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Design of Microstrip Single-Patch S-Shaped Antenna for ISM Band

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***Abstract* – Designing efficient micro strip patch antennas attains much significance because it got endless applications, due to their minimum weight, compact size, and easy for manufacturing. The current research work focuses on the existing drawback of narrow bandwidth of micro strip antenna. The proposed design is a single-patch broadband micro strip S-shaped patch antenna for ISM band. Micro strip S-shaped patch antenna, fed by a coaxial feeding. The antenna is designed by inserting two slots into square patch then it look like English letter S. Because of the slots and thick substrate, bandwidth of antenna can be confined. The proposed antenna is operating at center frequency of 2.45GHz (in ISM band range) It gives bandwidth 2.269 GHz to 2.69 GHz. the antenna is best suitable for S-band, and applicable for Digital Audio Radio services (DARS). Simulation results are obtained with the electronic design automation software** Advanced Design System **(ADS). The simulated result of the antenna is as best as proposed center frequency of 2.45 GHz for which the VSWR is and return loss S_{11}. Practically applicable in Weather radar, surface ship radar, and some communications satellites, especially those of NASA for communication with ISS and Space Shuttle.**

Keywords: Micro strip, patch antenna, ISM band, ADS, VSWR, microwave, return loss.

I. INTRODUCTION

In the world of communication systems, wireless technology is one of the vast areas of research and a study of communication systems is incomplete without an understanding of the operation and fabrication of antennas. Microstrip antennas are an extension of microstrip circuits. This feature has given rise to microstrip integrated active antennas in which circuit functions are integrated with the antenna to produce compact transceiver and in spatial power combiners to overcome power limitations of solid state devices. Conventional microstrip patch antennas basically have a conducting patch that is made of copper or gold, printed on a grounded dielectric substrate.

Various feed configurations can be used to transfer energy efficiently from transmission system to antenna. Although there are more commonly used patch shapes especially that can be expressed geometrically like rectangular, circular, triangular, etc. If it has desired specifications, the microstrip patch antennas can be realized at any regular or irregular shapes. A microstrip antenna has driven very extensive applications in recent times .The rapid growth in wireless communication system, antenna development has focused on small wide band antennas which are small in size and also easy to fabricate. This compact small size is a demand factor for several applications as mobile devices. These two requirements have triggered research on the design of compact and single or multiband antennas operation. There are many directional antennas like horn, helical, Yagi -uda with very high gain and bandwidth. But they have 3D complex structure and installation is very difficult. So the patch antenna emerges as an excellent candidate for the new generation of wireless communication. These antennas have planar and non-planar configuration, small size, cost effective, but major disadvantage of these antennas are narrow bandwidth and gain. Christo Ananth et al. [5] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles. To overcome these advantages various techniques like different patch shapes like S, E, W and Z shapes are used. In the present work, 'S' shaped antenna is designed and simulated using ADS software. The analysis and plotting of radiation pattern for measurement of gain is done using software to achieve the operation with frequency 2.45 GHz which is very much useful in ISM band.

II. MATERIAL & METHODS

Dielectric substrate plays an important role in the design of micro strip patch antennas. These are different types of substrate used for the design of antenna. In this paper, the

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dielectric substrate is chosen as FR-4 whose dielectric constant is 4.6. The main advantages of microstrip patch antenna are plannar profile, ease of fabrication, compatibility with PCB and integrated circuit technology. The input impedance of patch antenna should be 150 - 400Ω and the desired impedance is the characteristics impedance 50 Ω

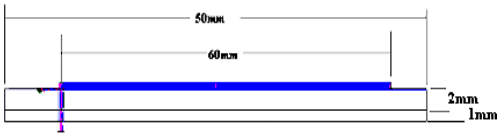
2.1 Microstrip S -Shaped Patch Antenna

The single patch microstrip S-shaped antenna fed by a coaxial feeding is designed using ADS software. This antenna can be used with ISM band for all industrial, scientific and medical applications. The obtained gain and bandwidth is well suited for ISM operation. The antenna designed by this method has low volume and low profile configuration, easily mounted, low fabrication cost and light weight.

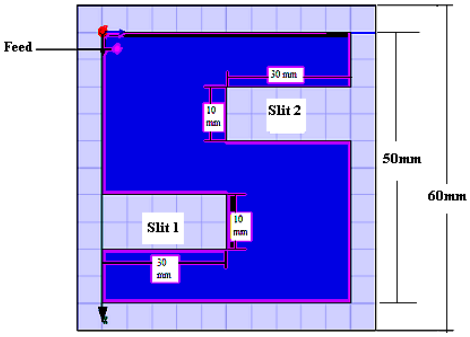
The study of microstrip patch has become popular nowadays. They also can provide dual and circular polarizations, dual frequency operation. To minimize the bandwidth of the antenna, the substrate thickness can be increased with low dielectric constant. Generally the bandwidth and size of the antenna are mutually interrelated (i.e.) if we improve any one character, the other parameter will be normally degraded. Therefore in this paper the micro strip 'S' shaped antenna with thick dielectric substrate having low dielectric constant is used which provides better efficiency.

2.2 Design and Analysis

The micro strip antenna is fabricated on square patch of 50x50 mm^2 FR-4 substrate with the dielectric Constant ε_r =4.6 and loss tangent tanδ =0.002. Fig.1 shows the geometry and configuration of a ISM Band antenna. As shown in the Fig. 1 (b), the shape of the radiating element is rectangular and there is an S-type slot on the radiating element. The patch is fed by a coaxial probe along the side line (x-axis) at minimum distance from the edge of the patch as shown in Fig. 1 (b). Table 1 shows the optimized design parameters obtained for the proposed patch antenna. The electromagnetic software ADS is employed to perform the design and optimization process.



(a) Side view of antenna



(b) Top view of antenna 1

Figure 1a-b. Geometry of the proposed Antenna

2.3 Antenna design formula

The operating frequency fr is known. The width of the patch is calculated using the formula:

$$W = \frac{c}{2f\sqrt{\frac{\varepsilon_r + 1}{2}}}$$

The effective dielectric constant is given by the f

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

To determine the length extension, we use this formula:

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

To determine effective length we use this:

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}}$$

To determine the resonant length of the patch we use this:

$$L = L_{eff} - 2\Delta L$$

2.4 Feeding methods

The feeding techniques used in microstrip antenna are broadly classified into two forms contacting feed and non-contacting feed. In contacting feed method, the patch is

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directly fed with RF power by the connecting elements. On the other hand the patch is indirectly fed by means of electromagnetic coupling. Apart from the mentioned feeds, aperture coupled feed and proximity couple feeds are also called as non-contacting feeds. In this paper microstrip feed is used .The main advantage is perfect impedance matching, no additional circuitry, very simple to analyze and also easy to manufacture. Feeding is very much important because it affects the whole design and reduce efficiency.

III RESULTS AND DISCUSSIONS

The 'S' shaped microstrip antenna was designed and simulated using ADS. The antenna parameters like gain S11 and, VSWR are obtained as -22 dB and 1.253 respectively with required radiation pattern. In order to examine the return loss (S_{11}). Characteristics of proposed antenna, the model based on the design was compared with the simulation results.

Simulated return loss obtained from ADS Software are presented and compared in Fig. 3 and Fig. 4. It can be seen in Fig. 3 that the center frequency band is about .45 GHz and bandwidth of 2.269 GHz to 2.69 GHz. The return loss (S11) is -22 dB, which meets the bandwidth requirement for ISM Band. It is also observed changing size of twos slits cut in rectangular patch for S-Shape as shown in Fig. 1.b. Can provide the best return loss with improvement in bandwidth at higher frequency band can also find multiband operation

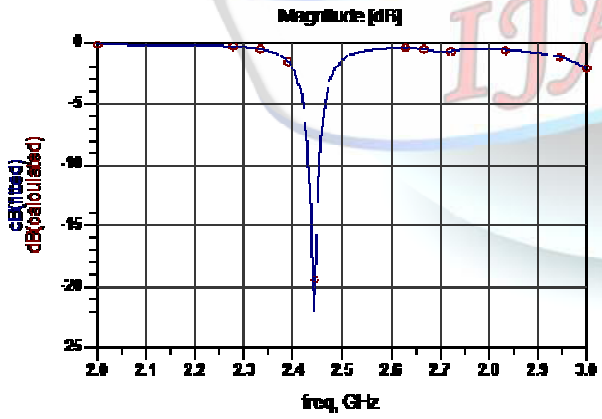


Fig 2.Return loss S_{11}

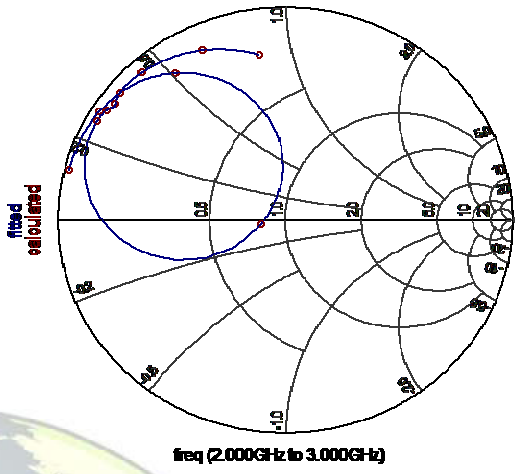
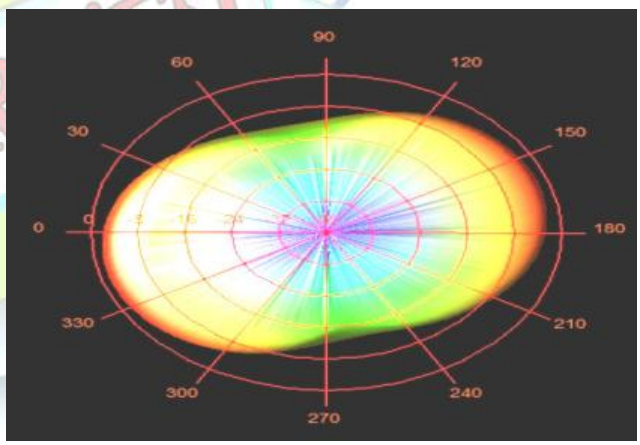


Fig 3.Smith chart for VSWR calculation

Table I VSWR Values

Frequency in GHz	Band	VSWR
2.5 GHz	II	1.253



(a) Bottom view of radiation pattern

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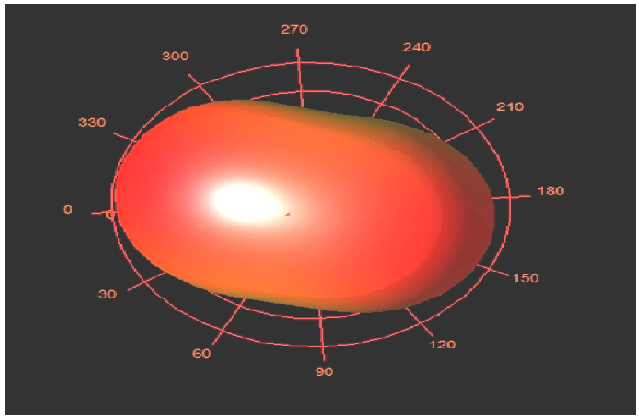
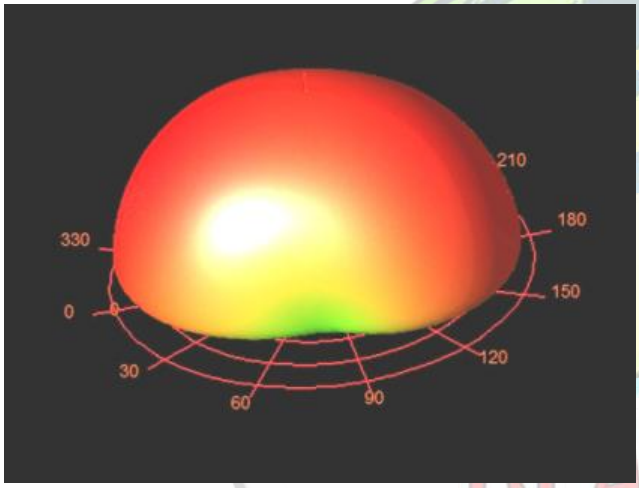


(b)Top view of radiation pattern



(c) Side view of radiation pattern

Fig 4. 3D view of radiation pattern of the patch

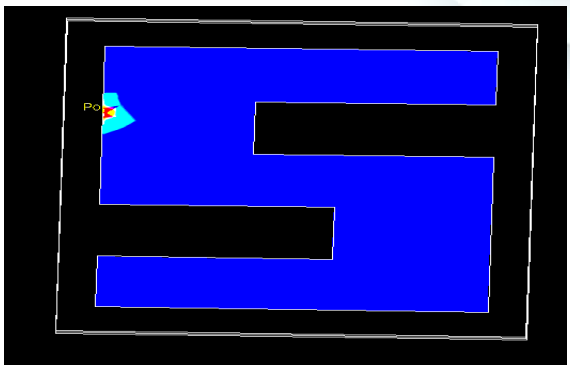


Fig 5. Design of S shaped patch antenna

IV CONCLUSION

The 'S' shaped microstrip antenna is designed analyzed for the efficient functioning in the frequency 2.45 GHz. Further conclusions from the analysis, it is found that the resonances and bandwidth of the antenna depend on the parameters of the slots cut in the patch which results into controllable bandwidth of the antenna, development of 'S' shaped arrays. This can be still continue for further parameter analysis

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