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Design and Optimization of Rectangular Microstrip Antenna for UWB Applications

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Abstract

A novel rectangular microstrip antenna for ultrawideband applications is proposed. The ultrawide frequency response is achieved by determining the dimensions of the radiating patch of antenna .The simulated reflection coefficient is smaller than -10 dB for fractional bandwidth greater than 20%. The fractional bandwidth is further enhanced by providing improvements in the proposed design. Besides a directive radiation pattern, high efficiency and a constant gain is achieved in the operating bandwidth.

Keywords: *Antenna, Microstrip, Patch, Rectangular, Ultrawideband.*

1. Introduction

In recent times need of very high data rate has emerged for short distance transmissions. High data rate with low power consumption is needed in applications such as wireless monitor, radio diagnosis etc for efficient working. In order to achieve high data rates of around 500Mbps, Ultrawideband has been identified as the key technology. The spectrum allotment of 3.1– 10.6 GHz is done for UWB by Federal Communications Commission [1]. Suitable antennas are needed to be designed for efficient and effective transmission at such high frequencies. Designing of antennas that can work on UWB range is a challenge. This instigated researchers to dwell deep into designing of UWB antennas. Microstrip patch antennas fare good as a candidate for designing UWB antennas. Various researchers have devoted efforts to propose designs of such microstrip antennas. The antennas of various shapes such as disc[2], fork[3], L-Strip[4], Pentagon [5], Square-Ring[6], E–Shaped [7],Diamond [8],Reciprocal U Shaped[9] have been reported for microstrip UWB antennas. The fractional bandwidth greater than 100% can be achieved using complex slotted ring structures [10] but the simple structure design of the current work makes it a good candidate for applications targeting specific range in UWB.

In this work, a rectangular microstrip UWB patch design is proposed. This antenna is mainly composed of a radiation patch with good radiation performance in the UWB range of 3.1 to 10.6 GHz. Further the design is optimized for enhancing the operating bandwidth within the UWB range.

2. Design Model

The antenna is optimized for ultra wide band. The substrate material used for the design is FR4_epoxy with relative permittivity of 4.4. The effective dielectric constant of substrate is calculated as 3.783.The height of substrate is 0.1588 cm. The basis of radiation is the metal patch and the optimization in targeted centre frequency range is achieved by varying the length and width of the patch. The length of patch is 1.03038 cm. The width of patch is 1.304 cm. The ground plane has length and width of 1.17294cm and 1.034cm respectively. The patch and ground plane have height .001cm. The width and

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length of the CPW feed line are fixed at 1.0mm and 0.07128 cm respectively. Excitation is done using the wave port of 50 ohms impedance and height five times the height of the substrate and width three times the microstrip feed which amounts to (.794cm × 0.3cm). Using these specifications the simulations are performed. In the improved designs proposed the basic dimensions are kept the same and some subtractions in the metal patch are done to create radiating slots which results in enhanced bandwidth.

A general electromagnetic solver is used to numerically investigate and optimize the proposed antenna configuration. The return loss graph and the radiation pattern for each design are plotted using a discrete frequency sweep throughout UWB with a step size of 0.1 GHz.

3. Results and Discussion

Figure 1 shows the rectangular antenna design with dimensions as specified in the previous section. Figure 3 shows return loss graph for this design. The centre frequency is achieved at 6.4 GHz and the return loss achieved at this point is -29.1db. For $S_{11} \le 10db$, the bandwidth achieved is around 1.3GHZ (5.8 to 7.1GHz). A fractional bandwidth of 20.31% is achieved.

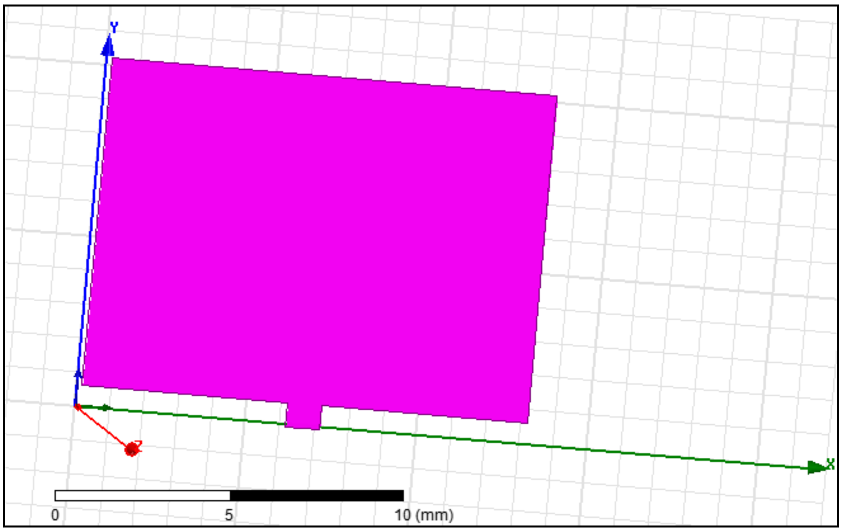

Figure 1

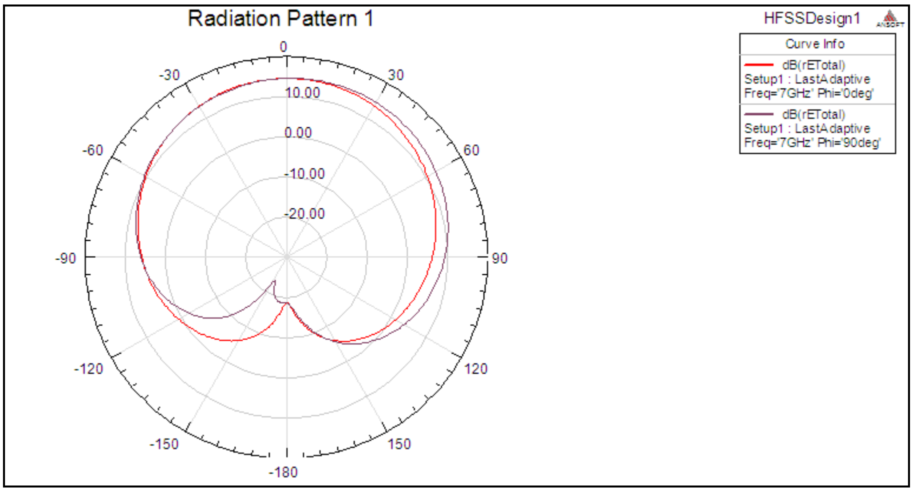

Figure 2

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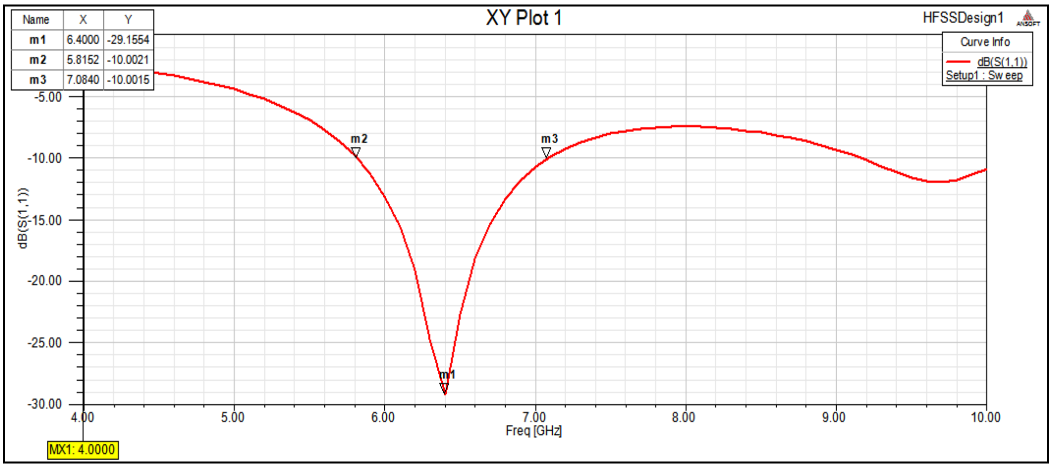

Figure 3

For enhancing the operating bandwidth and fractional bandwidth another design as shown in Figure 4 is proposed. In this design, four equidistant strips are added in one half of the antenna. For $S_{11} \leq 10db$, the bandwidth achieved is 4.3GHz (6.3 to 10.6GHz) as shown in Fig. 6. Operating bandwidth is increased from 1.3 GHz to 4.3 GHz. The fractional bandwidth achieved is 50.8%. This design covers more than half of the entire UWB range. Both the proposed designs have a directive radiation pattern as shown in Figure 2 and Figure 5. This pattern is suitable for application in most wireless communication equipments.

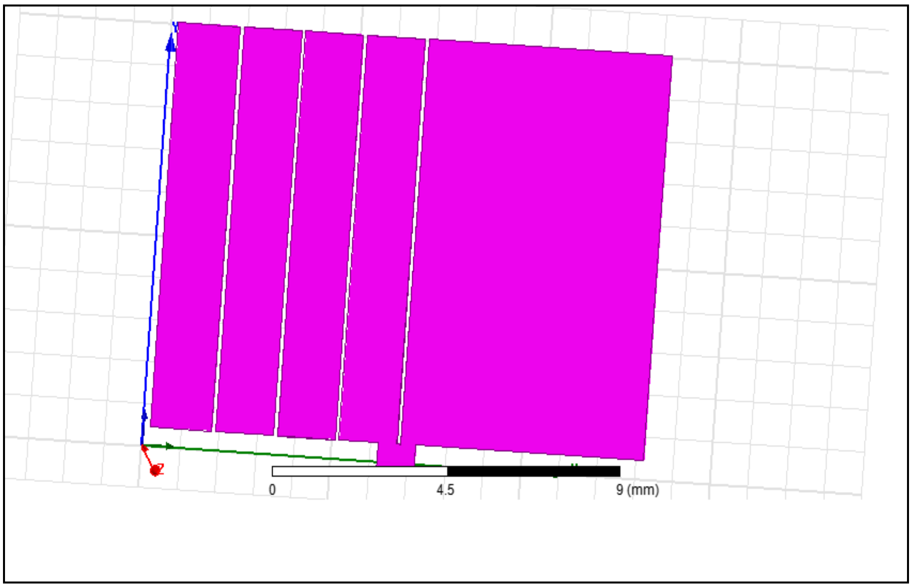

Figure 4

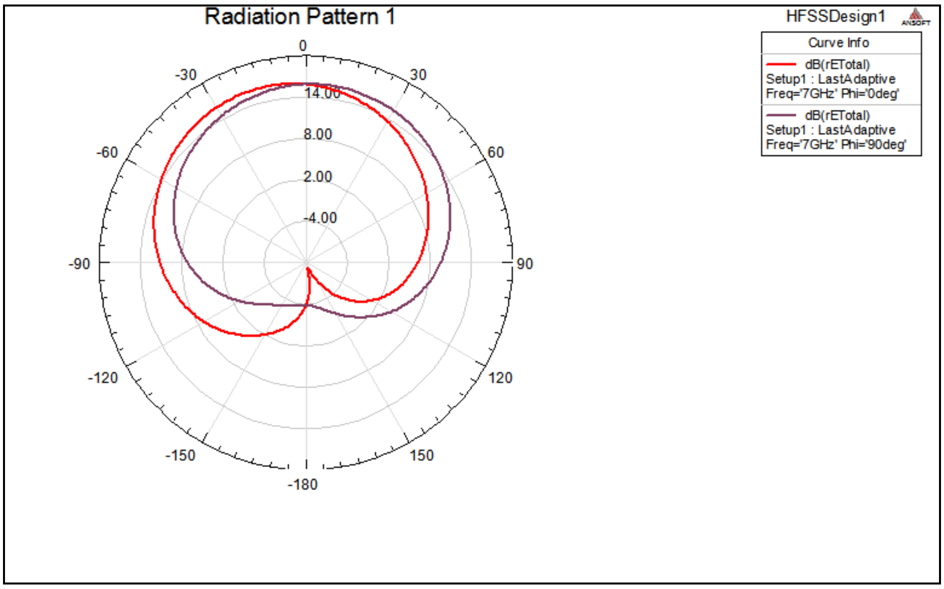

Figure 5

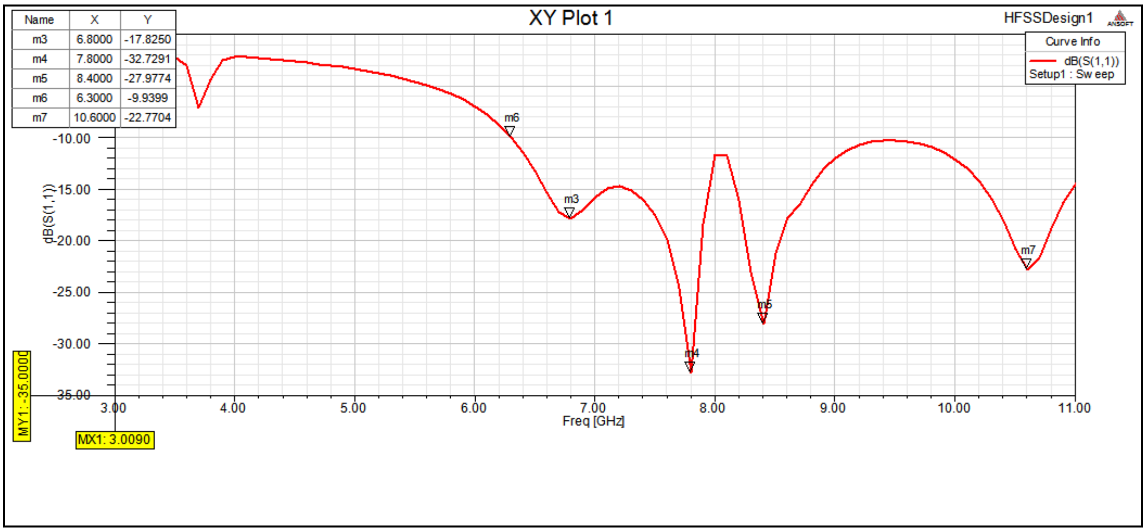

Figure 6

4. 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 1.3 GHz to 4.3GHz. 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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