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Design Rectangular Microstrip Patch Antenna for IEEE 802.15.3a (WPAN) with MB-OFDM Ultra Wide Band Communication System

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Abstract**—** A rectangular microstrip patch antenna was designed on three layer substrate for ultra wide band (UWB) wireless communications system. The proposed UWB antenna simply consists of a rectangular patch with microstrip line feeding and on three layer substrate. Where used substrate permittivity is 2.2, 2.33 and 4.4, that is placed on the ground plane. The proposed rectangular microstrip patch antenna was simulated which covers the range of 6.9 to 8.7 GHz. Here study the graph of return loss, input impedance, 2D radiation pattern and 3D radiation pattern.

Index Terms**—** Ultra wide band (UWB) MB-OFDM and microstrip patch antenna.

INTRODUCTION

The antenna is a vital part of any wireless communication system. It is used for coupling between the guided medium and free-space. For wireless communication system highly used microstrip patch antenna because this antenna has following advantages like small size, light weight, low cost low power consumption. But a major drawback of this antenna is the narrow bandwidth. The many methods to used increasing this bandwidth, like changing feeding technique, increasing substrate height, changing the substrate permittivity, multi layer substrate and changing the patch shaped [1]. Here the antenna substrate divided three layers and each layer having different permittivity. Then get wide bandwidth microstrip patch antenna that is used for IEEE 802.15.3a (WPAN), MB-OFDM UWB communication system.

UWB is a very important technology for future short-range wireless communications. This UWB communication has some advantages, its gives high data rates and immunity to multipath interference. Also this system design very simple, low cost and low power consumption. Because here used very short-duration baseband pulse which is able to propagate without modulation. So here dose not required up converter, down converter and amplifier.

UWB was approved by the Federal Communications Commission (FCC) in March 2002 on the allocation of a 3.1–10.6 GHz spectrum for unlicensed use of UWB devices [2].

A more recent approach to UWB is a multiband system where the total UWB spectrum from 3.1 GHz to 10.6 GHz total 7.5 GHz divided into several smaller bands. Each of these bands has a bandwidth greater than 500MHz, to comply with the FCC definition of UWB.

In 2004, Batra *et al.* from Texas Instrument proposed the MB-OFDM scheme for IEEE802.15.3a [3], [4]. The proposed scheme divides the available UWB spectrum into 14 non-overlapping subbands of 528 MHz bandwidth for each channel. Here the first four band groups have three subbands each, and the last band group has two subbands as shown in Figure 1. The advantage of the grouping is that the transmitter and receiver can process a smaller bandwidth signal while taking advantages from frequency hopping. Here the combination of three subbands 8, 9 and 10 make additional band group 6. So for IEEE 802.15.3a (WPAN) with MB-OFDM ultra wide band communication system required designed antenna having bandwidth more than 1.5 GHz.

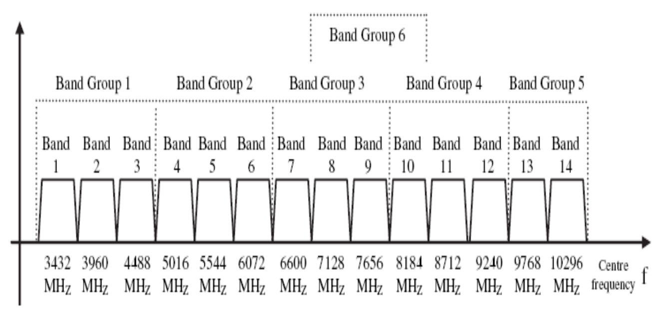
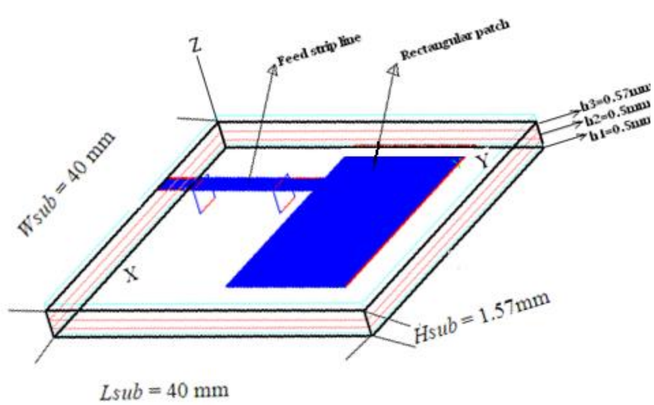


Figure 1: Division of the UWB spectrum from 3.1 to 10.6 GHz into band groups containing subbands of 528 MHz in MB-OFDM systems [5].

ANTENNA SPECIFICATION

The proposed geometry of the rectangular microstrip patch antenna is shown in Figure 2. This is consists by a rectangular patch with finite-size ground plane. The rectangular patch is situated top of the substrate and the ground plane is situated bottom of the substrate. The antenna has the following parameters length of substrate L_{sub} = 40 mm, width of substrate W_{sub} = 40mm, height of substrate H_{sub}= 1.57mm, length of patch L_p =15mm, width of patch W_p= 30mm, and height of patch H_p = 0.5mm. Where is used Microstrip line feeding technique. The feed strip length is L_f = 20mm, feed strip width is W_f =2.5mm and feed strip height is H_f = 0.5mm.

Special future is where we divided total substrate height H_{sub} = 1.57mm in to three parts h_1=0.5mm, h_2=0.5mm and h_3=0.57mm respectively. The permittivity of those three substrates is 2.2, 2.33 and 4.4 correspondingly.



(Scale size taken X=1 Y=1 and Z=2)

Figure 2: Geometry of the proposed antenna.

RESULTS AND DISCUSSION

The proposed antenna was analyzed and optimized with the help of Conformal Finite Difference Time Domain Maxwell's Equations Solver (CFDTD) software. The simulation results of the return loss (in dB) for this proposed antenna are shown in figure 3. It is indicates that the proposed antenna cover 6.9 to 8.7 GHz, that is some portion of UWB. Here the maximum return loss is found -20dB at 7.8 GHz. The bandwidth obtained from this graph is 1.8 GHz. Here are obtained the lower cutoff frequency 6.9 GHz, upper cutoff frequency 8.7 GHz and the efficiency 23%.

This proposed antenna can cover additional band group 6 or subbands 8, 9 and 10 are shown in figure 1

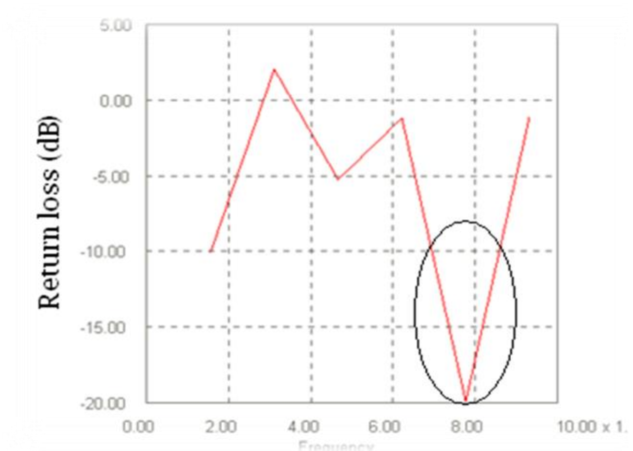


Figure 3: Graph of return loss for the proposed antenna.

The frequency verses input impedance graph is shown in the figure 4. Here we are obtained input impedance around 50Ω in the operating area.

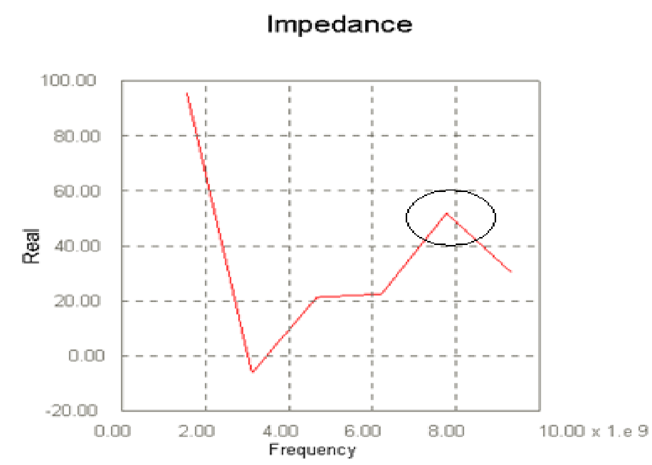
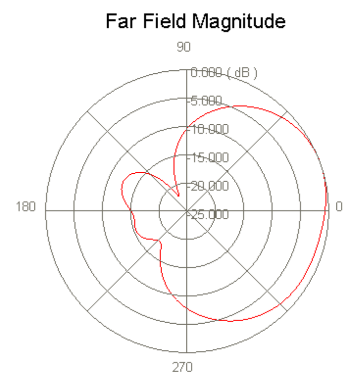


Figure 4: Graph of input impedance for proposed antenna.

The radiation patterns of the proposed antenna are also investigated. The 2D radiation patterns of proposed antenna for five different frequencies are shown in the figure 5. This figure shows that the simulated total field radiation patterns at 7GHz, 7.5GHz, 8GHz, 8.5GHz and 9GHz. The proposed antenna is characterized by a quasi-omnidirectional pattern in the combination of E-plane and H-plane. It can be seen that the excellent wide band radiation patterns are observed.



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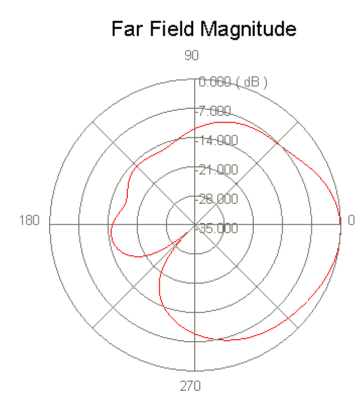

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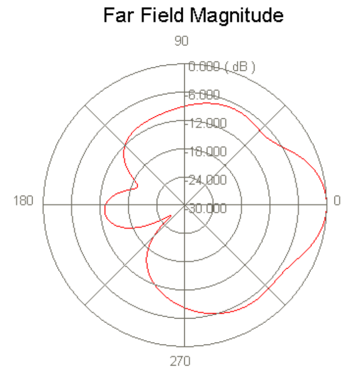

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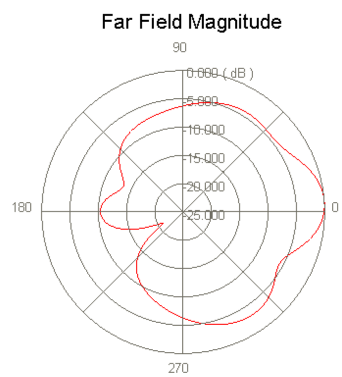

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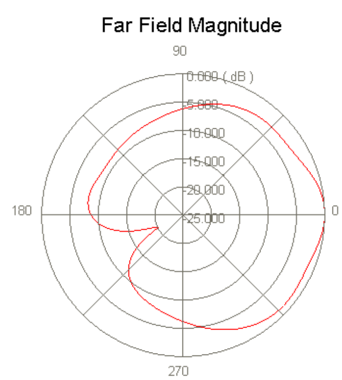
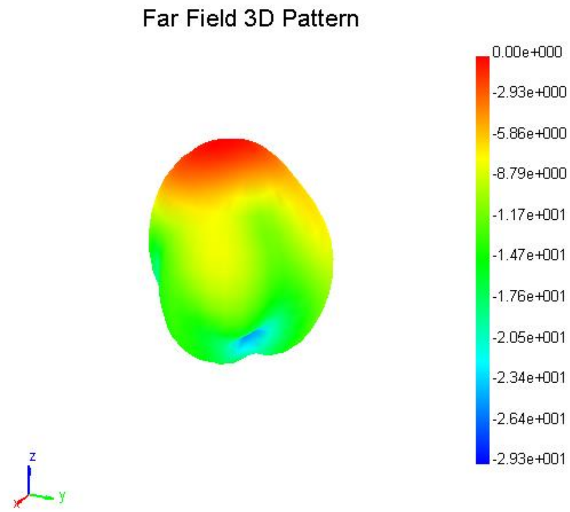


(e)

Figure 5: Shows 2D radiation pattern of the proposed antenna at (a) 7GHz (b) 7.5GHz (c) 8GHz (d) 8.5GHz (e) 9GHz.

The Figure 6 shows the 3D radiation pattern for the 7GHz, 7.5GHz, 8GHz, 8.5GHz and 9GHz frequencies. These patterns present the relationship between the co-polarization that is desired component and cross-polarization that is undesired component. Moreover it gives a clear picture as to the nature of polarization of the fields propagating through the UWB microstrip patch antenna.



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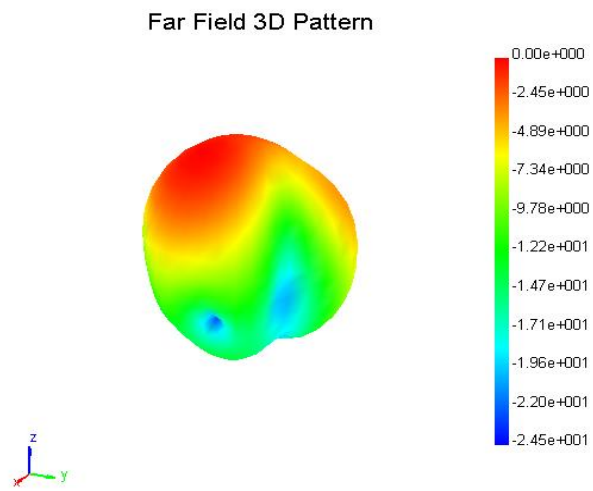

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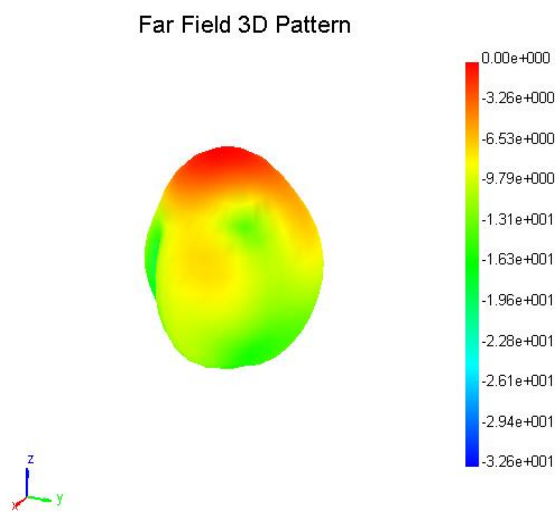

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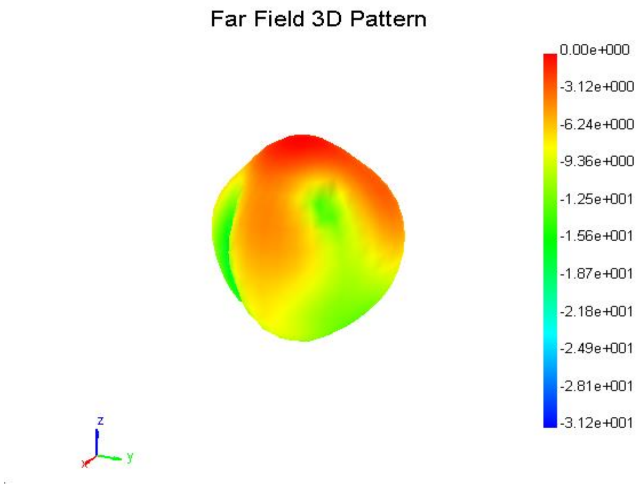

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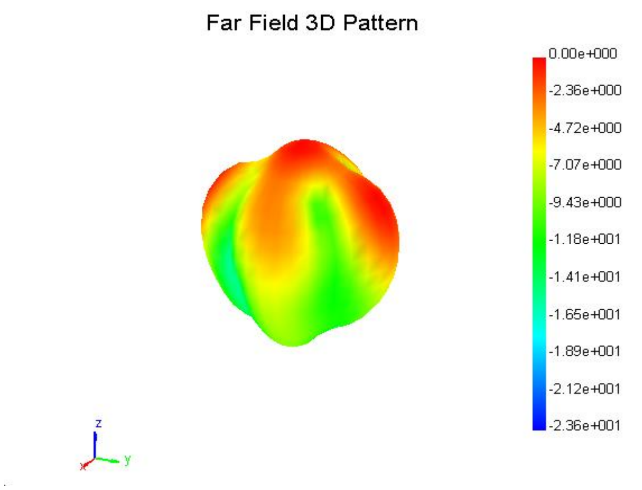

(e)

Figure 6: Shows 3D radiation pattern of the proposed antenna at (a) 7GHz (b) 7.5GHz (c) 8GHz (d) 8.5GHz (e) 9GHz.

Conclusion

In this paper gives the concept of designed UWB rectangular microstrip patch antenna using three layers substrate and each layers having different permittivity. Various parameters of this antenna designed are optimized and the optimized design is prototyped. The various simulation results like return loss characteristics, input impedance, 2D radiation pattern and 3D radiation pattern of the proposed antenna are indicate that this antenna suitable for IEEE 802.15.3a (WPAN), MB-OFDM UWB communication system. This simulation results also be help full for next generation indoor wireless communication and remote sensing systems designed.

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