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High Bandwidth F-Shaped Microstrip Patch Antenna for C-band Communications

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Abstract: In this paper, a F-shape microstrip patch antenna is designed and analyzed. The antenna design is simulated using a tool named Sonnet Suites, a planar 3D planar electromagnetic simulator that use Method of Moments. Probe feed technique is used in the proposed F-shape patch antenna. Simulation results show that the impedance bandwidth is 36.6% of the center frequency.The measured return loss is below -10dB.The proposed microstrip patch antenna is suitable for C-band communications.

Keywords: Patch Antenna, F-shape, Dielectric Substrate, Bandwidth, Return Loss, C-band, Sonnet.

I. INTRODUCTION

The drastic and dynamic development in the field of wireless communication leads towards miniaturization of the device size without compromising with its features. Same is the case with antenna technology, as the antenna technology is advancing day by day the small antenna size with good performance are in high demand.

Many conventional antenna structures such as Yagi, Parabolic Reflector, Helical, Horn etc. have wider bandwidth and gain but large size of these antennas restrict their use in various applications, so these antennas cannot be used in the devices which are smaller in size and are used as an moving object. To meet this requirement of wireless communication, microstrip antennas are widely used which satisfies the requirements of the wireless communication system.

The microstrip patch antenna is employed for the recent deployment in wireless communications such as radar, space communication, satellite communication, microwave and mobile communication etc. [**1**] because of its light weight, low volume, low profile planar configurations, inexpensive and easy to integrate with microwave integrated circuits [**2**]. Over the past two decades, microstrip patch antenna received attention for communication due to its advantages. Microstrip patch antenna has also disadvantages are narrow bandwidth, excitation of surface waves, low gain and depleted radiation pattern [**3**]. Intensifier research has been carried out to overcome the cons of patch antenna. Different techniques with different shaped patch antennas are applied to increase the bandwidth and overcome the limitations.

In this paper, designed an F-shaped microstrip patch antenna for C-band communication covering 4-8 GHz [**4**] primarily used for satellite communications [**4**] and full-time satellite TV networks or raw satellite feeds.C-band also used for long-distance radio telecommunications, some Wi-Fi devices, cordless telephones, some weather radar systems and commonly used in areas that are subject to tropical rainfall which is the absorption of radio signals by atmospheric rain, snow or ice [**4**] to improve bandwidth as well as to mitigate the problems.

II. PATCH DESIGN & CONFIGURATION

The proposed F-shaped microstrip patch antenna has the resonant frequency f_o = 4.1GHz and used dielectric substrate animulA to design this antenna. The dielectric constant of the substrateε_r= 9.9, thickness of the substrate h = 2.032 mm and Co-axial probe feeding technique also been used to design the F-shaped microstrip patch antenna.The Proposed F-shape microstrip patch antenna has over all dimensions W (15.7 mm) × L (11.1 mm).The width and length of the microstrip antenna are determined as follows **[5]**:

Width Calculation (W)

$$W = \frac{c}{2f_0\sqrt{\frac{(\varepsilon_r+1)}{2}}} \quad (1)$$

Where C is the free-space velocity of light, $\varepsilon_r$is the dielectric constant of substrate, f_o is the antenna working frequency, W is the patch non resonant width, and the effective dielectric constant is ε_{reff} given as

Calculation of Effective dielectric constant (ε_{reff})

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

Where the dimensions of the microstrippatch along its length have been extended on each end by a distance ΔL, which is a function of the effective dielectric constant and the width-to-height ratio (W/h), and the normalized extension of the length, is

Calculation of the Effective length (L_{eff})

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \quad (3)$$

Calculation of the length extension (ΔL)

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad (4)$$

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Calculation of actual length of patch (L)
The actual length of the patch can be determine as

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

Microstrip antenna is designed and simulated by using Sonnet Software that use method of moments. The geometry of F-shape microstrip patch antenna with box wall port which is the most common types of port that use reference planeto remove the effects of the transmission line effectas shown in Fig. 1.

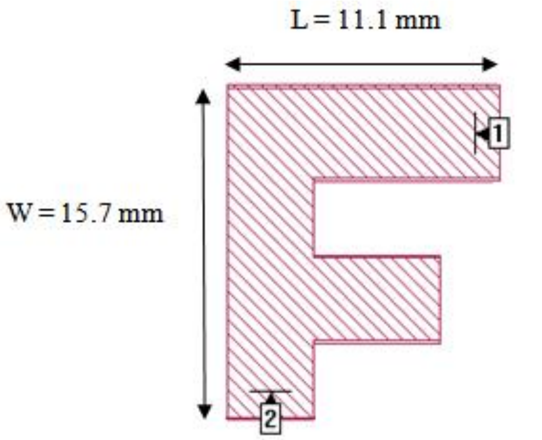

Fig. 1. Top view of the F-shaped antenna

And the 3D view of F-shaped patch antenna is shown in Fig. 2.

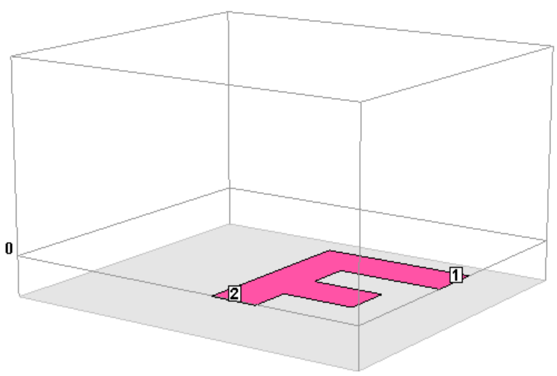

Fig. 2. 3D view of the F-shaped antenna

Design parameters of the proposed F-shaped microstrip patch antenna is shown in Table I.

Table I: Proposed F-shaped Patch Antenna Design Parameters

Antenna Design Parameter	**Material / value**
Dielectric Material	Alumina
Dielectric Constant(ε_r)	9.9
Loss Tangent	1.0e-4
Height of Substrate(Thickness) (h) (mm)	2.032
Width of the Patch (W) (mm)	15.7
Length of the Patch (L) (mm)	11.1
Resonant Frequency (f_o)(GHz)	4.1

III. SIMULATION RESULTS

In this research, broad banding technique F-shaped patch is presented. The simulation results are presented below. Finally, the results are discussed. The results are explained in terms of the return loss, input impedance. The current density on the antenna is also showed.

A. Return Loss Curve
This can be defined as difference in dB between the forward and reflected power measured at a given point in an RF system.
The first important parameter is return loss curve which is very much helpful to calculate the bandwidth of the antenna structure is its S11 parameter in decibel versus frequency. The return loss curve of the designed antenna is shown in Fig. 3, and minimum S11 level of -13.11 dB is shown in m3 caption. Figure shows that the antenna resonates at 4.1GHz band.

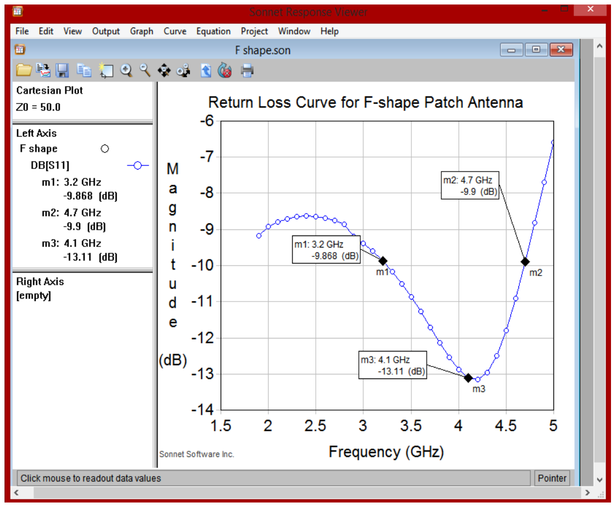

Fig. 3. Simulated Return Loss of **F**-shaped patch antenna

The bandwidth can be described in terms of percentage of the center frequency of the band.

Calculation of the bandwidth

$$WB = \frac{F_H - F_L}{F_C} \times 100 \ \textbf{[6]} \quad (6)$$

Where F_H =Higher Frequency, F_L = Lower Frequency andF_C = Center Frequency.
Here F_H=4.7 GHz, F_L=3.2 GHz and F_C=4.1GHz. So the obtained bandwidth is 1.5 GHz which is 36.6% of the center frequency.

B. Input Impedance Curve
The input impedance curve tells us the magnitude, phase angle and vswr of the input impedance of the antenna at the respective frequencies.

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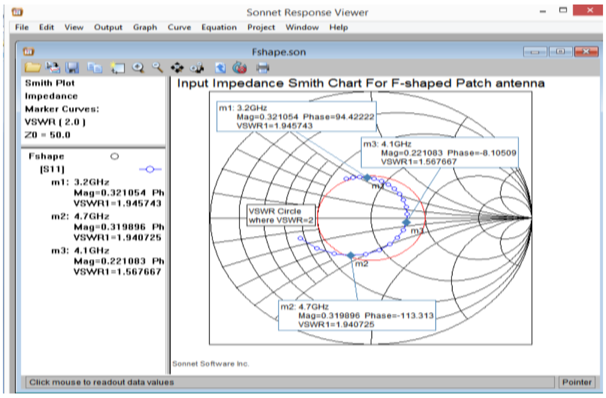

Fig. 4. Input impedance curve ofF-shaped patch antenna

The above graph shows the input impedance curve on a Smith Chart. The red circle is a vswr curve showing VSWR = 2.

C. Current density Diagram

The physical meaning of current density distribution is that it is a measure how the antenna is producing a beam. Fig. 5 is a diagram showing the current density distribution on the patch surface.

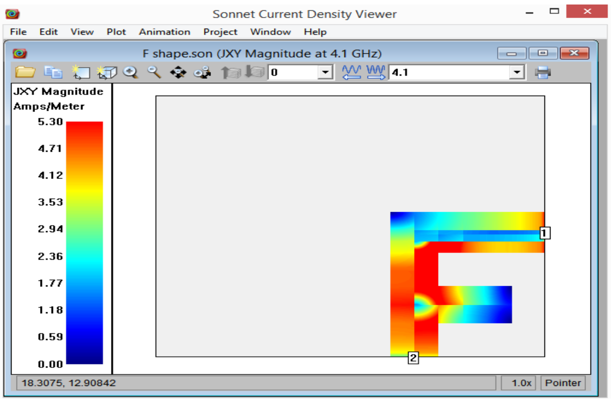

Fig. 5. Current density diagram of the **F**-shaped patch antenna**at 4.1GHz**

IV. DISCUSSIONS

The bandwidth increases as the substrate thickness**[5]**. Thickness of proposed F-shaped patch is slightly greater and as a result the obtained bandwidth is higher than previous. Then, t he substrate thickness increase results reduce conductor & dielectric losses**[5]**. In this case, the F - shape patch has no or poor conductor & dielectric losses. Next, a s the substrate thickness increases, the surface-wave power increases, thus limiting the efficiency **[7]** and proposed F-shaped patch has some efficiency problem. On the other hand, as the substrate thickness or height increases, the quality factor Q of the patch decreases **[8]**, thus increases the efficiency **[5]**. As a result efficiency problem has reduced slightly. We know that, a higher dielectric constant results in the small patch, but generally reduces bandwidth **[5]** and in this case, proposed F-shaped patch size is small and bandwidth is greater. So Finally, it was seen that proposed F-shaped patch is better than previous.

V. CONCLUSION

In this research paper, the main target is to improve the bandwidth of microstrip antenna constructed with dielectric material with higher dielectric constant. A novel design technique for small and compact size F shaped patch antenna is presented, simulated and discussed for wireless communication specially the satellite communication covering 4-8 GHz and box wall port is used to feed the antenna. The fo tnatsnoC circteleiD si animulA9.9. The thickness of the proposed patch antennas is 2.032mm. The vswr parameter is less than 2 within the operating frequency range and resonant frequency is found at vswr = 1.56. The Bandwidth obtained for C-band communications is greater than other existing F-shaped microstrip patch antenna.

REFERENCES

[1] M. AfsarUddin, M. HumayanKabir, M. Javed Hossain, and M. A. Rahman Khan, "Designing High Bandwidth Connected E-H andE-Shaped Microstrip Patch Antennas for S-band Communication", International Journal of Computer Science and Information Security, Vol. 13, No. 6, June 2015.

[2] Rachmansyah, Antonius Irianto, and A. Benny Mutiar, "Designing and Manufacturing Microstrip Antenna for Wireless Communication at 2.4 GHz", IJCEE, Vol. 3, No. 5, pp. 33, October 2011.

[3] Md. RabiulHasan and Abdulla Al Suman, "Substrate Height and

[4] Dielectric Constant Dependent Performance ofCircular Micro Strip Patch Array Antennas forBroadband Wireless Access", Journal of Emerging Trends in Computing and Information Sciences, Vol. 3, No.10 Oct, 2012.

[5] MagaliVaissiere, "Satellite frequency bands," 17 November, 2014.http://www.esa.int/Our_Activities/Telecommunications_Integrated_Applications/Satellite_frequency_bands.

[6] ZewduHailu, "Comparative Study on Bandwidth enhancement Techniques of microstripPatch Antenna", Addis Ababa University, pp. 20-25, January, 2008.

[7] Prof. Dr.Sandro M. Radicella, Prof. Dr.RyszardStruzak, and Prof. Dr.RyszardStruzak, "Radio Laboratory Handbook", pp. 64, Italy, 2004.

[8] Sharma and G. Singh, "Design of Single Pin Shorted Three-dielectric layered Substrates Rectangular Patch Microstrip Antenna for Communication Systems", Progress In Electromagnetics Research Letters, Vol. 2, 157–165, 2008.

[9] Rakesh Kumar Tripathi, "Dual Frequency Wideband Rectangular MicrostripPatch Antenna for Wireless Communication Systems", ThaparUniversity, pp. 25, June, 2011.

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