Designing of Broadband Rectangular Microstrip Antenna Loaded With X Slot

SwetaSrivastava,Mr.Mukesh Kr. Sone,SwetaAgarwal

Abstract: A broadband Antenna rectangular microstripantenna is very useful for wireless LAN applications. The proposed antenna works on S-Band (2-4 GHz). The size of prototype antenna is 30X30X4.8 mm^3 to achieve high bandwidth. FR-4 material is used as substrate having dielectric constant 4.4. IE3D is used for simulation purpose.

Keywords: Broadband antenna, IE3D, Microstrip Antenna.

I INTRODUCTION

A microstrip antenna has various advantages and disadvantage. The various advantages such as low profile, versatile and low cost device. The advantages of microstrip antennas make them suitable for various applications like GPS, mobile communication andRADAR systems. With some advantages, it has some drawbacks such as narrow bandwidth (1-2%)[1], low gain and the excitation of surface wave.

There are several techniques have been proposed in literature for enhancement of impedance bandwidth. Introducing stacking of patch [1], use of a thick substrate [1], and cutting slots on the patch.

In this paper an X-shaped microstrip antenna is proposed. This provides area reduction and has similar radiation characteristics as a conventional rectangular patch antenna. This antenna is simulated by IE3D (version 14.1) Simulator.

II MICROSTRIP ANTENNA DESIGN

Micro strip patch antenna with X shape slot can be designed by using a cavity model [1] suitable for moderate band width antennas. The lowest mode, TM_{010}, resonates when effective length across a patch is half of the wavelength. Radiation occurs due to fringing field. The brief description of resonant frequency, cavity model is given as:

A. Resonant Frequency

The resonant frequency f_{mnp}depends on the size, dimension and the filling dielectric constant [2, 3] as follows:

$$f_{mnp} = \frac{k_{mnp}c}{2\circledR\sqrt{£_r}} \quad (1)$$

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Where m,n,p ={1,2,3,----------} are respectively , number of half –cycle field variation along the x,y,z directions; kmnp is wave number and ε_r is relative constant and

$$k_{mnp} = \sqrt{\left(\frac{m\circledR}{W}\right)^2 + \left(\frac{n\circledR}{L}\right)^2 + \left(\frac{p\circledR}{h}\right)^2} \quad (2)$$

W is radiating edge, L is non-radiating edge,h is thickness of the substrate. The ratio W/L =1.5 is usually chosen, and L/W<<h, it gives good performance according to the side lobe appearances [1]. In practice the fringing effect causes the effective distance between the radiating edges of the patch to be slightly greater than L. Therefore, the value of the resonant frequency is slightly less than f_{mnp}. For TM_{0n0} mode, the length of the non-radiating rectangular patch's edge at a certain resonance frequency and dielectric constant according to eq, (1),(2) becomes:

$$L = \frac{nc}{2f_{mnp}\sqrt{£_r}} \quad (3)$$

Taking into account the effect of the fringing field, the dielectric constant for TM_{0n0} mode is derived using [4,5]

$$£_{eff} = \left(\frac{£_r + 1}{2}\right) + \left(\frac{£_r - 1}{2}\right)\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}} \quad (4)$$

If (W/h)>1 then:

$$\Delta L = 0.412h\frac{\left(£_{eff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(£_{eff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \quad (5)$$

III ANTENNA CONFIGURATION

The geometry of proposed antenna is shown in figure (1). The proposed antenna has very simple structure. This antenna contains the thickness of substrate is 4.8 mm. This is created by stacking three layers of substrate material. The size of the patch is 30mmX30 mm, is implemented on the substrate. Two slots cut on the patch, having dimension of 16mm X 2mm at the 45^0 and 135^0 rotation from the horizontal axis of the patch. These are cut on the centre of the patch. In this antenna two slots and thicker substrate are

used for improvement of impedance bandwidth. Coaxial feedingis used for the feeding purpose.

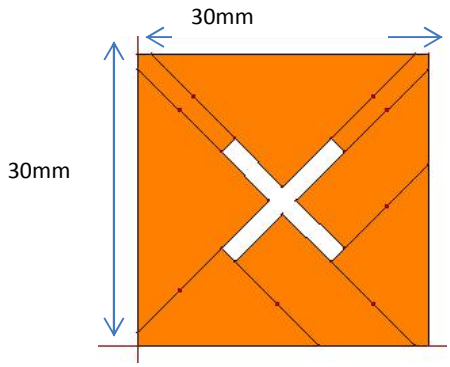

Fig 1: Schematic Configuration of proposed Microstrip Antenna

IV SIMULATION AND RESULT

Bandwidth of the microstrip antenna is defined as

$$BW=\frac{f_H-f_L}{f_R} \qquad (6)$$

Where f_H and f_L are high and low frequency range, and f_R is the resonant frequency. For calculating the value of f_H ,f_L, and f_R, return loss curve is used. In return loss curve taking the range where the return loss is – 10dB. The return loss curve is shown in figure 2.

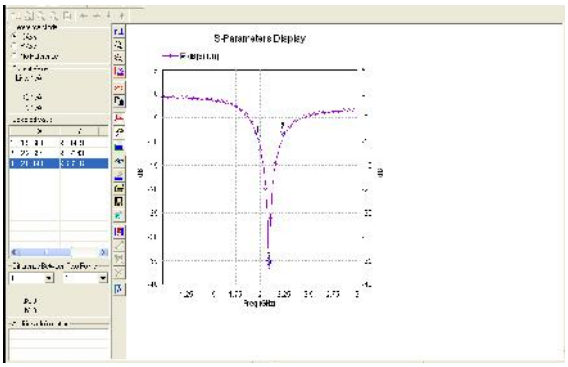

Fig 2: Return loss v/s frequency

This graph shows from 1.9866GHz to 2.2369GHz frequencyrange where return loss is -10 dB. The resonant frequency is 2.0914GHz.The impedance bandwidth is 11.5%.

The VSWR is in the range of 1-2. This is shown in figure 3. The value of VSWR is 1:1.03043.

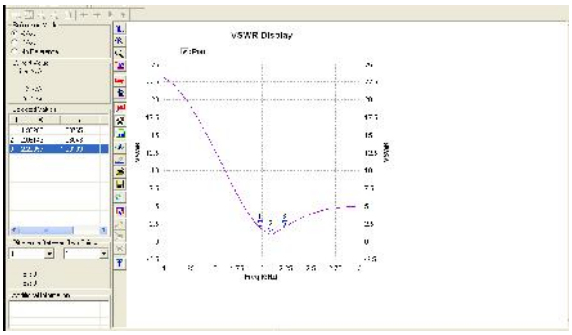

Fig 3: VSWR v/s Frequency

Antenna should be perfectly matched for transfer the maximum power. This should be calculated by the input impedance. The input impedance graph is shown in figure 4. The value of input impedance is 50.1ohm.

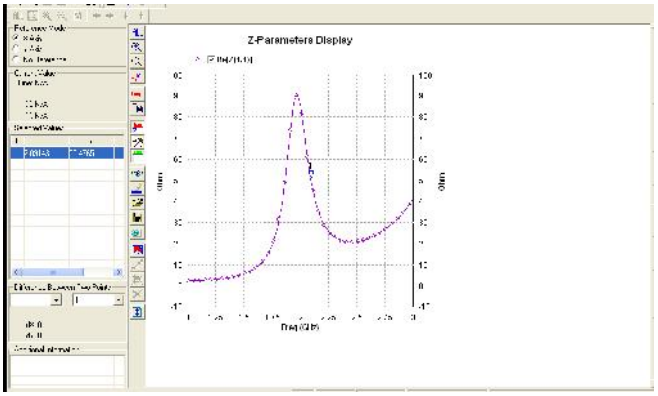

Fig 4: input impedance v/s frequency

Return loss at various lengths from 15mm to 19mm is taken. The graph is shown in figure 5.

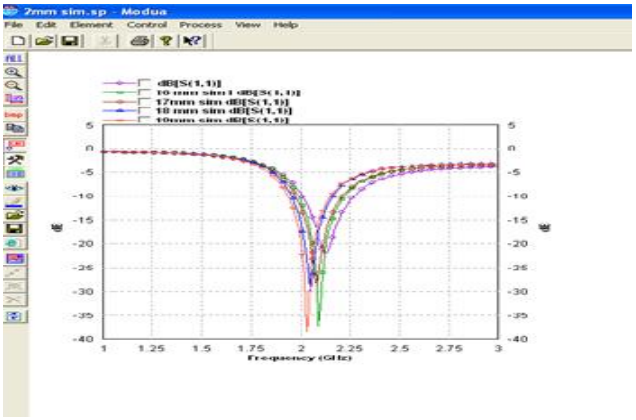

Fig 5: return loss v/s frequency(at various lengths of the slot)

Figure 6 shows the effect of width variation(1 mm – 5mm) on the performance of the antenna.

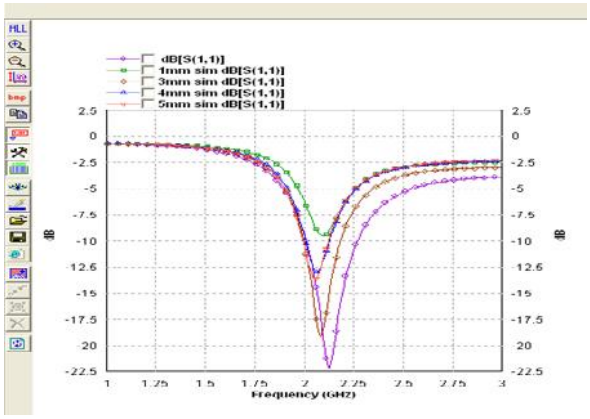

Fig 6: return loss v/s frequency (at various width of the slot)

V CONCLUSION

This paper presents a X shape microstrip antenna which covers the S band range of frequency and operate at the frequency of 1.9866GHz to 2.2369GHz. Increasing the thickness of the substrate and cutting the slot on the patch , bandwidth is enhanced approximately 11.5 %. Thisis high as the normal bandwidth 1-2%. This type of antenna is very useful in wireless LAN, GPS Applications and Satellite Communication.

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