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Gain Enhancement in Ultra-Wideband Antenna Using Frequency Selective Surfaces

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Abstract— In this paper, an ultra wide band (UWB) antenna is proposed for wireless applications. The antenna under investigation is fed by a 50 ohm microstrip line. The basic shape of the frequency selective surface reflector and monopole is presented in paper. A significant enhancement in the gain has been achieved in a low profile and compactness of UWB antenna with good impedance matching. The gain of antenna has been increased 1.54dB to 3.92dB as a consequence of the use of frequency selective surface reflector. The proposed antenna is studied thoroughly and presented in the paper.

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Keywords— Ultra wide band Antenna, microstrip feed line, frequency selective surface, wide bandwidth, gain, bandwidth, Returnloss.

INTRODUCTION

Federal Communication Commission in 2002 allocated 3.1-10.6 GHz frequency range as the UWB frequency band. UWB technology provides significant potential in short and long-range communication which is mainly employed for home or business thereby enabling high data rates and flexible equipment mobility. Wider bandwidth and smaller dimension rather than conventional antenna parameters has been used in such antenna for telecommunication systems. This concept has gained tremendous impetus in radar based systems like GPS, security based networks, automotive collision avoidance. The FCC allocated an absolute bandwidth up to 7.5 GHz which is about 110% fractional bandwidth of the center frequency and the large bandwidth spectrum is available for high data rate communications as well as radar and safety applications to operate. The UWB technology has another advantage from the power consumption point of view and due to spreading the energy of the UWB signals over a large frequency band [1-2]. Frequency-selective surfaces (FSS) and partial reflecting surfaces have been integrated with printed antennas to enhance the performance of the antenna over a narrow or a broad band. An FSS has also been used as a backing reflector in order to extend the useable frequency range [3].

In this paper, an ultra wide band antenna is proposed for wideband applications. The main aim of this investigation is to enhancement of gain of the antenna which has wide bandwidth. The designed antenna is operating in the UWB range as is assigned by FCC. The entire antenna designs as well as simulations are performed in HFSS 2014.

THE BASIC CONCEPT

A circular monopole antenna is designed using with a radius of r and Wf is the width of the feed and Lf is the length of the feed. The dielectric substrate has a height of 1.6mm and a relative permittivity is FR4 of 4.4. The antenna is fed by a 50 ohm microstrip feed line.

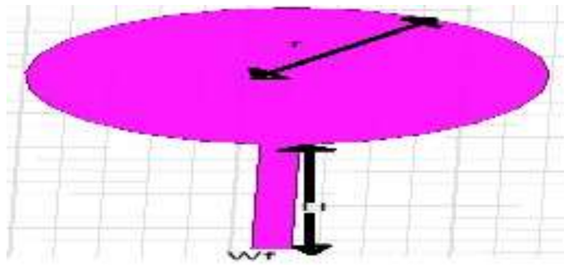

Fig. 1 Circular disc monopole antenna

A. BASIC FREQUENCY SELECTIVE SURFACES

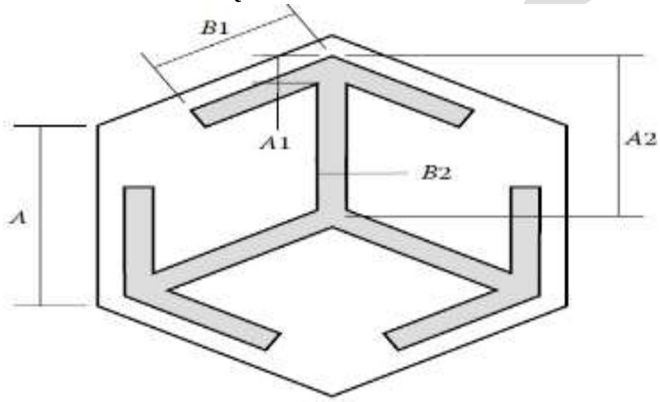

Fig. 2 Unit-cell of frequency selective surfaces [4]

DESIGN OF THE PROPOSED ANTENNA

Fig.1 depicts the circular monopole antenna designing for ultra wide band application with radius r is 10.5mm and width of feed is 2.2mm, length of feed is 13.6mm.the dimension of the 50 ohm microstrip feed line is taken as 35 x 35 mm^2 and height of substrate is 1.6mm, permittivity is 4.4 shown in Fig.3.Fig.4 shows a thin sheet of length 13mm is used as ground. The dimension of the 50 ohm microstrip feed line is taken as 13.6 x 2.2 mm^2.In order to achieve high gain using a tri-pole frequency selective surfaces reflector shows a Fig. 2 as an unit cell of fss and Fig. 5 shows a whole structure of frequency selective surface 6 x 6 with dimension of unit cell is 5 x5 mm^2 and width is 0.5mm, permittivity of reflector is 2.2 [4]. Fig. 3 shows the detailed design of the antenna in HFSS 2014. Fig. 4 shows the back side of the antenna having half ground.

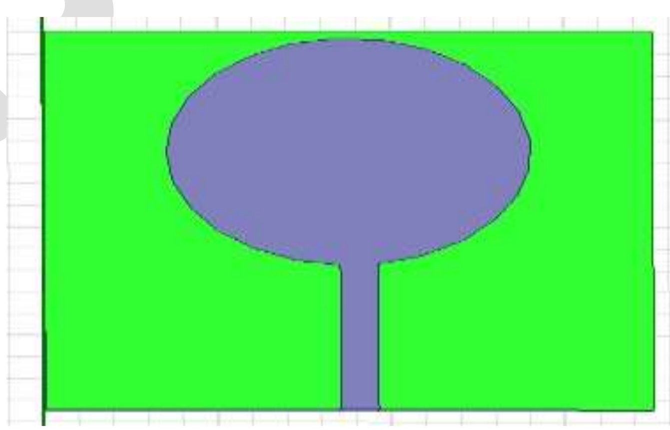

Fig. 3 Front View of the proposed antenna

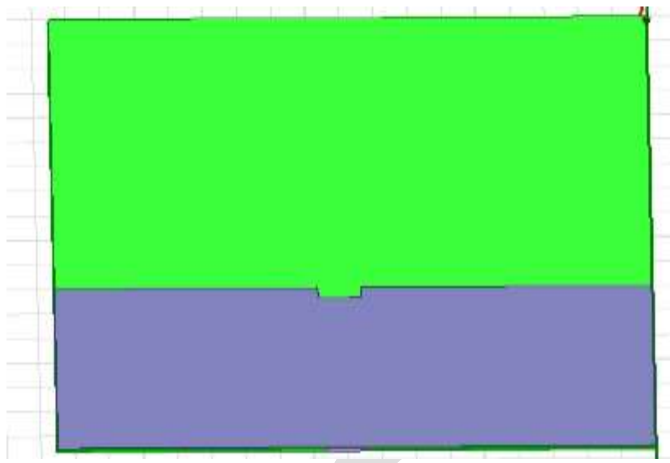

Fig. 4 Back side view of the proposed antenna

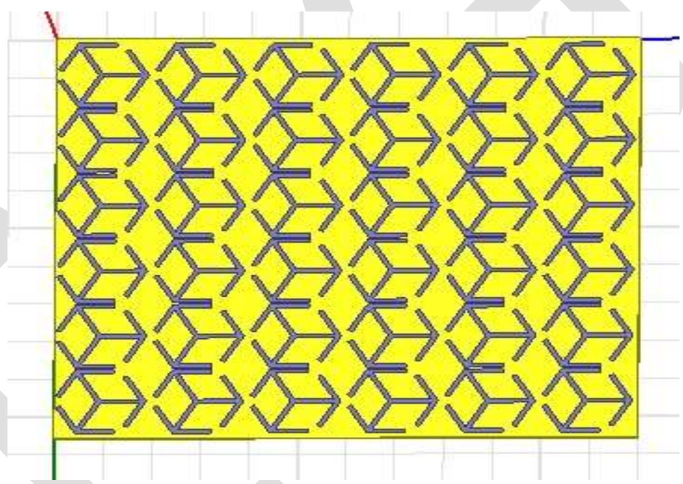

Fig. 5 Tri-pole frequency selective surface structures 6x6

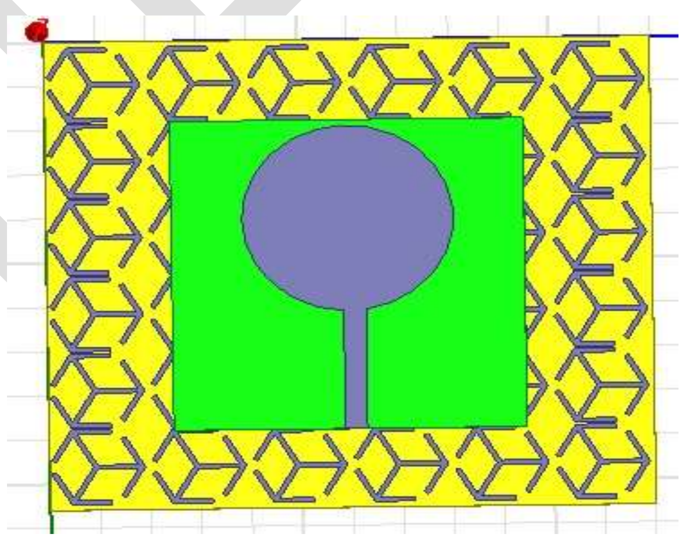

Fig. 6 Tri-pole frequency selective surfaces with UWB

Antenna

SIMULATION RESULTS

Fig. 7 shows the return loss vs. frequency plot of the proposed antenna. It can be seen from the graph that the antenna resonates at 3.15GHz,3.75GHz, 6.1GHz,7GHz,10.25 and 11.75 GHz having return loss of -10.094dB, -29.14dB, -23.57dB, -27.87dB, -28.65dB and -10.16 dB respectively.

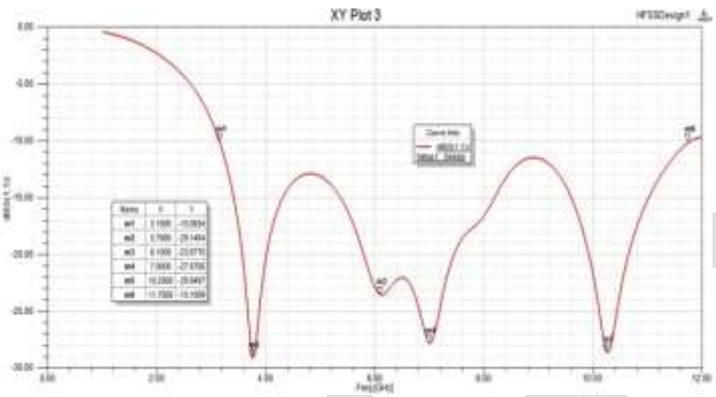

Fig. 7 Return Loss of the proposed antenna

Fig. 8 shows the radiation pattern of the antenna at 3.15 GHz is 1.54dB gain respectively. Radiation patterns are obtained by

Varying theta (θ) and phi (φ) angles. Here, only θ values are varied but φ remains constant to zero value.

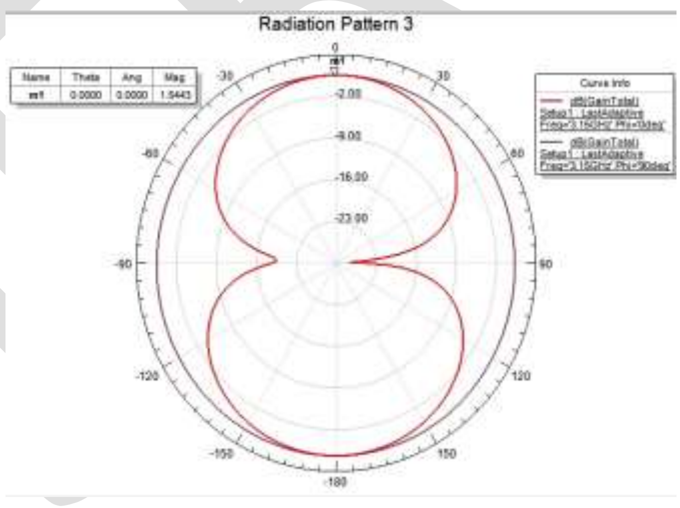

Fig. 8 Radiation pattern of the antenna at 3.15 GHz

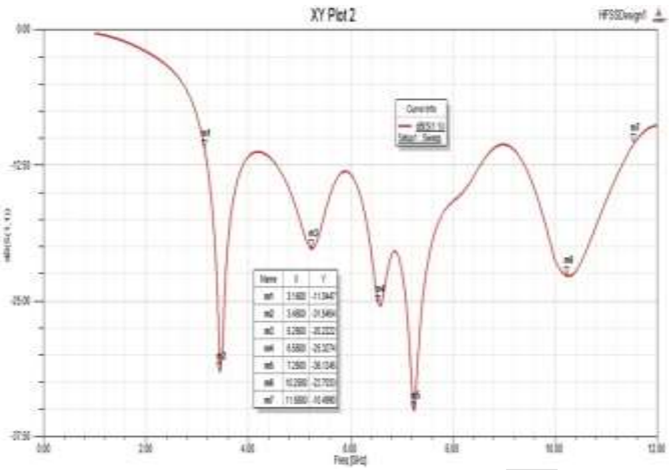

Fig. 9 Return Loss of the proposed antenna using Tri-pole frequency selective surfaces

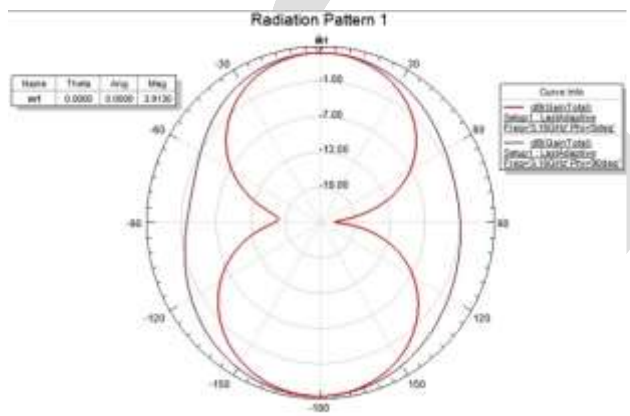

Fig.10 Radiation pattern of the antenna at 3.15GHz using Tri-pole frequency selective surface reflector

Fig. 10 shows the radiation pattern of the antenna at 3.15 GHz is 3.92dB gain using as a frequency surface reflector. Radiation

Pattern is obtained by varying theta (θ) and phi (φ) angles. Here, only θ values are varied but φ remains constant to zero value.

CONCLUSION

The proposed antenna has resonated in multiple frequency bands between 3.15GHz to 11.75GHz and showed wide bandwidth in their respective bands. From above results, it is concluded that UWB antenna using frequency selective surfaces gives better gain, radiation characteristics and vswr. Frequency selective surfaces are used to increase the gain of antenna and maintain the compactness of proposed antenna. So, the proposed design has shown compactness and can be incorporated for short and long range communication systems.

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