

# Broadband Microstrip S-shaped Patch Antenna for Wireless Communication

Naresh Kumar Joshi  
Student  
Dept. of E&C  
RIET Jaipur

Anoop Singh Poonia  
Professor  
Dept. of E&C  
RIET Jaipur

Piyush Choudhary  
Assistant Professor  
Dept. of E&C  
RIET Jaipur

## 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. The proposed antenna is operating at centre frequency of 4.3GHz (i.e near to 4.5 GHz). It gives an enhance bandwidth, which is over 12% for  $|S_{11}| \leq 10$  dB ranging from 4.037 to 4.563 GHz. VSWR of this antenna is 1.226 which is within the range of 1-2 at resonant frequency 4.3GHz. 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 IE3D software.

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

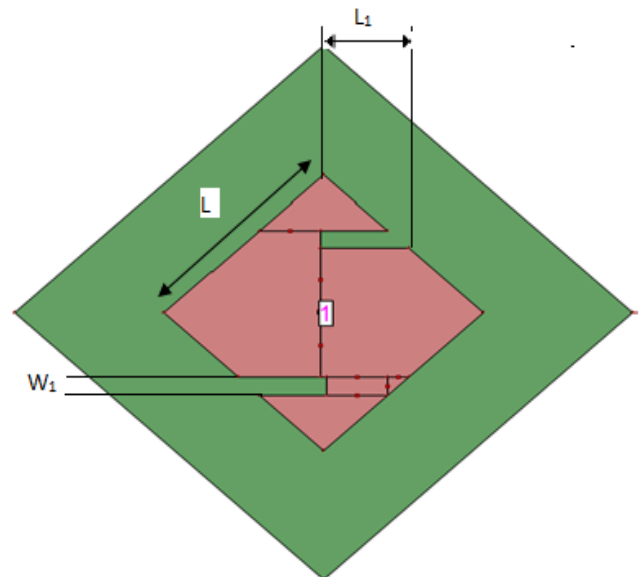
## 1. INTRODUCTION

The microstrip patch antennas have several advantages of being low profile, versatile, conformal and low-cost devices. The advantages of microstrip antennas make them suitable for various applications like, vehicle based satellite 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 have some 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, by using a low dielectric substrate, by using various impedance matching techniques, by using multiple resonators, 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, larger 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 geometry of 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 is 4.4. A rotated square patch size of 32mm  $\times$  32mm is implemented on this layer and two slots of 30mm  $\times$  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  $\times$  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: Designed S-shaped Patch Antenna**

Mainly designing of microstrip patch antenna depends upon three parameters, namely dielectric 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 ( $\epsilon_r$ ) = 1.07, Height of the dielectric substrate (h) = 5mm.

## 2.1 Calculation of the width (W)

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

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

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

## 2.2 Calculation of Effective dielectric constant ( $\epsilon_{\text{reff}}$ )

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

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

The effective dielectric constant was calculated by using (2)  $\epsilon_{\text{reff}} = 1.056$ .

## 2.3 Calculation of the Length Extension ( $\Delta L$ )

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

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

The extended length of patch was calculated by using (3)  $\Delta L = 3.245\text{mm}$ .

## 2.4 Calculation of the Effective length ( $L_{\text{eff}}$ )

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

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

The effective length of patch was calculated by using (4)

$L_{\text{eff}} = 32.437\text{mm}$ .

## 2.5 Calculation of the resonant length of patch (L)

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

$$L = L_{\text{eff}} - 2 \Delta L \quad (5)$$

This comes out to be  $25.947\text{mm}$ .

Finally selected optimized dimensions are size of patch is  $32\text{mm} \times 32\text{mm}$ . and size of ground plane is  $62\text{mm} \times 62\text{mm}$ .

## 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 plot for coaxial feed antenna is shown in Fig. 3. The value of 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  $50\Omega$  in order to perfectly match the port with the antenna. As shown in fig. 4 the antenna impedance for this antenna is  $50.05\Omega$ .

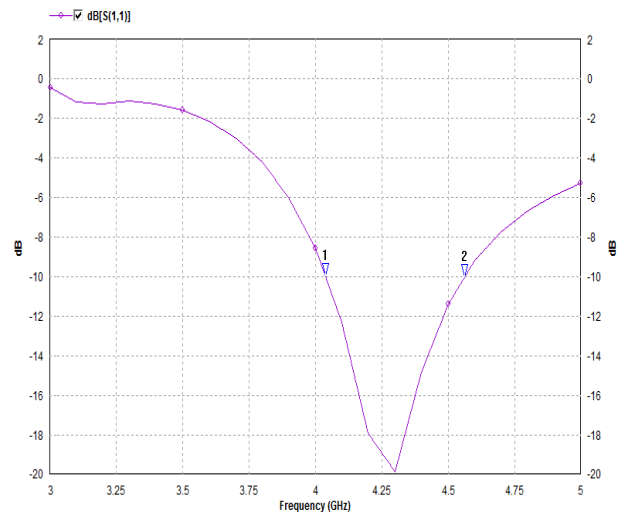


Fig. 2: Return loss v/s Frequency

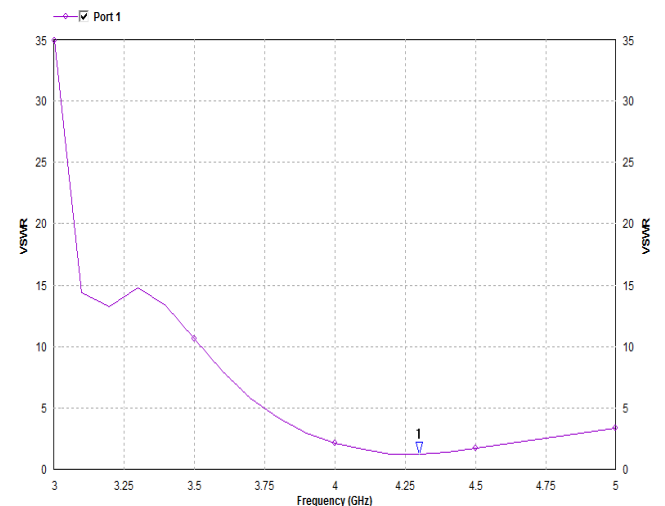


Fig. 3: VSWR v/s Frequency

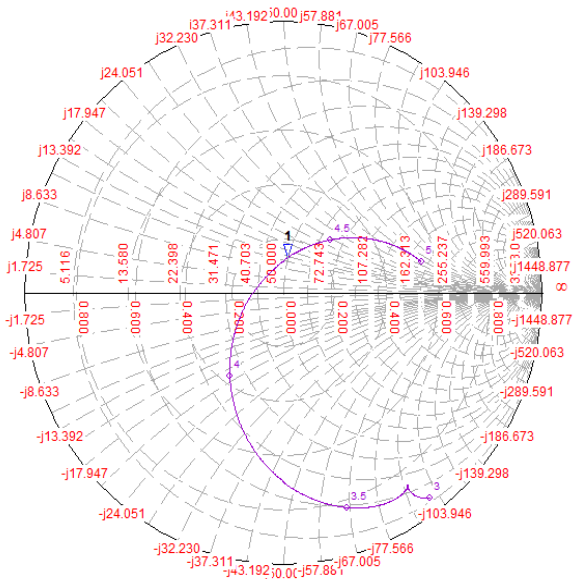


Fig. 4: Smith Chart

#### 4. CONCLUSION

In this paper, we 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  $50\Omega$  at the resonant frequency 4.3GHz. The simple coaxial feeding technique used for excitation of this antenna. Finally the antenna attains a bandwidth of 526MHz. From the analysis of simulated results it can be seen that the antenna is best suitable for C-band and UWB frequency operations. This antenna is best applicable to modern communication devices and wireless communication frequencies operating at 4.3GHz.

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