Design of a Microstrip UWB Antenna with Enhanced Bandwidth

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Abstract— In this paper, a novel ultrawideband antenna with enhanced bandwidth is presented. Experimental results show that the antenna achieves good impedance match from 2 to 14 GHz with the voltage standing wave ratio (VSWR) less than 2. From HFSS13 simulations, dimensions of antennas are chosen for better performance. It is shown that return loss of the antenna at solution frequency 7 GHz is less than -10 dB. The antenna is designed on Epoxy FR4 substrate. It covers nearly UWB band 3.1 to 10.6 GHz which is FCC decided. The proposed microstrip antenna is highly suitable for applications of wideband systems..
Key words— return loss, VSWR and ultra-wideband antenna.

I. INTRODUCTION

ULTRAWIDEBAND (UWB) technology has obtained attention due to its attractive characteristics, such as low cost, low complexity, low power density, high data resolution, very low interference, and high data transmission rates, which have been urging the development of the UWB antennas greatly. Various antennas have been investigated for UWB communication, though-wall radar, medical imaging, precision location systems, electromagnetic environment sensing, etc. Wire antennas have been used since the beginning of the wireless communication era. Among common UWB antennas, the circle disc is a typical form for wideband antenna design. The circular antenna has been widely used for its ultra wideband and omnidirectional radiation pattern characteristics. 'Ultra-wideband' (UWB) commonly refers to signals or systems that have large bandwidths. Due to the narrow bandwidth it is not possible to achieve high speed and high data rates to carry out communication. The Federal Communications Commission (FCC) finally allocated the 3.1-10.6 GHz spectrum for Ultra Wideband (UWB) radio applications, in February 2002. Frequency regulators all over the world assign narrow frequency bands to specific services and/or operators. UWB systems violate these frequency assignments as they emit radiation over a large frequency range, including the bands that have already been assigned to other services. Now there is a main challenge in design of antenna for communication due to interference. For successful transmission and reception of an Ultra Wideband signals, an antenna should fulfill following requirement. The antenna

- covers an extremely wide band, (3.1 GHz to 10.6GHz)
- has a high radiation efficiency
- has linear phase
- offers low dispersion
- has a VSWR < 2 for entire band
- has minimum power loss due to dielectric and Conductor losses.
- has electrically small size.
- holds a reasonable impedance match over the band for high efficiency
- has a non-dispersive characteristic in time and Frequency, to provide a narrow pulse duration to Enhance a high data rate
- has the reflected power < -10db.

In telecommunication, there are several types of microstrip antennas (also known as printed antennas) the most common of which is the microstrip patch antenna or patch antenna. A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common microstrip antenna radiator shapes are square, rectangular, circular and elliptical, but any continuous shape is possible. Some patch antennas eschew a dielectric substrate and suspend a metal patch in air above a ground plane using dielectric spacers; the resulting structure is less robust but provides better bandwidth. Because such antennas have a very low profile, are mechanically rugged and can be conformable, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices.

Microstrip antennas are also relatively inexpensive to manufacture and design because of the simple 2-dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonance frequency. A single patch antenna provides a maximum directive gain of around 6-9 dBi. It is relatively easy to print an array of patches on a single (large) substrate using lithographic techniques. Patch arrays can provide much higher gains than a single patch at little additional cost; matching and phase adjustment can be performed with printed microstrip feed structures, again in the same operations that form the radiating patches.

Several factors need to be considered while designing the antenna, including bandwidth, directivity, polarization, power gain, radiation pattern and return loss. In recent years, many varieties of UWB antennas have been proposed and investigated. Several studies used various antenna structures in ultra wideband (UWB) antenna design.

In this paper, simulation of the microstrip antenna for increase in bandwidth for UWB application is presented. An antenna design and configuration is presented in section 2. Sections 3 discuss the results for the simulated Antenna. Antenna parametric study is presented in section 4 depending on that Conclusion is given in Section 5.

II.ANTENNA DESIGN AND CONFIGURATION

The conventional rectangular patch antenna was designed as the basic structure using Microstrip patch antenna using HFSS software. This antenna was designed at which is compatible with indoor wireless applications.

The operating frequency *fr*

Thickness of the dielectric medium,

$$h \leq 0.3 \times \frac{c}{2 \times \pi \times f_r \times \sqrt{\varepsilon_r}}$$

Width of metallic patch,

$$W = \left(\frac{c}{2 \times f_r}\right) \times \left[\frac{\varepsilon_r + 1}{2}\right]^{\frac{-1}{2}}$$

Length of the metallic patch,

$$L = \frac{c}{2 \times f_r \times \sqrt{\varepsilon_{reff}}} - 2\Delta l$$

Where,

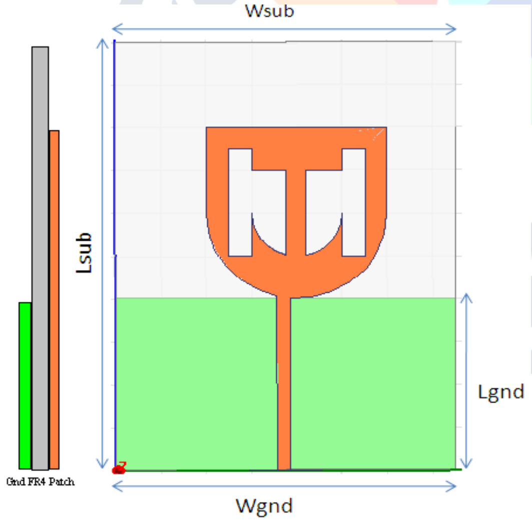
$$\Delta l = .412 \times h \times \left[\frac{(\varepsilon_{reff} + .03) \times (W + .264h)}{(\varepsilon_{reff} - .258) \times (W + .8h)}\right]$$

And

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

The geometry of the proposed modified rectangular microstrip antenna is illustrated in figure 1.

This antenna has a modified combination of rectangular and circular patch antenna fed by a microstrip line, with rectangular feedline.



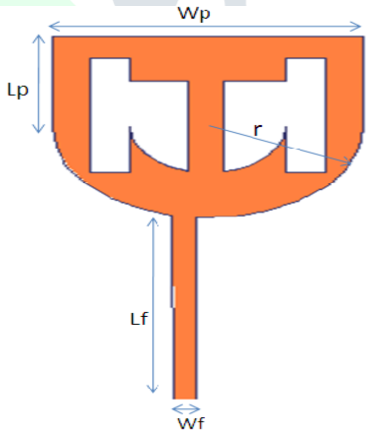


Figure 1. Whole structure *Figure 2. Top view*

The patch and ground are printed on different sides of the substrate. It is etched on a rectangular (LxW) FR4 substrate with thickness t=1.6 mm and a relative dielectric constant ε_r=4.4. The two slots are symmetrical in shape. L1 and W1 are the height and width of the two symmetrical identical branches.

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III. SIMULATED RESULTS

Return loss

The proposed microstrip antenna is illustrated in Fig. 1. A proposed antenna with a 50Ω microstrip feed line are printed on the same side of the dielectric substrate (in this study, the FR4 substrate of thickness 1.6 mm and relative permittivity 4.4 was used). Lsub and Wsub denote the length and the width of the dielectric substrate, respectively. The width of the microstrip feed line is fixed at

W_f =3mm to achieve 50 impedance. On the other side of the substrate, the conducting ground plane with a length of Lgnd=40mm only covers the section of the microstrip feed line.

Figure 3.1 shows the simulated return loss curves and figure 3.2 shows the simulated VSWR curve. GHz

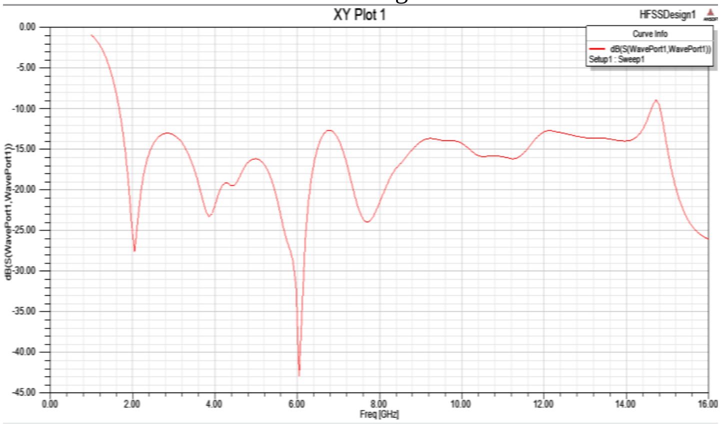

Figure 3.1 Return Loss

The most important design parameters that affect the performance of the modified patch antenna are the dimensions of the patch and the height of the branches. Thus those parameters must be investigated to reach the optimum design. Before reaching the optimum design, we passed through many steps of simulation. We started with the design and the thickness of the substrate (t) is 1.6 mm.

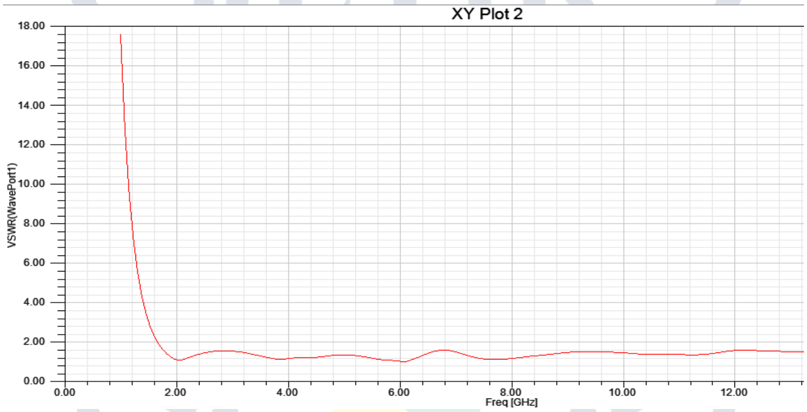

Figure 3.2 VSWR

These simulations were performed using the Ansoft High Frequency Structure Simulation (HFSS). Figure 3.1 shows the simulated return loss curve with the optimal design, i.e. The simulated return loss bandwidth is from 1.8 to 14.3 GHz for which s11is less than -10 dB and SWR is also less than 2 in this range as shown in the simulated result in figure 3.2, which confirms to the UWB standards. Moreover a considerable increase in bandwidth is obtained relative to the design. This permits to use the antenna in more applications operating under UWB band.

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IV.PARAMETRIC STUDY

The important design parameters that affect the antenna performance are the width of the ground plane and the dimension of the patch and feed line. The effects of variation in feed length parameters can be well explained by investigating the current distributions of the antenna.

A. Current Distributions

The simulated current distributions at different frequencies for the optimal design with Lsub=100mm,Wsub=75mm, Lg=40mm and Wg=75mm are presented in Fig. 4 which is resonanace at 7GHz .

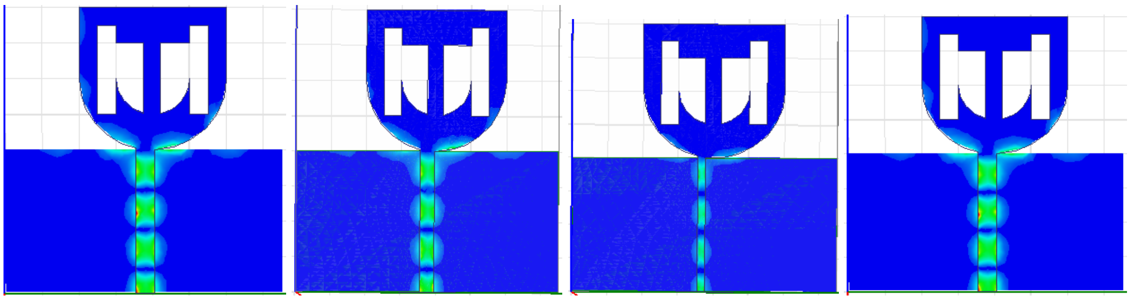


Figure 4.1 At Wf=3mm *Figure 4.2 At Wf=4mm* *Figure 4.3 At Wf=2mm* *Figure 4.4 At Wf=5mm*

Figure 4. Simulated current distributions

Fig. 4.1 shows the current pattern when feed length is 3mm. The current pattern when feed length is 4mm is given in Fig. 4.2. Fig. 4.3 and 4.4 illustrates the current pattern when feed length is 2mm and 5mm respectively. As shown in Fig. 4, the current is mainly distributed along the edge of the patch and feedline.
On the ground plane, the current is mainly distributed on the upper edge along the y direction. That means the portion of the ground plane close to the patch acts as the part of the radiating structure. Consequently, the performance of the antenna is critically dependent on the width of the ground plane. However, it also leads to a disadvantage, i.e., when this type of antenna is integrated with printed circuit board, the RF circuitry can not be very close to the ground plane.

B. The Effect of the Dimension of feedline

Fig. 5 presents the simulated return loss curves which should be less than -10db for different dimensions of the feedline width with their respective optimal designs at frequency 7GHz. Fig.5.1 shows the return loss for Wf=2mm , Fig.5.2 shows the return loss for Wf=3mm and Fig.5.3 shows the return loss for Wf=4mm.

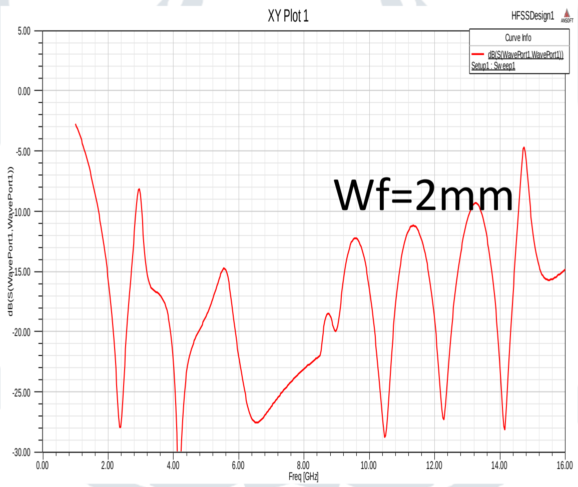


Figure 5.1 s11 for Wf=2mm

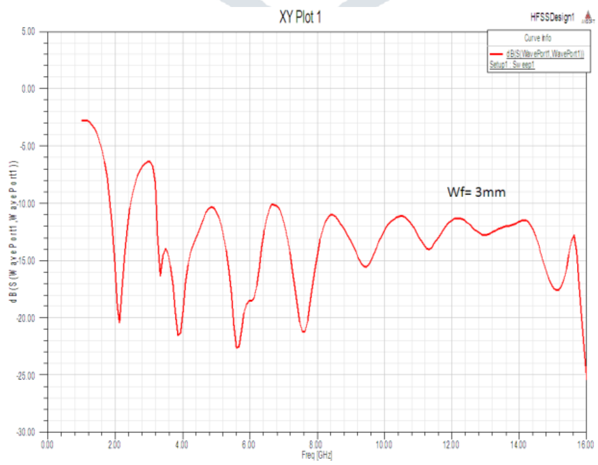


Figure 5.2 s11 for Wf=3mm

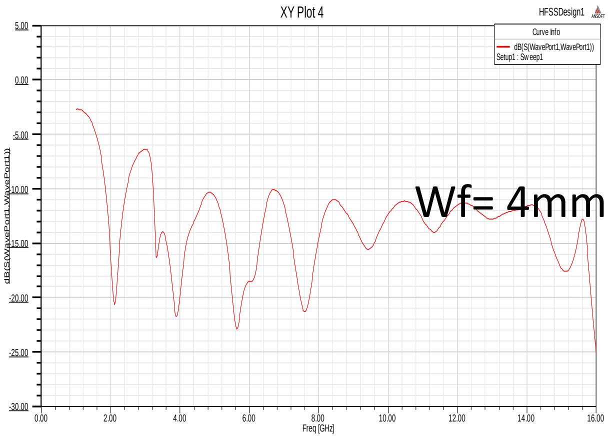
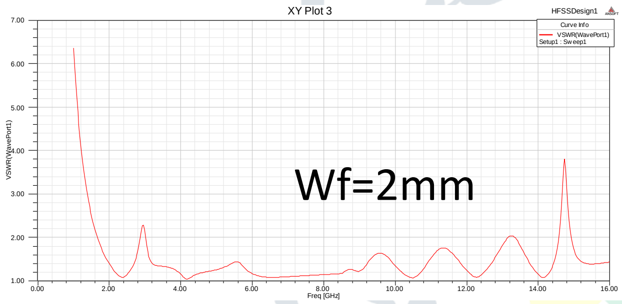


Figure 5.3 s11 for Wf=4mm

Figure 5. Simulated return loss

Fig. 6 presents the simulated VSWR curves for different dimensions of the feedline width with their respective optimal designs at frequency 7GHz. Fig.6.1 shows the VSWR for Wf=2mm , Fig.6.2 shows the VSWR for Wf=3mm and Fig.6.3 shows the VSWR for Wf=4mm.



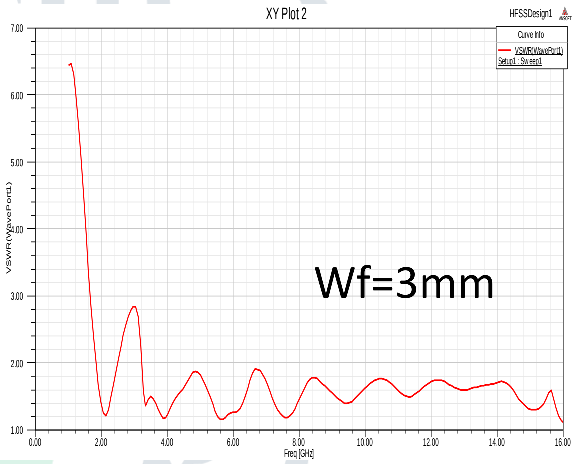


Figure 6.1 VSWR for Wf=2mm

Figure 6.2 VSWR for Wf=3mm

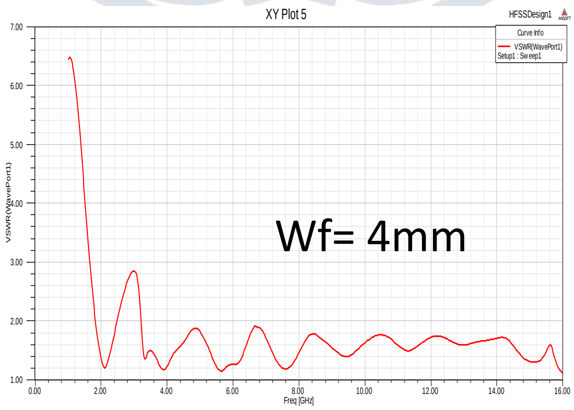


Figure 6.3 VSWR for Wf=4mm

Figure 6. Simulated VSWR curves for 1) Wf=2mm 2) Wf=3mm 3) Wf=4mm

In this simulated result, it is shown that VSWR is less than 2 for 2.8 to 14.3 GHz.

5.CONCLUSION

In this paper, an antenna was proposed having a wide bandwidth from 1.8 to 14.3 GHz for resonance frequency 7GHz. The designed antenna has simple configurations and is easy to fabricate. It has been shown that the performance of this antenna in terms of its frequency domain characteristics is mostly dependent on the dimensions and the height of substrate. It is demonstrated by simulation that the proposed antenna can yield an ultra wide bandwidth.

The modified elliptical slot antenna can be used for many applications including 3G, Wi-Fi, WiMAX, as well as UWB applications.

REFERENCES

[1] Microstrip Monopole Antenna With Enhanced Bandwidth Using Defected Ground Structure Ka Hing Chiang and Kam Weng Tam, Senior Member, IEEE, IEEE ANTENNAS AND WIRELESS PROPAGATION PAPERS, VOL. 7, 2008

[2] DESIGN OF COMPACT PRINTED RECTANGULAR MONOPOLE ANTENNA AND U- SHAPED MONOPOLE ANTENNA FOR L-BAND AND S-BAND APPLICATIONS, N.Suresh Babu, International Journal of Electronics Signals and Systems (IJESS) ISSN: 2231- 5969, Vol-1 Iss-3, 2012

[3] COMPARISON OF T-SHAPED MICROSTRI ANTENNA AND U SHAPED MICROSTRIP ANTENNA ,Mohamed Ismaeel, T.Jayanthy, ISBN:978-960-474-42-0, Proceedings of the 3rd WSEAS Int. Conf. on CIRCUITS, SYSTEMS, SIGNAL and TELECOMMUNICATIONS (CISST'09)

[4] A Modified Elliptical Slot Ultra Wide Band Antenna, Soubhi ABOU CHAHINE, Maria ADDAM, Hadi ABDEL RAHIM, Areej ITAN, Hiba JOMAA

[5] CST Microwave Studio 2006, Darmstadt, Germany.

[6] HFSS v.13, Ansoft Corporation, Pittsburgh, PA, USA.

[7] C.A. Balanis "Antenna Theory, Analysis and Design", John Wiley and Sons, 1997.

[8] Design of a Novel Ultrawideband Wire Antenna With Enhanced Bandwidth, Zhang Yang, Qiu Jinghui, Tenigeer, and Shu Lin, IEEE ANTENNA AND WIRELESS PROPAGATION PAPERS, VOL. 11, 2012