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Broadband Microstrip S-Shaped Patch Antenna For Wireless Communication

Dr. Anirudh kumar
Associate Professor & Head, Dept. of Physics
K.S. College, Laheriasarai, Darbhanga

Abstract

This paper presents a single-patch broadband microstrip S-shaped patch antenna. Microstrip S-shaped patch antenna, fed by a coaxial feeding. The antenna is designed by inserting two slots into rotated square patch then it look like English letter S. Because of the slots and thick substrate, bandwidth of antenna is increased.From the analysis of simulated results it can be seen that the antenna is best suitable for C-band, UWB and applicable for wireless communication. The antenna was designed using IE2D software.

Key words- *Broadband, Microstrip Antenna, Return Loss, S-shape, VSWR.*

Introduction

The microstrip patch antennas have several advantages of being low profile, versatile, conformal and low-cost devices. The advantages of microstrip antennasmake them suitable for various applications like, vehicle basedsatellite link antennas [1], radar for missiles and telemetry[1], global positioning systems (GPS) [2], mobile handheld radios or communication devices [2], and wireless communication system. But the microstrip antennas also havesome disadvantages, such as narrow bandwidth, low gain and the excitation of surface waves.

There are several and well-known techniques are used to increase the bandwidth of antennas, they are by increasing the substrate thickness, byusing a low dielectric substrate, by using various impedance matching techniques, by using multiple tesonators, and by using of slot into patch [3-6]. Generally the bandwidth and the size of an antenna are mutually interrelated i.e. if we improve one of the characteristic then the other characteristic is normally degraded. In this paper authors presented microstrip S-shaped patch antenna using a thick dielectric substrate having a low dielectric constant which provides better efficiency, large bandwidth at centre frequency 4.3GHz. A thick dielectric substrate increases the fringing field at the patch periphery like low dielectric constant and thus increases the radiated power. Microstrip S-shaped patch antenna is design by inserting two slots into rotated square patch. These slots also increase the bandwidth of antenna.

2. Microstrip S-Shaped Patch Antenna

The geometryof the proposed microstrip S-shaped patch antenna is illustrated in Fig. 1. The proposed antenna has a simple in configuration and is consisting of rotated square patch. This antenna consist two substrates of thickness 5mm. The first substrate, above the ground plane is consisting of foam of dielectric constant 1.07 with height 3.4mm and second substrate is consisting of FR4 material with height 1.6mm whose dielectric constant 4.4. A rotated square patch size of 32mm x 32mm is implemented on this layer and two slots of 30mm x 2mm are inserted into the patch. The coaxial feeding is used here for excitation at center position (0, 0). The ground plane size of 62mm x 62mm is chosen for this design. The antenna is designed and simulated using IE3D software version 14. In this antenna thick substrate and slot is used which increase the bandwidth.

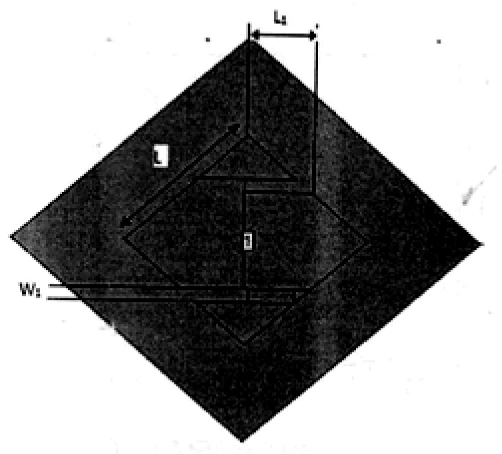

Fig.1 S- Patched Antenna

Mainly designing of microstrip patch antenna depends upon three parameters, namelydielectric substrate and its dielectric constant, height of the substrate and resonant frequency. In this paper, selected three parameters are: Resonant Frequency (f) = 4.5GHz, Dielectric constant (ε_r) = 1.07, Height of the dielectric substrate (h) = 5mm.

I. Calculation of the width (W)

The width of the Microstrip patch antenna is given by, as expressed in [7]

$$W = \frac{c}{2f\sqrt{\frac{\epsilon_r + 1}{2}}} \qquad (1)$$

The width of proposed patch antenna was calculated by using (1) W = 32.765 mm, where c is the speed of light.

II. Calculation of Effective dielectric constant (ε_{reff})

The effective dielectric constant is given by, as expressed in [7]

$$\varepsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2} \qquad (2)$$

The effective dielectric constant was calculated by sing (2) ε_{reff} = 1.056.

III. Calculation of the Length Extension (ΔL)

The extended length of the patchis given by, as expressed in [7]

$$\Delta L = 0.412h \frac{(\epsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\epsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \qquad (3)$$

The extended length of patch was calculated byusing (3) ΔL = 3.245mm.

IV. Calculation of the Effective length (L_{eff})

The effective length of patch is given by, as expressed in [7]

$$L_{eff} = \frac{c}{2f\sqrt{\epsilon_{reff}}} \qquad (4)$$

The effective length of patch was calculated by sing (4) L_{eff} = 32.437mm.

V. Calculation of the resonant length of patch (L)

The actual length of the patch is given by, as expressed in [7]

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

This comes our to be 25.947mm.

Finally selected optimized dimensions are size of patch is 32mm x 32mm. and size of ground plane is 62mm x 62mm.

3. Result & Discussion

It can be said that when the load is mismatched the whole power is not delivered to the load there is a return of the power and that is called loss, and this loss that is returned is called the Return loss. The bandwidth is a range of frequencies over which return loss is less than-10dB. The S_{11} scattering parameter (return loss) of microstrip S-shaped patch antenna is shown in Fig. 2 and measured return loss is -20dB and the measured bandwidth of the antenna is 526MHz, which is over 12% for $|S_{11}| \leq 10$ dB ranging from 4.037 to 4.563GHz. The VSWR is 1:1.226. VSWR is lie in the range of 1-2 which has been achieved for the frequency 4.3GHz, which is near the operating frequency value. The Smith chart plot represents that how the antenna impedance varies with frequency. The value of impedance should lie near 50Ω in order to perfectly match the port with the antenna. As shown in fig. 4 the antenna impedance for this antenna is 50.05Ω.

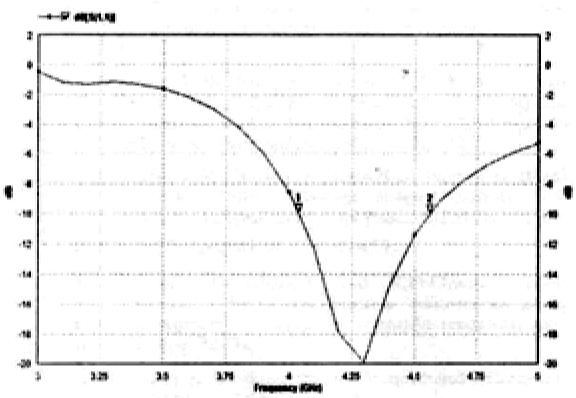

Fig. 2: Return loss v/s Frequency

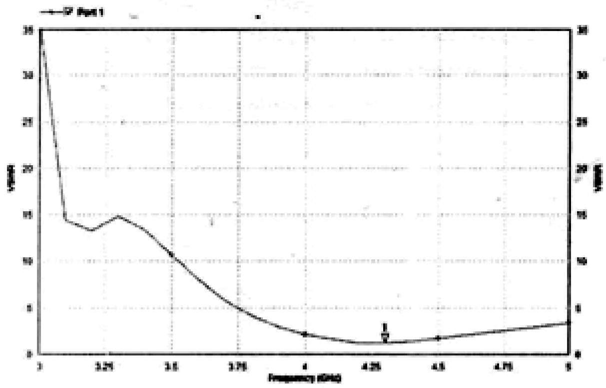

Fig. 3: VSWR v/s Frequency

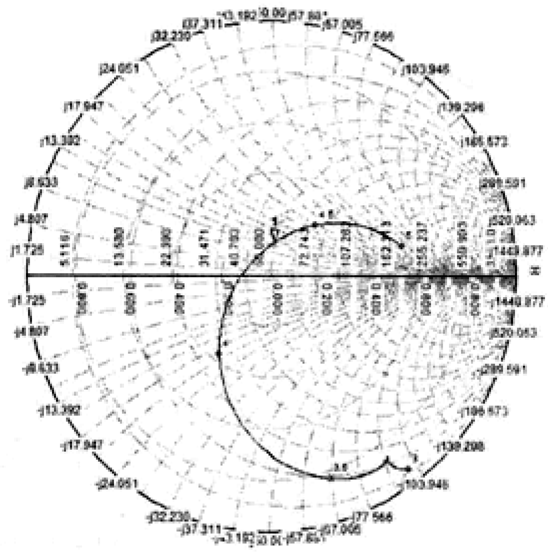

Fig. 4: Smith Chart

4. Conclusion

In this paper, we have presented the design of a microstrip S-shaped patch antenna covering the 4.037 - 4.563GHz frequency spectrum. It has been clearly seen that the S-shaped patch antenna provides a bandwidth of approximately 12% which is greater than simple microstrip patch bandwidth near about 4-5%. It shows a good impedance matching of approximately 50Ω at the resonant frequency 4.3GHz.

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