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Microstrip Antenna Design For Ultra-Wide Band Applications

Chiranjevulu.Divvala[1], Karusodi.Sirisha[2], Gurugubelli.Sravani[3]
[1]*Assistant Professor, P.G, Electronics and Communication, SSCE, Srikakulam, INDIA*
[2]*Student, BTECH, Electronics and Communication, Sri Sivani College of Engineering, Srikakulam, INDIA*
[3]*Student, BTECH, Electronics and Communication, Sri Sivani College of Engineering, Srikakulam, INDIA*

***ABSTRACT*:** *In this paper design of ultra-wide band (UWB) antenna. The UWB antenna is capable of operating over an UWB as allocated by the Federal Communications Commission (FCC) with good radiation properties over the entire frequency range. The techniques of enhancing the bandwidth of microstrip UWB antenna were utilized to enhance them performance of the designed antenna. The (UWB) antenna with substrate FR4epoxy having dielectric constant 4.4 and substrate height of 1.6mm is designed and analyzed with different parameters like VSWR, Gain, Peak directivity, Return losses, Bandwidth etc,.The rectangular patch has two slots one slot at the topmost left corner another one at bottom right corner. The simulated bandwidth with return loss (RL) ≥ 10 dB is 2.2–5.6GHz. The simulated results of the proposed antenna indicate higher gain at the passbands while a sharp drop at the rejected bands is seen. The radiation pattern is of dipole shape in the E-plane and almost omnidirectional in the H-plane. The high frequency structure simulator HFSS (High Frequency Structure Simulator) version 13.0 software is used to design and simulate the antennas behavior over the different frequency ranges. Measurements confirm the antenna characteristic as predicted in the simulation with a slight shift in frequencies.*

Keywords: *Microstrip; UWB; Patch; HFSS 13.0.*

I. Introduction

Wireless Communication has grown exponentially through the past few decades, which Replaced wired devices and gave freedom to communicate without any restriction on distance. The antenna is an essential part in the different communication systems to transmit and receive signals. The transmitting antenna is defined as a transducer that converts the generated electrical energy to electromagnetic wave radiated in space around the antenna, while the receiving antenna is also a transducer that converts the incoming electromagnetic waves from the surrounding space into an electrical energy and deliver it to the system components. Antennas maintain their characteristics regardless of their usage as transmitter or receiver. On the other hand, antennas can be considered as resonant devices since they work efficiently over a certain limited range of frequency band. Wireless communication systems need high data rate which is achieved by increasing the available bandwidth. In 2002, FCC approved the UWB technology in the frequency range of 3.1–10.6 GHz with maximum radiated power -41.3dBm/MHz and data rate between 110–200 Mbps within 10 m distance (FCC, 2002).

The advantages of the UWB technology are high data rate, less interference, secure, low cost and low complexity. The disadvantage of this technology is the need for accurate time synchronization at the receiver side since the pulse duration in time domain is fraction of nanosecond. It is used in different applications such as radar, imaging in medicine and military communication. There are many different patch shapes such as the rectangular, circular, elliptic, circular ring, triangular and hexagonal. There are various techniques for feeding the antenna such as microstrip line feed, coaxial probed feed, aperture-coupled and electromagnetically coupled. Several methods are used to enhance its bandwidth (BW) by using parasitic structures and other different arrangements (Ojaroudi et al., 2011; Chen et al., 2011; Rahayu et al., 2010).

Recently, researches focus on designing UWB antenna characteristics for wireless applications. This is achieved by adding slots with different shapes at the edges of the patch.(Choi et al.,2005; Eshtiaghi et al., 2010; Ali et al., 2012; Li et al., 2011; Ahmed and Abdel-Razik, 2009), or using defected ground structures (DGS) (Soltani et al., 2011) or by inserting quarter wavelength open ended slits (Yoon et al., 2005). In this paper the UWB antenna is presented in Section 2. Simulated results for these antennas are given in Section 3. Finally the paper is concluded in Section 4 with references.

II. Uwb Patch Antenna Desighn

The proposed rectangular microstrip patch antenna, shown in Fig. 1(a) is built on FR4 substrate with $\varepsilon_r = 4.4$ and tan δ =0.02. The antenna dimensions (in mm) are: the substrate has $W_{sub} = 34$mm, $L_{sub} = 47$mm and h=1.6mm, the input port has width W=3mm and height =1.6mm, the first slot has $W_1 = 1.5$mm, L_1 =5.5mm and d_1 =3.5mm the second micro strip feed lines has W_2 = 2.5mm, L_2 =8mm, d_2 =4.5mm the partial ground plane has width W_g =34mm and length L_g =22mm.

Frequency bandwidth (BW) is the range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard. The microstip-fed antenna was constructed and studied to demonstrate the proposed bandwidth-enhancement technique. The simulated results are obtained using the Ansoft simulation software high-frequency structure simulator (HFSS). Fig. 4 shows the simulated return loss curves for proposed antenna the simulated impedance bandwidth of the antenna, defined by 10dB return loss, can reach an operating bandwidth of 8GHz (2-10GHz), from proposed microstrip fed patch antenna with rectangular slot in patch and multiple slotted ground plane.

The simulated RL which is equal to –S11 (scattering parameter), shown in Fig. 4, for the proposed antenna shown in Fig. 1, shows that with RL ≥10 dB the antenna has BW 2.2–5.6 GHz with minimum RL of 17dB.

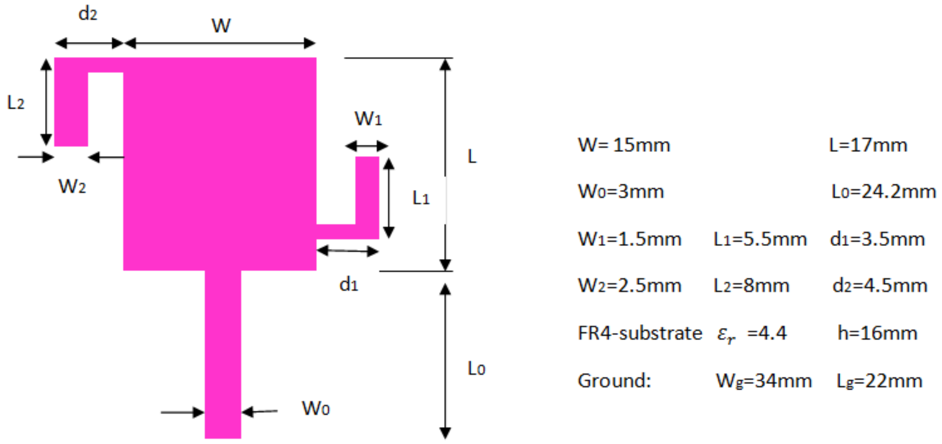

Figure1 The proposed microstrip antenna.

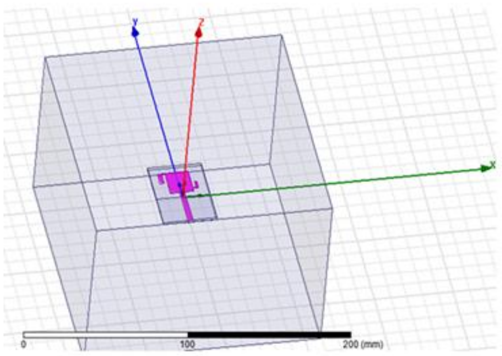

Figure 2 The proposed antenna with radiation box

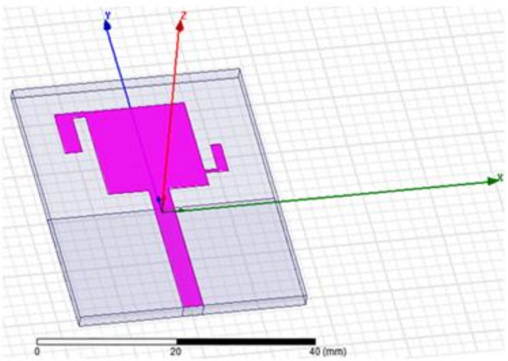

Figure 3 The proposed antenna without radiation box.

Simulated results for proposed microstrip antenna

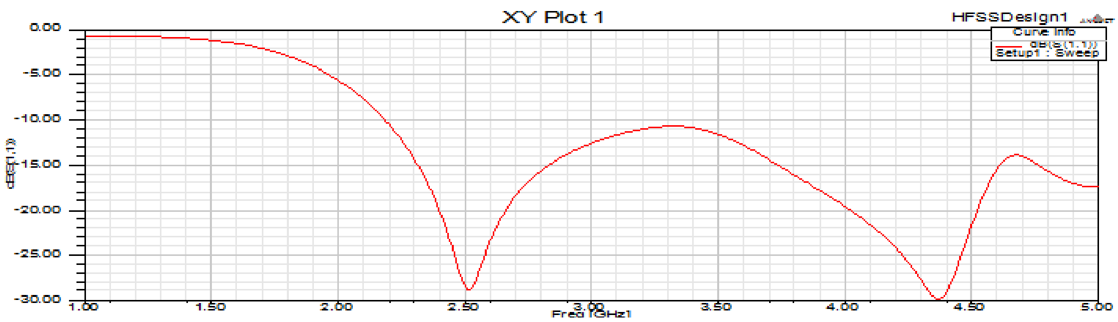

Figure 4 The simulated S11 for the proposed antenna shown in the Figure 1

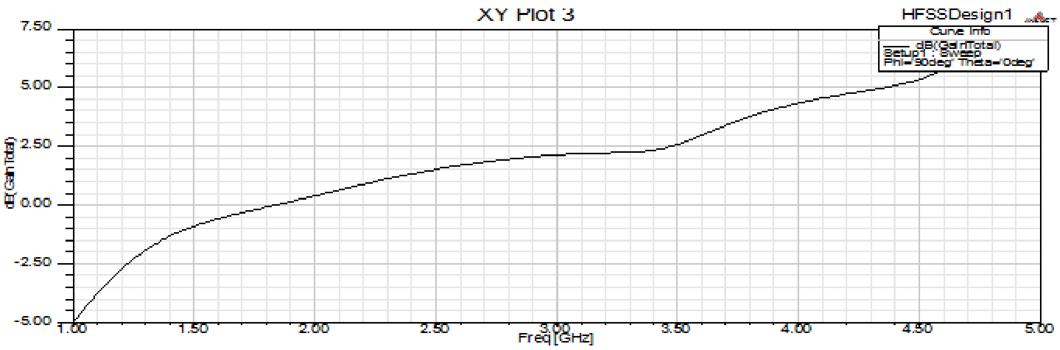

Figure 5 The simulated gain of the proposed antenna.

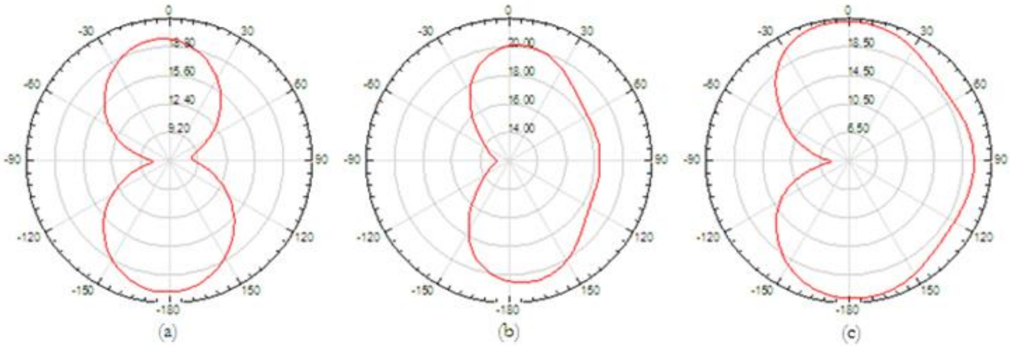

Figure 6 The simulated radiation pattern, E-plane, for the proposed antenna; (a) *f*=3GHz, (b) *f*=3.5GHz, (c) *f*=5GHz.

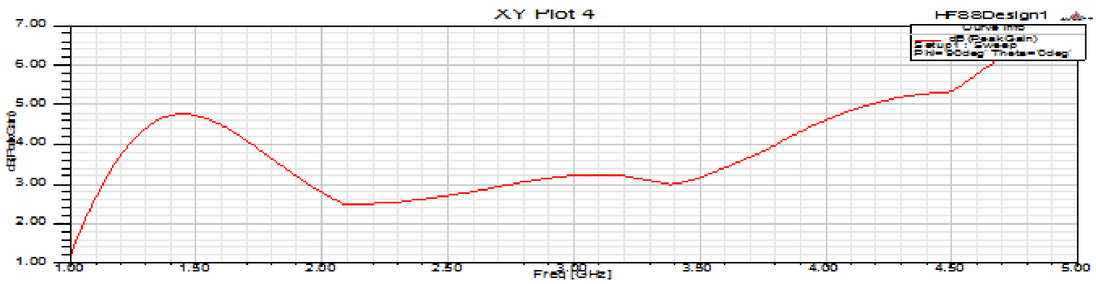

Figure 7 The simulatedpeak gain for the proposed antenna.

The simulated peak presented in Fig. 5, indicates an increase in the gain with increasing frequency reaching 6.5 dB at 5 GHz. The radiation patterns for the proposed antenna are presented in Fig. 6, where the E and H planes are the yz plane (φ= 90˚ and 0˚< θ < 180˚) and the xz (φ = 0˚ and0˚< θ< 180˚) respectively, at different frequencies: 3, 3.5 and 4.5 GHz. Radiation patterns in the E-plane are about the same as that of a dipole antenna, the number of lobes rises with the increase in frequency due to the existence of higher order modes. The radiation patterns in the H-plane are nearly omni-directional at lower frequencies.

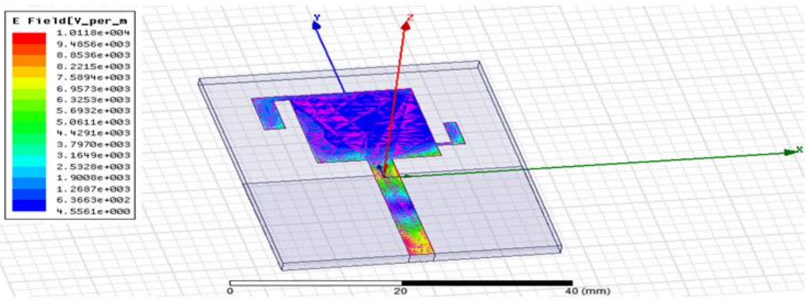

Figure 8 E-slot in the patch for proposed antenna.

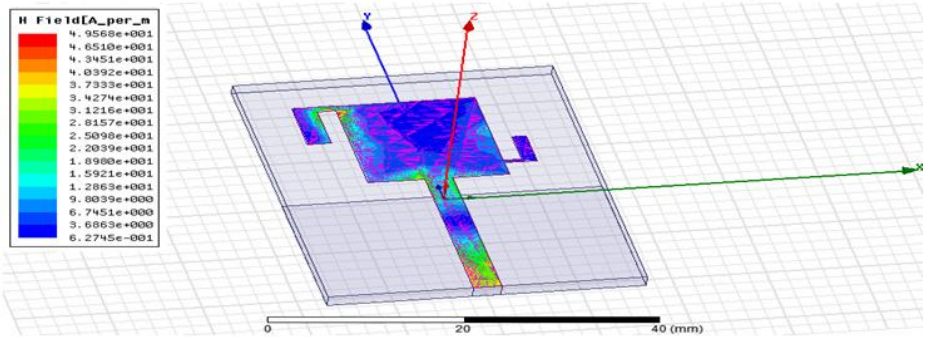

Figure 9 H-slot in the patch for proposed antenna.

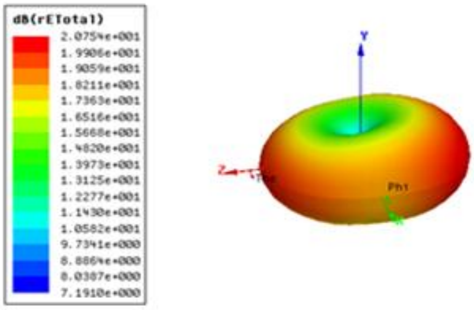

Figure 10 3D Radiation pattern for proposed antenna.

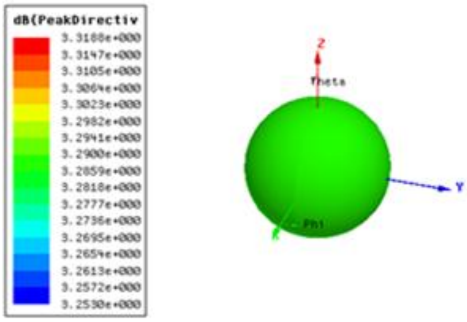

Figure 11 The peak directivity of the proposed antenna

III. Conclusion

In this paper, I presented a rectangular microstrip patch antenna for UWB communications. It has been demonstrated that the proposed antenna can yield a bandwidth in UWB of return loss less than -10 dB. The initial design yields a bandwidth of 1.3 GHz. An improvement in the design is proposed to enhance the bandwidth. The operating bandwidth is increased from 2.2 GHz to 5.6GHz. Also the fractional bandwidth is increased from 20.31% to 50.8%. It is observed that both the proposed antennas exhibit a reasonably directive radiation patterns. The proposed antenna designs can be a good candidate for UWB systems such as wireless monitors, printers etc.

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