtained for return loss, polar radiation and pattern voltage standing wave ratio (VSWR) shows its suitability for ultra wide band application.

Keywords

Microstrip antenna, Return loss, Bandwidth, VSWR, Reflection Coefficient, UWB.

1. INTRODUCTION

Since last two decades microsrtip antenna has been employed in various applications due to its significant merits of small size , low profile, light weight and easy integration [1]. To overcome the limitation of narrow bandwidth, many techniques have suggested e.g., microstrip patch antennas, probe fed stacked antenna, on electrically thick substrate, stacked shorted patches and slotted patch antenna have been proposed and investigated. In general, the impedance bandwidth of a microstrip patch antenna is proportional to the antenna volume, measured in wavelengths. However, by using two multi layered patches with the walls at the edges between these two patches, one can obtain enhanced impedance band width [1]. A compact stack antenna consisting of square loop resonators, aperture couples and feed line was reported for a dual band operation also the stacked structure was utilized for multiband structure again a stacked structure had been applied to an equilateral triangular microstrip patch antennas to reduce its overall size, the stacked structure is utilized for bandwidth enhancement also [1-6]. There has recently been noticeable interest in the two layer probe fed patch antenna consisting of a driven patch in the bottom and a parasitic patch [7-15]. The proposed antenna consist of a stacked square patch antenna having an arrangement of two substrates separated by an air gape and a coupling is provided using square loop structure.

This Paper consist of four section as follows:

Brief introduction of paper is discussed in Section I. In Section II basic antenna design is discussed; Simulation and Comparative result analysis with respect to reference antenna design is presented in Section III. Section IV conclude the paper.

2. ANTENNA DESIGN

The proposed antenna has a simple square patch using an inset feed; the patch antenna is designed using the basic concepts of the microstrip technology.

2.1 Basic theory

Microstrip patch antennas consist of a metallic patch of metal that is on the top of a grounded dielectric substrate of thickness h, with relative permittivity εr as shown in Fig. 1.

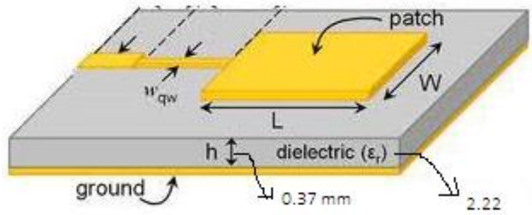

Fig. 1 Geometry of rectangular microstrip patch antenna

The geometry of a Rectangular Microstrip Patch Antenna (RMPA) is shown in Figure 1. The patch of length 'L', width 'W' and thickness 't' is printed on RT- Duroid (ε_r = 2.22) substrate.

2.2 Proposed Geometry

The proposed antenna is composed of a PEC (Perfect Electric Conductor) ground plane, substrate #1 which is RT-Duroid (ε_r = 2.22, h = 0.37 mm) above which a square loop structure is printed with PEC, an air gape is introduced between the first loop and second loop which is printed on the bottom of the substrate # 2 RT-Duroid (ε_r = 2.22, h = 0.37 mm) above this substrate the PEC patch is printed with inset feed line.

Fig. 2 Cross sectional view o the stacked structure patch antenna

The dimensions of the patch are calculated using the standard design equations and optimized to a value of 10 x 10 mm^2 , both the substrates have dimension 25.4 x 25.4 mm^2, length of the inset feed line is optimized to 10.2 mm with a calculated width of 1.2 mm [16]. The coupling loops #1 and #2 are squares of sides 18 mm and 15 mm respectively, the ground plane used here is defective ground structure (DGS) with dimensions 25.4 x 13 mm^2. Partial ground or defective ground structure is used here, in such technique, the ground plane metal of a microstrip (or coplanar, or stripline waveguide) circuit is intentionally modified to enhance performance [17]. The DGS helps in shifting the resonant frequency to get desired frequency , by combining with a defective ground plane, the resonant frequency is lowered and the bandwidth is augmented simultaneously [18-19]. DGS helps in convergence of field in a relatively small region shifting the high frequencies at lower dimensions, and in size reduction.

3. SIMULATION AND RESULTS ANALYSIS

Initial simulations were carried out for the design (Fig. 3) with the proposed geometry.

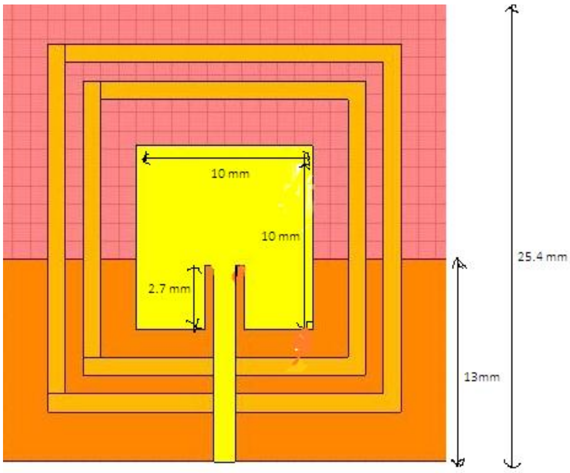

Fig. 3 Top view of the stacked structure patch antenna

The initial simulation results of Return loss (S_{11} in dB) is shown in Fig. 4, From the result obtained it can be seen that there are two frequency bands on the UWB range for which the S11 is less than -10 dB. So the frequencies obtained in this case are at 3.8GHz (1.84%) and 9.4(2.23%) GHz respectively. Above results are appropriate for the purpose of design, while the stack antenna presented in reference design have the frequency bands of 2.46 GHz with bandwidth (BW) 160MHz (6.58%) and 5.28 GHz with BW 450MHz (8.52%) [1].

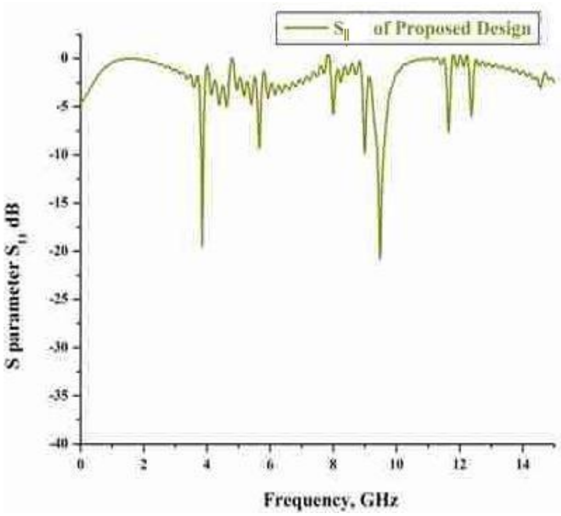

Fig. 4 S11 parameter of the proposed design

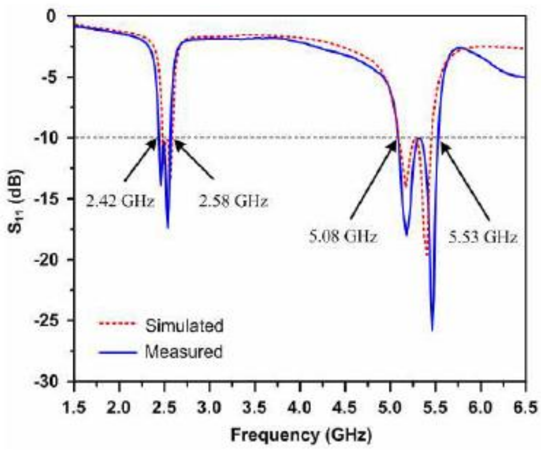

Fig. 5 S_{11} parameter of the reference paper design [1]

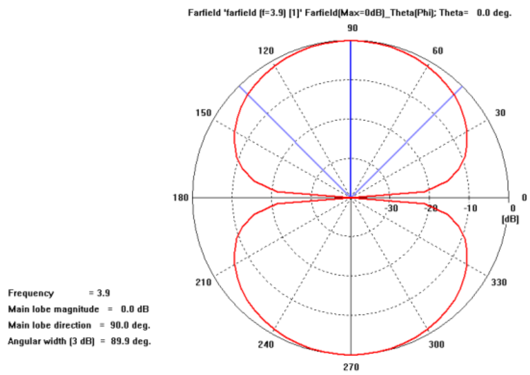

Fig. 6 Far Field E- Field of proposed antenna at 3.9GHz

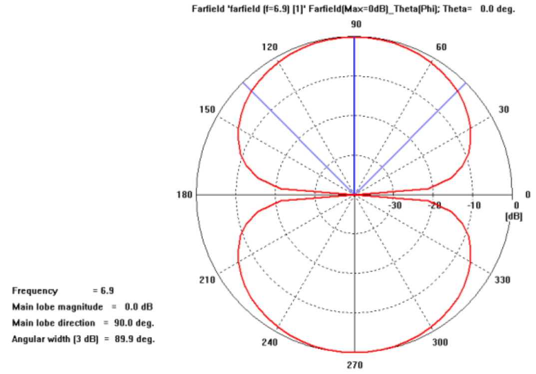

Fig. 7 Far Field E- Field of proposed antenna at 6.9 GHz

The respective radiation patterns for the central frequencies of the two bands i.e. at 3.8 GHz and 9.4 GHz are shown in Fig. 6 and Fig. 7 and it can be observed from the radiation patterns that the far-field pattern is invariant of the frequency.

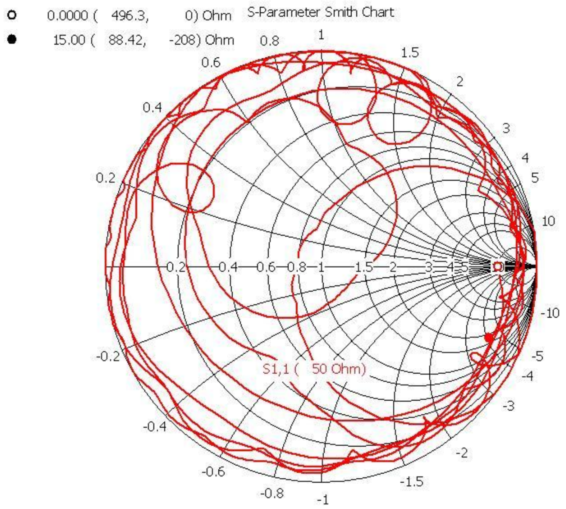

Fig. 8 Smith chart of Impedance matching of proposed antenna

The smith chart of input impedance for the proposed antenna is in Fig.8, the input impedance comes out from smith chart is 50 ohms.

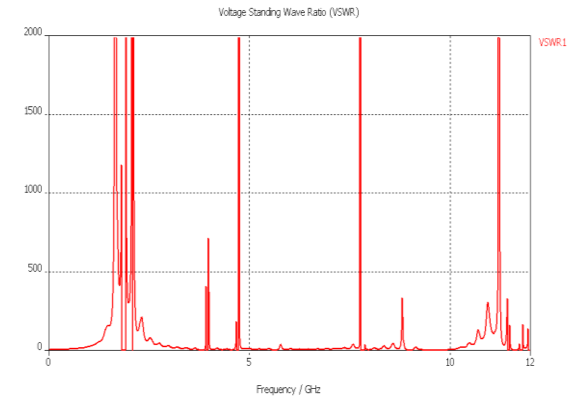

Fig. 9 VSWR graph of proposed design

The VSWR graph for the proposed antenna is presented in Fig 9 .The VSWR describes matching of impedances between antenna and free space or transmission line. It may be observed that VSWR is minimum on two frequencies 3.8 GHz and 9.4 GHz.

4. CONCLUSION

It can be concluded from the result obtained that antenna is appropriate for UWB applications and is can be used for the enhancement of bandwidth.

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